A Study of Using Oversized Display in Supporting Design Communication
Focus on interior design problems

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Abstract: This paper focuses on using oversized display for supporting design communication process between designers and clients. The interactive behaviors are analyzed and testified with a prototype developed in this research. Based on interviews with designers and clients, focus of the communication process in this research is onto developing an immersive environment for exchanging and negotiating the design artifacts. Several immersive virtual environment as well as visualization method (display) is reviewed. Furthermore, three over-sized display projects (ShadowLight, CaveUT and Blue-c) with immersive perception at full-scale or near full-scale design artifacts are studied as the inspiration of this research. Designers identify what kinds of influence they had on the design of client’s interior space and to what extent they are aware that they can design and influence their perception. An over-sized display environment with direct manipulation interface is developed for evaluation platform.

1. INTRODUCTION

1.1 Design communication as the understanding of the design artefacts

The communication problems between designers and clients often occur when the artefacts (design outcomes) produced by designers are not matched
to what clients expected. This is to say that how to understand or achieve the common understanding of artefacts between designers and clients are the issue addressed and studied mostly. Furthermore, large display often used in immersive environment while provides significant immersion for environment is also a powerful tool for showing what the artefacts are in an immersive simulation.

Presenting the artefacts that are easily recognized and associated with viewers’ real scene counterparts virtually can improve the communication in interdisciplinary teams in making decision. (Popescu and Hoffmann 2005) Therefore using virtual objects with large display can be a valid tool for achieving the understanding of artefacts between designers and clients.

1.2 Oversized display as a communication tool

While visual realism enables the dissemination of the simulation results to non-specialists, as addressed in (Popescu and Hoffmann 2005), for the communication purpose described above, the size of display needs to be over the human in order to achieve the immersive experience we needed.

For novice designers, while they are short of experience in scales and dimensions, the spatial dimensions and display are two key communication tools for them to understand and persuade clients. When using desktop-based computer-aided design environment with a shrink-sized on-screen display, the lost of normal scale will need a learning curve which is a shortage for communicating with clients.

In addition, the diverse of display media such as Full-scale display (Martens and Voigt 2001) or stereo display all provide different degree of immersion and exchange interface. For the interest of this paper, we choose over-sized display as the media for our communication study.

2. THE PROBLEM

With the background above, this paper studies the application of an over-sized display in communicating with clients especially onto the understanding problem of artefacts. Furthermore, the interior designers often depend on drawing such as the construction plan as the media for clients. While simple and strong is expressing design knowledge but failing on immersive experience from the client point of view. More media or presentation approaches are conducted in trying to resolve this issue.

With appropriate tool developed, the communication with clients should allow client to participate in the process or more actively involved. Therefore, the media developed should be simple and intuitive enough for
both designers and clients. While “intuitive” is a subjective term, we refer it to a common knowledge and consensus in normal situation. Moreover, when designing an interior space (such as a living room or a kitchen) in our ideal environment, designer should be able to hear the requirements from clients and to communicate with clients directly in a 3D immersive fashion.

3. RELATED WORKS

For finding suitable solution, the related works are divided into three catalogues: 1) virtual design environment, which shows the work done in several virtual design studio works for supporting our concept of communication with large display; 2) large scale display, which provides inspiration and research for implementing our system; 3) case studies, there are several researches done in similar approaches which can provide insights in both interface design as well as system approach; 4) gestalt analysis, for achieving the intuitive interaction using over-sized display, we need to analyze the possible gestures for our interactive purpose.

