Elastic Experiences: Designing Adaptive Interaction for Individuals and Crowds in the Public Space

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ABSTRACT
This paper presents insights into the design process acquired during the implementation and evaluation of an interactive art installation for two very distinct public environments. Issues of scalability, robustness and performance became progressively interwoven with the concern of creating an overall user experience sustaining consistent high engagement levels. Contextual factors such as audience size, dimensions of the interactive space and length of exposure to the artwork had to be handled gracefully in order not to interfere with the interaction flow. Adopting a research by and through design approach, the work uncovered a series of findings that are pervasive to the design of adaptive interactive experiences.

Author Keywords
Public space, large displays, crowd interaction, user experience design.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
Media façades can expand the urban landscape by transforming public spaces into "urban playgrounds" – interactive zones where people can congregate for fun and reflection. However, the fluid nature of a public space makes it an inherently difficult arena to design for.

The kind of activities enabled by urban playgrounds is hinted at by the nature of the interaction itself. It is often a deliberate outcome of the design process: 1) Interaction focused primarily on individuals; 2) Interaction focused primarily on crowds; 3) Interaction providing similar behaviour regardless of the audience size; 4) Interaction catering for different ("elastic") experiences. As the size of the audience grows or shrinks, the interaction adapts itself accordingly.

The initial problem we faced during our research consisted in developing such an interactive urban playground. The installation was envisioned to appear in two vastly different contexts. The target site chosen for the concept proposal was the Grid Gallery, a very wide media façade in the heart of the Sydney Central Business District (see Figure 1). The area is surrounded by commercial buildings near the busy transport hub around Wynyard train station and a short walk from Darling Harbour. In addition, a presentation night was also scheduled for a much shorter screen located at the University of Sydney, as part of the Urban Realities and Augmented Play exhibition (see Figure 2). Given its location, most of the passers-by are members of the academic community.

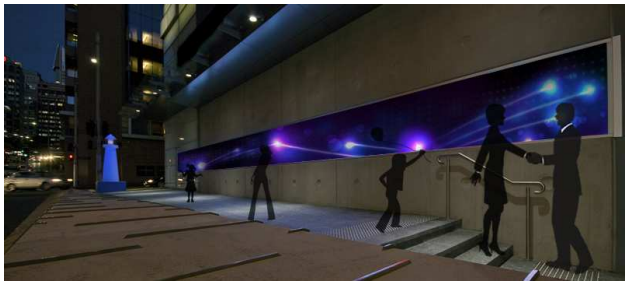

Figure 1. The Grid Gallery.

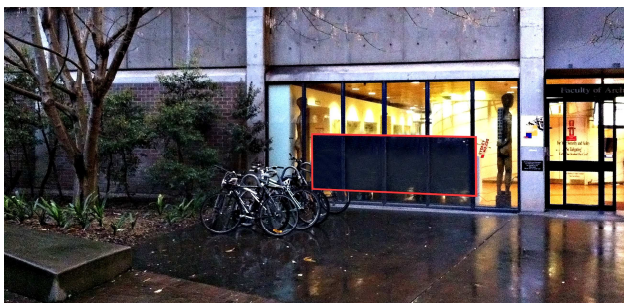

Figure 2. University of Sydney's Smartslab

Working from the brief, various issues of scalability and flexibility converged towards defining an approach that, in hindsight, conveys an *elastic* character to the design solution. We acknowledge the importance of such a strategy for the perceived success of our interactive experience under quite diverse circumstances. We argue that such approach can, in fact, be leveraged to similar design problems.

BACKGROUND
The growing ubiquity of technology comes not only with positive, but also negative, effects (Margolis, 2009). It is

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responsible for shifting human beings from becoming internally to externally driven, as humans are continuously bombarded with various kinds of media from all directions (Taylor, 2011). Some studies also show how, despite increased connectivity via technology such as phones, mobile phones, and the Internet, human beings are actually becoming more isolated and disconnected (Kraut et al., 1998, 2011).

