Social Sensing and Its Display

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Abstract

This thesis proposes a public interface that functions as a social catalyst in public spaces. Like a smart mirror, it intends to reflect the social identity of the environment and increase sensibility towards the place and among others in the environment by highlighting a particular aspect of it. Here, our particular use of the medium is to raise awareness of the boundaries among the residents; highlighting their differences and similarities of mobility, displacement and geographical limits. The medium is designed as a custom, multi-modal interface, which functions as a tangible, interactive sculpture that senses ambient sound, records deliberate user input and displays interactive graphics as its output. The design explores the utility of sound and physical interaction for envisioning new social, cultural and entertainment uses of public places and help us shape our relationships with each other with new social interfaces embedded in urban settings.

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Mural depicting Battle of Bogside,
12 August-14 August 1969,
Derry, Northern Ireland.
by Bogside Artists

1 Introduction

1.1 Introduction

Bulletin boards in libraries, commercial signage on buildings, graffiti on train stations, and stickers on lamp posts attach different meanings to places and extend their intended uses. Places become pockets of memory, locations for information and skill exchange and sites of active resistance where they are almost always re-purposed according to the needs of their inhabitants. These contemporary murals in Dublin [Figure 1.1 and Figure 1.2] remind us that people not only record the events happening in their places to archive their memories, but also use their places to communicate their presences as they struggle for having the right to live in them. Places and their inhabitants live in a continuous exchange of meanings where they shape each other.

This thesis is organized with an overarching theme of 'boundaries.' We have identified four integral boundaries among places, people and media and have responded to them in different capacities in our thesis work: 1) Spatial boundaries, 2) Social boundaries, 3) Boundaries between people and public media, 4) Boundaries between architecture and public media.

1.1.1 Spatial Boundaries

Places segregate people. Different forms and levels of access to them build different social groups. We attach to "origins," feel at "home," or suffer from "rootless"ness, depending on our relationship to places [Morley 2000]. People who live behind barbed wire feel different then those who live behind manicured lawns or lofts in corporate downtowns. Different lives create different needs

Figure 1.2
Political Murals
from Northern Ireland
by Bogside Artsists

to adapt, customize and transgress spaces, as they also produce different meanings for different individuals. While people ultimately provide the meaning of a place, its structure; from the affordances of the architecture to the right to access that space, shapes people's actions, behavior and identity.

Here, we specifically look at ways to understand and capture this synergy between the inhabitants of a place and the physicality of the location via the use of a pubic interface. We try to depict how people form their relationship with a given space and how this helps them to perceive each other. The fundamental questions we ask ourselves are "How can new media contribute to the role of architecture, and extend its meaning, so that we can conceive new kinds of public media that contribute to the social, cultural and political meaning of places? And as places and people dynamically shape each other over time, what is the role of a public interface in the boundary between places and people for mediating this synergy and have a say in the social identity of places?

As places often do mean different things to different people [Tuan 1977], they often need to adapt to different needs. While it is more difficult to imagine a dynamic physical adaptation of places to their inhabitants, we argue that it is possible to design different kinds of public interfaces that can reprogram the functions and roles of public places, allowing them to become more about their inhabitants and also giving inhabitants more say in the functionality of these places.

1.1.2 Social Boundaries

People look, sound and express differently. When people from diverse origins, social classes, beliefs and language inhabit the same place, the sense of belonging attributed to a place defies geographic boundaries and brings into focus many qualities related to the identities of its inhabitants, and eventually determines the social identity of the place [Lippard 1997].

For depicting differences and similarities among people, we observe the sonic qualities in the environment especially focusing on using voices to depict differences among people. Voice signifies presence; it carries rich symbolic and personal information. It is inherently tied to language, which communicates place: where one comes from, if he/she is a native or an outsider to that place [Dollar 2006]. While on the one hand language identifies the presence of borders, both geographical and linguistic ones, and brings the regimes of control into territories, as Morley points out, it also brings a strong sense of familiarity to the place. Hearing another speak one's mother tongue, with one's own accent or the local lingo forms bonds, a sense of locality among strangers. [Morley 2000]. Marking a presence in space with a voice is almost impossible without an

interface. Here, we consider the use of a public interface not only for depicting the differences and similarities of people (via the use of sound), but also to facilitate the process of communicating the differences among others, opening new ways to catalyze the interaction among inhabitants, bringing new uses to public spaces.

1.1.3 Boundaries Between People and Public Media

People neither physically nor functionally shape media in public; they don't touch their interfaces (other than pressing buttons), they cannot move them around or augment their behavior. Like works of art in a museum, most public displays are not intended to be touched by a respectful audience. We argue that there is an implied, yet strong, boundary between media and its audience that shapes our behavior in public.

People generally access information in public either by passively looking at billboards, screens, and (more recently) media facades or using their mobile phones and other wireless devices. While architecture, since Vitrivius, has been a discourse for investigating alternative relations between the human body and the physical environment; public media, today, often does not play a key role in reconfiguring corporeal relationships. It is still mostly function and usage-driven due to the utilitarian heritage of personal media.

Architecture, on the other hand, not only responds to the literal body by taking into account the scale, proportion and aesthetics of the human form, but also considers the social and individual meanings of body in given space: exploring the relationship among people, their surroundings, the public behavior they exhibit within the environment [Indra 2003]. Today, many formerly public physical interactions are now supplemented with personal media equivalents and social behavior is strictly shaped by their use. We can't talk to strangers via public interfaces, neither to those who share the same space nor to those who live in remote locations. It is almost impossible to leave something anonymously at a space for the next passer-by; we can't express how much we liked a particular place or how much we hated it, what it meant for us or what it could have meant for us. While personal media devices offer options for mediating different kinds of social relationships in virtual public places [Featherstone 1988], physical media lags behind in facilitating social interactions in public.

We argue that there is enough motivation to design interfaces that engage both physically and conceptually with their users in public settings, not only to challenge the historical boundaries between people and media, but also to find new roles for these interfaces in fostering social public interaction. We believe that alternative designs can explore both physical uses of the interfaces in relation to the human body, and also create new interaction modalities (e.g.,

Figure 1.3
Times Square 1919

Figure 1.4
Times Square 2004

private and public modes of interfaces) in social settings that can facilitate communication between the members of the public.

1.1.4 Boundaries Between Architecture and Media

New buildings are covered with all kinds of electronic screens to augment places with information. However, while these information surfaces are often designed to respond to the physical architecture of their environments, we often don't see an integral responsibility to the social aspects of their environments.

While historically, the culture of display in architecture was deeply rooted in the history, religion, and ideology of the environment, in which altars, columns, facades and other architectural elements added a diversity of meaning to places, today it is hard to observe a similar diversity in their predecessors. Facades turn into giant billboards, becoming spectacle displays, often not going beyond commercial propaganda [Figure 1.3 and Figure 1.4]. Information is mostly mediated similar to the form of traditional screens, but larger, brighter and more invasive, tracing the geometries of buildings. Architectural media, focusing on visual elements, often conceives its role as broadcasting only, which undermines other interaction modalities such as audio, visual and physical interaction that can be used for designing engaging, interactive interfaces.

On the other hand, when spaces do interact with people, the interaction between information, architecture and the inhabitants is primarily transmitted via personal media devices (e.g., mobile phones, PDAs, PCs... etc.), mostly happening in the background, almost invisible in the physical space. While wireless technologies make it almost trivial to access online information on-site via personal media, they don't necessarily inform the design of the physical environment or contribute to its social, cultural and political uses. In the

wireless world, where ubiquitous information defies physical boundaries and claims its own "Hertzian" spatial organization [Dunne & Raby 2001], places are primarily configured as information access points for the invisible information around us; they turn into shelter, space and electricity providers for information users, and often do not function as interfaces themselves.

We argue that architectural media can exhibit a middle nature. They can be designed to function as urban-scale public displays and still be able to physically integrate in to the architecture of a place and, therefore, be less intrusive in nature. More importantly, they can exhibit a visible and symbolic nature as interactive interfaces and have a more active social role in the public other than being a wireless access point.

Given these reference points, we formulated, implemented and evaluated the following:

1) We designed and evaluated a public medium to function as a catalyst in public spaces. Our intention is to reflect the social identity of the environment and increase sensibility towards the place and among others in the environment. Here, our particular use of the medium is to raise awareness of the boundaries among the residents; highlighting their differences and similarities of mobility, displacement and geographical limits.

2) The medium is designed as a custom, multi-modal interface made of LED-based display panels, speakers, microphones and a touch-screen based GUI panel, which together functioned as a tangible, interactive sculpture. One of our main goals is to create an interface that is specifically built for its concept. In this case, it is a response to the notion of boundaries among places, people and public media where we intend to challenge the differences between a display and its content, input and output device, and visualization and screen. By building this sculpture, we intend to challenge people's perceptions of interfaces and show that they can both functionally and physically be shaped by their users. As users manipulate the form of this medium, different geometries influence both the generation of the content and the different ways to access the content.

3) We explore the concept of "social sensing," in which the inhabitants of a place communally enter information about themselves via our interface. Here, we primarily use audio as the main source of input by sensing ambient sounds from the environment and recording the voices of the participants. We evaluate the use of audio in different public settings and observe its capacity to provide semantically rich input from people without violating their privacy.

1.2 Thesis Summary

In this thesis, we discuss a new kind of media that addresses these concerns and intends to make contributions to the research on public interface design. The following outline briefly identifies each section in the thesis and summarizes the concepts used for structuring our thoughts.

1.2.1 Meaning of Location

The role of electronic iconography is changing in architectural design, and there are plenty of opportunities to design interfaces that can integrate public media which contributes to the meaning of a location. We believe that physical environments have the potential to be re-programmed and re-purposed and to go beyond their intended meaning (with information), and we argue that different urban interventions can be used to articulate the social, cultural and political agendas of the spaces and communicate their multi-layered nature. Therefore, different physical social media can be implemented as interactive information surfaces embedded in public settings and can function as social catalysts to capture the social nature of the environment and provide a common ground for people to relate themselves with each other.

Given such interfaces, inhabitants can share and produce knowledge together and contribute to the symbolic meaning of their places. Site-specific, communal awareness in a particular location not only tells us what kind of people inhabit the same place, but also reflects the usage of the space beyond its everyday traffic, allowing us to observe the socio-cultural aspects of the environment in longer term.

1.2.2 Social Sensing

As a theoretical framework, we have been exploring the concept of 'social sensing' and looking at what kind of information can be sensed and recorded from people in the public. What kind of information creates a sense of belonging to a particular location? What would be the ways to represent the different aspects of a crowd? Which similarities or differences can be highlighted? What would be the incentives for people to participate and respond to social phenomena?

In this thesis, we primarily discuss the use of audio, human voice and ambient sound as our sources of input as, voice and the use of language have many features that reflect the identity of a person (e.g., intonation, stress, accent... etc.). From a technical design perspective, we observed that a simple set-up for recording audio provides sufficient semantically rich information that can engage the audience with each other in a given social context.

1.2.3 Social Media in Public

Given the different kinds of public displays and interfaces, ranging from media

facades to public sculptures and audio interfaces, we discuss different cultures of display in public. From community bulletin boards to media facades and audio-based social catalysts, we walk through different examples and identify the important characteristics to design a public interface that can carry symbolic information, and be physically manipulable and socially responsive in space.

1.2.4 Design

We designed an alternative public interface that can be used to sense the social identity of a place. We implemented the medium as an interactive public art installation and exhibited it in a number of venues for testing different designs. The medium primarily uses audio as input from the environment and plays an active role in helping the public to make social statements. In our particular application, the system is designed to make a statement about borders, displacement, limits of geographic mobility and movement in space.

This piece informs the audience by depicting the different aspects of the crowd that are otherwise undisclosed to each other. By asking two questions and recording the answers of various anonymous individuals. The audience then listens to a sound collage made of the voices of people saying where they are from and if they can go back or not. As users of the system, we hear words as they are explicitly spoken to the system and we physically interact with the interface to listen the answers.

Our design uses six LED-(Light Emitting Diodes) based panels and a voice recording panel with a touch-screen GUI (Graphical User Interface). Panels are attached each other with flexible joints so that the participants can bend the panels and change the shape of the interface. This interaction controls the topology of the graphics displayed on the panels. For example, a participant can bend a certain panel and reverse the flow of the graphics. He/she can make the graphics stop or go up or down by changing the structure of the display.

The display uses an abstract visual language, in which movement within space is represented with the flow of a single line. As the free line sweeps the panels, we hear the participant's response to the first question. The line acts like a 'reader head', as it traverses the space, moving back and forth, we hear voices from the panels from the current panels painted with the line. A physical manipulation of the tiles (e.g., bending them over their hinges) traps the line between tiles, causing it either to get caught in the gutter or between to two tiles. Then we hear the responses for the second question and learn from those who can go back or not to where they came from.

1.2.5 Evaluation and Critique

We evaluated our design in a number of locations, with our first major

installation at the Cambridge Public Library (Main Branch). The main technical problems were due to some vulnerabilities in the structural design and in the interaction design scenarios. We made a number of site-specific adjustments in our audio sensing applications. We also identified some usability issues with our recording application and took into consideration some suggestions we received from the users in the first days of the installation. We conducted a survey at which side and evaluated the impact of the interface in the given installation.

1.2.6 Future Work

Given the survey results and our evaluation criteria, we identified three major points that could be improved in the next iteration of the prototype: 1) A different graphic generation and visualization technique on the display, 2) more robust hardware structure and improved usability for the GUI design of the recording application, 3) a different suspension system that will allow better physical interaction. Here, we also discuss the possibilities for the future iterations of our technical design and the room for conceptual improvement.

1.2.7 Conclusion

We end with our concluding remarks on the project and the thesis.

The reader should note that this thesis does not have a specific chapter discussing all background works. Examples of prior work are referenced and discussed in context within the relevant chapter, in relation to the whole thesis.

2
Meaning of Location

2.1 Boundaries, Place, Home, Locational Identity

What are the shared social meanings of a place? What forms the social and cultural ground, the sense of proximity and locality, the idea of belonging to place? What kind of a social group emerges around an interface? What holds things group? How do the participants of an installation, compare to the inhabitants of a place? Where do people think they belong to? Where/what is "home" for them?

As we proceed to explore the boundaries between places and people, and people and people, we use these questions to articulate on the underlying logic behind both the content and the physical design of our interface. Here we look at some concepts that describe people's relationship to spaces and the ways they attribute meaning to their living location. The reader can find a discussion of the ideas in relation to our work at the end of each section.

Boundaries

Heidegger, brings to attention the necessity of recognize boundaries to differentiate spaces:

> "A space is something that has been made room for, something that is cleared and free, namely within a boundary, Greek peras. A boundary is not that at which something stops but, as the Greeks recognized, the boundary is that from which something begins presencing." [Heidegger 1971]

In this respect, boundaries are not only where differences are born, but, more importantly, where individualization is marked and recognized, giving birth to identities of places and of people who dwell in them.

On the other hand, people do want to transgress boundaries for the same reasons. They often give up individual differences to cohere with those whom they believe they share similarities. Social groups form around individuals who share a familiarity, a common sense of belonging to each other. The sense of this familiarity can be quite diverse; it can be due to the fear of others (those

who are outside their particular group), a nostalgia for past (for the shared origin) or use of the same accent or language, etc. Different means form different alliances between otherwise anonymous individuals and give birth to social groupings [Morley 2000].

Groups also individuate by forming boundaries between themselves and other groups. As borders mark the social and political territories and conflicts of interest, they need to be resolved, negotiated and suspended in various ways.

For Morley, it is not only the making of the borders, but also the process of attributing meaning to them that gives birth to conflict [Morley 2000]. Thus, it is the politics of access and denial that creates the tension among geographical borders, the context of belonging (e.g., citizenship) and not the act of territorial segregation and individuation, that is marked with differences.

Place

Thus, individuation, boundary making, and coherence become a dynamic, inseparable process that shapes both individuality and group behavior in places.

Places become an important factor that facilitate this process. They contribute to the sense of locality for individuals who share a similar perception of the space. Identification with a particular place via the sense of locality forms an empathy, a predisposing cause, for shaping the similar mindedness among people living in the same place.

Place defined by its inhabitants and boundaries becomes a site of regulation and control, as the borders constitute what is inside and outside, who is native, and who is foreigner in relationship to place. Borders determine the cost of belonging to a particular place and what it entails to become an inhabitant of it (e.g., citizenship, religion, moral values, use of same language) [Morley 2000].

People construct the notion of 'home,' 'origins' and 'exile' in relation to the space and the values it signify, and often feel being 'in place' or 'out of place' with their relationship to others who share the same values. [Lippard 1997].

Home

Home, among its many other meanings, refers to a particular kind of identification with a place. It entails a sense of belonging to a territory, a "rootedness" in which "one's affections centre, or where one finds refuge, rest or satisfaction." [Morley 2000].

While for some the notion of home corresponds to a conventional, strict sense of belonging to the most familiar values attached to a given place (e.g., mother

tongue, family, history, citizenship, nationality... etc.), for others home does not have to be a fixed place. It can be a contingent and negotiated place that changes over time, which it is mutually reconstructed with empathy and newly shared experiences with others outside the homeland.

Some feel much more at home when together with other like minded people whom they share their life with. Foreigners, non-natives, immigrants, illegals, and those who live in exile can dwell on a shared sense of dislocation. Therefore "homelessness" does not necessarily always correspond to "placelessness," but simply may be the status of lack of identification with a set of values created and shared by a social group.

Locational Identity

Another important aspect in understanding the relationship between place, people and meaning is to look at the connection among them.

Tuan names the affective bond between people and places that shapes our perceptions, attitudes, values and world views as "Topophilia" which primarily constructs the sense of place for an individual and determines its relationship with others. In this respect, the "loss of place," "placelessness," "rootlessness," "access to a place" or "territory," "the notion of home" and "lack of home" are some examples that significantly shape an individual's identity in relationship to his/her surrounding; building an attitude, a social and cultural stance, is almost always a collective process. [Tuan 1990]

Thus locational identity can be framed as the mixture of perceptions, attitudes and experiences originating from the inhabitants of an environment, which are temporarily captured and shared within the larger group. In its informal nature, this identity is created by an in-situ, emphatic social bond among the members where individual differences are represented [Kwon 2004].

In "Lure of the Local," Lucy Lippard brings into attention the collapse of geographical boundaries in the shaping of identities and a new need for connection to others beyond prescribed social roles and identities. As identity is shaped within the society, the limits of places, not perhaps physically, but socially, are transgressed with different senses of belonging to others [Lippard 1997]. Locational identities are not formed based on the sum of the individual identities of the people that occupy a given space; they are not "place-bound" [Kwon 2004]. On the contrary, they correspond to a sense of identity that is mutually constructed by people, with a sense of belonging in relation to each other and to the surrounding space.

* * *

Discussion

In this respect, we see our work as a commentary on the communication of differences and similarities among the inhabitants of a place. Like a special mirror, we focus the viewer's attention on particular aspects of what is reflected from the environment. We intend to capture where people are from and if they can or cannot go back to that location by asking them these questions. We record their voices as they speak their answers and represent their individual responses within a collage of voices, signifying their presence in a given space. In this emerging collage, we see a crowd of anonymous individuals that not only share the same location, but also begin to be aware of each other.

In these voices, some participants answered the question "Where are you from?" by telling us where they were born, some instead, told us where they have spent most of their lives, while some identified themselves only with their present location. (See Chapter 6 for a longer discussion.) We heard their hometowns, homelands or the places that stand for them. Given the diverse experiences with location, our interface intended to create an attachment point, a sense of belonging to the current location. As the inhabitants of the place contributed their voices, they began "presencing" (in Heideggerian terms.) While the people's voices depict their differences from each other, they remind us of the importance of conceptual, geographical and social boundaries that are still important for those who cannot go back to where they came from. As this emerging group becomes more and more aware of each other, it makes a statement about these boundaries and the possibilities and impossibilities of transgressing them.