3.1 Virtual design environment

While addressing in a more general communication problem, collaborative design researches have tested and conducted various directions in experimenting possible communication methods in both syntactic and semantic ways. Among those, diverse forms of Virtual Design Studio (VDS) (Achten, et al. 1999, Schmitt, et al. 2001) have established and realized part of global design teaching environment. The main communication among participants varies in tasks and structure. Some are purely text-based or include various forms of interactive, synchronous or asynchronous collaboration. However, ‘virtual’ in VDS often refers to the way they communicate with each other and exchanging design and ideas. Using Virtual Environment (VE) as tool of design and communicating with the remote partners is not what we expect in our research but the communicating process shows the interaction and display technology have been matured enough for our study. (Schnabel, et al. 2001)

3.2 Large-scale display

Large-scale displays have been used in different projects for different purposes. Seldom researches are done in comparing different displays in similar setting or purpose. The one which catch our attention is the immersive display for education using CaveUT (Jacobson, et al. 2005).
CaveUT (will be described in more details later) built large-scale immersive virtual reality displays with communicating (educational) purposes. Furthermore large-scale display in simulations has become an affordable research tool in science and engineering. However, precise models of the physical properties are required in order to provide enough considerations and appropriate geometric details. Material data and algorithms are devised and validated from experiments and theoretical considerations. (Popescu and Hoffmann 2005)

While display-only approaches only have one way of interaction that cannot provide enough immersive experience and the inputs for display-only approach have many limitations. Immersive Virtual Reality (IVR) as Virtual Reality (VR) with a sensorial immersive display shows the possible solution for our over-sized display—the sensible inputs.

Back to the large-scale display, some displays are clearly immersive (i.e. a six-walled cube, rear-projected on every side) and some are not (i.e. a standard monitor), while there is a continuum of displays in between. Furthermore, we call a display immersive if it fills more than half of the user's overview. With these reviews, over-sized display with sensible input methods will be the main study platform for our purpose. After this, we start to review several cases for finding the system implementation solution.

3.3 Large-scale display case studies

The cases in this session are ShadowLight, CaveUT and Blue-c. Each project shows some significance as well drawbacks in terms of our research purpose.

3.3.1 ShadowLight

ShadowLight (Leetaru 2004) provides a loosely defined environment capable of sustaining interactive schematic design using a variety of virtual media types. Rather than providing a built-in set of manipulators keyed to a particular set of design tasks, ShadowLight instead defines a basic set of interfaces against which third party plugin authors develop. These plugins are self-contained applications, with their own interaction, processing, and simulation logic. This allows for a very diverse spectrum of possible plugins, ranging from simple drawing tools to complete embedded simulations. The setting is shown in Figure 1.
The ShadowLight environment provides more services to the developer than traditional VR libraries. For example, a plugin to create freeform ribbons or tubes may have a very simple click-and-drag interface to draw a new shape in space, while a sculpting tool may have significantly more complex interface needs. A physical simulation, such as a fluid flow, might have any number of input and interactive control parameters. The plugin architecture allows that fluid flow to integrate with other plugin elements in the same virtual world.

In each case, the plugin developer is entirely free to leverage devices ranging from floating palettes and popup menus to proprietary widgets and gestural interfaces. The output of each plugin is a set of objects added to the space. In the case of sketching or sculpting tools, these objects may be static polygonal meshes, while in the case of more advanced tools; the result might be dynamic bodies with highly evolved behaviours.

Design in ShadowLight is based around the notion of a “world”, defined as an infinitely bounded space that serves as the medium in which the designer composes. To interact with this world, a six-degree of freedom “wand” is used which provides three buttons and a joystick. The wand is tracked over a certain physical space in front of a stereo-projected surface, such as a CAVE (Mullins and Strojan 2004) or ImmersaDesk (Czemuszenko, et al. 1997). The user may navigate about the world by pointing the wand in the desired direction of travel and pushing forward on the joystick. No global collision detection is performed, so the user is free to
travel to any location in the world through any path, to freely explore the space from locations not possible in real life.

3.3.2 CaveUT

CaveUT (Jacobson, et al. 2005) developed on BNAVE a PC-based CAVE-like display the Medical Virtual Reality Center and builds large-scale immersive virtual reality displays for the educational purposes. CaveUT supports off-axis projection for correct perspective and multiple views from the observer’s viewpoint.

CaveUT differs from most CAVE-like setups in a variety of ways, but the difference that is most significant to many people and institutions is cost. Even a very elaborate CaveUT setup costs a fraction of what standard CAVE setups do. CaveUT use for the two-walled UT-Cave, and the tripods to hold up the projectors. This makes CaveUT affordable for individuals.

