Public Interaction Framework for Dynamic Digital Displays

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ABSTRACT

The purpose of our program of research is to study dynamic digital displays (DDDs) "in the wild" to generate new ideas that will assist in transforming non-interactive DDDs into interactive ones in the built environment. In preparation for a series of empirical studies to be conducted on a permanent infrastructure of eight outdoor media façades embedded within an area of one square-kilometer in downtown Montréal, Québec, this paper presents the comprehensive literature survey carried out during the preliminary phase of our research; explains our proposed three-pronged methodological approach; and briefly describes our environment of study set in a real public setting. Using an ecological approach that draws on design ethnography and Fischer's concept of *cultures of participation*, we have conceived a *public interaction framework* intended as a tool to study actors and their actions with public display technology in shared spaces. We solicit feedback that could inform our future works.

Keywords

Interactive dynamic digital displays; ecological approach; design ethnography; cultures of participation; public space technology.

1. INTRODUCTION

Ten years ago, O'Hara et al. remarked that digital displays were slowly replacing non-digital ones in public space [16]. They predicted that the promising affordances of this technological platform would further accelerate this trend in the future. Their forecast has since come true. This paradigm change has given rise to new sets of research questions and approaches related to emerging forms of *public interaction* with digital media displays.

Media façades and large LED, LCD and plasma screens are examples of displays that are becoming ubiquitous in urban environments. They can be *static*, functioning as digital media placards with still, unchanging content (text or images) as we see with electronic signage on roadsides, contextual maps inside buildings or certain advertising billboards. They can also be *dynamic* when displays showcase videos, automatically cycle through animated text or content is programmed to change periodically as is the case when arrivals and departures are regularly updated screens in transportation terminals.

Whether they are static or dynamic, or whether they are used to publicize contextual information or broadcast news on subway platforms, the majority of digital public displays currently remain non-interactive; They are mostly used to deliver information. Yet the past decade has seen HCI research labs design a number of interactive digital displays. Often deployed in controlled private or semi-public settings, their designs are rarely grounded in a thorough analysis of how they might be used in real public space.

Our lab is concerned with studying and developing the interactive potential of these screens in their natural settings. Architectural scale dynamic digital displays (DDDs) constitute our object of study because, on the one hand, we are interested in screens large enough to be used for public interaction, and on the other hand, research has shown that they attract and retain attention more than static displays [12]. The increasing ubiquitous presence of DDDs in the very fabric of the city is changing the way we experience urban space. With the rise of pervasive computing and mobile HCI, it is just a matter of time before personal computing devices are routinely networked to DDDs to enhance the blending of physical and virtual worlds as we are currently seeing in the field of augmented reality (AR). Accordingly, our program of research asks, "What forms does public interaction take with interactive DDDs in urban environments?" Possible stakeholders in this question include the general public, the local (situated) community, the government, corporations and advertising firms.

Over the next few years, we will conduct a number of empirical studies on existing DDDs within a permanent infrastructure of eight outdoor media façades in downtown Montréal, Québec. This will allow us to iteratively conceptualize and operationalize a *public interaction framework* that could serve as a roadmap for researchers seeking to harvest the vast potential of public display technology in shared spaces. Our long-term objective is to tease out design principles and policy recommendations that could assist in transforming non-interactive DDDs into interactive ones.

This paper is divided into three sections. First, we present an overview of related works concerned with digital displays in HCI and compare each of these to our research. Second, we describe our methodology and articulate it with the operational concepts that have emerged during our preliminary observations. Third, we describe the research space we have chosen for our field work.

2. RELATED WORK

Although the study of interactive digital displays began in the late 80s and early 90s [19][24], most of the HCI research focusing on this platform spans over the last decade. In this section, we present a broad taxonomy of works by genre and function followed by a discussion of some of the major works that use an ecological approach to study the aesthetics of interactive DDDs.