As we learn more about the people and their places, we can start identifying the diversity within the given space, gaining a sense of "locational identity" of the place (in this case, the Cambridge Public Library) captured by the interface. We can see a space of differentiation, boundaries and their transgression for becoming a part of a social group of anonymous inhabitants that share their will to belong to each other.

As we explore the concepts of belonging and access, borders and places in a shared public space, in a public library in which admittance and participation is basically free, we intend to raise awareness of a larger social phenomena in the inhabitant's minds about people that are not free, those whose mobility is restricted. In respect to the world of borders, in which presence, participation and belonging is extremely regulated we have designed this interface as a stage to let people act with their voices. We depict those who believe that they can move freely beside those who cannot go back to where they came from (with or against their will) and intend to show the inhabitants of the place the diversity of relations that everyone has with spaces in regard to their borders.

We mix native with non-native speakers and locals with foreigners, in which the voices becomes a collage, a territory that defies geography. Here, everyone participate in a temporary sense of belonging and identifies with a "home" that is not geographically, nationally, culturally or historically bound and yet is mutually constructed from the differences and similarities of the anonymous passerby's voice, which communicates presence, age and gender; in this sense, it offers different subtleties accompanying the message. As we hear people telling each other where they are from and if they cannot go back or not through our interface, we hear weak, strong and dominant voices. People who have the right of mobility may answer firmly, without hesitation. People who are from this location, perhaps speak with more confidence than those who are reminded of a "home", a past to with they are forced to return. Some may even hesitate to communicate their difference (even in an anonymous setting) to others; they may pronounce their answers in their native accents and dialects, allowing only those who share the same language access to the information. The richness of a voice captures the subtleties of expressing resistance, hesitance or dignity allowing us to read deeper meanings from the process than the short written answers of these complicated questions could convey. This interface depicts a meaning that emerges from this local place, as the site becomes an interface for acknowledging the presence and the difference of others.

2.4 Reference work in Art & Architecture

Here we specifically look at examples in art and architecture that reflect the environment, have social responsibility in configuring the meaning of a place, and facilitate participatory practices for producing a shared meaning among its members. While these projects show great variations in medium, method and objectives, they all provide fundamental inspirations and reference points that shaped the thinking behind this thesis.

2.4.1 Art Reflecting the Environment

A number of artists, to create responsive environment, have used physical and conceptual mirrors as public interventions that transform the perception

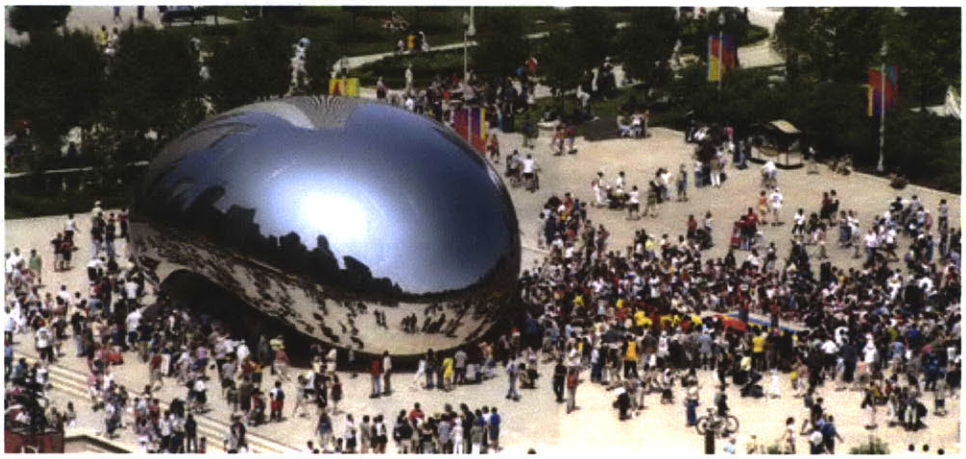


Figure 2.1
"Cloud-Gate"
by Anish Kapoor.

Figure 2.2 - 2.3
"Panopia" by Kristin Jones and Andrew.

of the environment for audiences. Anish Kapoor's "Cloud-Gate" [Figure 2.1], for example, is a bean shaped steel object that reflects its environment while distorting the viewer's perception. It encourages participation by inviting viewers to look at themselves from different vantage points. "The many different kinds of reflections of both the people and the overwhelming Chicago skyline surrounding it together create the illusion of a futuristic society. The hollow underneath allows people to walk through it creating an even greater sense of participation [Dosco 2004]."

Similarly, Kristin Jones' and Andrew Ginzel's, work "Panopia" [Figure 2.2 - Figure 2.3] showcases "colonies of convex mirrors" and focuses on the relationship between the community and the Austin /15th District Police Station in Chicago, using their artwork as an instrument for transforming the connections between public and the police and officer-to-officer. "Infinitively observant, the mirrors embrace the viewer and the lobby. They are aware and completely responsive to the dynamics of the moment, just like good police work. Never visually static, they track and indicate everything going on. [...] They form a colony not under our command of purpose but a universal amplification of visual capacity. Speculum creates an expansive embrace of vision, an all-inclusive diversity of perspectives." [Jones and Ginzel 2005].

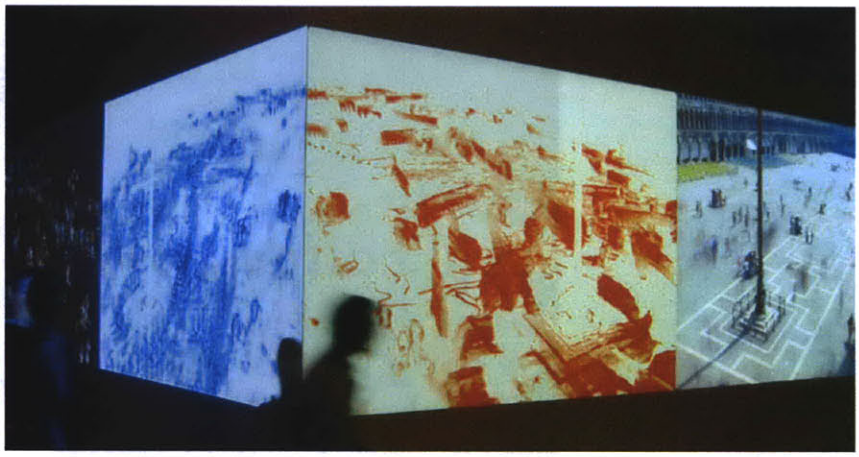


Figure 2.4
"Seen"
by David Rokeby.

In a different usage of mirrors, David Rokeby uses computer vision-enabled mirrors to depict the environment in a filtered way. In "Seen," [Figure 2.4] he captures multiple views of the Piazza San Marco in Venice and constructs artificial views based on the movement within the space. By separating what is moving from what is still, we see the famous architecture and the souvenir shops fading away, leaving behind only the traces of pigeons and people, as their presences are depicted by their traces.

Nox Architecture's work "D-Tower" [Figure 2.5 and Figure 2.6], on the other hand, functions like a neighborhood mirror, providing an interesting example of "social sensing." It shows an effort to sense and visualize socially interesting information collected in the form of questionnaires filled out by selected participants from a particular neighborhood. In this way, "D-Tower" is an interactive artwork that maps the emotions of the inhabitants of the city of Doetinchem (the Netherlands). As a pre-selected group of individuals respond daily to questionnaires, their results are represented in a tower, an urban monolith that represents the mood of the neighborhood with changes of color (e.g., similar to the ambient orb). It collects information on a statistical basis with questionnaire that contains 360 questions. With four new questions every day, the inhabitants of Doetinchem respond to questions like 'Are you happy with your partner?' With possible answers: 'very much' - 'yes' - 'a little' - 'no' - 'absolutely not' - 'not applicable'. As all answers have scores, it processes the information and measures HAPPINESS, LOVE, FEAR and HATE daily using various questions. "Every night, the tower in the centre of Doetinchem lights up in one of these colours. If there was a lot of HAPPINESS in the city on day 1, the tower will turn blue. If a lot of LOVE was in the air on day 2, the tower will glow up red... [D-tower 2005]".

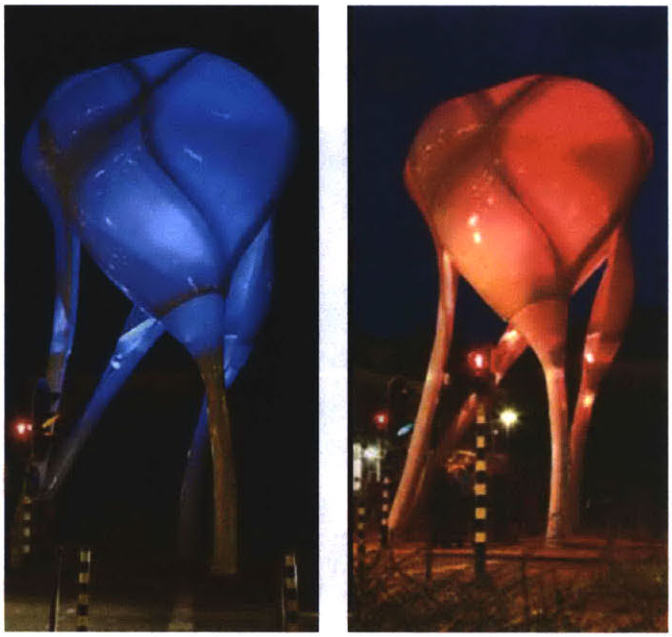


Figure 2.5 - 2.6.
"D-Tower"
by Nox Architecture.

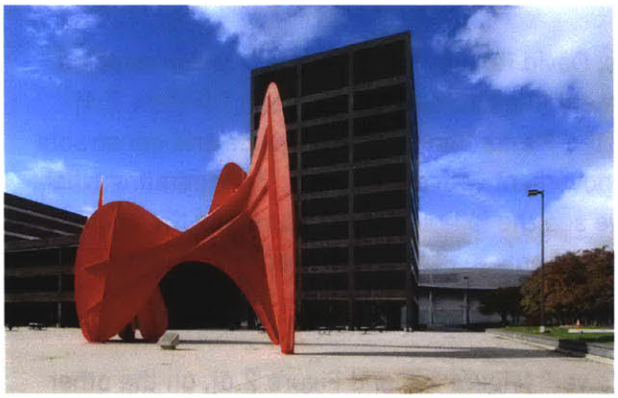


Figure 2.7
"La Grande Vitesse"
by Alexander Calder
at Vandenberg Center,
Grand Rapids, Michigan.

Figure 2.8
"Pomnikoterapia
- Memorial Therapy".
by Krystof Wodiczko
projection at Zacheta
National Gallery of Art,
Warshaw.

2.4.2 Socially Responsible Art

As Kwon argues, one distinction among various pieces of public artwork lies in their need from the surrounding space. Is there a physical and functional need to become part of the space? Or is it a social responsibility? Therefore, a monumental abstract, modern Alexander Calder sculpture [Figure 2.7] and Kryztof Wodiczko's projection [Figure 2.8-2.9] are examples of two different types of site-specific public art: an "integrationist," "assimilative" one vs. an "interruptive" and "interventionist" type.

Kwon argues that what legitimizes Calder style public art is size and scale where the publicness is primarily attributed to being an outdoor installation that is open to public access (e.g., parks, urban plazas, entrance areas of federal buildings, etc.) [Kwon 2004]. Wodiczko's public art, on the other hand centers on becoming a social commentary originating from the place itself. His projections being situated in a particular place carries a social responsibility to stand behind a message staged in space [Figure 2.8] [Wodiczko 1999]. In the "Cecut Project," the artwork gives "voice and visibility to the women who work in the 'maquiladora' industry in Tijuana." [Figure 2.9] By using a headset with an integrated camera and microphone connected to two projectors

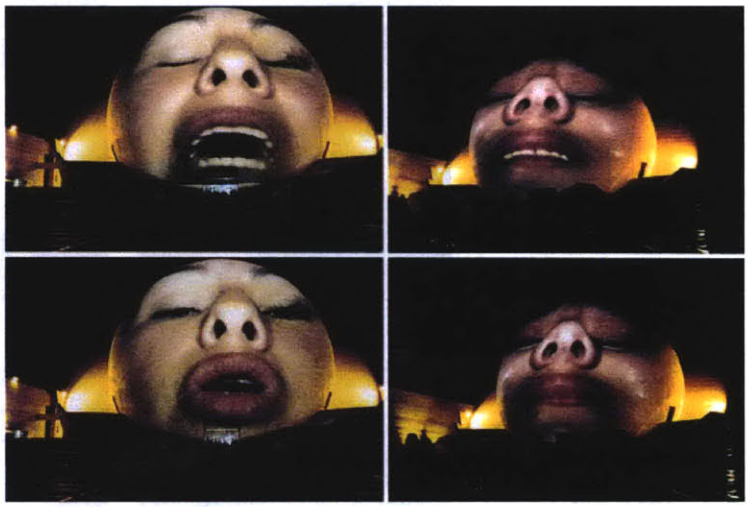


Figure 2.9
"The Cecut Project"
by Krystof Wodiczko,
Adam Whiton, Sung Ho
Kim.

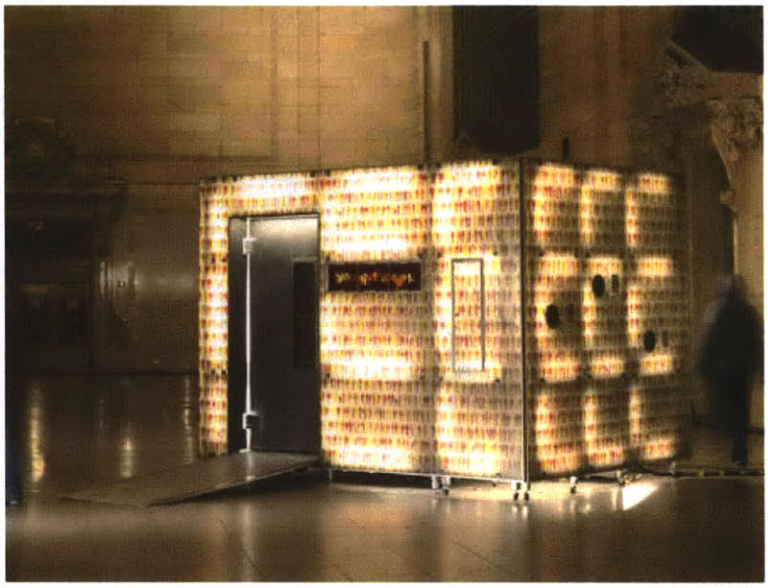


Figure 2.10
"StoryCorps" by Sound Portraits Productions.

and loudspeakers, the piece allows its subjects to transmit their testimonies live while their images are projected on the 60-foot diameter facade of the Omnimax Theater. As the women's testimonies focus on a variety of issues, including work related abuse, sexual abuse, family disintegration, alcoholism, and domestic violence, the piece stages a social documentary that not only reconfigures the meaning of the location but also its social and political use, while becoming an outlet for the voices of its participants.

2.4.3 Participatory Art

From collaborative storytelling to mural painting experiences to communicating stories in public places, participatory artistic practices showcase a long history of artworks that facilitate the process of depicting a community around a theme. In this respect, "StoryCorps," [Figure 2.10] by Sound Portraits Productions partnered with the Library of Congress, intends to contribute to the collective identity of a nation by archiving its citizens' stories. It facilitates the process of interviewing a friend, neighbor, or family member by placing recording studios in towns or visiting them with mobile studios. As recordings are collected, they are archived as part of a social documentation, a nation-wide audio portrait preserved in the Library of Congress.

On the other hand, a work from Debby Akam and the Byker Bridge Housing Association, "Points of View" deals with depicting a place via a collage of visuals provided by members of the community who explored their city on foot, revealing their own particular perspective on the place through conversations, memories and stories in a series of walks.

As the final work is installed at Byker Metro Station, Newcastle's "Points of View" presents the results of these separate excursions as a single image, the

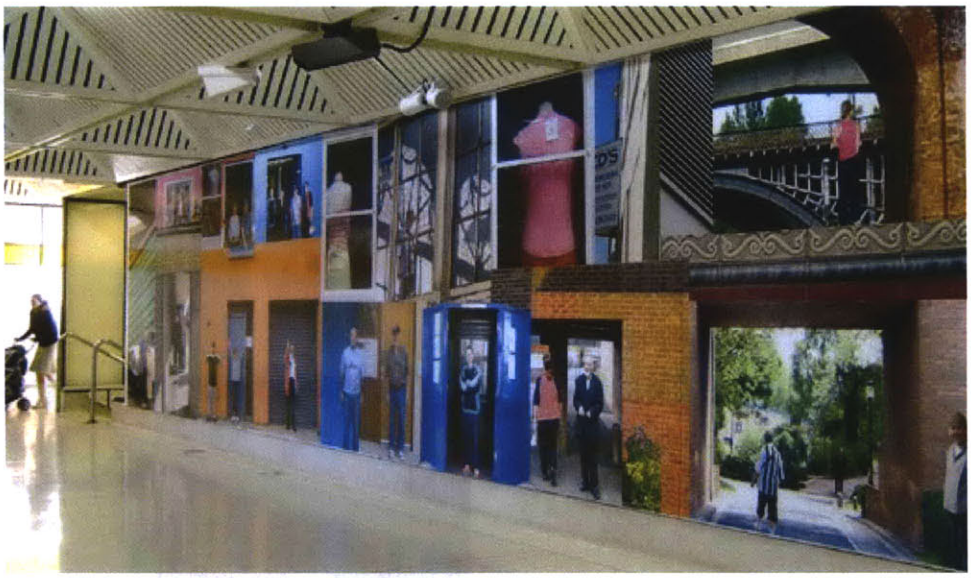


Figure 2.12
"Points of View" by Debby Akam and Byker Bridge Housing Association.

architecture of Byker providing the stage for the protagonists to present their environment as a series of moments in which topography is made personal through a shared process." [Akam 2006] [Figure 2.12]

* * *

Discussion

In our work, we also use the metaphor of a public mirror that functions similar to the "Cloud-Gate" or "Panopia;" our mirror presents a view that raises questions about the environment. While it reflects back voices rather than images, like Rokeby's "Seen," it transforms the view of the locality by emphasizing its features. It focuses the viewer's attention on a particular aspects of what is reflected; in this case, places and boundaries and a person's capacity to transcend them.

Our interface explores a similar role to the "D-Tower," albeit with an unknown group of people that change the content every day. Unlike the level of abstraction exercised in "D-Tower" (e.g., calculated statistics representing mood with color), our interface depicts the social nature of the place with the directness of the voice, and intends to capture the subtleties of intonation, stress and mood embedded in the voices accompanying their message.

In our design, we inspire to the kind of social responsibility rooted in Wodizcko's work. Similar to the "Tecut Project," our interface intends to give a voice to people so they can make a social statement. While our work is spatially less interventionist and socially less interrogative than his, we depict a number of anonymous individuals together, and explore their emergence as a group that cohere around their similarities and differences.