We were interested in exploring how technology could be designed to address those two points. The first point deals with technology as a catalyst for self-reflection, versus serving merely as a vehicle for information consumption. For this purpose, we decided to use a Microsoft Kinect sensor to detect the audience presence and display a corresponding representation of their auras on-screen.

An "aura," in parapsychology and spiritual practice, is defined as a field of light that emanates from a being. We decided to use an aura to depict the user's presence rather than a mirror image to emphasize internal reflection, given that an aura highlights one's inherent energy.

Secondly, we wanted to use technology in order to foster a sense of connectedness. The focus in this situation is the concept of *familiar strangers* – the people we encounter on a regular basis, recognise, but do not personally know (Milgram, 1977). While technology can bridge together individuals over great distances via methods such as SMS, phone calls and e-mail, we were interested in bringing together individuals who were physically nearby, though emotionally distant.

At a glance, these two points appear contradictory. However, we envisioned an elastic experience that would foster both individual awareness and group connectivity, depending on the installation circumstances. To enhance the visual experience, we incorporated auditory and tactile elements. The auras in the screen surface would appear to be gliding through water, while a water mister positioned at the back of the interaction zone would sprinkle a fine mist onto the audience in response to interaction patterns. We called the work *Liquid Light.*

DESIGN METHOD

From the beginning, we were committed to follow a *research in and through design* approach (Dalsgaard, 2010). The methodology of design thinking emphasises, among other things, the importance of understanding the target users. This is done through activities such as observation, interviews, shadowing, prototyping, etc. These methods allowed us to gather a deep understanding of the motivations and behaviours of the users. This aspect was especially critical to the project given the focus on people, as individuals and crowds.

People act differently when they are alone versus when they are in a group; in fact, an entire branch of psychology – crowd psychology – deals with this phenomenon. We conducted various data gathering activities to try to understand these behaviours. There were numerous site visits where we studied how individuals and crowds interacted with the existing space. Other activities included interviews, surveys, and review research on ethnography of the target audience.

We opted for an agile approach to the software development process – findings from user research could then be swiftly fed back to the next round of development and amendments smoothly rolled out. The creation of the first prototype with initial functionalities enabled us to test it from the preliminary stages. We progressively increased audience sizes during tests and the resulting continuous feedback loop allowed us to program changes, make improvements, and experiment with additional features such as sounds, mist, etc. Frequent testing ensured that the subsequent iterations continued to comply with the initial brief. Applying such agile model to each stage of the implementation, we ensured that the final installation would yield the desired outcomes.

Issues and Actions Taken

The employment of evolutionary prototyping resulted, for each iteration, in outcomes that were noticeably different from previous versions. Thus, it was important that we were able to quickly apply changes to the code based on user feedback in time for the next round of user testing.

Some of the adjustments necessary to achieve a fluid experience across different audience sizes included:

- *Increasing response time to user movements.* The system showed a fast response time for interactions with individuals. However, once multiple users began interacting with the system, the response time would increase. To improve performance, we took advantage of the low resolution presented by the LED displays available to both exhibitions to tune the code so that it would provide a more fluid interaction regardless of the number of users. Code optimization became a top priority in order to ensure that the auras and energy bonds promptly responded to the users' movements and such responsiveness scaled well.
- *Colour changes for aura differentiation.* Testing with users indicated that assigning different aura colours based on each individual's length of time exposed to the system caused users to better identify it as their "self" (for individual interactions) or "self vs. others" (for group interactions).
- *Improved visualization of energy connections.* Since connectedness was one of the main themes of our project, the resulting energy bonds conveyed this message by being clearly represented at the screen.
- *Selection of ambient sound.* The accompanying sound had to be coherent with the local environment. However, it was also designed to support the interaction: each person moving in front of the screen would trigger different musical notes, like a virtual harp. This became a challenge since the sound was tied in to the activity onscreen, affected by the number of individuals interacting with the work at the same time. Initially, the assigned sounds were optimal only when a single person was using the system; when more users arrived, the sounds proved to be too overwhelming and rather cacophonous. To mitigate this issue, different

pitches of soothing flute sounds were selected so that the experience sounded relaxing for an individual and melodically richer and euphoric as the audience grew.

