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# ASSIMILATING INTERACTIVE TECHNOLOGY INTO ARCHITECTURAL DESIGN

*A quest for developing an 'architectural drawing' for urban interaction design as a communication platform through combining physical sensing devices with simulation software*

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**Abstract.** The research presented in this paper investigates the need for an equivalent of architectural drawings for urban interaction design in an architectural scale in order to communicate interaction design intentions to design participants and clients through using state of the art computer, gaming and sensor technologies. The paper discusses two projects (a) Blur Building, as a large scale interaction design project executed through an experienced team and (b) presents as student design project coordinated by the researchers as a reference project. Both projects in this paper are discussed and evaluated from an Urban Interaction Design point of view. This paper emphasizes the significance for establishing 'drawing' equivalents for urban interaction design, discussing representation of ideas in architectural design; followed by outlining existing methods of interactive design representation, such as storyboards to then introduce current advancements in gaming environments. The following paper introduces a framework for future research projects that will design, deploy and evaluate of prototypes as a communication platform combining physical sensing devices in combination with gaming engines to enable a digital / physical hybrid. This would allow designers and clients to test, evaluate and improve urban interactions in a design phase prior to completing the project.

**Keywords.** Spatial design; human-computing interfacing; interactive architecture; smart environments; sensor technology.

## 1. Introduction

The aim of this paper is to outline a possible transition of how urban interaction design is communicated to design collaborators and clients in order to (a) develop

and communicate ideas with one platform; (b) assure an easier understanding of the design for non-educated clients; (c) test and simulate the design prior to installation and (d) evaluate and visualize real-time changes to the design.

Urban interaction design is an area of research and development that focuses on creating autonomous reactions for users within a space. These reactions can be a visual or physical change in the environment to express information or aid in creating an improved space (Buxton, 2007).

Fabrication of interactive environments pose issues with trying to acknowledge how users will react, experimentation on a micro level to observe user and component can be beneficial, however on a macro scale when a user is immersed in an autonomous environment can change how the user will understand and interact with the space. Two methods of design representation, Storyboarding and 3D gaming environments will be evaluated.

The aspects foreshadowed in the introduction above lead to the following observations that are further outlined when setting the scene by analysing two projects: Blur Building by Diller Scofidio + Renfro and a student project called "Hypersurface Architecture [Redux]" coordinated by M. Hank Haeusler, Sally Hsu and Danny D. Nguyen, outlining observations made by analysing the two projects that then lead to the core research question. Subsequently the paper will then present first research findings that work towards answer the question.

## 2. Research Background

The motivation for choosing the two above-mentioned projects is based on the extensive documentation that has been recorded. Each project gives insight to the processes and challenges undertaken by The Blur Building's experienced team on a large-scale project and the student design team on a smaller-scale project.

The Blur Building highlights in particular the communication undertaken by the design team and sponsors that lead to changes in the design due to confusion of design direction.

The student project enabled the coordinators to take the role as a "client" to observe processes from a research perspective of design decisions made by the students and how interactive design was created, tested and experimented within the time frame of the project.

Both observations and analysis of the projects were based purely on the aspect of designing an interactive spatial environment in order to argue for the significance of establishing an 'architectural drawing' equivalent for interactive spatial environment.

## 2.1. THE BLUR BUILDING

The Blur building by architects Elizabeth Diller and Ricardo Scofidio was the centrepiece pavilion of the sixth Swiss national exhibition 2002. The design was to incorporate approximately 31,400 nozzles that sprayed mist into the air, which allowed the exterior of the structure to be shrouded and look similar to a cloud (Diller and Scofido, 2002). Prior to entering the cloud, each visitor responds to a questionnaire/character profile and receives a "braincoat" (smart raincoat). The coat is used as protection from the wet environment and storage of the personality data for communication with the cloud's computer network. Using tracking and location technologies, each visitor's position can be identified and their character profiles compared to any other visitor. As visitors pass one another, their coats will compare profiles and change colour indicating the degree of attraction or repulsion, much like an involuntary blush – red for affinity, green for antipathy. The system allows interaction among 400 visitors at any time.

### *2.1.1. Explaining design process for interaction*

During the initial phases of designing the Blur Building, many different ideas were conveyed in regards to how users interact with and within the Blur Building. For example, Ben Rubin a contributor to the Blur project introduced an idea to use "smart raincoats or braincoats" that will allow users to autonomously connect to one another like online dating (Wolfe, 2006). The matchmaking was based from questions that were asked by an automated voice prompter embedded in the coat itself, depending on the answer, it will begin to guide the wearer to users with similar responses. However, influence from their major sponsor saw that ideas were lost because a lack of understanding from the Sponsor's executive board members, "Some of the executive members were lost and had no sense of the project direction anymore" (Diller and Scofidio, 2002). This onslaught of confusion between designer and audience resulted in the Blur Building to negate any interactive elements and to only show the building.

