Be Green: Implementing an Interactive, Cylindrical Display in the Real World

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ABSTRACT
Many studies in Human-Computer Interaction and related fields, such as pervasive displays, have historically centered around user evaluation and knowledge production, focusing on usability issues and on creating a more efficient user experience. As the trajectory of HCI moves toward the so-called 'third wave', new values are being emphasized and explored. These include concepts such as embodiment and engagement, complementing usability as the primary metric of evaluation. This paper explores the ideation, iteration, design, and real-world deployment of such a 'third wave' interactive pervasive installation in the form of an interactive, large cylindrical display. The purpose was to display the air quality data in a manner that would inspire elevated environmental consciousness and discussion among Umeå citizens, especially with regard to the environmental impact of different methods of transportation.

Categories and Subject Descriptors
H.5.2 [Information Interfaces and Presentation]: User Interfaces —interaction styles

General Terms
Design, Human Factors.

Keywords
Design-oriented HCI, Public installation, Pervasive display, Cylindrical display

1. INTRODUCTION
Human-Computer Interaction (HCI) has historically found itself enamored with creating novel objects, interfaces, and artifacts with the primary purpose being evaluation with users and ultimately knowledge production. These things—the artifacts and interfaces that HCI's researchers and designers produce—are typically created by with the intent to make an idea or a concept so tangible it may become subject to user testing and thus comparable with other concepts and ideas. The artifacts are typically used in structured lab-based testing sessions or placed into an existing context in which their effects on behavior and other factors can be assessed. Traditionally, HCI has emphasized the various aspects of usability as the yardstick used to compare different designs as well as, more lately, on various forms of user experience [7].

Recently however, there has been a strong push into the so-called 'third wave' of HCI, in the form of efforts such as research through design, design-oriented HCI, reflective design, and aesthetics [see e.g. 1, 3, 4, 5, 6, 7, 8, 9, 12, 14]. What is a common trend among these approaches is that they, first, explore other means than those of usability to allow HCI researchers and designers to compare, assess, and measure success, and second, that they increasingly rely on design-oriented ways of working and thinking over a more traditional metrics-focused scientific attitude [5,7].

The project described and discussed below follows both these trends and is thus an exploration in third-wave design-oriented HCI. In this paper, we discuss the process of ideation, design, and implementation in the real world an interactive artifact in the form of a large cylindrical display.

The purpose of the project is to inform and raise awareness among the citizens of Umeå, Sweden, with regard to their current air quality as well as a means for the local municipality to engage and involve citizens in a discussion about air quality and potential health hazards. Located on the coast in northern Sweden and generally recognized for being close to wildlife and nature as well as providing ample opportunities for outdoor activities, the air quality is generally not something that the average citizen of Umeå even recognizes as an issue with which to be concerned. However, the air quality in Umeå city actually varies quite a lot over the year, due to a combination of weather, traffic, geographical location, and surrounding topography. Typically in the winter and especially along some main roads in Umeå, the air quality can be so poor as to constitute a health hazard.

The design brief given to the team by the municipality of Umeå was to create some kind of public installation that, first, raised the general awareness of air quality as something that its citizens might want to be aware of and, second, would actually inform these citizens about the present air quality. The municipality speculated that awareness of the problem, in combination with continuous feedback as to the current air quality level, could be enough to inspire citizens toward environmentally conscious choices such as choosing the bike over the car when traveling in the town.

While the end result of the project is an interactive pervasive public display in the form of a large cylindrical LED screen; we argue that one of the most significant values of this project lies in describing the design process itself, perhaps especially the many problems, hurdles, and levers we have either used or stumbled upon when designing and deploying a pervasive display in the real world. We argue that in practice, pervasive displays for use in the real world, by real people, in a public space is neither straightforward nor easily planned for a multitude of reasons. While some of the issues we have come across are specific to this installation, many can be thought of as quite common to pervasive display installations and therefore also potentially valuable to others in the field of pervasive displays for the real world.

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2. RELATED WORK

The literature on pervasive displays presents a number of interesting case studies. For example, Wang et al. proposed the Peddler Framework for proxemic interaction in the context of advertising. [13] In *"Ambiguity as a Resource for Design"'* Gaver et al illustrate examples of how pervasive displays might employ ambiguity and how said ambiguity may be of use for designers.[8] In a third case, Bedwell et al. describe "…the design and deployment of Rivers a mobile phone-public display system within an exhibition…" [2] These efforts provide valuable and novel insights into pervasive displays, yet most of these case studies do not delve into the design process with a fine level of granularity.