Like the "Storycorps" project, we collect voices from participants, although not as stories but as snippets of responses. We construct a collage out of these

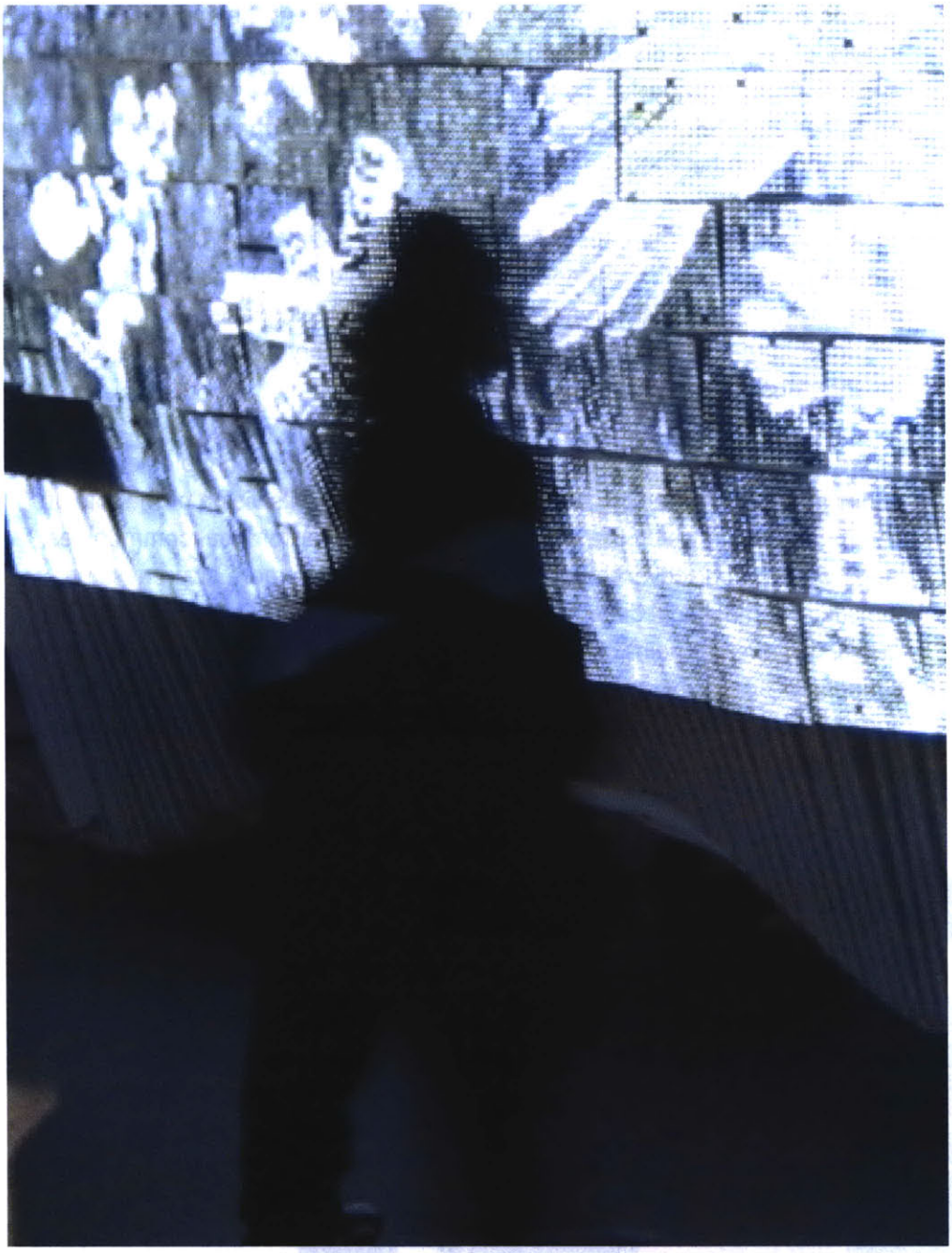
sounds and play them back with physical interaction. At the end of the day, all individual responses dissolve and become part of a larger whole. While in this audio portrait, individuals lose their importance, we hear a collective message on places and their boundaries, a message that shapes the social identity of the place and contributes to the social and political meanings of the place.

If we return back to our questions "What kind of social group can emerge around an site-specific interface?" and "How could an interface create a sense of belonging?" this brief survey on the concepts of self, place, and identity in relationship to public art provides us with a vocabulary on framing the role of the interface as a catalyst with social responsibility.

As we discuss more specifically the alternative roles and technologies of public media in the coming sections, we share Lippard's vision of the role of community art, in which the artist serves as facilitator for local communities, helping them to discover their own identities and have more awareness on the social and political dimensions of their environment [Figure 2.13]. In this thesis, we take her point of view on art, that, it should be "of place," which she defines as "accessible art of any species that cares about, challenges, involves, and consults the audience for whom it is made, respecting community and environment." [Lippard 1997]

Figure 2.13
A contemporary mural example. Real life and How to Live it, No.1 by Ross Sinclair. Mural painted in Riquethaus, Leipzig. Translation:

Do/Not
1. - Burn Your Passport
2. - Abolish Geography
3. - Embrace Statelessness
4. - Renounce Citizenship
5. - Explode Borders
6. - Annihilate Nations
7. - Ignore Continents
8. - Dissolve Cities
9. - Abandon Republics
10. - Secede



Detail from the sensing-display-user interaction from the "Self-Organizing Bus Stop" project [Bouchard et al 2006].

3
Social Sensing

1.1 Terminology & Introduction

In this thesis, we use the term "sensing" both in the literal sense, to accept input via our sensory-motor organs (as a machine would sense with its sensors), and also as being aware of something as a result of perception, interpretation and understanding that it is also a symbolic and cognitive process shaped by knowledge and belief and is determined by social and cultural characteristics [Maturana and Varela 1988]. Also, to clarify our phrasing, when we say we 'sensed people' we refer to sensing via a microphone (for analyzing data in the time or frequency domain to extract various features for classification) and when we say we 'recorded people,' we refer to a simple audio recording process using a microphone, primarily for playback purposes.

With 'social sensing' on the other hand, we refer to a series of sensing and recording activities carried on a group of people for depicting different features of their group, crowd or collective that are otherwise immediately visible. Social sensing here, is performed by the inhabitants of a space and facilitated by an interface. The intention is to contribute to the production of site-specific information about the place via its users, to raise awareness of their living environment and towards each other, and eventually to catalyze their social interaction in public.

In this respect, we propose our interface as a "probe" [Paulos and Jenkins 2005], situated in the public setting for facilitating the sensing activities, aggregating its results and presenting its findings to its users. Tying back to our primary interest of understanding the meaning of places and locational identities, 'social sensing' is the act of producing the meaning that can be attributed to a place by its inhabitants.

As places have different meanings for different people, 'social sensing' intends to highlight the similarities and differences between these perceptions and to identify converging characteristics of different spaces, thus rendering these locational identities as time-based depictions of the places based on both the audio features of the environment, as well as the individual characteristics of their inhabitants.

We view of the inhabitants of these places as anonymous crowds that eventually may gain more insight to each other by interacting via our interface. While remaining anonymous to others, this intervention creates the context and reasons that enable them to share enough of their personal data to find a common ground that will relate themselves as part of a collective, emerging from this communal experience.

In the following sections of this chapter, we will contextualize our approach in relation to different notions of sensing. We look at differences and similarities between sensing places and people, as done by individuals and groups and explain our experience in how we have sense semantically rich and private information that would have been otherwise difficult to access.

Early Disclaimer
Here, we have to state that our findings, neither from this thesis nor its project part are intending to make any ethnographic claims about places and people. While we certainly share methods and media with ethnographic studies, our interests are limited to public interface design research and its evaluation within the relevant social context. Our approach for 'social sensing' can be read as more artistic than social science, as we do not see in ourselves an ethnographic authority that should justify its social findings. We argue that via the use of our interface, our sensing results will always be contingent to its users and the mappings that will attribute meaning to this data will be subjective in nature. As designers, we intentionally participate in the process (by recording our own voices and sensing our own presences) and engage with our audience and seeing ourselves as part of the emerging community. We argue that our intervention should not function as a social "proxy" for its audience, but to remain as a catalyst.

3.2 **Sensing Individually** vs. **Social Sensing**

We naturally make sense of each other in public, attribute meanings to things and spaces around us based on our perceptions and situate ourselves against others in relation to how we are perceived by them. Because of this, our perceptions alone, as opposed to in a group show fundamental differences. Our subjective experiences are significantly shaped when we have access to each other's perceptions. If I know what you think about me, I will think differently of myself then I would prior to this knowledge [Morley 2000].

In our installation, we designed an interface in the form of a public sculpture, through which we asked users two questions via a touch-screen interface "Where are you from? If you are not from here, can you go back?" and recorded their voices via a microphone. As users recorded their voices, they were able to interact with the sculpture by listening the other's answers, which were displayed as a collage of anonymous voices. (See Chapter 5 for more details of the design).

When we asked these participants where they were from, we were given various responses. Some simply gave their answers as location names; some chose to respond to each other's answers: "I am from here," "I am not from Boston," "I am not from where you are." While our assumption was that the participants would simply be recording their own answers without taking others' into consideration, our observations and interviews with the participants showed that their answers were in fact influenced by others'. By able to hear each others' answers, some users reported that they responded to a question largely as if they were responding to a group of people. We attribute this to a sense of participation and empathy that emerges from the interaction, and interpret it as the participant's desire to a react to a larger whole, perhaps to become part of it. We often observed that while recording their voices, some users talk straight to the sculpture (as opposed to directing their answers toward the microphone), as if they are giving a response to a question or statement they heard from another person through the interface.

For us, the act of 'social sensing' has the potential to turn a group into its own interface, producing its own shared meanings. Questions asked by the system are turned into questions directed by the individuals to one another; not only to learn each others' answers, but also turning their response into a larger question: where are "we" from? As they turn these otherwise individual answers into communal statements, the interface builds a collage of voices showing the emerging "we" that becomes a multitude of differences and similarities of places and people.

3.3 Sensing People vs. Sensing Places

There have been numerous research initiatives at MIT and elsewhere on sensing people for understanding group dynamics, social behaviors and collective interaction patterns in public by using people as sensors. Sensor badges, wearable media, mobile phones and various kinds of personal devices are already in use for sensing and interpreting group interactions by looking at an individual's data recorded in social settings (e.g., workplace, school, lab environment) [Olguín Olguín et al 2006]. In typical scenarios, we see a group of people being sensed, tracked, recorded and analyzed based on their motion, location, proximity and voices. Here, sensing is often a relational practice, where meaning is mostly constructed within the context of relations among the members in a group (e.g., those who wear a tracking sensor), based on the individual relationships with each other, and but not within the context of their surrounding space: Mary met with Mike at the cafeteria today more than yesterday. Even if the location is registered in these readings (as coordinates, labels), the individual's personal relationship with the space can often go unconsidered, because it is not that easy to sense the 'importance' of space a simply from numerical data. Registering oneself in the gray cubicle twenty times a day doesn't inform us a lot of their perception of their working environment.

As space both symbolically and architecturally influences the social climate of a group, we believe that understanding the individuals relation to space is inherently important to understanding their socio-cultural nature. However, in this thesis, we focus on understanding places via people. While we share some of the data analysis and recording methods with others' projects, we diverge from other practices by designing an interface that brings into attention the architecture of a place with a central interface that outputs its results in real-time and provides immediate feedback of what has been interpreted from the act of sensing. Our findings are not deterministic and are always contingent on the responses of the current users. While this makes it difficult for us to come up with a precise model of a place and its relationship with its inhabitants, we try to help participants reconstruct this relationship by making them more aware of each other. For example, even when we asked participants where they were from, the open ended nature of the question allowed them to give many different answers to the same question. People can think that they are from many places at the same time, making it impossible to get even a rough estimate of the birthplaces of the inhabitants at a given location.

3.4 Sensing the Private

On the other hand, with an open ended question, it becomes possible to create the context for learning more personal information about participants. In our user studies, we observed that people do share more when if they learn from each other and often reward a culture of reciprocity if it emerges during their interaction. I may not normally say if I can go back to my home or not, but if others cannot go to their home too, I can feel that I share with them. I am not alone.

Different sensing applications trigger different levels and kinds of concerns against privacy. Immediate feedback to the user and sharing the findings of others develop a sense of trust. (See Chapter 7 for more details on our findings.) Being exposed in similar ways also helps people to share a common ground, and reinforces their sense of belonging. Thus, a bit of data that may normally be regarded as private and secret in an everyday context can become a personal, anonymous identifier of a person, if shared with others in the right context.

3.5 Sensing the Objective vs. Sensing the Symbolic

Sensing an audio response to a question cannot be as objective as sensing GPS coordinates or accelerometer-based activity readings. While on the instrument side, the audio data can be objectively and precisely recorded and analyzed based on its signal values, (given that technical limitations, such as noise, echo and distortions are avoided, it is very hard to capture the symbolic meaning that is unique to the interaction and context.

When sensing and its interpretation happen in the background, sensing results

become accessible to individuals in applications and interfaces almost always in a derived form. My location data and the number of people that I interact with everyday shows a personal profile, a daily interaction pattern that translates my sensing data into an interface that attributes the meaning from an outside perspective. Once the meaning of data is reconstructed in an application, we argue that it is alienated from its context and we are not necessarily able to explain the experiential intent behind it.

In their derived context, it is not easy to map the objective data to semantically rich, meaningful interpretations. What does it qualitatively mean to be with Joe and Mary throughout day? As different mappings and subjective interpolations are imposed on the data, the interpreters of the data (e.g., application designers) run into risk of forcing their data into pre-determined categories or models.

In either case, sensing the symbolic attributes of humans is inherently complex not only in finding the right questions to ask, or choosing the right sensing criteria within the right context, or overcoming technical limitations on the devices and instruments used in the sensing interfaces. Ultimately, it is the question of the contingent nature of meaning that is always negotiated differently by different inhabitants in different times.

Our sensing interface intends to facilitate this process by allowing the inhabitants to create their own interface by letting them sense and interpret their own social environment in a given place. Its primary role is to create the context for sharing their commonalities with each other in relation to the space that surrounds them. Our role is to let others attach meaning to a places and customize its role in their lives, by starting to know each other.

3.6 Sensing Ambient Voice and Recording Sound

Since our initial studies, we have looked at a number of research projects in the realm of audio and spoken language analysis at MIT and elsewhere on identifying audio features from the environment and detecting voice characteristics (e.g., age, gender, dialect/accent, language) of speakers from speech using statistical and pattern recognition methods [Schultz 2006], [Håkon 1993], [Huang 2001]. Shafran's work on "Voice Signatures," which classifies speech qualities unique to a person based on the analysis of prosodic features [Shafran et al 2003], became an important inspiration for us in understanding the kinds of people who inhabit spaces. On the other hand, given our conceptual approach, in our final design we focused primarily on sensing ambient sound from the environment and used deliberate audio recordings.

3.6.2 Ambient Voice

Throughout our work, we looked at different possibilities for extracting the

prosodic features discussed by Shafran, *et al*, 2003. We primarily explored the possibilities of gender and age detection discussed and focused on detecting voice in the environment.

We developed a gender detection algorithm by analyzing sound on the frequency domain based on Harb's method using used zero crossing rate, average pitch and center of gravity of the frequency distribution for training our classifiers using SVNs [Harb 2001]. For this we mostly used open source analysis applications, such as "Praat" [Boersma 2007], and data mining applications, such as "Orange" [Demsar 2004] and "Weka" [Ian et al 2005].

In our final design, on the other hand, as we decided to output the human voice as it was, there was no need to do any real-time classification on the voices for gender or age, etc. We determined that it would be best to replicate the same information visually for the users. As a human listener would perform much better than our algorithm, we left the real-time interpretation of the data to them. On the other hand, for a future possibility of visualization of the history of sounds in public space by graphical methods, we stored five second snippets of audio data (frequency and energy values) from the environment every 30 seconds, which may be post-processed for different uses.

We used our audio analysis work to detect presence and absence of people in the environment based on the audio levels. By looking at the energy values in human voice range frequencies, we represented the activity of the space by the activity of a line. We mapped the intensity values to vertical movement of the line, while it horizontally traversed the panels. The line was more active while more people were around and used both the horizontal and the vertical axes of the panels; it remained more subtle and more horizontal as it detected less human voice in the environment.

3.3.2 Recorded Sound

We recorded three seconds of audio for capturing the users' responses to the questions, without much processing; we only normalized the audio that was below certain thresholds.

We then manually went over the recordings to be sure that they were not too loud or irrelevant due to technical issues. We encountered some of these everyday, as we found the microphone displaced from its location (e.g., due to being pressed in), causing the recording of echoes, reverberations, etc.

However, we intentionally tried to not censor any of the recordings even if they were too clipped, full of background noise, consisting only of laughs or devoid of content (e.g., full silence). Some users had difficulties in saying what they

wanted to say in three seconds, and some chose to answer the questions in their own way (e.g., shouting, singing, etc.), we did have some recordings that were not very understandable, but we left these in. As our intention was to capture the social interaction between the people and with the interface as much as possible, we preferred a noisier collage over a hygienic one.

Given these reference points and the theoretical framework for why we chose audio as our primary source for 'Social Sensing,' we will begin to discuss in the following chapters the social role of public interfaces and the ideas that shaped, the rationale behind the design of our interface and its implementation.

Detail from Würzburg Cathedral, depicting the visual complexity of meaning integrated to the architecture. The meaning of the place is configured both with the architecture and the information on its surfaces.

4

Social Media in Public

4.1 Introduction

In this chapter, we present a number of public media projects that intend to contribute to the symbolic, site-specific meaning of public places. Our intention is to discuss alternative uses of social media and provide a background before we explain the rationale behind our design in the following chapter.

We will look at a number of programmable surfaces and interfaces that intend to fulfill a social need for communicating information either for or about a targeted audience in public. Our focus is both the social and architectural roles of the media within the intended application. We will survey different interface elements and discuss different interaction methods that have been used in these interfaces.

To support the social uses of public media, we will look at William Whyte's concept of "triangulation" and explain its role in building social catalysts that can initiate the preliminary contexts that would begin the interaction among participants.

We begin with clarifying a number of terms we use extensively in this section. We will use "programmable surfaces" to refer to media that has material, mechanical or electronic properties that can computationally be programmed to display information. While these surfaces may be designed and manufactured from scratch existing surfaces, media and architectural elements may also be turned into programmable surfaces, with the necessary modifications (e.g., building lights can become programmable to be quickly turned on and off to resemble the pixels of a computer monitor). Programmable surfaces are inherently different than static surfaces (e.g., graffiti, murals, billboards or walls), or broadcast-only media (e.g., TV screens); they can dynamically be reprogrammed for different content and re-purposed for different uses. By 'public displays' we refer to any artifact that may be used to communicate information in public. Billboards, large-format displays, projections, building facades, walls, when used for outputting information (e.g., social, commercials, political, educational), regardless of their technology, all can function as public displays.

'public interfaces,' on the other hand, are public displays that can also receive input from their users. While their input methods can vary (e.g., sensors, keyboards, mobile phones, bluetooth... etc.), they exhibit an interactive (or responsive) nature, where an action will cause a change either in the content or the presentation of the content.

4.2 The Culture of Public Display

Today, we no longer see, or at least expect to see, hieroglyphs, mosaics or frescos on facades of buildings. A long time has passed since a quest for abstraction in modernist architecture erased the traces of symbolic cultures or obliterated the representations of their inhabitants from the facades of buildings. Even stencil art and graffiti like material interventions are reconsidering their radical positions against virtual practices. Location-based text messaging and virtual tagging are marking presence, while the language of resistance finds new ways to be mediated within urban landscape via mobile technologies. While new visual markers of site specific identity are in need for further articulation in today's urban environments, Venturi and Brown's question "What do places communicate?" posed in the 1970s, remains valid for understanding the relationship between architecture and people, people and spaces, and people and people especially while discussing the potential of digitally and physically blended, information-rich "hybrid environments" [Venturi et al 1972]. Venturi and Brown's study of the semiotics of the urban space and architecture as signs and systems, since the publication of "Learning from Las Vegas" still provides a relevant frame of reference for understanding the meaning of place in a broader context, articulated in a network of symbolic exchanges between places and their inhabitants. From manierist cathedral murals, Las Vegas's commercial signage, to Times Square and Tokyo, Venturi evaluates different elements of information communicated via architectural elements with different uses of screen technologies [Venturi et al 2004]. The role of electronic iconography is changing in architectural design, and there is plenty of opportunity to design interfaces to integrate public media that contributes to the meaning of a location.