2.1 Genre

In HCI, design principles and prototypes are often informed by the affordances of non-digital artifacts and their metaphors. For instance, interactive digital displays have been adapted to take the form of personal/group information management tools [21], interactive horizontal tabletops [11], interactive electronic walls [10], rooms augmented with multiple horizontal and vertical intelligent surfaces [25], electronic whiteboards [30], as well as digital poster boards and bulletin boards [4]. Our survey of display prototypes by genre has revealed that DDDs "in the wild" come in many different forms — for instance, when they are built into tables for cafés. This is noteworthy because we are interested in studying large DDDs that lend themselves to public interaction.

2.2 Function

Because early research on displays was driven by the field of computer-supported collaborative work (CSCW), it was largely concerned with developing tools to support collaborative and independent work practices in office environments. In the last decade however, this ever-growing body of research has come to include the study of interactive displays for educational purposes [1], to support the exchange of information in healthcare environments [30], to optimize communication between scientists and engineers [21], to augment social space at professional gatherings [5], and to enhance the experience of public transport [8]. More recently, research on this platform has extended its reach into public space. While many labs have chosen to study the social interactive potential of the platform by using gaming software [17], artists and media researchers have also experimented with using it in the context of public sphere theory, that is, to engage civic participation on social and political issues [27]. A small number of HCI researchers have built software on large digital displays to encourage civic participation [22] or to develop the potential of community space [15]. The literature review we have conducted on the function of digital displays has been instructive in our study of DDDs in public space because, on the one hand, it helps us to understand what interactive DDDs can be used for, and on the other hand, it suggests that displays are increasingly used as community platforms in the public realm.

2.3 Aesthetics

With the exception of Huang [12], we have found no evidence of studies that investigate the aesthetics of DDDs "in the wild" using an ecological approach that includes an analysis of public space. In the past decade, a few researchers have proposed conceptual frameworks that loosely draw on an ecological approach within a controlled research setting; They either largely focus on understanding and facilitating social interaction through displays [4][5][15] or place more emphasis on spatial factors [2][3][29].

In 2003, Mankoff et al. published a *set of heuristics* that could be used to evaluate the effectiveness of peripheral and ambient displays [14]. These included aesthetic considerations such as "peripherality of display", "aesthetic and pleasing design", "easy transition to more in-depth information" and "consistent and intuitive mapping" applied either to the display or to its interface. The only heuristic that took into account the display within its setting was "match between design of ambient display and environments", but it was left out of the final seven heuristics derived from the survey. Consequently, these heuristics provided guidance for aesthetic principles and frameworks to come, but showed no concern for contextual location or architectural setting.

Conversely, the *proxemics interaction framework* developed by Ballendat, Marquardt and Greenberg is articulated on an ecological approach that explores the complex interplay between people, devices and non-digital objects [2]. While studies around the proxemics interaction framework have largely been device-driven and concerned with the engineering of location awareness, our research intends to provide an understanding of the aesthetics of public interaction with DDDs in the built environment.

In their study of how users interact with large interactive public displays, Brignull and Rogers identified three distinct "activity spaces" hinging on the user's orientation with, and distance from, the display [3]. Their *spatial interaction flow model* provides a framework from which interaction guidelines can be drawn. HCI practitioners have used it, for instance, to design systems that support transitions between its three thresholds [27]. Although their work successfully bridges social and spatial factors and suggests the usefulness of an ecological approach in the study of digital displays, it ignores urban space altogether.

In their longitudinal study of 46 large ambient displays, Huang et al.'s reported observations made "in the wild" on people's awareness of large displays located in a variety of semi-public and public settings [12]. They used field notes and still photographs to describe the display as artifacts and how people act around them. Loosely related to aesthetics, their final recommendations are design strategies intended to attract, maximize and maintain people's attention. Focusing mainly on *awareness of*, and *attention to* displays, their study does not measure participation.

3. METHODOLOGY

Rather than place the emphasis on heuristics, proxemics, social interaction, spatial configuration or awareness factors, our research proposes to tailor a holistic approach to study DDDs in terms of actors and actions in public space, which we broadly define as any publicly accessible area or as Goffman wrote of "public places", as "any region in a community freely accessible to members of that community" [9]. Our framework rests on three methodological pillars. The first is the ecological framework used in HCI. The second is design ethnography which has been one of the standards in HCI design research for over a decade. The third builds on Fischer's concept of *cultures of participation*.