- *Adjusting interface brightness.* We envisioned showing the installation at night. Thus, initial versions of the code had the onscreen drawings at very bright settings. While this looked perfect when only one person was playing with the system, the glare generated by multiple people was at times painful to look at. The solution was to tune the code so that it could be visually appealing in all circumstances, regardless of the audience size.

FINDINGS

For a month, we ran weekly user research sessions at the University of Sydney. Each session lasted about one hour and involved both individuals on their own and small groups of 3 to 5 people. A dry run for the final presentation was also performed, enabling testing with a larger audience of about 20 individuals, whereas during the presentation night itself the audience size surpassed 50 people. Subjecting the *Liquid Light* installation to differently sized audiences highlighted differences in the type of attention and level of involvement experimented by individuals as opposed to those realised by crowds.

Individual versus group shared engagement

Crowd configurations change according to the environment and object of attention (Brown et al., 2009). When only few individuals are involved in the interactive experience, their engagement is focused more on the screen rather than on the other participants around them. That is not to say that fellow participants are overtly ignored, but that occasional interactions between individuals – as opposed to occurring directly – are in fact mostly mediated by the façade. Despite their physical shared occupancy of the space, they are mostly aware of each other's presence solely through the interaction between their avatars, in a typical ***v-shaped interaction*** pattern (see Figure 3). With few people around to distract the experience, individuals seemed to get naturally immersed into a more intimate flow pattern, playing with the basic elements of the artwork: the *auras*, the *water ripples*, the *glowing connections* between people and the *sound* triggered by each individual. For the most of it, each person was only aware of their own sole experience.

When a large number of people were interacting with the installation, however, the focal interest seemed to rapidly shift towards a more expanded model for interpreting the surrounding reality. As the space got filled, people became acutely aware of each other's spatial presence, not only because it became physically harder to move around, but also for the façade growing clogged into a singled merged *collective aura*. Elements of the design external to the screen – like the *sounds* and the *water mist* – started then to emerge and came to the fore. The decreased interactive experience on the façade itself was thus balanced with a progressive sharpening of the sense of singularity about the surrounding environment. Under such circumstances, we observed that people started looking around at the other participants, pointing at elements on and off the screen and frequently even engaging into conversations, in a more fluent ***triangular interaction mode*** (see Figure 4). Whereas for individuals the focal interest was near the screen, for crowds it jumped off the screen and merged into the space itself.

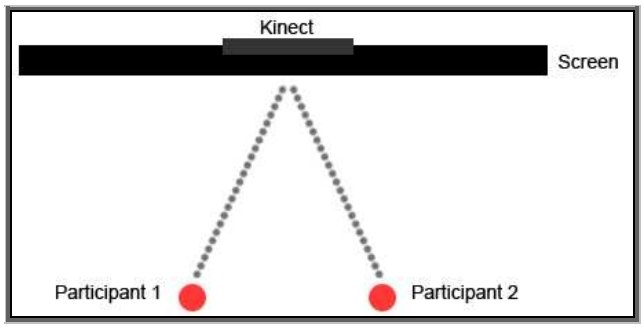

Figure 3. V-Shaped Interaction.

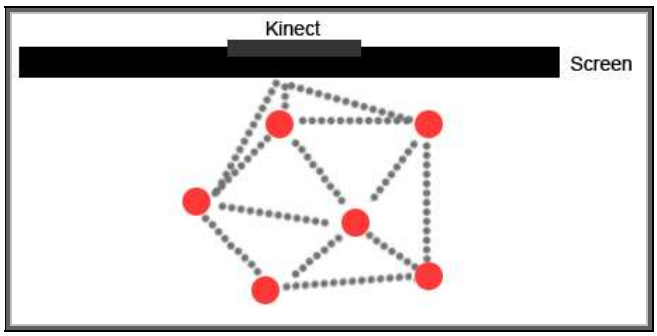

Figure 4. Triangular-Shaped Interaction.