On the other hand, the current perception and use of electronic iconography in public is inherently tied to the culture of personal computers, mobile phones and their related technologies. We continue thinking in the traditional format of the screen space and augment the facades of buildings with pixels to build large-scale electronic billboards. The reprogrammable and generic capacity of screens and information surfaces are often translated into generic commercial displays, which often do not go beyond commercial propaganda. Traditional material practices (e.g., frescos, mosaics, murals) that historically contributed to the production of symbolic and site-specific meaning for reflecting the social, cultural and political nature of places are not carried by the electronic versions of public displays, leaving them underutilized in engaging with their audiences and their surrounding architecture. Spaces are often too uninformed about their

inhabitants and fail to reflect the nature of their locations even though they can be easily used to provide more opportunities for the inhabiting community to have more say about their space.

The heritage of desktop and wireless computing is also largely influencing the ways to access information in architecture. As wireless information is ubiquitously available in public settings, it is mostly accessed with personal phones, PDAs or computers. Architectural media is often designed for broadcast purposes only (e.g. media facades), in which the ways to interact with information does not necessarily shape the design of the built environment. Architecture provides the shelter, space and electricity for its user but its capacity to introduce the interfaces that can allow people to shape their spaces with information is generally underutilized in the current architectural design practice. As we stated before, we believe that physical environments have the potential to be re-programmed and re-purposed and to go beyond their intended meaning (with information), and we argue that different urban interventions can be used to articulate on the social, cultural and political agenda of the spaces and communicate their multi-layered nature.

4.2.1 Showing Presence in Public (Community Collages)

We will begin with discussing the role of a community bulletin board we saw in Cambridge Public Library [Figure 4.1], where we did our first installation. While our interface does not necessarily compare to a bulletin board in form or function, it is worth making a comparison in their social uses within a community as each aspires for the use of a collage that can depict a rich nature of expressions from the users and the environment.

Figure 4.1
Community bulletin board at Cambridge Public Library (Main Branch)

Figure 4.2
Detail from community bulletin board at Cambridge Public Library (Main Branch)

From corkboards to large-screen, networked, interactive plasma screens [Churchill et al 2004], there are many versions of bulletin boards that function as public interfaces used for information exchange practices among different audiences. While their dynamic and responsive nature makes them prevalent interfaces for being news and information sources in public settings, community bulletin boards also become social landmarks, depicting different levels of interest and different responses to different subjects within communities.

Bulletin boards can be very active interfaces, with many anonymous users who input everyday. But here, we are especially interesting in the way a social group or a community "presence" in it and the way a community board depicts that social group. In this board, we see three phone numbers torn from a Spanish teaching service posted by an English teacher. Four numbers were torn from a flyer looking for an "eco-minded networking engineer" [Figure 4.2]. With a simple count on the number of disappearing phone numbers from these posts, we can make a rough guess on the local social climate that emerge from the responses. While it would be very difficult to use a machine for this task, for us it would not be hard to see what is in more demand in this small community of Cambridge Public Library this is socially very rich data: what is more appreciated or what is less? What kind of jobs get greater response? Who comes to the library? Are they native English speakers or mostly Spanish-speaking people? Engineers who are looking for jobs? How many people are interested in Yoga? Is this the third consecutive post on Yoga teachers? Why are there so many baby sitter ads? Are there a lot of moms coming to the library?

In its simple set-up, the bulletin board is a utilitarian collage that is of a highly visual nature, whereas our interface facilitates the composition of an audio one, capturing the answers to questions with snippets of voices. However, we see similarities in both collages in their capacity to become community mirrors reflecting the interests and values of a shared community. While our collage functions in a much more guided and limited context, it also expresses a rich quality of information about the inhabitants of the place. As we hear sounds from people in different ages, genders, accents and languages, we get a sense of what kind of people actually live in the space: young people, old people, natives, non-natives, children running in the background, etc. Like the implicit expressions we depict from the torn phone numbers in the bulletin board users, we capture meaning in the subtleties of voice contributing the meaning of the messages waiting to be heard in the background.

4.2.2 Programmable LED panels (Low-Resolution Displays)

While LED panels find their traditional uses as information tickers or indoor signage for communicating textual information, they have made appearances in

a number of artists' work. In Jim Campbell's work, for example, the technology is used to create custom media that questions the perceptual qualities of LED displays, their aesthetics, and capacity to transform reality in relation to sound and movement [Figure 4.3]. Jenny Holzer's work, "Truisms" (1977 -)[Figure 4.4], on the other hand, showcases a different usage by reconfiguring their use as a situated display element for making social statements in architectural space. As she uses the circular architecture of the Guggenheim Museum, both the medium and its message dissolves into the architecture of the space and becomes a public media that is both spatially and socially responsible towards its users. As Holzer's "Truisms" also respond to meaning of the gallery and the architectural space, we see the medium becoming about the place, not only transforming its physical shape but also its social and political perception.

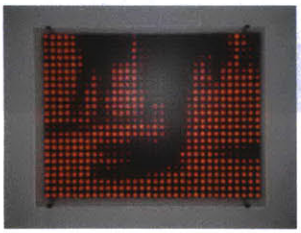


Figure 4.3
Fifth Avenue Cutaway #2, 2001, by Jim Campbell.

LED panels can also be tiled in quantities for covering large physical surfaces. In a collaborative project between for MIT Mobile Experience Lab, we also designed a six-feet custom LED display to cover the three-dimensional surface of a bus stop [Figure 4.5 and Figure 4.6] [Bouchard et al 2006].

While being designed as a responsive display surface that incorporates the input of a number of sensors (e.g., vision, microphones... etc.), this display allowed us to design a public interface in the shape of a virtual botanical garden that senses audio and light for growing different kinds of vegetation that depict the environmental factors sensed from the surrounding space. Some plants grew in response to loud traffic noise, some responded to the presence of

Figure 4.4
A selection of "Truisms" exhibited at Guggenheim in 2005 by Jenny Holzer.

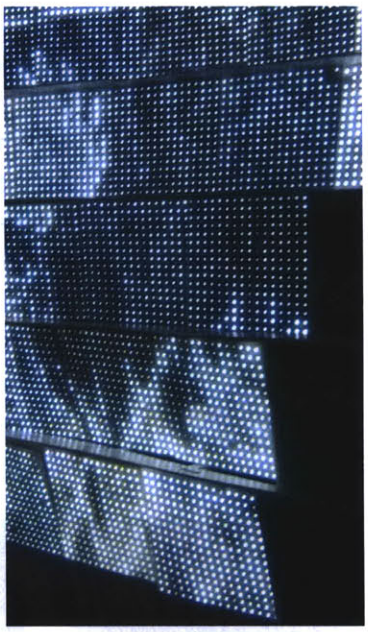


Figure 4.5
Self-organizing Bus LED display detail.

people gathering around the interface. As the amount of people in the environment increases, the garden flourishes and grows more and more. By reflecting some basic environmental factors of the environment, this work was a first attempt to design a socially-and environmentally-responsive interface, in which we tried to create a sense of place, a virtual habitat around a bus stop. To give the users a more direct say in shaping their garden, we designed a secondary interface, a community message board, through which they were able to leave messages for each other. We displayed a message's presence by showing posts on messaging plants. As more messages accumulated over time, people could become more and more aware of each other, the garden becoming a mirror of this activity, creating its own community.

The variable uses of LED displays bring a number of advantages for public displays. While being low-resolution in nature, they provide many possibilities for the design of programmable surfaces that can communicate semantically rich information. As Holzer's work shows, the displays can be integrated both socially and architecturally into a space. As in like the bus stop example, their capacity to be designed as flexible panels that can be tiled in quantity for custom sizes, shapes and surfaces, gives them an important advantage in

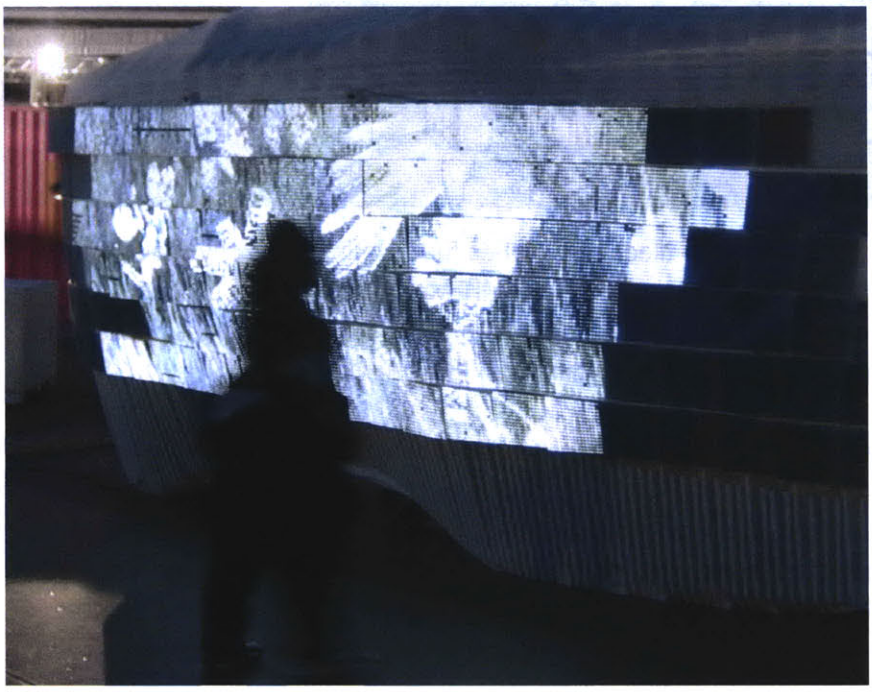


Figure 4.6
Self-organizing Bus Stop. Collaborative work between MIT Design Lab - Mobile Experience Lab, MIT Media Lab - Smart Cities Group, Ambient Intelligence Group, Sociable Media Group.

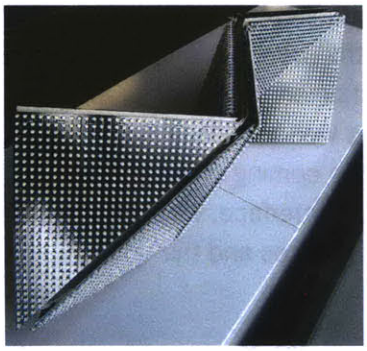


Figure 4.7
Diagonal attachment points in the foldable display architecture

physical manipulability. In our interface, another factor for choosing them as the display surface is their ability to be abstracted as individual addressable elements (e.g., like pixels) that can be driven electronically for a triangular shape unit. This flexibility in the form factor, allowed us to design a diagonal cut on the display panel, that is not possible for any other screen technologies. As will be presented in the coming chapters, this kind of a custom geometry allows many possibilities for designing interactive and foldable LED panels that can be used in public interface design [Figure 4.7].

4.2.3 Interaction with Architectural Media:

"Blinken lights" turns an ordinary office building in Berlin into a programmable display. Its audience can send instructions via SMS messages with their mobile phones and also use these devices to play the famous computer game "Pong" on the buildings facade. While having the ability to play a game on the building façade and turn the building into an active canvas gives an interesting perspective on the urban ramifications of the computer game culture, this example reminds that interaction with buildings is still strictly following the heritage of the personal computing culture. There are a number of examples in architecture today in which information is mostly accessed and mediated via personal information devices (e.g., mobile phones, wireless devices, PDAs, personal computers, etc.). While wireless interaction provides important affordances to the inhabitants, many other interaction modalities are underutilized; we don't see many examples of audio interfaces, computer vision-based systems or possibilities for physical interaction architectural design.

In our interface, we intend to explore the use of physical interaction with a public interface. As we conceived the role of the architectural media more than being broadcast only, we wanted to use multiple interaction modalities for different uses. We record audio with a touch-screen interface and allow users to physically manipulate the geometry of the interface for interacting with the

Figure 4.8
Project Blinken Lights. Haus des Lehrers" (house of the teacher) office building at Berlin Alexanderplatz. (Image by Dorit Günter & Nadja Hannaske.

content. While we chose this scheme primarily to meet our conceptual needs (e.g., communicating a message on boundaries), we argue that new kinds of architectural interfaces can benefit from physical interaction and physical manipulability for better integration with the environment, as well as a capacity to be able to interact with three dimensional interfaces. In the coming chapter, as we discuss our experiences and findings based on such an interface, we will present the viewer with the benefits of three-dimensional interfaces and the ways to interact with them

A sign of a great place is triangulation. This is the process by which some external stimulus provides a linkage between people and prompts strangers to talk to each other as if they were not." - William H. Whyte

4.2.4 **Triangulation & Social Catalysts**

An important aspect for us that defines the social use of public media is "Triangulation," which was formulized by Willim H. Whyte [Whyte 1988]. As Karahalios states, public media can have a catalyzing, activating function by becoming ice-breakers in the environment. These can mediate the necessary link between strangers to initialize conversations, start interaction with each other and, in our case, produce content, knowing that it will be viewed by others. [Karahalios 2004].

Public sculptures, in this regard, are often social catalysts for the curious type according to Whyte [Whyte 1988]. People ask each other: what is it made of? Is this wood? A special plastic? For Karahalios, public instruments at a subway station can embrace the same role; people shout at each other from the other side: Keep harder, keep harder, you will hear it soon. Given the public nature of urban interfaces, catalysts provide the context and define the form of the interaction that will bring together unfamiliar strangers. From serendipitous encounters to more directed interaction, media artifacts can be designed for fostering different kinds of social interaction by forming a triangulation around them.

4.2.4 Audio Based Social Catalysts

A number of projects showcase the use of audio in mediating conversations between spaces, and also using it to transform the social use of public space by catalyzing different activities in them.

Karahalios's work "Telemurals" [Figure 4.9 and Figure 4.10], in this respect,

Figure 4.9 - 4.10
"Telemurals"
by Karrie Karahalios,

Figure 4.11
"Agoraphone"
by Kelly Dobson.

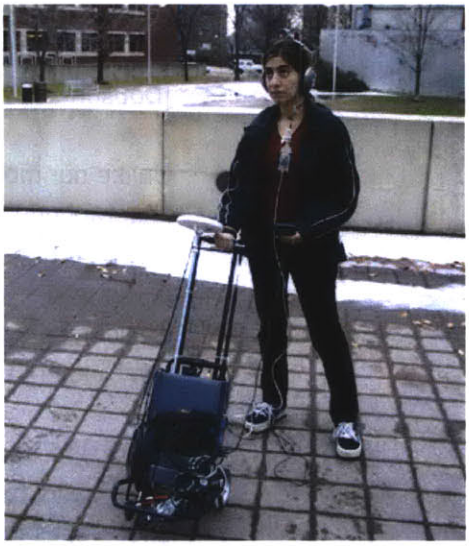


Figure 4.12
"Here and There"
by Joey Rozier and
Karrie Karahalios.

show us the ways how two places can be socially connected to each other primarily with audio and non-photorealistic graphics. As she connects two places, she uses a selective, transformative strategy to represent the parties on each side. Instead of depicting participants in full resolution video, she converts the data into an abstract, visual language, asking the viewers to interpret the other side. The abstraction of person, setting and feedback between the spaces provides the social catalyst for the experience, according to Karahalios. These murals create "a common ground for interaction" and "an object for experimentation" that activates the social use of the space. [Karahalios 2004]

"Telemurals" provide a relevant perspective on the design of a common ground for a social catalyst. As a public sculpture, it identifies strategies for participation and shared meaning. It shows us that being not able to see each other clearly doesn't hinder the communication, but instead catalyzes it, given the right context. Here, Karahalios not only connects two locations with each other, but also shapes the meanings of these locations as they become entry points for anonymous individuals to an abstract space where they may relate to each other. Similar to her blending images, we see in our audio collage a temporary space for anonymous expression, where individuals not only respond to individual questions, but also to their shared presence in a public space.

"Agoraphone" by Dobson [Figure 4.11], on the other hand, addresses the activation of the public space by anonymous urban public communication. Her sculpture functions like a public medium, in which people can call from any touch-tone phone. As a communication sculpture, it "enables and encourages citizens to easily respond, be responsible towards each other, in urban public places." As the practice of public speaking intends to rise communal

awareness, for Dobson, AgoraPhone also serves for an object to play, "to satisfy curiosities, to casually converse about anything, to sing to the place..." [Dobson 2002].

Unlike our more guided interaction, which asks specific questions to users, "Agoraphone" creates a free channel for one-on-one communication in the urban setting. While each work differently in technique, both aim to rise communal awareness. They both respond to the social and cultural context of an open public space and intend to change their audience's perception of the environment with a social object.

"Here and There" by Joey Rozier and Karrie Karahalios [Figure 4.12], on the other hand, focuses on asynchronous aspect of public communication and encourages people to "virtually drop sounds at any location in the real world" [Rozier and Karahalios 2000]. By using an GUI, the designers allow the users to imprint audio files in physical spaces, which can then be browsed by a GPS-based listening interface. From recordings of personal thoughts or anecdotes, and music or other sounds that are associated with a given area, "Here and There" transforms both the uses and meaning of public places by augmenting the space with information.

"Here and There" is particularly important in its focus on making an information overlay on the physical environment. While this information is not tied to a physical interface and is only accessible via a GPS-based personal interface, it provides an important view on how space can be completely re-purposed and reprogrammed with participatory practice. While the content will be invisible to the normal eyes, the space will be radically different for a group of people that have created their own meaning out of it. The fundamental similarity we see between our work and "Here and There" is the intention to foster community awareness, making a space by and for its people. By allowing virtually all members of a community to participate in imprinting sounds to the same shared space, both pieces intend to bring different perceptions of the space by different people. Again, we see the rich expressions carried by snippets of voice that not only bring their content to the place, but the layers of meaning hidden in the qualities of the voices (e.g., age, gender, accent, etc.) that depict the socio-cultural aspects of the space.

4.1 Comparison of Public Media

In this section, we would like to provide the reader more background on the design aspects of our interface. As we will begin to describe our interface in detail, we will also provide the reasoning behind our interface design.

In the following diagram [Figure 4.13], we intend to give the reader a comparison of different displays and interfaces we considered for our prototype

design. While this list does not intend to be a full ontology to discuss all aspects of public interfaces, we used this subset for its potential to be used and explored as public interfaces in different applications.

In our prototype, we intended to use different interaction paradigms for different input/output purposes, therefore, our design needed to have a modular architecture to allow us to combine different interface elements (speakers, microphones, bent sensors) with each other. After deciding to use a touch-screen interface for running a GUI-based audio recording application, we experimented with the following media for building an interactive programmable surface that could have a sensing infrastructure in it for recognizing its own shape. Here is a summary of our experience with the media that we experimented with before making the final decisions in our prototype design:

1) Electronically/mechanically responsive materials (e.g., shape changing alloys, Nitional... etc) [Coelho 2007], "programmable materials," are limited in their information capacity (e.g., slowness, resolution, material limitations) but are highly flexible for physical manipulation. While they can be efficiently used for permanent outdoor installations, their slow responsive time make it difficult for direct user interaction and feedback.

2) "Peripheral displays" [Tara et all 2004] (e.g., ambient orb, "D-Tower") are very unintrusive in nature and have the capacity to carry both symbolic and abstract information. However, they can only communicate for those who already know the mapping between the input and the output. Like the "D-Tower," the information is only accessible to those how to read the meaning. These displays are highly re-purposeable for different mappings, as they do not offer much flexibility for user-driven, interactive information.

3) LED panels (e.g., bus stop, our prototype) are low resolution in nature and therefore have limited uses for close proximity interaction (e.g., text is only readable from a distance). On the other hand, they have good potential as outdoor interfaces when tiled in large quantities. As LEDs' are individually addressable, one can design custom geometries with them (e.g., triangular, circular).