The design process, including the many real-world challenges and opportunities of designing and deploying pervasive displays in situ, is typically only discussed as a tool to support other intended goals, including user experience, usability concerns, and so on. We believe however that there is value in expanding on and further explaining the design process when it comes to pervasive displays; specifically in the case of an artifact designed in the context of a client/designer relationship.

This paper thus explains, in fine detail and to a high degree of contextual specificity, the design of a pervasive display installation. We further assert that the challenges inherent to this way of design creates constraints that do not necessarily exist in the creation of artifacts created for the purpose of exploration or research and elucidating this type of process will be of value to the broader community.

3. DESIGN BRIEF

The project was initiated when we were approached by an organization called *Be Green Umeå*, which is a large project initiative within the local municipality promoting sustainable life[1]. Be Green Umeå focuses on citizen resources and creating opportunities to live and work sustainably in the Umeå area in northern Sweden. The organization was formed because reduced energy use and environmentally friendly travel is difficult, if not impossible, to achieve without individual participation and willingness to change. Be Green Umeå disseminates information about how to change behavior to live cleaner, and have less negative impact on our environment.

The initial design brief given to us by Be Green Umeå was to design something that would catch the eye of average Umeå citizen, informing them about the current quality of their air. Initially, we were asked to both disguise and incorporate an existing weather station that had previously been installed in the center of town. The weather station is filled with sensors to measure and analyze air quality, including carbon particles and nitrogen dioxide. This information is then passed on to a web server and displayed on the municipality website in real time, informing citizens about the current state of the air quality.

The levels of nitrogen dioxide (NO2) have increased in central Umeå in general and are typically higher in winter than in summer, partly because of higher emissions from traffic but perhaps above all because of a combination of unfavorable meteorology, geographical location and surrounding topography of Umeå. During the winter, there is 'stable stratification' or inversion over 50% of the time. Vertical air mixing is low to non-existent, leading to higher concentrations of air pollutants, and the potential for the horizontal spread of such.

The existing weather station (see figure 1) has been housed in a temporary trailer, sitting next to the main highway that runs through the center of the city, where the air quality was deemed to be at its worst.

Figure 1: The existing weather station

To try to raise the awareness of the air quality problem, the local municipality had been collecting the data and made it available on their website. Yet, the website had received little to no traffic at the time and the awareness of the issue among the citizens remained almost non-existent.

According to the municipality in their original brief, the problem was that citizens needed to actively search for the air quality meter, which was quite well hidden in the municipality website, most people did not even know that it existed. If someone actually managed to dig out the link, they were presented by the 'air quality meters' as seen in Figure 2; a result of a previously commissioned project by the municipality.

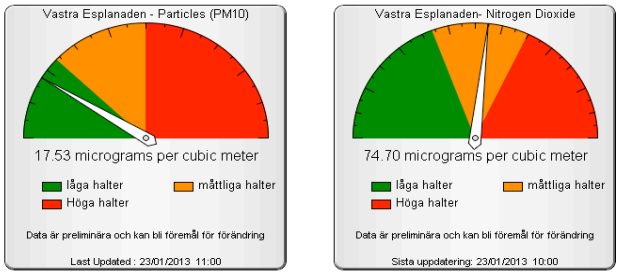

Figure 2: Air quality meter as seen on the municipality website

To deal with the situation, the municipality through the Be Green initiative made the decision to try to find a way to make the existing information more visible to town citizens, in the hope that this would raise the awareness of the problem and that in the long run, awareness of the problem would yield change in individual behavior, such as taking the bike to work rather than the car.

Be Green's initial idea was to use the existing weather station as a projection surface and display the data on the trailer itself using some sort of projection mechanism. Because of the trailer's unappealing form, its many uneven surfaces, and lack of good locations to actually house a projector in the surrounding environment, we were, however, rather quickly able to jointly

[1] See: http://www.begreenumea.se/

abandon this idea in favor of allowing us to build an outer shell more suitable to rear projection or other means of displaying information.

For this concept, we were thus required to either build an entire new structure replacing the current trailer to both house the technology and inform the passing traffic of the current air quality status, or keep the existing trailer and build a shell around it. Here, we chose the former, to create a small, insulated kiosk that would consist of the sensors and hardware, where its walls would have some type of display technology or back projection surfaces embedded within or on them (see figure 3).