3.1 Ecological Approach

Considering our exploration is concerned with the aesthetics of DDDs, we argue that this platform is best understood as an environment, rather than, as Dourish has outlined, a space, place or locale primarily created by, and through social interaction [6]. As a result, the ecological approach commonly used in HCI constitutes the first pillar of our framework.

With its roots in Gibson's Ecological Psychology, this approach has mostly been used to understand "how people interact with artifacts" by means of two of his conceptual tools: *ecological constraints* and *affordances* [20]. We have chosen not to use these two concepts because the way they are currently applied offers too narrow a reading of Gibson's theory which limits interaction to what has been designed, not what a medium could allow for [13]. For instance, it would not account for the fact that possibilities for interactions and new phenomena may emerge holistically from the ecology itself, a critical concern in the context of public space.

In our investigation of DDDs, the focus is placed on observations of actors and their actions with DDDs situated in public space. We purport that applying the ecological approach in true Gibsonian

terms provides us with a more nuanced tool to describe the multiple relationships between the observer and the competing elements that compose an architectural scale media environment, namely people, technology, artifacts, buildings, empty spaces, changing atmospheric conditions and of course, bodies in motion.

3.2 Design ethnography

Accordingly, the second methodological pillar of our framework is design ethnography, also known as applied ethnography [6]. It is an inductive research method that consists in making field observations "in the wild" to learn more about how people socially interact through, and with, cultural artifacts [23]. Given that it can be used to understand a particular environment or domain of people for the purposes of designing new technology products, it is particularly well-suited to our current research.

In addition, there have been few instances in which design ethnography has been used to study DDDs in naturalistic environments. Our review of the extant literature clearly demonstrated that prototypes tend to be designed, deployed and studied within the controlled conditions of research labs or academic environments rather than in semi-public or public space.

Our objective is to gather data in non-controlled environments to conceive theory and design principles that can be generalized to a wide variety of DDDs. For the type of exploratory research we are conducting, labs or academic environments would have provided limited findings. More varied and nuanced data can be obtained from the field study of DDDs in public space. Thus, design ethnography gives us the flexibility to make descriptive inference.

In the field, raw data will be collected in the form of detailed field notes, digital photographs and possibly some digital video. Like Huang et al., we will use the "micro-shadowing" technique to observe how people behave around DDDs, and whether or not they are drawn to them [12]. Finally, we intend to conduct semi-structured interviews by asking open-ended questions to about one to two dozen people actively interacting with a DDD for more than a few minutes. Using the snowball sampling technique, we will take this opportunity to recruit a few participants for more in-depth interviewing on their perceptions of a specific media façade event to obtain qualitative data that will help us better understand how people experience and interact with DDDs in public space.

3.3 Cultures of Participation

Finally, our public interaction framework draws from Fischer's concept of cultures of participation defined in these terms:

> The rise in social computing (based on social production and mass collaboration) has facilitated a shift from consumer cultures (specialized in producing finished artifacts to be consumed passively) to cultures of participation (in which all people are provided with the means to participate). [7]

Fischer proposes his concept be applied to domains as various as software development, education, healthcare and urban planning, indeed in any sociotechnical environment where people have the possibility of becoming active contributors. His framework has many affinities with the Web 1.0 vs. Web 2.0 metaphor. As outlined by Warschauer and Grimes, the key distinction between Web 1.0 and Web 2.0 is the level of participation: the former entails *publication*, while the latter emphasizes *participation* [29]. In essence, Web 1.0 and Web 2.0 describe two different models of online communication. The former is essentially limited to the consumption of content that is delivered to the users. O'Reilly

calls the latter model an *architecture of participation*, enabling the authorship and design of content through interactivity [18].

Similarly, Fischer opposes consumer cultures to cultures of participation. We suggest that these terms be construed as two distinct modes of communication framing a wide spectrum of practices existing on a continuum. Drawing on Fischer's schematic diagram illustrating the different roles actors can play in ecologies of participation, we have prepared Table 1 to show how actors and their actions are operationalized into *levels of participation* which we are measured as part of our framework.