4) Static public displays (e.g., billboard, walls, columns, stickers) are relatively very cheap to use as public media. They can carry high-resolution symbolic information (e.g., image, text), but they are not re-programmable or re-purposeable and therefore are not suitable for any interactive application.

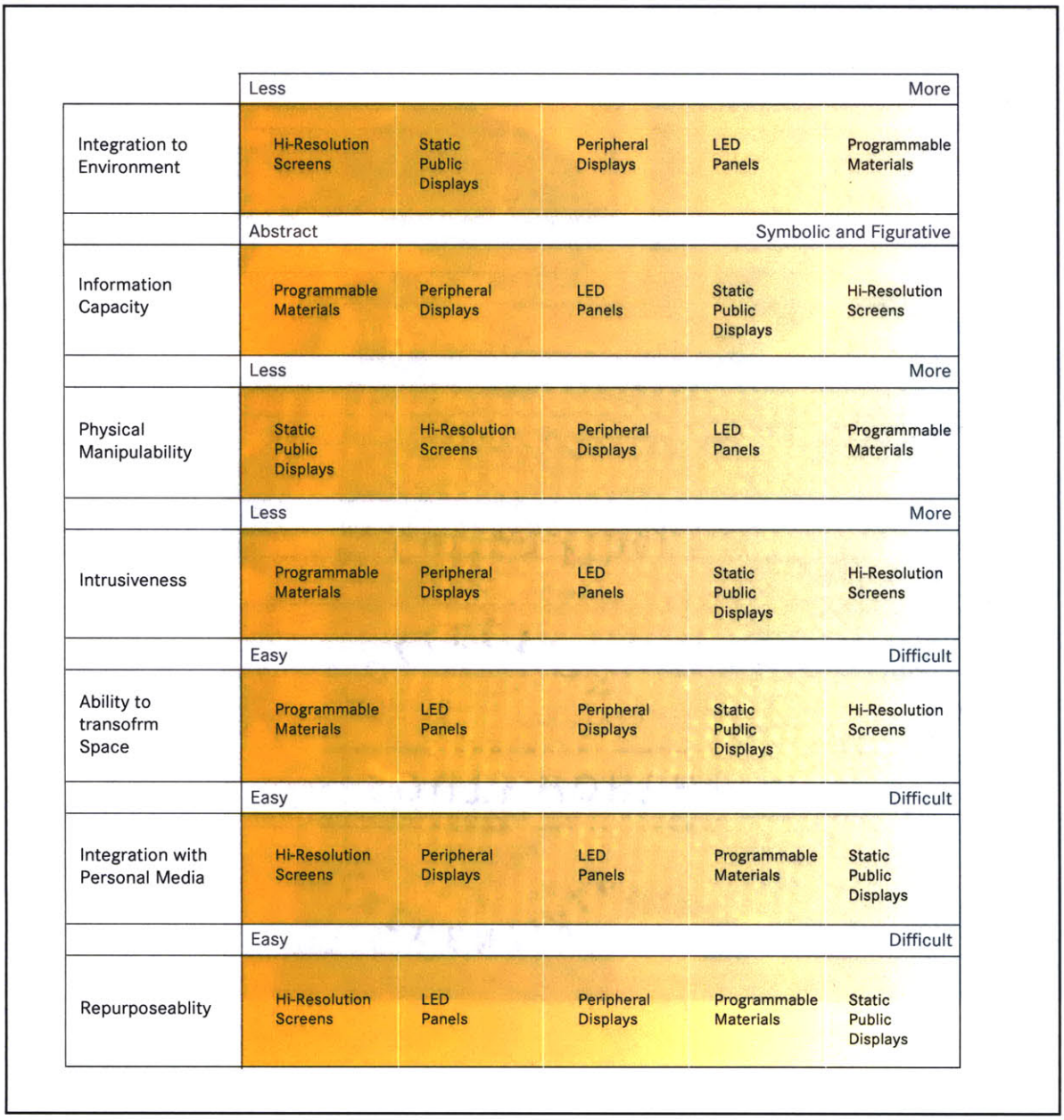
5) High-resolution screens (e.g., a TFT monitor), as they are already extensions of the desktop media culture are widely available for integrating with

personalized media. However, they are quite expensive to be tiled as large-scale displays. Their specific screen design also makes them difficult to integrate with the existing architecture of a place.

It is the trade off between the physical manipulability of a public medium and its capacity to carry symbolic information that primarily influenced our decision to use LED panels for our current design. As seen in Shirvanee's work, LED technology may also be used for building an interface that is partly a peripheral display and partly a physically-manipulable surface for different usage scenarios. For us it is ultimately the desired resolution and the type of physical interaction that determines the role of an urban public interface.

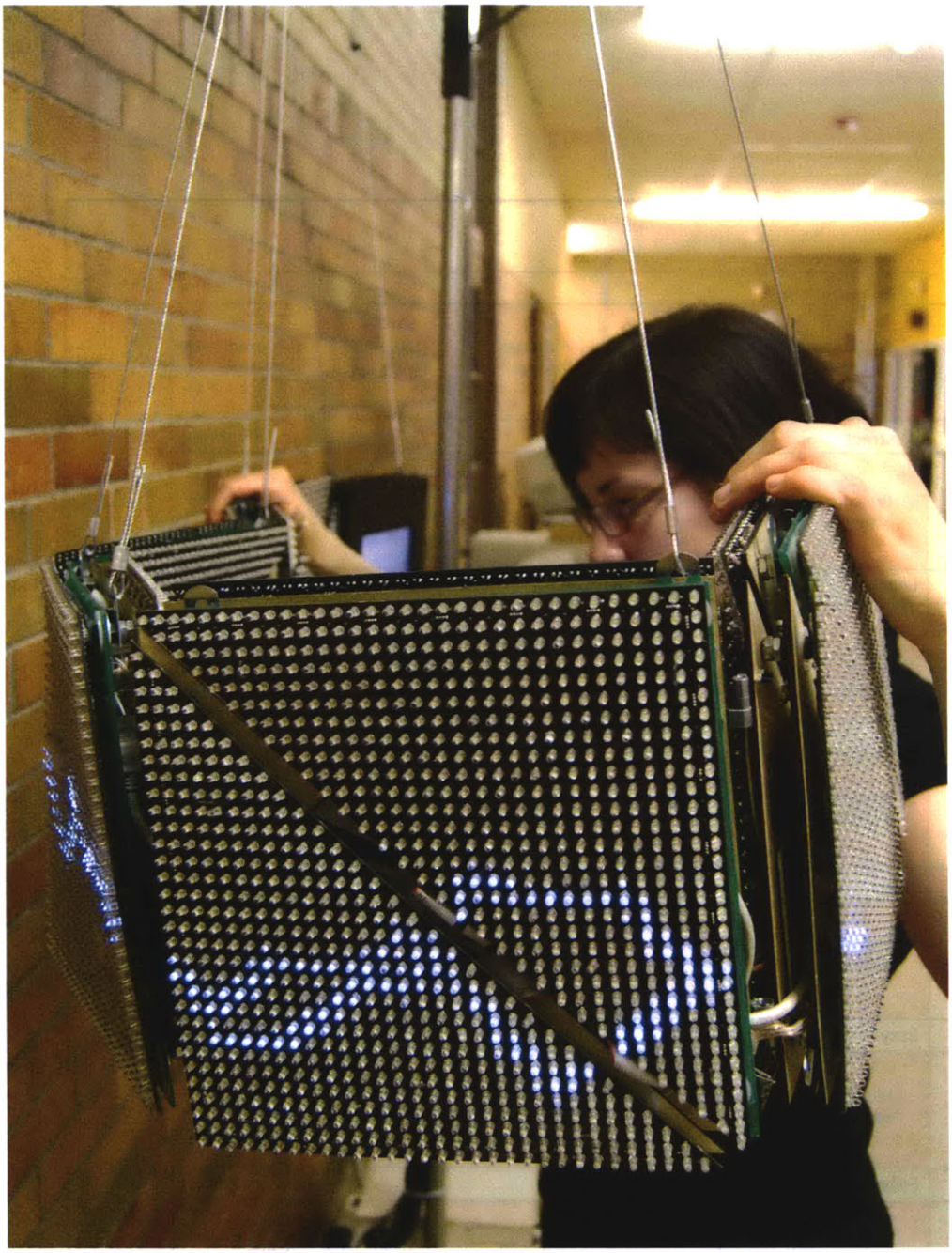
Our choice of the LED technology was primarily based on its suitability for the triangular panel architecture. This gave us a considerable amount of degrees of freedom for foldability. This characteristic is not possible with any other existing technology, other than programmable materials. While we also could have had more physical flexibility and better integration with the current architecture of a place by programmable materials, we needed a medium with enough resolution (at least 10K pixels) that could represent more figurative and symbolic information for its users, especially when there is a need to provide immediate visual feedback. On the other hand, the ability to address individual pixels in almost any geometry also allowed us to conceive a very modular architecture that could incorporate other interface elements (e.g., a touch screen).

We also remind the reader that we considered the use of projections for our purposes. While they have many advantages as public displays and find appropriate uses in art and architecture, [Figure 2.8 and Figure 2.9], we didn't use this because of our need for physical interaction. We wanted to the users to be able to physically change the information surface (to be able to manipulate its edges, borders) and have a control over the shape of the interface; this was not possible to achieve with a projection.



	Less				More
Integration to Environment	Hi-Resolution Screens	Static Public Displays	Peripheral Displays	LED Panels	Programmable Materials
	Abstract				Symbolic and Figurative
Information Capacity	Programmable Materials	Peripheral Displays	LED Panels	Static Public Displays	Hi-Resolution Screens
	Less				More
Physical Manipulability	Static Public Displays	Hi-Resolution Screens	Peripheral Displays	LED Panels	Programmable Materials
	Less				More
Intrusiveness	Programmable Materials	Peripheral Displays	LED Panels	Static Public Displays	Hi-Resolution Screens
	Easy				Difficult
Ability to transofrm Space	Programmable Materials	LED Panels	Peripheral Displays	Static Public Displays	Hi-Resolution Screens
	Easy				Difficult
Integration with Personal Media	Hi-Resolution Screens	Peripheral Displays	LED Panels	Programmable Materials	Static Public Displays
	Easy				Difficult
Repurposeablity	Hi-Resolution Screens	LED Panels	Peripheral Displays	Programmable Materials	Static Public Displays

Figure 4.13
Comparison of
Public Interfaces



Detail from the interface-user interaction. Users interact with the recorded voices by changing the geometry of the interface.

5
Design

5.1 Design Features

We designed a custom, multi-modal interface made of LED based display panels, bent sensors, speakers, microphones and a touch-screen panel, which together function as a tangible, interactive sculpture integrated into a single medium [Figure 5.1 and Figure 5.2]. Our final prototype has six double-sided, square LED panels and one GUI panel mounted together with flexible, torque resistant hinges that are able to hold the panels at various positions.

Figure 5.1
User folding interface

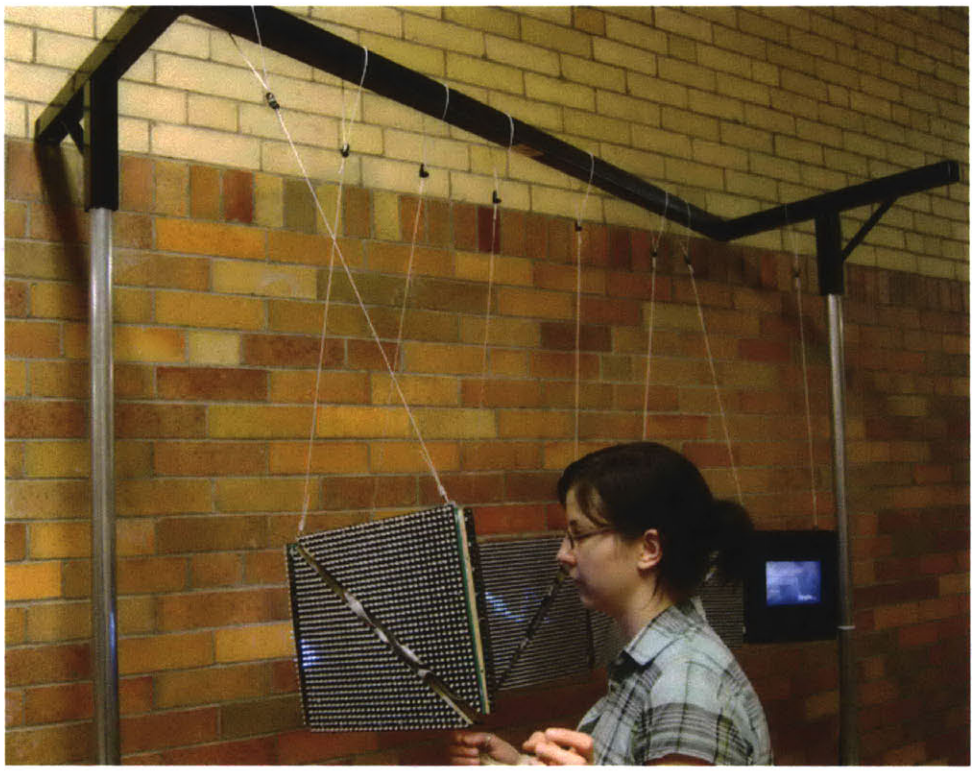


Figure 5.2
Interface suspended from custom frame

Each panel has 1024 white LEDs (on each side) and is divided diagonally into two halves. Panels are driven by custom electronics enclosed into a frame holding the LED arrays. Frames provide the support structure for the panels and also include hanging elements for alternative suspension/mounting applications [Figure 5.3 to Figure 5.6].

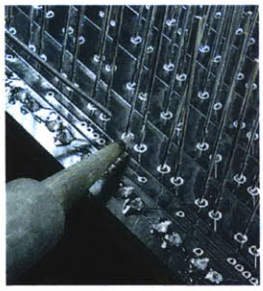


Figure 5.3
Soldering process

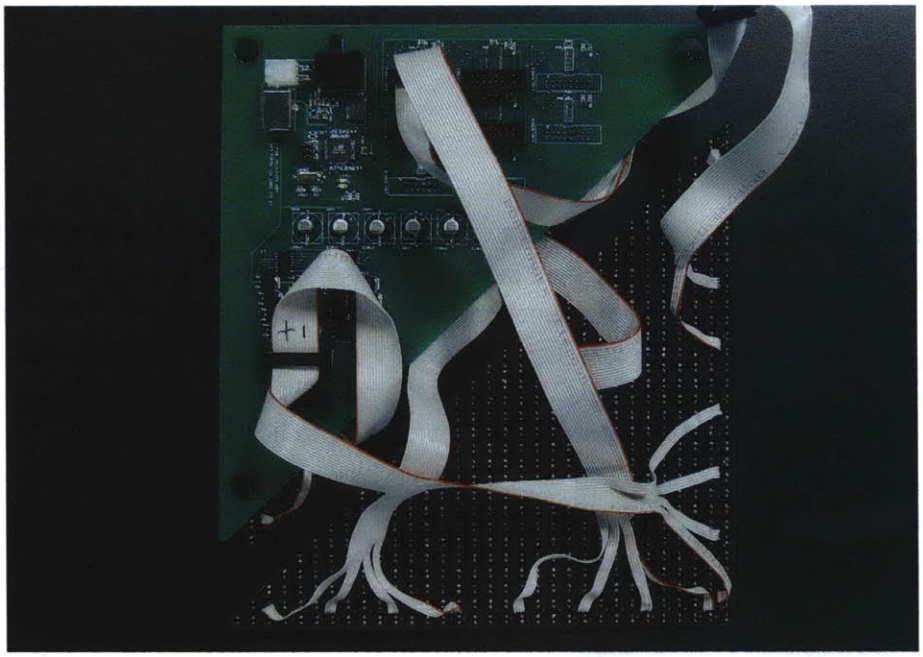
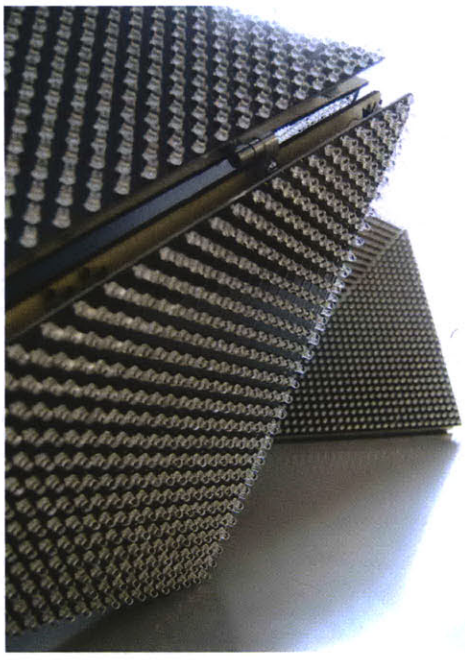
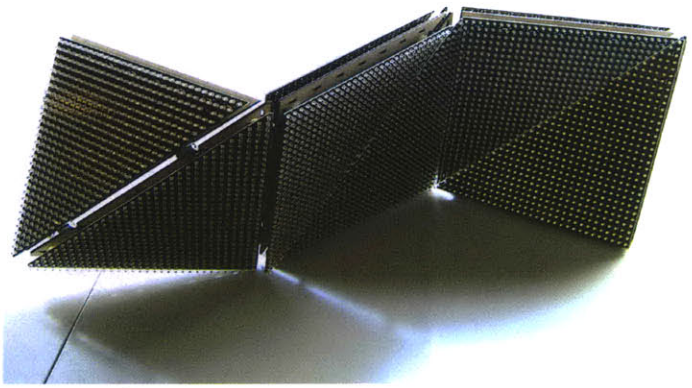


Figure 5.4
Electronics connected to LED panel

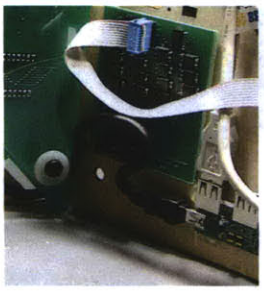
Figure 5.5
Panel Detail

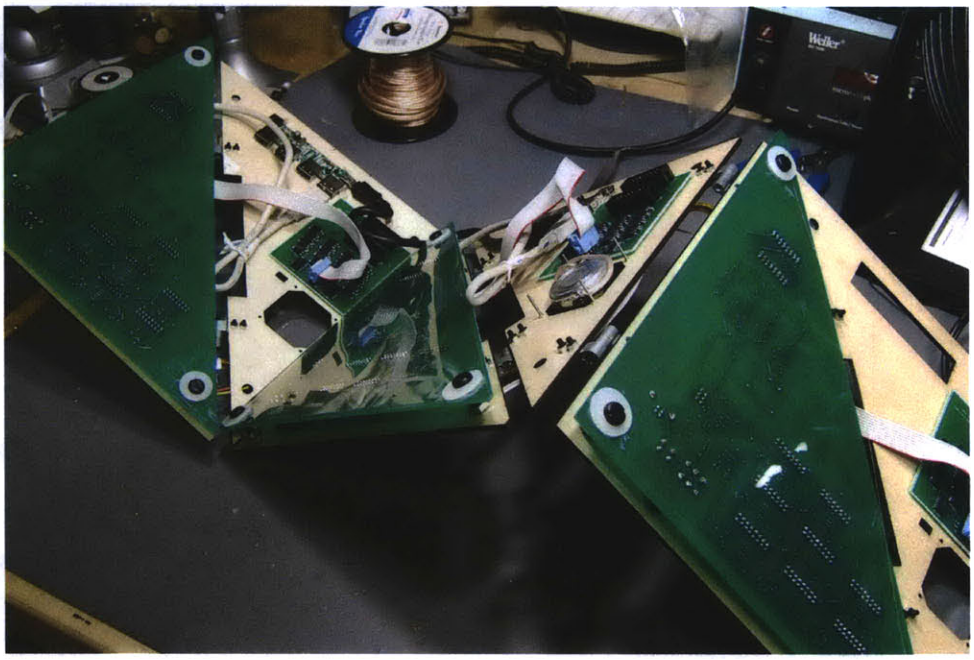
Figure 5.6
Three panel set-up





Panels are modular, expandable and autonomous designs that are mechanically and electronically connected and daisy chained with each other (via USB) for the transmission of information [Figure 5.7 and Figure 5.8].