We also started to ideate as to the nature of the visualization. Since we were not dealing with a complex data set, we thought that a more abstract visualization would be appropriate. Therefore, we argued, it was not necessary for the new structure to high-resolution display, we could rather rely on a low resolution solution based on LED (light-emitting diode) display or projection technology. This, we argued, would also have the advantage of being bright enough to be seen in varying lighting conditions.

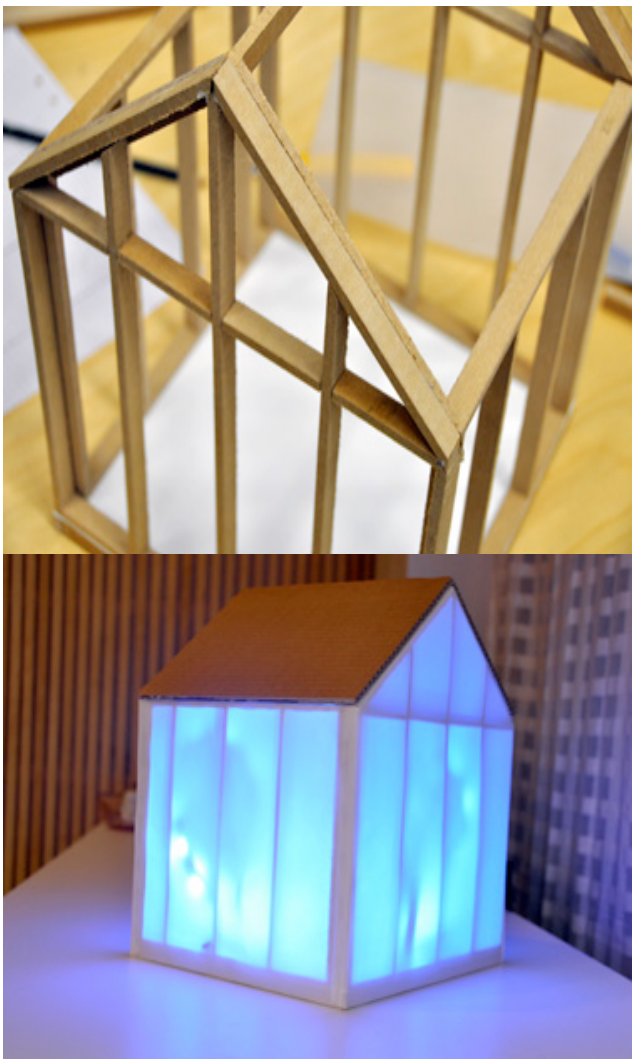

Figure 3: Early models of the shell structure

4 PROCESS

4.1 Obtaining Permits and Working with Local Authorities

When designing and deploying a public installation for a city environment, it is our experience that one should not underestimate the number of permissions from different departments and authorities that are needed. The construction of this particular installation involved the local building authorities, the national road authorities, the police, the environmental authorities, and a local commission for aesthetics in public spaces. When dealing with the local bureaucracy in particular, one also needs to take into account that the same organization does not necessarily speak with a unified voice. A high profile project like this runs the risk of surfacing existing office political struggles and between individuals and departments, and the role of the designer often turns into acting as a mediator between various strong wills within the client organization.

While trying to acquire the various permits, we encountered the fact that the national traffic authority had difficulties making a viable judgment on the installation, due to the suggested concept of moving images. After a rather non-transparent internal process, they finally decided not to approve the display of moving imagery next to a main road at all, as it ran the risk of distracting the drivers. We proposed new sketches of the visualization, which would limiting our display output to a minimum, but in the end the stakeholders decided we would be best served by choosing a new location.

4.2 Location, Location, Location

This decision meant that the project started over on a blank sheet, which was both good and bad for us. A blank sheet of course meant more freedom for us as designers, but on the other hand also meant less constraints on the part of the municipality, which in turn allowed everyone in and around the project to 'think freely' about almost every aspect of the project. At this point, several locations were proposed, investigated (and eventually turned down), that were all more central in the cityscape as well as closer to pedestrian traffic flows (for examples, see figures 4-6). For us as designers, this was a partly frustrating and time consuming process.

At the end of the day however, this process significantly altered project requirements as follows:

- we no longer needed to build a structure that would also house the actual air quality sensors, so the size and shape of the installation could be reimagined and redesigned
- our target viewers were no longer passing drivers of cars with the attention span of a few seconds, but rather passing pedestrians that could stop by and even interact with the installation
- we could now work with a 360° awareness, i.e. that the installation could be something which could be experienced from many different angles, rather than from just one angle of approach

During the process of trying to decide where the final location for the installation would be, delays of several months were incurred. The project timeline slipped as a result of necessary approvals and permits needing to be acquired from the relevant authorities.