The Students have used state-of-the-art computational architectural methods to design physical pixel building components that when assembled form the media walls. Each media wall comprises 300+ Pixels as 'digital bricks'. Each 'Digital Brick' has been generated following the same design logic with a scripted variation in order to achieve a gradient from small to large size and to enable them to be assembled as a complex curved non-Euclidian surface. Each 'Digital Brick' contains an AHL S18 LED to transform an otherwise static wall into a dynamic media wall that is able to showcase interactive media content transforming the installation into a vibrant light sculpture.

*Figure 1. Picture of two installations (left to right: detail view, situated on site, detail view).*

### *2.1.2. Explaining design process for Interaction*

The student project required the use of an interactive element that will be displayed on the Wall Installation. Parameters of the interaction were based on available devices, budget and spatial environment of the Customs House in Sydney. Due to the parameters, tests were completed to make aware of the types of devices that allowed information to be captured in an environment and streamed to a computer. The devices that were selected for the interactive element of the project were a wireless webcam and microphone. Both of these devices allowed data to be streamed into a simulation program that re-contextualizes the streamed data to produce images that would be displayed via the LED system. The interaction that was chosen for the each wall based on the device was:

- **Webcam Wall:** A digital ball floated in random directions on the wall, and as users were detected by the webcam, the ball would follow the user and begin to change colours randomly.
- **Microphone Wall:** An animation of several lines moved across the wall surface, and as users created sound, more lines would appear.

The studio was successful in being able to produce 2 interactive walls that were displayed in a public domain. Both walls functioned as specified by the design brief, however noticeable flaws in the post fabrication phase highlighted areas in the interaction that were overlooked due to the complexity of designing for public users. The surrounding environment of the exhibited walls inhibited the users to become immersed into the interaction and understand completely the ideas the students were trying to convey through interaction.

## 3. Research Question

What observations did the researchers make by (1) investigating a large scale interaction design project executed through an experienced team of various reknown designers that have to communicate their interaction design idea to either themselves or to their clients; and (2) executing a studio on their own in which we were able to place ourselves, as tutors, into the role of the clients of a project where students need to communicate their interaction design ideas?

Both investigations outlined following observations:

- **Blur Building:** design interaction was conveyed to sponsors via visual imagery; however it still created confusion, as the blur structure created an environment that would have further expanded the experience of the interaction. Without proper understanding of the environment, there is a key element that is missing from the overall 'package' of the interaction proposal to client.
- **Student project wall:** Though simulation programs were used to evaluate the interaction and design of the wall, the spatial environment was not considered thoroughly for the end public user, as they are being immersed into this interactive element, the surrounding environment hinder their experience.
- The ability to test and understand how users would interact with the wall was not made apparent in both case studies.

Based on the above listed observation and the aim of the paper is to demonstrate the significance and vision of research in terms of a central question to the research:

> *What would be the equivalent of architectural drawings (plan, section, elevations) for interaction design in a public urban domain, on an architectural scale, in order to communicate interaction design intentions to design participants and clients through using state of the art computer, gaming and sensor technologies?*

In answering the research question, the objectives for the research in general are: to investigate related research and projects in the area; to research designer and client requirements in regards to communicating and understanding interaction designs; to design, deploy and evaluate prototypes as a communication platform using state of the art computer, gaming and sensor technologies. More specifically this paper will, due to its limitation in size, outline the significance of such undertaking by discussing representation of ideas in architectural design; followed by outlining existing methods of interactive design representation, such as storyboards to then introduce current advancements in gaming environments. Thus the presented paper introduces a framework for a research project that will work towards designs, deployments and evaluations of prototypes as a communication platform

using state of the art computer, gaming and sensor technologies. The paper wants to conclude with a vision for the research and the research projects to come by introducing the next steps of the project.

## 4. Forms of Representation of Design

This section introduces current forms of design representation of how designers communicate their concept to clients that do not have the same understanding as the designer. The method used to communicate knowledge is to help gain "attention, inspire recipients, to anchor a message through addressing emotions, to improve recall or to provoke discussions" (Burkhard, 2004). Current forms of design representation will be addressed, and how such methods are being applied to interactive design, through methods of storyboarding and Gaming Environments.

### 4.1. METHODS OF DESIGN REPRESENTATION

Burkhard (2004) describes Architects as being experts of design representation, as they are at the centre of such projects where a cluster of engineers, designers, and contractors all must have a similar understanding of the project. Sketches, drawings and 3D renderings are a similar form of visually communicating information and have been successfully used to transfer knowledge. Brody (1982) suggests pictures can "excite the learner, explain difficult concepts and expand the written narrative". However, communication of ideas can be hindered when the concept itself, requires the use of individuals to partake in its design to allow an immersive environment to be created through physical human behaviour to further expand the potential of the design. Therefore, interactive design with the purpose of human interaction can be a difficult outcome to achieve, because though such methods as storyboarding and imagery exists, there is a lack of "emotive behaviour" that is found with human interaction, as such design representation can only interpret a probability of events (Wiethoff and Gehring, 2012).