Each panel includes two bent sensors, which are used to determine the current geometry of the interface and dynamically calculate a response to the physical interactions caused by the user [Figure 5.9]. Selected panels also have embedded speakers, which can separately be programmed for audio output.

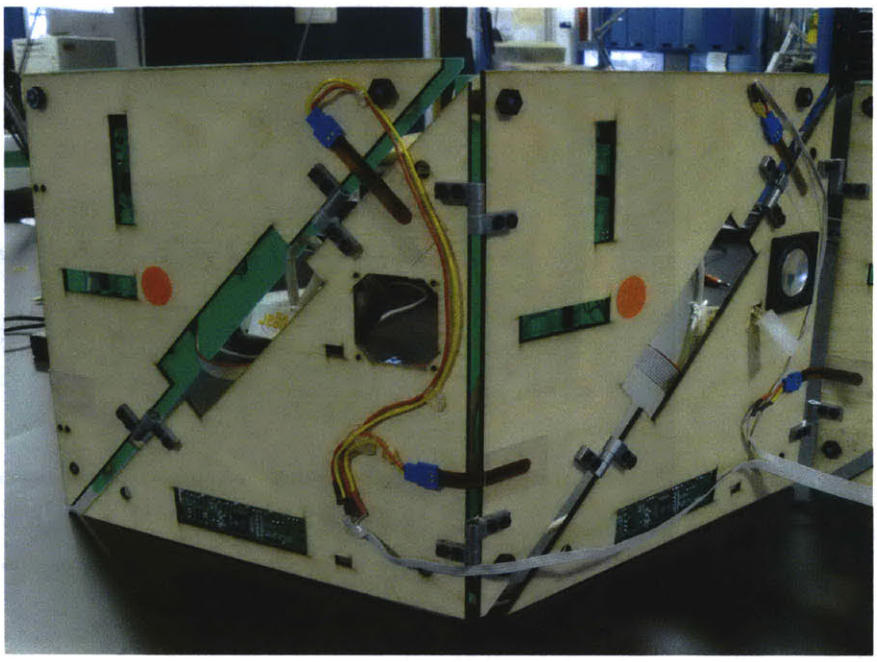


Figure 5.7
Panel daisy chaing detail

Figure 5.8
Electronics mounted on the wooden structure.

Figure 5.9
Sensor infrastructre

Panels can be folded diagonally and sideways in a three-dimensional, reconfigurable screen architecture, which allow them to be used either as individual screens or a continuous extended display surface [Figure 5.10 and Figure 5.11] .

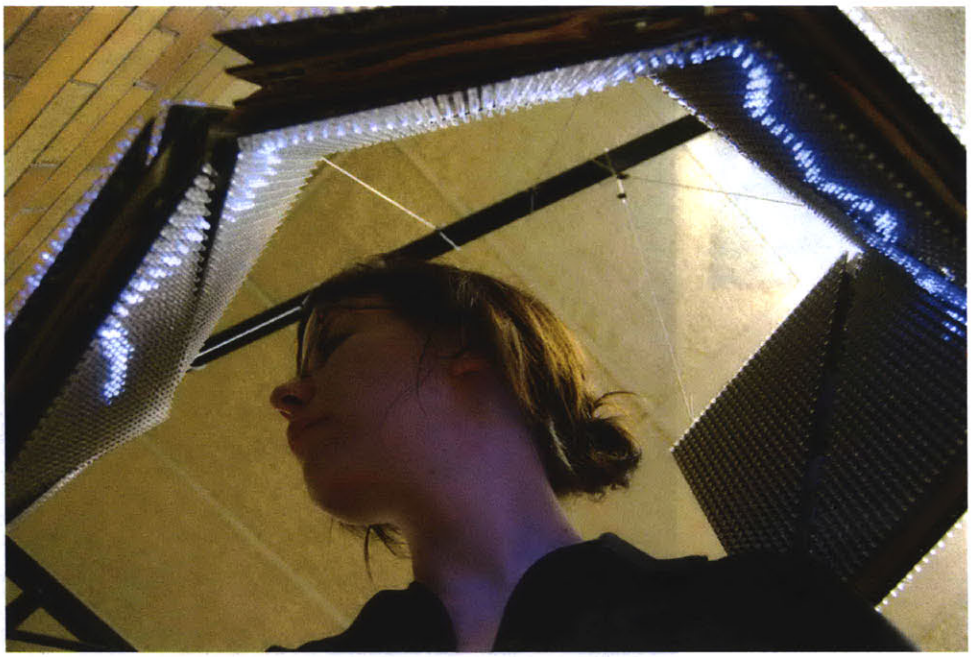


Figure 5.10
Graphics respond to existing geometry: line flowing freely between panels.

Each panel includes two bent sensors, which are used to determine the current geometry of the interface and dynamically calculate a response to the physical interactions caused by the user. Selected panels also have embedded speakers, which can separately be programmed for audio output

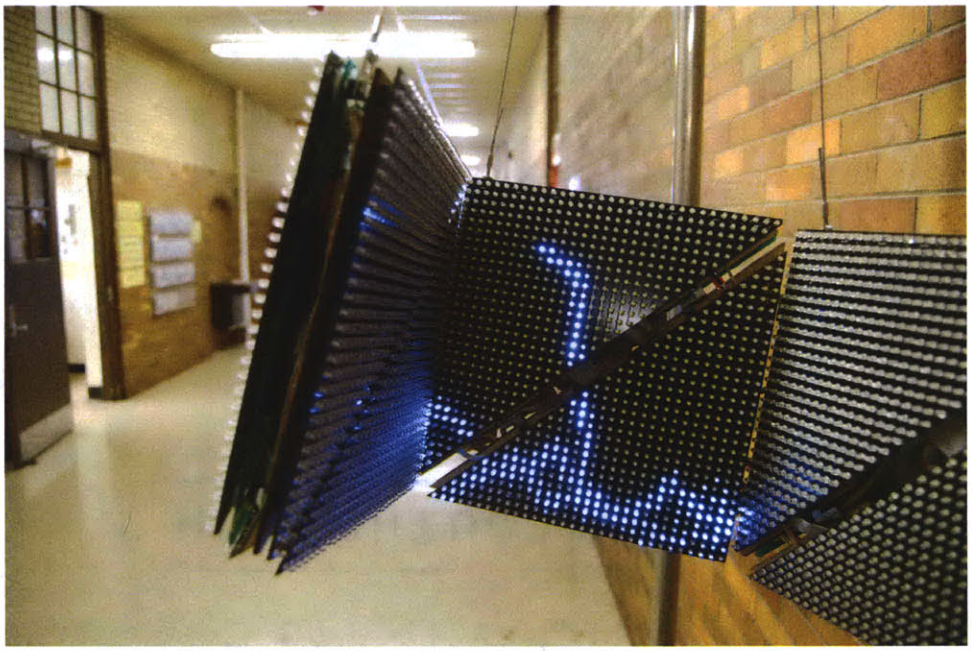


Figure 5.11
Graphics respond to existing geometry: line trapped between panels.

The GUI panel holds a microphone and a 7" touch-screen, 800 x 480 pixel, TFT display used for displaying high-resolution information such as text and GUI elements for more conventional input [Figure 5.12 and Figure 5.13].

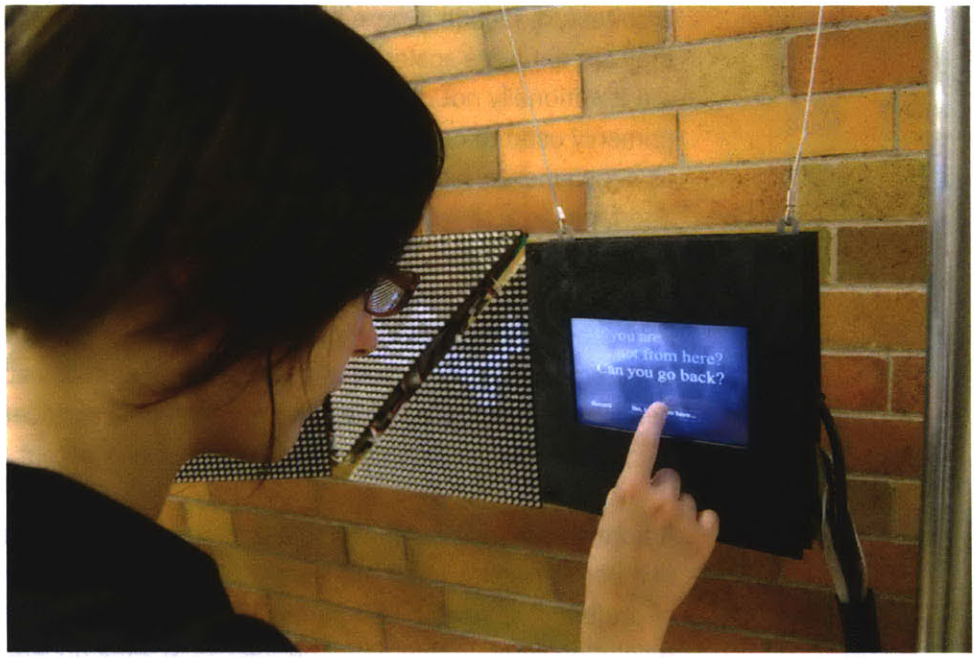


Figure 5.12
User navigating the menu in the GUI Panel.

Figure 5.13
User recording audio using the GUI Panel.

5.1 Design Concepts

In Chapter 4, we argued that existing public displays and interfaces remain underutilized if they become overly literal translations of desktop and personalized computing metaphors, and by not paying enough attention to their surrounding architecture. The 'window' based spatial organization of information on desktop interfaces, finds very literal translation in a storefront or architecture façade, where buildings are augmented with digital surfaces as if they are flat large scale displays. Also, we believe that programmable surfaces are traditionally not designed as individual architectural elements, but instead primarily used to cover other elements or to be attached to them functionally as supplements, leaving their potential often underexplored as stand alone interfaces in architectural design.

Given our conceptual framework, one of the main intentions of this project is to propose a new kind of public interface that can blend in better to the architecture of a place and raise important questions about the technical and conceptual boundaries between programmable surfaces and architectural elements, screens and interfaces and input and output devices.

Before committing ourselves to a particular public media, we considered a number of display, input and output technologies and looked at the affordances of projections, flexible LED panels [Reference to Bus Stop], and small hi-resolution screens that could be tiled for scaling up larger scale displays. Our final design reflects a mixture of these solutions. The reader can find a more detailed and a comparative study of these different media elements in Chapter 4, Table X.

Figure 5.14
Experiments in 3D geometries

Here, we discuss a series of concepts with which we experimented, implemented and tested for exploring new perspectives on the relationship between information, architecture and public interfaces.

5.2.1 Three-dimensionality

Our prototype uses a three-dimensional display architecture that is not constrained to the aspect ratio of a traditional screen (e.g., 3:4, 16:9, etc.) and therefore can potentially integrate with other three dimensional forms around it [Figure 5.14]. As the display is situated in a given architecture (e.g., mounted on a wall, suspended from a ceiling), it can be extended in size and reach different lengths. While the visual surface of our interface is 9 inches by 63 inches, it is possible to virtually reach any length and be able to use the interface as a continuous surface for outputting information.

5.2.2 Physically Responsive Interfaces

By using bent sensors, we are able to design a reactive surface, which can sense both its existing shape and the location of its content while responding to

Figure 5.15
Double-sided interface

user interaction. This architecture allows us to design a topology for the visuals on the surface, making them respond to the surface they occupy. Therefore, it becomes possible to control the flow, aggregation, direction and turn of graphics and turn these physical parameters into design elements during the presentation of the information.

5.2.3 Double-sided Interfaces

By designing double-sided interfaces, it is possible to free the form of interface from a dependency on supporting surfaces [Figure 5.15]. As the interface gains volume, it functions more as a sculpture, creating a three-dimensional space around it, allowing us to experiment with alternative input methods (e.g., gestural, physical input) that provide different relationships with the environment. While we explore an origami like display design metaphor (as foldable panels), it is important for us to blur the difference between the beginning and the end or the back and forth of a screen and consider it as a double-sided canvas shaped in the hands of the user.

5.2.4 Breaking the Traditional Frame

Breaking the conventional screen geometries, also suggests new ways to think about the representation space. From wide-screens to long-screens, these new architectures provide seamless surfaces that not only break traditional perceptual habits, but also create opportunities for unique visuals that can only be presented in these displays. As we experiment with our prototype, we observed that we can not only achieve fully curved (mobius-stip-like) surfaces, but also witness many surface effects (e.g., folds, bents, turns) that create optical illusions due to the double sided nature of the display.

Similar to the American modernist painter Frank Stellas' paintings on shaped canvases, a break in the traditional visual frame finds new ways to interpret the relation between content and canvas, image and surface exploring three-dimensionality of visual representation with sculptural forms.

Figure 5.16
Frank Stella's 'Harran II', 1967. Polymer and fluorescent polymer paint on canvas
Image from: http://en.wikipedia.org/wiki/Image:Frank_Stella%27s_%27Harran_II%27%2C_1967.jpg

5.2.5 Sentient Interfaces

As these new geometries allow us to conceive new visuals, we argue that one can design custom interfaces, which can blur the distinction between content and its canvas, presenting an interactive sculpture-like object. While the tradition is to design images for generic displays reconfigurable and reactive surfaces allow us to experiment with dynamically changing, responsive images that not only respond to a user input, but also to the very physical structure. With the disappearance of traditional GUI elements (e.g., mouse, buttons, menus, etc.), graphics become visual responses from light-emitting surfaces. Like a chameleon's skin, which responds to environmental stimuli, the interface can show its response to the user interaction both physically and visually, as if exhibiting a sentinent nature with (presumed) agency.

5.2.6 Interface as Visualization

As the role of this interface is to primarily sense and reflect the changes in the environment, another challenge is to use the interface as visualization itself, again blurring the boundary between the content and its display. While we haven't fully experimented with this aspect yet, we realized that the on-site physical interaction with the interface also provides enough parameters and real-time data to be used for depicting user interaction. As the interface is used by different places and by different audiences, it becomes possible to use physical information as another source of input that can reflect the user's interaction to a particular content that is specific to that location. If the users bend the display always in a particular way, it is possible to interpret it as a reaction to the content that can be understood beyond playful interaction.

5.2.7 Interface Shaped in Progress

While traditional interfaces often do not change their form and content in a given application, a responsive interface can alter its behavior and functionality for a different physical shape in a given context, turning this feature also into a design element. We designed our interface with slight variations in behavior for different amounts of content and different screen geometries, sometimes creating unusual responses to surprise the users and emphasize its sentient nature. Depending on which tiles are bent more than the others, the graphics gravitate more or less towards that direction, moving from their usual place.

5.2.8 Modular Architecture

As we designed this prototype for sensing and reflecting different features of the environment, we experimented with a number of sensing technologies, input and output paradigms. Therefore we developed a modular interface architecture that was able to use various kind of HCI strategies with each other to avoid the mixing of different paradigms for specific uses. For example, in order to display instructions for our voice recording application, we used a

hi-resolution screen and a GUI based approach and didn't try to use the low resolution LED panels for the same purpose. In a modular interface, where different units are connected via similar architecture, it becomes much easier to design an interface specific to a location and adapt to its custom needs.

5.2.9 Multi-Mode Interface

Starting from our early prototypes, we experimented with the possibility of having multiple modes in our interface determined by its physical geometry (e.g., private interaction mode, vs. public display mode). If these modes are also supported by the underlying graphics and interaction scenarios, we observed that it is quite possible to switch different parts of the interface to different modes and therefore to use it for different purposes. In our final implementation, for example, we identified two main states for the interface: 1) a flat mode, in which the graphics will flow without interruption, and a bent state, which controls both the topology of the graphics and also the sound output in a specific way and 2) a bent mode, so when bent in a particular [Figure 5.11] shape (registered as two bent panels and a flat panel between), the interface switches to a more private mode, as if creating a private corner for the user, letting him/her to crawl in and isolate themselves from the environment. As the display marks a boundary around the user, it physically separates them from their environment, but surrounds them for a more intimate experience, in which they are presented with a different set of output (e.g., answers to the second questions asked by the GUI interface)

5.2.9 Foldable Interface

We started with a Origami like metaphor for designing foldable screens. As opposed to flexible displays [Figure 5.17], our screens can preserve their state in a given position with the use of a supporting architecture (e.g., hinged frames). While our screens are relatively thick in nature and have seems between them (due to the limits of a low budget and a hand-made manufacturing process), we still were able to explore the potential of a foldable surface that can virtually behave like a strip of paper, which can be folded from the edges and the diagonals into different three dimensional forms. For future work, we imagine many other uses of this technique for designing thinner, seamless and more foldable interfaces that can introduce new interaction paradigms for different applications.

Figure 5.17
Flexible Screen by Universal Display Corporation (Image from: http://www.pocketpcmag.com/_archives/Feb05/images/Feb05_p80_3.jpg)

5.3 System Design

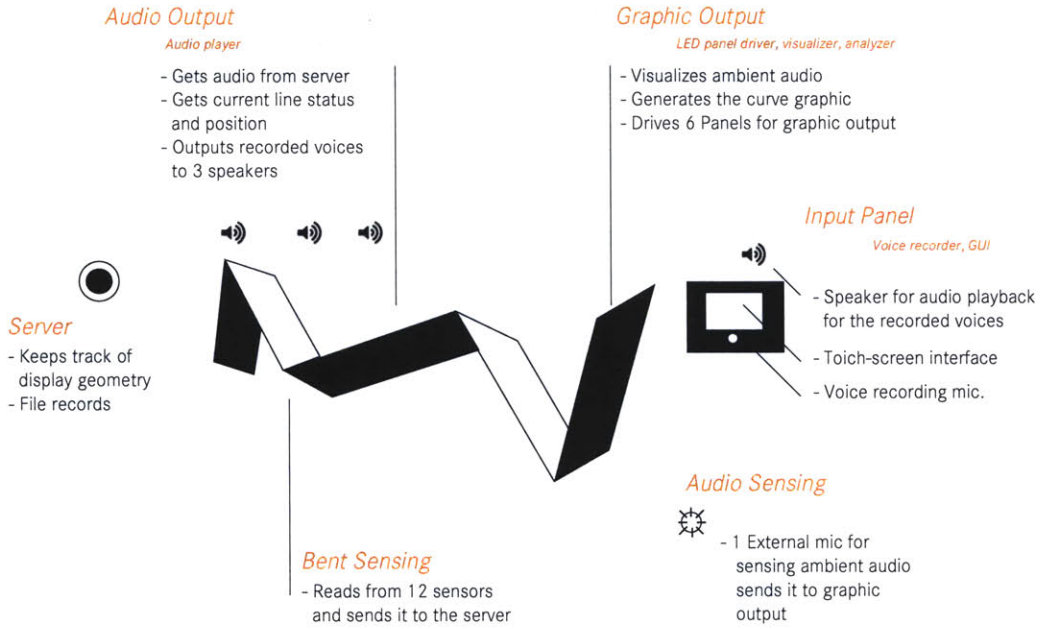


Figure 5.18
System Design Schematics

This interface is mainly composed of the following interdependent units [Figure 5.18]: 1) Graphics output, 2) Audio Output, 3) Bent Sensing, 4) Audio Sensing, 5) Input Panel, 6) Server.