Eventually, it was decided that the installation would be placed in a square adjacent to the main bus depot in the center of town. This location seemed ideal as it has a high level of continuous pedestrian traffic and a close proximity to one of the main shopping malls, the city library, the theater and opera, and so on. Essentially, if you live in Umeå you cannot miss passing this location at some point in time (see figure 6).

Figure 4: The Esplanade

Figure 5: The tower of the town

Figure 6: The bus depot in front of the main theater

4.3 From Rectangular to Cylindrical

Since the original display was going to be adjacent to the main highway, and had to demand only a short window of attention, we had ordered a rather large LED screen curtain. Fortunately, this curtain is detachable and thus highly configurable, so that that one may easily achieve many various screen formats. Since the forced change of location, we decided to re-visit and rethink the original form of the installation. After several proposed shape ideas, we opted, in a joint decision with Be Green, to create a cylindrical screen format (see figure 6).

4.4 Visualization and Interaction Concept

Given the numerous changes in the brief, we were only left with a month and a half (of an original 18 months in total) to implement the final design. So, any relevant work, in design, interactivity, and construction had to be realized in this rather short window of opportunity. A number of initial ideas had been sketched and presented at the beginning of the project, but these became redundant as each iteration brought change to the screen and placement. The final design, a cylindrical screen placed at street level, imposed certain constraints on the final interactive installation. We kept the initial function, a visualization of the air quality values, but added an interactive game concept to make sense of the location and encourage a more meaningful experience for both the user and those observing the user. The extremely low resolution of the screen guided us into a design approach where we treated this resolution issue as an advantage, rather than a problem.

The graphics were created in the style of an old 8 or 16 bit game. This was achieved by color indexing them and then scaling them down radically. In a similar vein, the basic gameplay utilized a simple 'old school' scenario and interaction. In fact, the only 'modern' element in this was the mechanism of interaction itself, which utilized a Microsoft Kinect. Using the Kinect to track users in front of the installation, the users see a simplified, but still recognizable, color silhouette of themselves and are able to use their silhouettes to play a simple game by manipulating on-screen objects including numerous vehicles and other figures. By using their silhouettes to block one of three lanes on a circular road, continually spinning around the cylindrical display, the users can cancel out various vehicle and other objects that appear on the road.

As the screen is cylindrical, an individual user only sees the objects that appear on his or her side of the screen. With the help of a friend or a by-stander, the user is able get help or hints about upcoming objects that are not in his or her view, thus affording social interaction and engagement in a simple but quite effective way.

To connect the game to the Be Green initiative, the game keeps a tally of the balance between environmentally friendly elements and those that are perceived to contribute to the air pollution. Depending on the result, the city environment depicted in the background of the game becomes more or less visually polluted. So by canceling out for instance trucks and cars, the player creates a cityscape with visibly cleaner air. If they choose to cancel cyclists or a rollerblader however, then the background will become more smog-filled.

The current air quality level is always present. When the game is not actively played, it is displayed on the screen through explicit speech bubbles that also effectively link the installation to a current advertising campaign. While the game is being played, the current air quality is represented by an on-screen tree acting as a metaphorical thermometer representing the scale of particles and harmful gas in the atmosphere.

4.5 Designing a Public Installation for Sub-Zero Temperatures

Creating interactive installations for outdoor public use is generally challenging for a variety of reasons. However, designing such installations to withstand extreme negative temperatures, rain, sleet, snow, and ice build-up, which is the reality in northern Sweden in the winter, increases difficulty.

When implementing the installation, we decided to encase the LED panels in a sturdy housing constructed from aluminum. It was welded together in a cylindrical form and a layer of frosted acrylic was used to provide protection in front of the LED panels. The acrylic also served a secondary purpose as a diffusor of the individual LEDs, which meant that the light generated by each individual light would bleed together slightly, and provide a softer appearance overall.

The entire structure was slightly raised of the ground to allow for adequate insulation of air and that all the internal electrical components were isolated from the ground humidity and chill. This also allowed for some information space to be used by an advertising agency in collaboration with Be Green, informing the public about the installation and some graphics depicting how best to interact with the installation, harmonizing the installation's appearance to both a concurrent advertising campaign as well as to the style of Be Green's other activities.