Table 1. Operational concepts of the public interaction framework derived from Fischer's ecologies of participation.

LEVEL	ROLE	ACTION
level 7	meta-designer	one who designs environments that can be modified by others
level 6	designer	one who organizes content
level 5	collaborator	one who communicates with others
level 4	content contributor	one who uploads content
level 3	active observer	one who actively searches for content
level 2	engaged observer	one who consumes content
level 1	unengaged observer	one who observes from afar
level 0	uninvolved actor	one inattentive or unaware of displays

The following section is intended to further ground our discussion by offering a brief description of the DDD network in Montréal, Québec, where our field studies will be conducted "in the wild".

4. RESEARCH SPACE

Figure 1 shows a red-colored map that marks an area of one square-kilometer in the downtown core of Montréal, Québec. The white boxes represent different buildings simultaneously used as digital media façades at night for different public art projects.

Figure 1 - Bird's eye view of eight architectural scale digital displays located within a perimeter of 1 square-kilometer.

In the years to come, we propose to use our public interaction framework to conduct empirical studies around these media façades with the aim of generating theory and design principles.

5. CONCLUSION

The public interaction framework presented in this paper remains purely theoretical as we are still in the preliminary stages of our research. It will need to be applied to empirical studies, critically worked through and refined through iterations. We have presented this paper to solicit feedback from the community before we do

this as it is difficult to predict whether it will prove to be a useful tool in measuring public interaction with DDDs in urban space.

6. ACKNOWLEDGMENTS

7. REFERENCES

[1] AlAgha, I., Hatch, A., Ma, L. and Burd. L. 2010. Towards a teacher-centric approach for multi-touch surfaces in classrooms. In *Proc. ITS '10*, ACM, NY, NY, 187-196.

[2] Ballendat, T., Marquardt, N. and Greenberg, S. 2010. Proxemic interaction: designing for a proximity and orientation-aware environment. In *Proc. ITS '10*, ACM, New York, NY, 121-130.

[3] Brignull, H. and Rogers, Y. 2003. Enticing people to interact with large public displays in public spaces. In *Proc. of Human-Computer Interaction*, *INTERACT'03*, M. Rauterberg et al., Eds. IOS Press, IFIP, 17-24.

[4] Churchill, E.F., Nelson, L. and Denoue, L. 2003. Multimedia fliers: informal information sharing with digital community bulletin boards. In *Proc. C&T '03*, Kluwer, 97-117.

[5] Churchill, E.F. and Nelson, L.D. 2006. From media spaces to emplaced media: digital poster boards and community connectedness. *Media Spaces Workshop CSCW'06*, Banff, Canada (November 2006).

[6] Dourish, P. 2001. *Where the Action Is: The Foundations of Embodied Interaction*. MIT Press, Cambridge, MA.

[7] Fischer, G. 2011. Understanding, fostering, and supporting cultures of participation. *ACM Interactions* 18, 3 (May & June 2011), 42-53.

[8] Foth, M. and Schroeter, R. 2010. Enhancing the experience of public transport users with urban screens and mobile applications. In *Proc. MindTrek '10*, ACM, NY, NY, 33-40.

[9] Goffman, E. 1963. *Behavior in public places: notes on the social organization of gatherings*. The Free Press of Glencoe, New York, NY.

[10] Guimbretière, F., Stone, M. and Winograd, T. 2001. Fluid interaction with high-resolution wall-size displays. In *Proceedings of UIST '01*, ACM, New York, NY, 21-30.

[11] Hancock, M., ten Cate, T. and Carpendale, S. 2009. Sticky tools: full 6DOF force-based interaction for multi-touch tables. In *Proc. ITS'09*, ACM, New York, NY, 145-152.

[12] Huang, E.M., Koster, A. and Borchers, J. 2008. Overcoming assumptions and uncovering practices : When does the public really look at public displays? Unpublished paper submitted to *PERVASIVE'08*, 1-18. http://www. elainehuang.com/huang-koster-borchers-perv2008.pdf

[13] Kaptelinin, V. and Nardi, B. 2012. Affordances in HCI: toward a mediated action perspective. In *Proc. CHI'12*, ACM, New York, NY, 967-976.