5.3.1 Graphic Output

A group of applications that drive the LED panels, visualization and the analysis are grouped under this unit. It is mainly responsible for generating and animating the curve depending on the external audio levels, forming the whole display buffer and dispatching the graphics to individual panels based on their current geometries sensed by the bent sensors.

5.3.2 Audio Output

This unit communicates with the server and the graphic output unit to decide which files needed to be played while the line traverses the screens. It generates the audio collage from the voices by controlling their play, fade in and fade out order.

5.3.3 Bent Sensing

A custom circuit continuously reads from 12 sensors embedded inside the panels and sends it to the graphic output, where all sensor values (one diagonal and one side per pane) are updated 30 times per second. From here, the recent geometry of the interface is uploaded to the server (every 30 sec.).

5.3.4 Audio Sensing

This unit handles the ambient audio sensing, voice detection, analysis and recording applications together with the Input panel. It uses the microphone on the input panel for voice recognition and an omni-directional mic for sensing the environment. After noticing the need for normalization of certain audio files due to low quality recordings (e.g., because of users being too quiet, or too far from the microphone), we added an audio quality monitoring application to this unit, which checks audio values and normalizes them if they are below average.

5.3.5 Input Panel

The GUI is the primary application in this unit. It guides the interaction with the user to provide the introduction to the installation and the recording/playback of the answers for the questions.

5.3.6 Server

We used the server for primarily keeping track of the history of the screen architecture and the records for the audio files (e.g., date of creation, how many times they are played... etc.)

5.4 Interaction Scenarios

We named the first installation of this public interface as "Echologue" and designed two kinds of interaction scenarios for it: a physical interaction mode, in which users can reconfigure the geometry of the interface by bending the panels for interacting with the graphics, and a GUI input mode, in which they interact with the touch-screen panel to answer the two questions we asked.

While these interactions are mutually dependent on each other, we did not expect the users to always participate in both of them. The goal was to design the system as an interface for people who are willing to participate in it, but also to make it survive as a public display in which case, the users would only browse its content as passers-by.

5.4.1 Physical Interaction

As discussed before, our thesis intends to question a number of issues concerning borders: borders between information and places (media and architecture), people and information (information users and producers) and people and people (social and spatial borders). We designed the interface with the possibility to challenge its own physical shape and boundaries and to explore different conceptual links within the overall theme.

By enabling panels to recognize their edges and connections points to the other panels, and therefore making them aware of their beginning and ends, we can address each panel either individually or connected: either with broken borders

or as a connected whole. Thus the users' physical interaction with the panel becomes conceptually linked with the content, as their interaction determines both the way they access the content and also its presentation.

As a visual and conceptual aid, we guide the physical interaction with the use of graphics. Starting with a free flowing line that bounces back and forth between the first and last tile, the user is confronted with an "unbroken," smooth interface. Without any interruption the line flows from panel to panel and whenever it hits a panel with a speaker plays a voice randomly picked from the pool of answers to the first question (Where are you from?) recorded by the previous users. Users hear a collage of voices as each sounds fade in and out: I am from Cambridge. I am from Ivory Cost, I am from Belgium, Egypt, Jordan, etc. While the line traverses its path, it plays a recording on every other panel and creates a localized sound experience.

If/when the user interrupts this scene by folding one of the panels, he/she traps the line, not only breaking the flow but switching the interface to a secondary mode, in which the line plays voices from the answers of the second question. [Please see figure x for an example of trapped line]. Now, we hear from the users who say: No, I cannot go back. I don't want to go back. May be. One day. Never, etc. Being trapped in a single panel plays the sounds only from that panel, until the user folds the panels back and releases the line.

For supporting this basic interaction scene, we tried a number of strategies to make the interaction more intuitive. After some feedback from our users, we decided to give more direct visual cues to indicate the changes caused by physical interaction. As it was not very obvious to users if they were doing something right or wrong when they broke the flow of the graphic, we decided to give visual feedback on the borders of the tiles by highlighting the edges of the tiles (with a single pixel vertical line) as they are folded.

While communicating the benefits of the physical interaction for the explorer type user (e.g., young kids in the library) was easy, we experienced significant difficulties with first time users. Could it took on average three days for some regulars to discover what they could do with the panels and to start touching the panels, prepared to see changes. Given that if it is not common practice to touch an LED surface or monitor that is not presented as a touch-screen interface, we tried to inform them a little more with some subtle clues which we communicated through handouts.

However, as a lesson for the future versions of the interface, we realized that we need to support the interaction with a metaphor that will create a much stronger theme, or underlying logic to fold the displays without expecting any

changes. For example, if we had presented the interface as a creature that responds to a special kind of physical gesture (e.g., such as flipping the tail of a fish), we believe we would have had more immediate response from the users.

On the other hand, creating a conceptual unity among all the other parts of the project was already difficult for this installation, so we decided to implement those kinds of changes in future installations.

5.4.2 GUI Interface

The GUI interaction consists of a series of screens primarily for collecting answers for the two questions: Where are you from? And if you are not from here, can you go back? [Figure 5.19]

With an initial screen that explains the project, this is a simple interface that walks the reader through the process of recording their voices. Each user is asked to respond to the questions in three seconds, allowing us to encourage them to make up their mind quickly and also standardize the duration of the sound files in the sound collage. The GUI presents them a countdown counter that indicates the remaining time. As they finish, they can playback, record again and start-over at anytime.

It is worth mentioning that we switched to a GUI interface after trying an audio only interface for handling all parts of the interaction. In a simple recording scenario (start, record first question, stop, playback, either record again or proceed to next question, start, record second question, stop, finish), we got

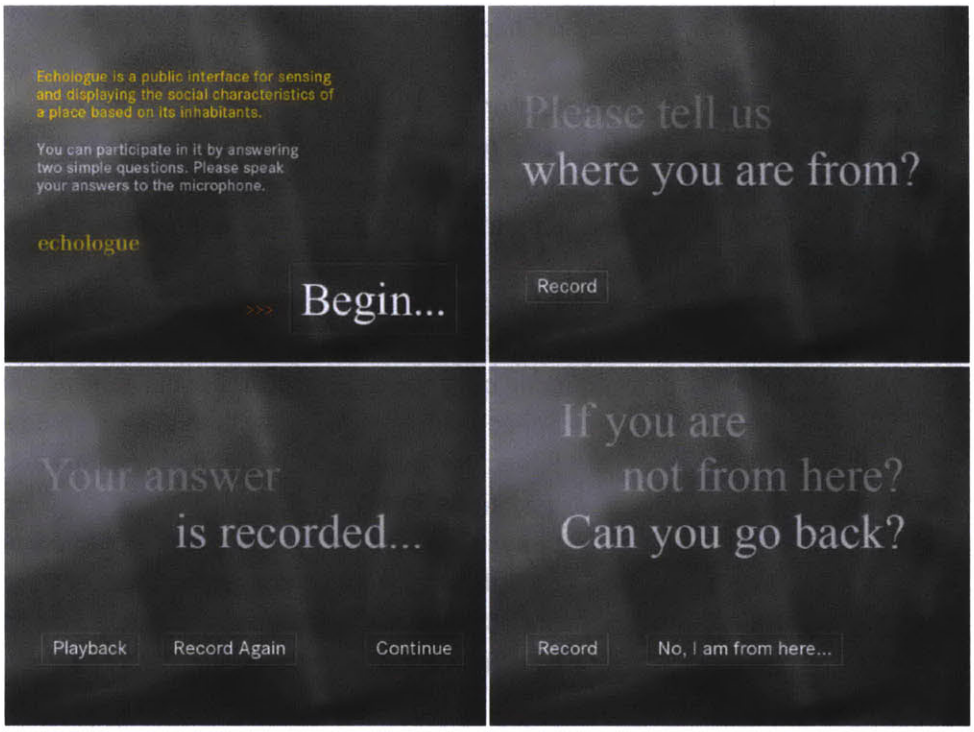


Figure 5.19
Sample screen grabs from touch-screen interface

Figure 5.20
Simulator programmed in Python using OpenGL, PIL, Pygame for graphics; PyAudio, PyMedia, Praat and custom libraries for audio analysis; Orange for pattern recognition and classification algorithms. Models are designed and loaded from Blender 3D.

reasonable technical success with an audio online interface that primarily was operated by audio analysis (e.g., Sensing a nearby user, starting recording with voice activation, stopping recording by detecting silence... etc.). However, after a set of initial user testing, we decided to switch to a GUI set-up to increase the robustness as well as decrease the cognitive load on our users. Users performed much better when they had visual feedback during the process (e.g., starting a recording, stopping a recording). We discuss this aspect much more detailed in Chapter 5 in "Evaluation and Critique".

5.5 Information Design

5.5.1 Simulator

After deciding on the interface architecture, we built a simulator [Figure 5.20], a graphics programming application that allowed us to experiment with different screen geometries, input and output methods.

We modeled the physical interface in a 3D program (Blender) and loaded it to the simulator, in which we could visualize the outputs of a variety of sensing and analysis techniques based on ambient audio sensing and voice input. We tried:

- Speech recognition for digits to detect zip codes
- Speech recognition with a limited vocabulary for detecting answers of questionnaires
- Speech analysis for detecting ambient audio intensity
- Speech analysis for gender and age detection (e.g., young, mid-age, old)
- Speech analysis for silence vs. noise vs. speech differentiation and machine vs. human sound differentiation.

We mapped these outputs onto different kinds of visuals (e.g., numbers, abstract graphics, symbols) and tested their look in real-time with the different screen geometries explored in the simulator [Figure 5.21 and Figure 5.22]. In our final design, we selected the features that we thought fit best with our interaction scenarios.

5.5.2 Technical Specs

In our design, a single 9" LED panel consists of 32 rows and 32 columns and forms a matrix of 1024 individually addressable pixels for each side of the panel. Each 32 x 32 (w x h) panel is horizontally tiled with the adjacent one to form a 32 x 198 pixels design area for both the back and the front of the display.

This six panel LED, 54" configuration allows us to design 12-bit grayscale graphics that can be updated more than 60 fps. We oserved that the high frame rate was necessary to avoid flicker in the display as the fast turn on/off rate of the LEDs superseded the persistence of vision of the human eye that usually sees no flicker in 30fps update rate in 50 Hz Screens.

To not compromise the update rate, we designed our graphics in 8-bit and allowed the LED drivers on the electronics circuit to do the color correction and 8-bit to 12-bit conversion. This resulted in a sharp gamut that is quite different than TFT monitors. While we haven't made any precise measurements, we noticed that it is quite difficult to differentiate grayscale values after 70% (e.g., the difference between 70 and 80 and 80 and 90 are almost indistinguishable). We compensated for this in software and programmed a software gamut control in our software to maximize the use of grayscale values.

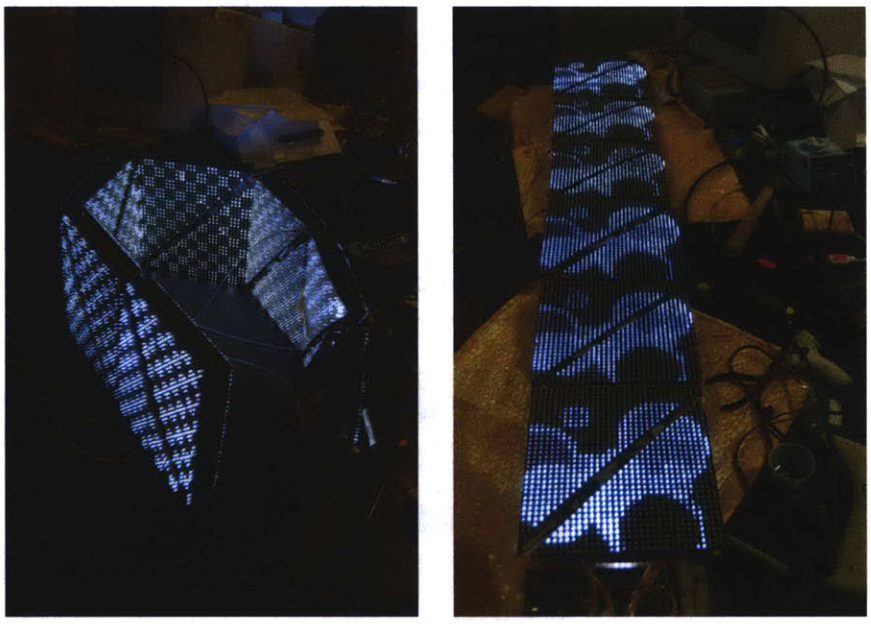
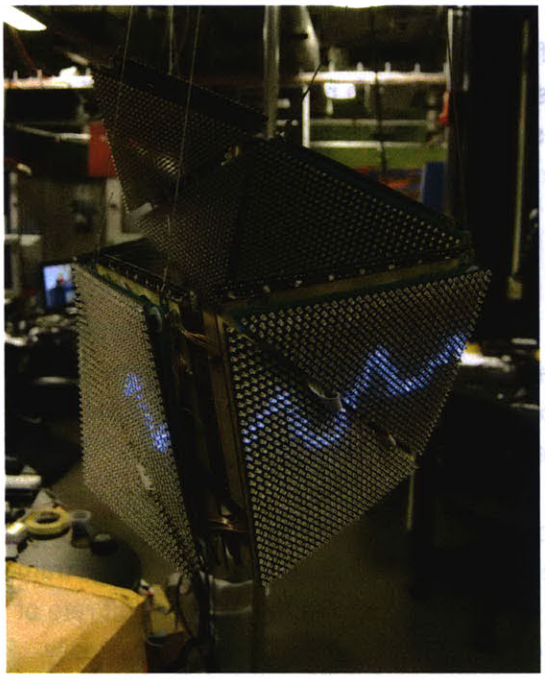


Figure 5.21
Panel tested for screen geometry

Figure 5.22
Panel data test with abstract graphics



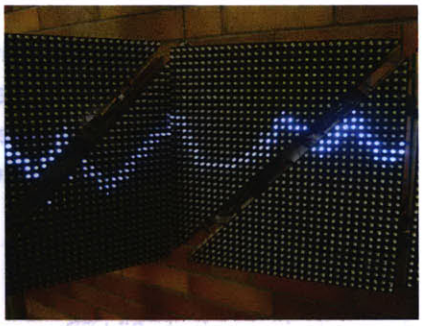


Figure 5.23 - 5.24
Panels can be folded both from sides and diagonals.

5.5.3 Screen Design

One of the main objectives of this thesis is to design an interface that is very specific to its use. As we often address our concern for on blurring the boundaries between content and display, we conceived this interface very much in line with an overarching theme on boundaries.

The display part of this design is made of modular tiles that are formed by diagonally cut square LED panels. This form factor allows us to have a very reconfigurable geometry in which the interface can be transformed into many shapes with physical interaction. Like a long paper strip, the interface can be folded into different forms that can communicate different meanings. Here we primarily use this architecture to communicate the difference between a flat geometry and a broken one for using it as seamless surface that can be broken into different segments when the panels are manipulated from their borders [Figure 5.23 to Figure 5.25].

The physical borders between the panels conceptually map to the design of the graphics, allowing them to show a continuous flow (moving on a continuous display) or an interrupted, broken one (trapped in one of the displays).

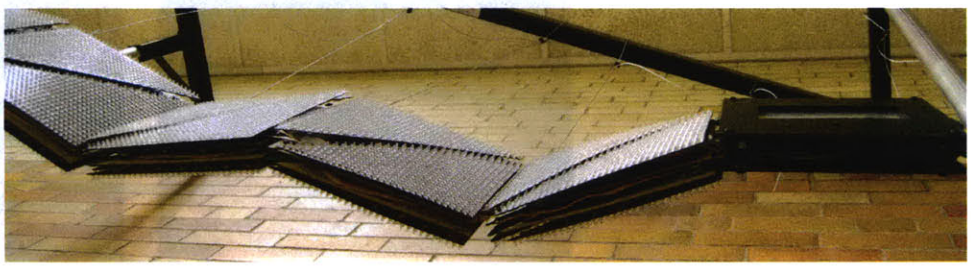


Figure 5.25
Different suspensing methods allow different geomerties.

5.5.4 Graphic Design

Given the low resolution of the display and the semantically rich nature of the data (e.g., human voice), our initial designs focus on very abstract graphics that will not fight for attention with the sound output.

"An active line on a walk, moving freely, without a goal. A walk for a walk's sake."
- Paul Klee

Our final prototype features a single line that is generated by segments of Bézier curves [Figure 5.24]. For visual reference and inspiration, we based our design on calligraphy (e.g., zoomorphic calligraphy) [Figure 5.23] and scriptural typography. As we intend to create a special relationship between the form of the visual and its display area, calligraphy provides a vast amount of techniques and visual vocabulary to create very elaborate forms and figures by simply bending and folding a single line. As a first sketch in computational calligraphy, we parameterized a curve's behavior based on the intensity values of the ambient audio levels (determining the y-axis) and current physical form of the interface (determining the x-axis). Our graphic was still intentionally abstract to avoid the communication of any other message that would come with an arbitrarily generated shape. So we intentionally used a very limited vocabulary in our graphics and primarily used them to support the physical interaction with the interface (e.g., trapping and releasing the line) and give the user visual feedback for their action.

As we represented the community and its voice, we avoided any visuals that would stand for people. As we achieved a denser and richer collage at the end of our installation period, we believed that it served well for depicting the diversity in the community. We also avoided making any classification on the sounds (e.g., based on gender, age, etc.) or visualizing, it as that information was already communicated through the voices.

On the other hand, we see many potential uses of this interface for different applications. In our coming iterations we will certainly experiment more with the graphics and the relations between the sensing and its display. After all, the message of this thesis is the interface as a whole and not any of its individual components. Here, the interface intends to become the facilitator for creation, aggregation and the access point to the content that is primarily there for creating its users awareness about themselves and other within the environment.

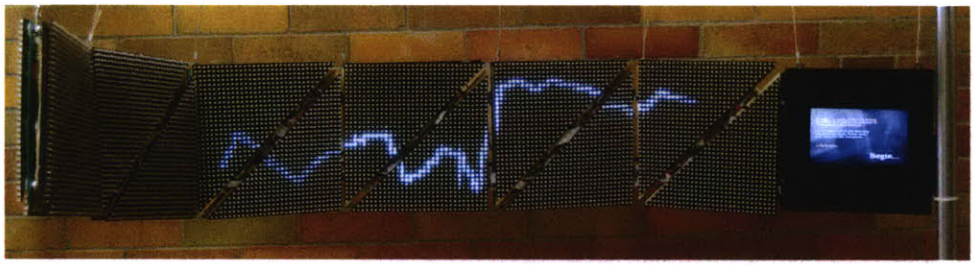


Figure 5.23
Zoomorphic Calligraphy

Figure 5.24
Graphic flowing freely between six panels.

6
Evaluation & Critique

6.1 Public Installation

6.1.1 Cambridge Public Library, MA

As a first major evaluation, we installed our prototype at the main branch of the Cambridge Public Library (August 8-14, 2007) in a public corridor [Figure 6.1]. We used a special frame for suspending it next to the wall to comply with the fire regulations of the building. Unlike an art gallery installation, we installed the interface next to other computer terminals, bulletin boards and information panels so that it would blend better into the existing landscape of the library.

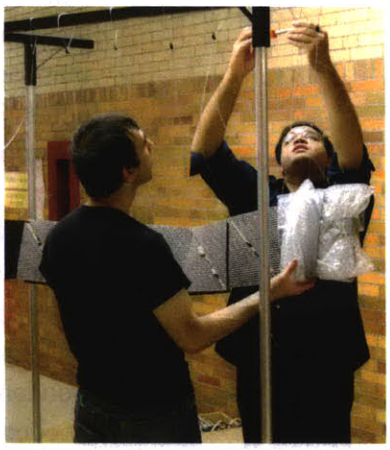


Figure 6.1
Installation at the library.

Although we presented the work to the Library as a pubic art installation, we did not make any public announcements. For the average library user, it appeared to be a temporary addition to the library. While its strange form gave a distinct presence to it initially, in a couple of days, it became part of the natural setting.