#### *4.1.1. Storyboarding*

A storyboard is comprised of several images that are used to communicate designs to clients through depicting imagery of design, functionality and interaction within context. Within the area of designing interaction, storyboarding has allowed designers to methodically explain during prefabrication phase, how their design functions, and the triggers of interaction within the design. The use of storyboards forces the designer to evaluate the implications of designs that could be adherent

to abstract concepts (Van der Lelie, 2006). However, as such, a designer can only simulate the possibility of how a person will react with the design in their storyboard. This could result in designs not functioning as intended, because there was a lack in understanding emotive behaviour from humans that do not share similar thoughts or interaction processes as depicted in the scenarios created in the storyboard.

### *4.1.2. Gaming Environments*

A gaming environment is an immersive world a person can access through controlling an avatar, which is an object that is able to interact in the gaming environment. Dependent on the game itself, the avatar is able to interact with objects, other people and be a part of changes that occur within the game. Each avatar is controlled by a real person, subsequently means that the avatar's behaviour in game reflects the player's own emotive state (Warburton, 2009). This idea has been used to create environments that can simulate situations that would be either impossible or difficult to create in real life. For example, Drettakis et al. (2007) discuss how gaming environments can be used to simulate Architectural design of interior and exterior space and shell of a building to involved users/clients. Therefore gaming has evolved to being a capable tool in design simulation.

This form of design representation can be extended to allow simulation of interactive designs to be tested by users in a virtual gaming environment. Though this form of representation is advancement to the aforementioned method of storyboarding, there lacks a quality of immersive environments that is attached to designs that create or develop in spaces that is occupied by users or current objects that can influence actions of the user. The main interest is not in designing interactions for existing spaces or for existing gadgets but for using interactivity as a design parameter to define space.

## 5. Research Project – Physical and Digital Parallels

The paper has investigated how design representation to clients and collaborators without prior specialist knowledge can cause confusion and also bypass untested elements of the design. Though there are techniques such as storyboarding, and 3D gaming environments, it still lacks the interactive element that is achieved through human emotive behaviour of a user that is immersed in the interactive environment. With the research question established, development of an alternative method of design representation through bridging physical prototyping and computer simulation technology can be used. The purpose of the connection is to

allow users to be immersed in an environment that has been created by simulation software and also interact with physical components, this interaction gives users the ability to test interactivity and also see a result through the computer simulated model. The combined method of computer simulation and physical prototyping can create an improved understanding of how the user will behave in an interactive and immersive environment.

During the next stage of this research, a review of current devices and techniques will be observed to determine how current forms of Urban Interaction Design are being implemented. This will give precedence to experiment with alternative means of communicating Urban Interaction Design to users and also make available visual representation techniques that adhere to the unique properties of interaction design. The experiment will look into devices that give users the ability to interact with digital objects in a physical space, such as the Kinect system which has been gradually increasing as a powerful tool in Human-Computing Interfacing field (Giles, 2010).

To examine the interaction quality of these devices with digital simulations, a goal of the experiment will be to create a rectangular border comprised of equal cubes. However, only 2 cubes will be physical components, whilst the rest will be made up from a digital simulation that is being projected on the surface. The connection that is to be achieved will have the physical cubes interact with the digital system, as such if the physical cubes are moved inwards or outwards, then the digital simulation will adjust accordingly to the physical components, giving the impression that the 2 systems are working in unison. This combination of physical and digital technology gives users access to understanding through visual aids and physical touch. The success of the experiment will allow further testing for larger-scale projects and the examination of creating immersive environments developed from digital projections and physical components that both aid in representing the proposed interactive design to the end user.

## 6. Conclusion

Modern forms of representation in Architectural design, such as static imagery, video and 3D gaming environments are a common practice to visualize and communicate design information. However, as such these forms of design representation can also lack a level of detail when physical or mental interaction is required by the user. Current forms of representation can only give users a minimal level of interaction understanding, however lacks the important level of human emotive behaviour when they are not only inter- acting with the design, but also immersed in the spatial environment.

The case studies chosen for this research paper, demonstrated how difficult design interaction can be visualized by users without specialist knowledge. The Blur Building case study focused on the design representation stage where the sponsors disregarded many different interaction designs due to their lack of knowledge in understanding the intentions of the designers in the storyboards and did not visualize the interaction on a holistic view when coupled together with the immersive fog structure. The Architectural Computing Studio demonstrated how concept design from sketches and computer simulations still did not foresee the issues that pertained to how the Interactive Walls were placed within the spatial environment and the affected visual interaction design. Thus the aforementioned case studies give precedence to determine an area of research that can introduce an alternative form of communicating Urban Interaction design to collaborators and clients that lack specialist knowledge and improve interaction design awareness.

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