[14] Mankoff, J., Dey, A. K., Hsieh, G., Kientz, J., Lederer, S. and Ames, M. 2003. Heuristic evaluations of ambient displays. In *Proc. CHI'03*, ACM, New York, NY, 169-176.

[15] McCarthy, J.F., Farnham, S.D., Patel, Y., Ahuja, S., Norman, D., Hazlewood, W.R. and Lind, J. 2009. Supporting community in third places with situated social software. In *Proc. C&T '09*, ACM, New York, NY, 225-234.

[16] O'Hara, K., Perry, M., Churchill, E.F. and Russell, D. 2003. Introduction to public and situated displays. In *Public and Situated Displays: Social and Interactional Aspects of Shared Display Technologies*, K. O'Hara, M., Perry, E.F. Churchill and D. Russell, Eds. Kluwer Academic Publishers, Norwell, MA, xvii-xxxiv.

[17] O'Hara, K., Glancy, M. and Robertshaw, S. 2008. Understanding collective play in an urban screen game. In *Proc. CSCW'08*, ACM, New York, NY, 67-76.

[18] O'Reilly, T. 2007. What is Web 2.0: design patterns and business models for the next generation of software. *Communication & Strategies* 65 (2007), 17-37.

[19] Pedersen, E.R., McCall, K., Moran, T. P., Halasz, F. G. 1993. Tivoli: an electronic whiteboard for informal group meetings. In *Proc. INTERACT'93* and *CHI'93*, ACM, New York, NY, 391-398.

[20] Rogers, Y. 2004. New theoretical approaches for human-computer interaction. *Annual Review of Information, Science and Technology 38*, (2004), 87-143.

[21] Russell, D.M., Trimble, J.P. and Dieberger, A. 2004. The use patterns of large, interactive display surfaces: case studies of media design and use for BlueBoard and MERBoard. In *Proc. HICSS 2004*, HICSS Digital Library at IEEE, 40098B.

[22] Schroeter, R. 2012. Engaging new digital locals with interactive urban screens to collaboratively improve the city. In *Proc. CSCW '12*, ACM, New York, NY, 227-236.

[23] Spradley, J. P. 1980. *Participant Observation*. Holt, Rinehart and Winston, New York, NY.

[24] Stefik, M., Foster, G., Bobrow, D.G., Kahn, K., Lanning, S. and Suchman, L. 1987. Beyond the chalkboard: computer support for collaboration and problem solving in meetings. In *Commun. ACM* 30, 1 (January 1987), 32-47.

[25] Streitz, N.A., Geißler, J., Holmer, T., Konomi, S., Müller-Tomfelde C., Reischl, W., Rexroth, P., Seitz, P. and Steinmetz, R. 1999. i-LAND: an interactive landscape for creativity and innovation. In *Proc. CHI'99*, ACM, 120-127.

[26] Struppek, M. 2006. Urban screens - the urbane potential of public screens for interaction. *Intelligent Agent* 6, 2, 1-5.

[27] Tang, A., Lanir, J., Greenberg, S., and Fels, S. 2009. Supporting transitions in work: informing large display application design by understanding whiteboard use. In *Proc. GROUP '09*, ACM, New York, NY, 149-158.

[28] Vogel, D. and Balakrishnan, R. 2004. Interactive public ambient displays: transitioning from implicit to explicit, public to personal, interaction with multiple users. In *Proc. of UIST'04*, ACM, New York, NY, 137-146.

[29] Warschauer, M. and Grimes, D. 2007. Audience, authorship, and artifact: the emergent semiotics of Web 2.0. *Annual Review of Applied Linguistics* 27, 1-23.

[30] Xiao, Y., Lasome, C., Moss, J. Mackenzie, C.F., and Faraj, S. 2001. Cognitive properties of a whiteboard: a case study in a trauma centre. In *Proc. ECSCW'01*, Kluwer Academic Publishers, 259-278.