While we presented some explanation about the piece on the touch screen panel, we provided additional information on flyers, assuming that the library's regular visitors might feel more comfortable to interact with it if they were able to read more about it.

Over a period of six full days, the installation was left on twenty-four hours a day, but was only open to public during the main library hours (Mon-Thur 9am-9pm, Fri-Sat 9am-5pm, Sunday Closed). We only had one major technical problem that required us to turn it off for two hours.

Other than documentation and conducting a user survey in random periods, the installation was on its own, with the exception of some minor maintenance such as fixing the microphone on the touch screen interface and normalizing the audio levels of some recordings.

6.2 Technical Evaluation

Here, we discuss the structural, software and hardware problems that we observed during our installation. While these usually affected the overall performance of the system, we will discuss more usability-related issues in the design and usability evaluation chapter.

6.2.2 Structural Problems

Since the beginning, one of the main challenges in our panel design was space. While we had multiple iterations of the structural and electronics design, we weren't able to shrink the size or number of certain components (due to cost of components, cable lengths, connector types, speaker size, etc.) therefore we had to operate in a very tight space. As we didn't want the tiles to be thicker than three cm (for maximum foldability), we ended up with very packed tiles that had many layers of complexity and increased debugging and maintenance times. Especially for a major breakdown in hardware, it became quite difficult to find problems, fix them and return the piece to operation.

Due to limited development time, we also were not able to engineer a truly modular solution for connecting the panels. We tested different connection types, but none save the torque resistant hinges (also known as laptop hinges) gave satisfying results, and these required permanent connections to the wooden infrastructure (with screws). While we were able to get more degrees of freedom with these hinges, we sacrificed our ability to connect and disconnect panels quickly from one another during set-up and transportation.

In a similar nature, we experienced some problems in our electronic connections, mainly during physical interactions. As panels were bent in different directions, certain cables (especially the USBs) stretched too much and pulled their connectors out of their housings. We had to overcome this problem by increasing the amount of slack between the cables and by soldering almost every connector in place, again resulting in more sacrifices from our modular design.

6.2.3 Software problems

Although we have a complex software architecture, using multiple computers running multiple applications talking to each other, we did not experience any major problems or unexpected, post-testing bugs. On the other hand, there is certainly room for improving the usability of the GUI interface (e.g., using larger buttons, better visual feedback... etc.)

6.2.2 Hardware problems

As we mostly decoupled the operation of hardware from the software infrastructure, no hardware failure resulted in a complete break down of the system. Our most common hardware problem was a sudden resets of the

LED panels due to malfunctioning USB connections caused by overstretched cables. The system generally managed to recover the malfunctioning panels and put them back into use once the USB connections were restored (without necessarily restarting the entire system).

Other than the need to customize the audio sensing settings for the installation space, we also experienced some audio recording problems, as the users often confused the microphone with a button and pressed it in, obstructing its line of sight and therefore reducing its recording capabilities.

6.2 Design and Usability Evaluation

As we worked to further understand the implications and significance of a multi-model interface, we learned a series of lessons on designing public interfaces. Here, we present a design and usability evaluation based on our personal observation and a survey we conducted at the library.

Everything that looks like a button is assumed to function as button.
As we placed our microphone on the touch-screen panel, we almost always found it pressed in, as users confused it with a button to start the interaction on the touch-screen. Strangely enough, adding a label underneath it only cut the number of this mistake in half, proving that a physical button is a very strong design element that easily overshadows other GUI elements on the interface. But as a second note, we realized that this button-pushing problem may also be caused by very young kids, who can approach the interface on their mother's lap, and immediately push the first thing that appears pushable on the panel.

The use of touch-screens is not innate to users and it is not easy to accommodate all users' needs.
In the library installation, we experienced many problems with the user interface. Some were on our side because of conceptual problems resulting in a less intuitive experience, but some were also due to a very diverse range of users. While we could identify our faults easily, the problems caused by varying physical factors (e.g., finger sizes or longer finger nails) or different experience levels with touch-screens (or with technology in general) forced us to think deeper about solutions.

We ran into problems such as the misregistering of finger position by the interface, which caused lack of feedback to the users and made them believe that they were not pressing the right button or that the system had crashed. Even when we tried to solve the problem by making the cursor visible on the screen for immediate feedback of the registration of the touch, we could not entirely avoid the problem for all users, as then time users tried to use the screen as if using a mouse, trying to drag the pointer onto the button to be clicked.

People have a strong tendency to transfer their former experiences with other GUI elements to new interfaces.
We noticed throughout this project that users expect to see GUI elements that are used to seeing in other interfaces, that they think would make sense in this context. Two users asked why didn't we have counters on the user interface, as they thought that it might be useful to count the number of people who had visited the installation (as if it were a web site).

Both understanding and utilizing physical interaction is difficult and requires time, so it should not be the primary source of input.
As we were prepared to see a delay in understanding the physical interaction component of the interface, we designed the interface in such way that the whole system did not depend entirely on physical manipulation. Even in a limited nature, the public interface needed to survive without it and also had enough components to encourage people to try it again. As we observe the learning curve of visitors (either the library regulars who were able to come and experiment with it in multiple times, or people who learned by watching at others), it became more apparent that there needed to be stronger metaphors or analogies to users to relate their current experience with a former one.

Interaction in public is intimidating for most people.
People sometimes feel uncomfortable to interact with our interface in public, especially during busy times. However, they report that they were able to revisit it at another time, either during less busy hours or with someone else whom they believe had more success with it.

People are afraid of breaking complex-looking systems or worry about looking unintelligent while engaging with a complex system.
Given the unfamiliar and complex nature of our interface, we certainly ran into the problem of intimidation caused by complexity. As it is not a common practice to bend or even touch light emitting surfaces (other than kiosks or ATM machines), passing the initial overhead of interaction can be hard for some users. We agreed with our users that this part of the project needs more thinking for future improvements, if we would like to utilize physical interfaces in public settings.

People learn by watching others.
The mutual discovery of a system motivates people, not only to browse the contents of the installation (e.g., listening together) but also encourage active participation. Listening to someone who just finished recording encouraged many users to input their own voices. While we were monitoring the project, we observed a couple spontaneous and serendipitous encounters among different users, discussing how would they answer the question "Where are you from?"

As one asked the another, "Should I say where I am really from?" or "Should I say my birthplace?" He was able to answer the way the other did.

As a second note, some users reported that having the artist around (not necessarily giving them further instructions) motivated them to greater participation. Our presence often resulted in longer conversations where we discussed the installation in large, especially within the context of what it intended to do in the meaning of places, social sensing and public interfaces. We identify the interaction between strangers in front of the installation as an act of "triangulation" (See Chapter 4 for more details) facilitated by the interface, which is primarily designed as catalyst for these kinds of social interactions.

Audio-only recording interfaces need graphical support for robustness.
In our earlier prototypes we had designed the recording interface primarily as an audio only interface, expecting that it would function well given a good noise-canceling microphone. In a simple recording scenario (start, record first question, stop, playback, either record again or proceed to next question, start, record second question, stop, finish), we received reasonable technical success with an audio online interface that primarily operated by audio analysis (e.g., sensing a nearby user, starting recording with voice activation, stopping recording by detecting silence, etc.). However in our tests, we observed that even in this simple interaction scenario, the users performed better with a GUI interface, which is more error tolerant than the audio-only one. As the audio only interfaces need to follow a linear structure, a small mistake on the user side, required a start over, and caused enough frustration to spoil the experience. With a GUI interface, we not only able to reduce the cognitive load of the process (by making them able to see at which stage they were in the process) but also to give them the ability to go back at any point in their system to correct their mistakes. As we increased the tolerance for user mistakes, the system was much more smooth and robust. Also as a secondary advantage, a visual counter that shows the remaining time from the allowed recording duration gave us a chance to fix the durations of the recordings to avoid arbitrarily long messages.

Experience with a fun, engaging (and transparent) interface may reduce concerns on privacy.
Being an unusual, playful and experimental interface for public interaction, we learned from our survey that the interface was quite stimulating and engaging to use and didn't create major concerns on privacy. Only two out of ten users expressed that they were worried about the privacy of the information they put into the interface. We think that this could be attributed to both to the experimental and friendly nature of the interface (e.g., as it tells you how others

answered the same question) and also the transparent design of the sensing and recording activity. As the system outputs whatever being sensed and recorded to the user immediately (without mapping it to a derived meaning), it does not create (a reportable) concern on privacy.

6.4 Discussion of Survey Findings

We organized our survey questions in the following way, here we discuss the results based on surveys filled by ten random people we picked from the participants of our first installation:

Q1. Where are you from?
Q2. If you are not from here, can you go back?

Intention:

We asked the same questions asked by the touch-screen interface in a written form to compare if the system has voices of these people recorded and functioned technically well.

Discussion:

One out of ten users' answers didn't match with the recording in the system, which we think can either be not entirely recorded; if the users made a mistake such as not making their response on time (while the visual counter and recording were active) or the message was be very quietly recorded and not registered by the system due to a low volume voice or a microphone problem.

Q3. Was it easy to listen the audio? What do you remember?

Intention:

For a technical evaluation, we asked if the audio output functioned well in the given space.

Discussion:

At the library, we explicitly turned the volume down: 1) for fitting the nature of the place, 2) to create a feeling of an echo/whisper of sounds, 3) to make it easier for people to hear their own voices while the interface was playing a sound collage. However, our findings show that the audio level was generally considered low and demanded to be higher. Some users complained about the mixed up, collage nature of the sounds and found it a bit noisy. As we didn't choose to normalize all voice to a standard level, some were recorded louder than others (e.g., differences caused by shouting towards the interface vs. quietly saying it), some were clipped, some were noisier, etc. Therefore, when the system played a random sample, the real-time collage showed great differences from time to time resulting in different levels of appreciation.

Q4. Did you interact with the screens or observe any changes?

Intention:

As this was the least intuitive part of the system, we wanted to see if people noticed the screen and interacted with it or if they chose to remain as a spectator. As this was one of the novel aspects of the project, it was important for us to understand if it made any sense to design a display technology that interacted with users or not.

Discussion:

Seven out of ten users responded positively to this question. While the question was not very precise in learning more about the nature of the interaction, the rate of interaction surprised us. In our personal observations, however, we noticed that almost none of the users were able to figure out the full interaction scenario by themselves (See Chapter 5 for the full details of the interaction scenario). Therefore a full discovery not only would involve a considerable amount of self-play with the interface, but also require an extremely self-confident user, who would not worry about making a mistake or breaking the panels.

Q5. Did you feel a serious concern about your privacy while answering the questions asked by the system?

Intention:

As designers of public technologies and alternative sensing techniques, we wanted to know if the users felt concerned about their privacy or not. If they been, they would not only have been less realistic about the data they were giving out to the system, but would also be skeptical about others' answers, losing the sense of communal trust that we expected to see in this kind of a social interaction scenario.

Discussion:

Privacy was not a major concern for the set of users that responded to the survey. Only one out of ten felt some serious concerns, and another expressed that while he/she was concerned about privacy, after reading from the informational flyers that the data would not be made publicly available (after the installation), it was ok with him/her.

Given the small size of the pool, we do not feel comfortable making decisive observations about privacy. However, after finding that one particular user wanted a copy of the recordings (in the form of the sound collage), we tend to think that the data that was recorded is perceived very differently by different people. While for some it is still answers to questions to others, it can sound like a recording from an anonymous choir, interpreted mainly for its melodic and harmonic nature.

Q6. What do you think you learned from other people sharing the same space with you?

Intention:

The answer to this question primarily tells us if the users care to listen each other's voices from the interface or not. Also, on a more social level, it would give us a sense of how meaningful the experience was for them and if they really thought about the information presented about this space or not. It was quite important for us to know if the project achieved anything further than its technical accomplishments and if it reached its conceptual goals.

Discussion:

Here, on the one hand, we received responses like:

Diversity, variety, similarity (between me and them), a shared capture of a big question.

But also:

Nothing, just mumbling noises, nonsense... Could not hear precisely what's been said... Do not care.

We perceive that variety of responses in a social group, is another metric of diversity, depicting the inception or the rejection rate of such public interfaces. While it will matter some to share their voices with each other or as part of a communal activity, it will certainly not be meaningful for others. However, with this study, we have a chance to see the spectrum of differences and similarities among the members of the shared space, which again helps us to understand it better.

Q7. Are there suggestions you would like to make concerning the content, technical set-up and social implications of the project?

Discussion:

Some users suggested that the abstract line graphic (which visualized the audio intensity of the environment as well as the conceptual flow of free or trapped movement in space) should be more responsive to user input. Some stated that they wanted to see a more articulate visual as opposed to an abstract line. We also received some suggestions to map some of the prosodic features onto different shapes, using the visuals more figuratively, so that users could see the difference between louder recordings and quiet ones. As we experimented with a number of different analysis and pattern recognition techniques with audio input (e.g., gender detection, age detection), we decided that for future iterations we may incorporate more parameters into the generation of the line and use it for reflecting more symbolic meaning. However, here, the challenge is to find the right

mappings for right meanings we strive to make the process as transparent and as intuitive as possible for the users.

We see the design of the graphics more as an exploration of electronically generated calligraphy that is specifically designed for this custom form factor. While we may certainly explore alternative parameters for the line generation, keeping the visual simple, abstract and inline with the concept is key to our design.

On another note, two users suggested using another type of suspension system as an alternative to steel wires. As we hung the interface with fixed-length wires, we were told that the physical interaction was quite constrained in the middle parts of the display due to the stiffness of the cables. By using polyurethane (bungee-cord like) cables in the future we expect that we can overcome the problem and have a more flexible architecture guided with a stretchable suspension system.

7
Future Work

7.1 Lessons

In our technical and conceptual evaluation we identified a number of possible improvements for the project, but also received very useful user feedback that included interesting suggestions for future iterations of the interface. In sum, we will focus our changes in these four areas: 1) exploring different styles of graphics generated with different audio-sensing parameters. 2) more robust hardware with better physical connections between the panels and improved GUI usability for the recording interface, and 3) alternative suspension systems that will allow more physical interaction. On the other hand, different observations of the interface during the library installation gave us four new perspectives on future designs which we can summarize as follows:

7.1 Possibilities

Relationship with the body

We spent a great deal of our time thinking about new relations between media and architecture, but there is still much to do in exploring new corporeal relationships with public interfaces. For future versions of this design, an important direction will be to explore different metaphors and scenarios that will ask the user to behave particularly for different geometries of the display. While in our current set-up we are already experimenting with a limited set of bodily gestures, such as bending panels, moving sideways and around the interface and giving the ability to define a private corner in the interface (Please see Figure 5.11), we believe that this aspect of the design may be explored further if the interface could show different responses to different configurations.

Interaction adjusted to number of participants

While we focused our attention on mostly a one-to-interface or many-to-interface relationships, we would like to explore if the interface can facilitate a more directed peer to peer relationship among the members of a social group. Thus, the question becomes: Can we design a functionality of the interface in which two people can mutually interact with each other? Can there be a third mode, in addition to the public and private mode, in which the interface can catalyze the interaction between two people for a more specific interest? Likewise, in a future version when the interface is equipped with an ability to

recognize a previous participant, it could respond differently to different users and provide them with different kinds of information.

Exploring the graphic-sensing relationship

As we continue to explore different kinds of social sensing techniques, we will be exploring new kinds of visual and audio input. As our users are already expecting to see more articulated relationships between sensing and the generation of the graphics, we will design new visual responses to the system. We will look at how we can map different prosodic features into visuals, which we can aggregate over time for time-based visualizations of the sensing data.

Build a stronger metaphor for interaction

We believe that our interface needs a stronger metaphor and interaction scenario for fostering physical interaction. As a first idea, we will explore the possibility of considering a more figurative being than an abstract interface. Like an origami style character designed from LED panels, the interface could be a long dragon or a chameleon, a new kind of screen-animal, which can exhibit a sentient nature. As the interface can still carry its social responsibilities (e.g., for catalyzing communication, making its audience aware of each other), a stronger character will create better metaphors for creating the visuals or producing the sounds. We assume that stroking a chameleon's skin will cause different feelings in the audience than simply touching LED panels.

As we explore alternative agencies for the interface, there will certainly be different kinds and levels of interaction to be experimented with between the user and the artifact. As we see more and more of these kinds of interfaces in public, we can imagine different kinds of interfaces presented as public characters, agents or screen-animals that will catalyze their environments and raise different questions about their environments and the people around them.

8
Conclusion

In this thesis we argued that the role of electronic media in architecture is changing and that it is becoming possible to design new urban interfaces and architectural media for re-programming and re-purposing the uses of public places (with information) to extend their the social, cultural and political uses. In this respect, we particularly focused on the design of a medium that could to raise awareness among the inhabitants of a space. Here, our theme was about boundaries among the inhabitants of a place and the role of the interface was to facilitate an interaction so that it could reflect their differences and similarities their geographic mobility and its limits.

To address this hypothesis, we provided a theoretical foundation on understanding the meaning of location and its role in shaping identities, and the ways it forms the bonds between people and social groups; we discussed the role of different public interfaces and architecture to mediate these relationships. By visiting a number of concepts, such as boundaries, place, home and locational identity, in relation to site-specific and participatory public art practices, we investigated different types and uses of public media, especially with a focus on their social uses.

We built a custom public interface in which we both physically and conceptually explored a number of boundaries (e.g., spatial boundaries, social boundaries, boundaries between people and public media, boundaries between architecture and public media, etc.). We explored new ways to interact with public interfaces and invited people to explore boundaries by literally manipulating the physical shape of the interface (e.g., bending the panels of the interface changes the form of it - See Figure 5.10 and Figure 5.11 for details) We tested our prototype with a public installation at the Cambridge Public Library where we ran a user test for six days and conducted a formal survey. Here are some salient points resulting from the findings of that research and the explorations of this thesis:

- It is possible to conceive a public interface that is specifically designed to communicate a single theme, in which both content and the physical interface can be shaped by the user. In this respect, the medium itself (the

very form, concept and its social role in public altogether), as McLuhan states, is the very core of the message [McLuhan 1994]. These kind of interfaces can exhibit a social responsibility in different settings and contribute to the production of the social identity in a given location. As social catalysts in urban settings, they can facilitate different interactions within the public and have an active role in helping the public have more say about the social, cultural and political aspects of their environment. They can also reflect certain aspects of the environment and help the inhabitants focus on a particular perception of their space. Not only can they make the public more aware of each other, but also can help them contribute their presence to a larger question, a social statement about the places (e.g., such as capturing the diversity of the place, and showing the fact that there are many people living among us who do not have the same geographical movability as we do for many different reasons).

Our prototype design showed us the potential of LED panels for designing modular, double-sided, three-dimensional, foldable interfaces that could incorporate different input (e.g., microphones) and output components (e.g., speakers) in them. With further research and a more flexible budget, they could be engineered to be thinner, more foldable and more robust and be placed in urban settings for different social sensing scenarios.

We found that audio is a reliable source for providing semantically rich information about people. It not only carries a message, but also reflects many cues (e.g., based on age, gender, accent, etc) about social-cultural characteristics of people.

Our findings also show that privacy becomes less of a concern for most users when they are mutually contributing information to the same interface. But, here, the ability to preserve anonymity and the transparency of the recording process is key for this result.

As we work further to explore different concepts, media and their technologies to configure the relationship between places, people and information; we hope that this thesis presents a compelling concept and inspires others for developing new perspectives for alternative public media designs. We believe that experimental interfaces can not only contribute with new ways to understand the relationship between architecture and media, but will also help us find new strategies to identify boundaries among us, boundaries that we need to use for "presencing" ourselves different from each other, which, in return makes us more curious about our differences and similarities and the boundaries that we need to transgress, to become social beings again to be shaped by our places and others...

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