Unfolding Emotional Spaces

The observed crowd dynamics yield the notion of distinct *emotional spaces* permeating the members of the audience under different conditions. While an interaction involving a small number of people naturally assumes a more intimate and introspective character, when more people are involved the experience naturally unfolds into a social event. In elastic design terms, such transition is supported – and, in fact, encouraged – by certain elements of the design solution getting more prominent in each circumstance. The interactive experience is dynamically reshaped backwards and forwards to cater for the accompanying natural shift on emotional bias.

In *Liquid Light*, two very distinct emotional spaces could be observed. During user tests, people tended to playfully interact individually or at best in pairs with their own auras and the connections between them. They engaged in a *focused flow state* with the façade almost in a direct basis. On the presentation night, however, attention was diffused into the social context and the audience more inclined to *socialize while immersed on the installation* – the work, therefore, enriching that social aspect.

Elastic Engagement

One can therefore characterize such evolving aspects as ranging from the individual interaction *with* the work to the collective interaction *through* the work. This is similar to the framework often applied to compare the levels of engagement enabled by sculpture/painting (individual absorption *by* the work) to those afforded by

architecture (collective absorption *of* the work) (Benjamin, 1970).

Certain elements built into the design solution proved to be particularly efficient when it came to ensuring such elasticity. It was our view that such transitional elements should operate almost as *bonding agents* between the different stages envisaged for the installation.

- *The connecting halos*. The glowing bonds between the auras hinted at the concept of increasing or diminishing interconnection as the audience grew or shrunk, respectively. With such expectations set, to articulate the growing graphical complexity of the screen, people needed to negotiate the physical space they were occupying in front of the façade, thus engendering a localized social contract.
- *The audio*. Despite its continuous presence, the perception of the auditory dimension was also determined by the size of the audience. For smaller groups, the effect of individual movements on the actual sound being played (the "virtual harp") was clear and sharp, inviting for a direct engagement with the façade. In larger groups, albeit such effect on the screen was not necessarily distinguishable, participants could realize they were somehow still contributing to the complexity of the ambient soundtrack.
- *The water mist.* Placed a few meters from the screen, the main function of the intermittent water mist was to delimit the interaction zone and avoid people from getting too far from the façade. In addition, the notorious dreamlike aesthetic evoked by mists greatly added to the atmosphere, turning it into a core element of the installation concept. By confining people to a pre-determined zone, the water mist became a fundamental catalyst of social and psychological integration among the audience – by taking their eyes off the screen to turn and watch the mist, people are also compelled to contemplate each other as co-authors of a special moment in time and space. Such a role, albeit secondary (and predominantly aesthetic) during the interactions of small groups, grows dramatically in relevance with the size of the audience, only to resume its comparatively peripheral setting once the installation was replayed for a smaller crowd.

The observations above consolidate the hypothesis of high elasticity as an essential component of experiences designed to engage different public dimensions. By employing such bonding elements, overlapping user scenarios unfolded gracefully. The installation thus managed to hold its integrity, providing different levels of interaction for different audience sizes.

CONCLUSIONS

Interfaces and experiences, in general, can be designed for certain audiences under optimal conditions and then adjusted to cater for scalability. This can be done either through progressive improvement or graceful failure. There are, however, certain situations – like designing for media facades or public interactive art installations and displays – where dynamically catering for a broader range of scenarios and a more diversified audience represents a highly desirable requirement.

To design for such situations we discussed the notion of elastic engaging experiences. In our work we needed to design in a highly flexible environment and, by doing so, believe to have tapped into a few findings to shape interactive experiences beyond issues of *scalability* and *adaptability*. Elastic engaging experiences can be achieved through the use of aesthetic elements standing as representatives for each interactive scenario and brought to the fore or receded to the back accordingly. Small sized audiences (v-shaped interaction) have the main action centred around the moving aura images on the façade. As more individuals gathered, triangular-shaped interactions took place, reflected on collaborative playing between individuals and the screen and culminating in a collective appropriation of the whole interactive space. Throughout the process, *bonding agents* alternated prominence at different moments, enabling natural transitions between the unfolding *emotional spaces* the audience shifted across and supporting a coherent narrative for the whole of the interactive experience.

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