Figure 7: Constructing the circular display

The Kinect camera had its own sub casing constructed which was attached under the aluminum roof of the structure and a series of holes were bored out of the acrylic under the camera lens for ventilation. These holes also allowed for voice commands to be registered by the microphone array, which we utilized in the game to allow certain game characters and objects to appear on command. A small visor was also built above the position of the camera to ensure that falling snow would not affect the camera's optics or impede it in any other way.

As the Be Green installation was installed in a public location, all pertinent electricals were raised out of arm's reach, so that children would be able touch any cabling. This was achieved by bringing a steel pole with a concrete base and running an insulating wire into the screen housing. The electrical wire also had a thick plastic coating that would withstand snow and ice buildup, and steel wires were used to fasten it in place so that should there be an ice build-up on the wire, it will continue to hold its own weight.

The inside of the structure was also fitted with a dehumidifier. The heat from the three power supplies used in the setup could create high humidity within the screen housing, with a risk of icing. So, the dehumidifier ensured that the internal components were kept dry and safe from electrical shorts.

5. Future Work

In the near future we hope to refine the process elaborated above and our experiences can be summarized into a checklist for the creation of pervasive displays for public installation especially when working with clients or stakeholders.

We are also in the process of using the installation as a platform around which other interactions and visualizations for different purposes can be prototyped. Some examples may be to display more complex data to make the visualization more complex with a new type of interaction. We also plan to use the artifact as a platform to test more exploratory types of visualizations and interactions. For instance, we aim to repurpose the installation to be part of a large arts festival in the spring of 2013 using very different means of interaction.

Lastly, we are in the process of collecting data from the campaign with regard to both the direct user experience of the installation as well as to the grand project purpose to raise awareness of the air quality in Umeå.

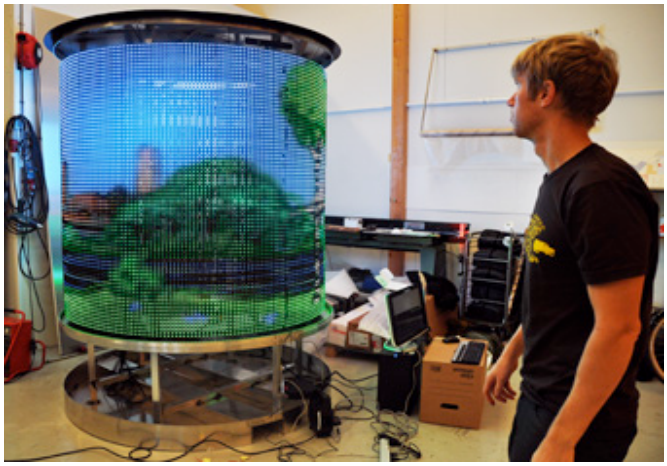

Figure 8: Testing the circular display and the game in the lab

6. CONCLUSION

During the course of this project, we encountered several issues that we believe may be typical or at least recurring when designing pervasive, interactive displays together with a local municipality for deployment in the real world. While not an exhaustive list, we believe the following issues might be applicable and valid outside of the scope of this particular project:

First, the client, especially if it is a local authority, does not speak with one unified voice and may not always know what it wants, but still desires to retain control of all decisions. As a designer, one must frequently assume the role of mediator between different stakeholders within the client organization. In our experience, it is not possible or viable to simply demand that the client make a decision; an active stance is necessary to ensure project advancement. Second, when creating any kind of public

installation, a designer typically needs to deal with a labyrinth of regulations from municipalities, possibly on multiple levels ranging from local to national to international, on a plethora of topics ranging from safety issues to snow removal to aesthetics. Even if the local authorities are positive in general and share the same overall goal, it is not certain they are in internal agreement or share the same criteria. In hindsight, we think it would be useful to early on in the project identify and coordinate all major stakeholders with the attempt to reach consensus about the main goals of the project. This would have saved a lot of footwork on our part as well as sped the entire project up significantly. Again, in an ideal world, this would be the responsibility of the client, but in practice responsibility often lands on the designer to organize and facilitate such a meeting.

Finally, to keep the project focused on the task and to limit the potential problems and issues that the authorities might conjure and unearth. Designers might early on in the process, guide the stakeholders into identifying and accepting some constraints that effectively narrow the 'design space' of the project. In our experience, transforming ideas from ethereal to tangible may help stakeholders to conceptualize what the final artifact will be, what it might look like. Finally this may encourage less micromanagement liable to hinder or impede the design process and foster creativity and collaboration.

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