CaveUT use simple equipment and reach powerful visualization display, this technology help our project to build low-cost immersive display wall.

![Figure 2. National Science Foundation's Education with Virtual Experience Workshop.](image)

3.3.3 Blue-c

Blue-c (Gross and Staadt 2001) developed in ETH is a new generation immersive projection and 3D video acquisition environment for virtual design and collaboration. Blue-c combines simultaneous acquisition of multiple live video streams with advanced 3D projection technology in a CAVE-like environment, creating the impression of total immersion. The
main Blue-c portal currently consists of three rectangular projection screens that are built from glass panels containing liquid crystal layers. These screens can be switched from a whitish opaque state (for projection) to a transparent state (for acquisition), which allows the video cameras to “look through” the walls. A sub-project using Blue-c technology is called Powerwall is shown in Figure 3.

Figure 3. Powerwall by ETH.

The projection technology in Blue-c is based on active stereo using two LCD projectors per screen. The projectors are synchronously shuttered along with the screens, the stereo glasses, active illumination devices, and the acquisition hardware. From multiple video streams, we compute a 3D video representation of the user in real time. The resulting video inlays are integrated into a networked virtual environment. Our design is highly scalable, enabling Blue-c to connect to portals with less sophisticated hardware.

The second Blue-c portal consists of single projection screen, similar to a powerwall. The whole installation looks like a open box, literally shifted into one of the hallways of the building of the architectural department. In contrast to the cave, this portal has been built in a public space, free accessible for students and visitors at all times.

In order to acquire the users and transmit their three-dimensional representations to the cave portal in real-time, sixteen cameras are placed inside the walls. Stereo projection and six-dimensional mice offer the users the impression of full immersion. Next to the Blue-c technology capabilities, this space can also be used for meetings and presentations.
The Blue-c application of Architectural Design, the architects work with both low-scale physical models and computer-generated images of buildings. But the advantages of full immersion, involving visual, acoustic, and hectic senses remain widely unexplored. The Blue-c system will provide the technology for a variety of new collaborative design, management and refinement procedures between the architect, his/her client and third-party experts.

3.4 Gestalt analysis for interacting with 3D information space

After reviewing the possible technological solution for our display, we now turn to define the interaction needed. There are several interactive behaviour researches such as (Lu 2005) are focusing on the behaviours in front of large display. Most are focusing on navigation that is a clear and important behaviour for communicating with clients.

Based on Lu’s thesis, navigational behaviour particularly corresponding to human intuitive hand gestures can be divided into 2 directions: orientation and event transmission. It can further break down the modes through which human being’s turning, jumping, grasping and walking are simulated in manual control of 3D VES pertinent to basic navigational operation. The gesture provide feedbacks to navigational experience in the immersive 3D environment and at the same time information is read conducts searching in conjunction with icons such as spatial types, layouts and locations. The analysis matrix from (Lu 2005) is shown in Figure 5.

![Figure 4. Gesture Analysis.](image-url)
4. METHODOLOGY

With reviews, we have examined the requirement for implementing the over-sized displays as well as the gestalt analysis for interaction. For achieving the platform for studying the over-sized display in communicating with clients, the interviews for communicating in over-sized display is conducted as well as the analysis of the interactive behaviours in front of display. Followed by implementation and used usability analysis for the display as a communication tool. Result and usage discussion is discussed and argued.

5. ANALYSIS AND IMPLEMENTATION

For reifying the concept in our study, we analyze the possible interactions including: 1) user how to navigation between physical and virtual, 2) how to present, and 3) how to modify. The analysis for navigation is shown in Figure 5. After this analysis, the system implementation is shown in 5.1.

<table>
<thead>
<tr>
<th>forward,</th>
<th>static</th>
<th>backward,</th>
<th>turn left</th>
<th>turn right</th>
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<tbody>
<tr>
<td><img src="forward.png" alt="Image" /></td>
<td><img src="static.png" alt="Image" /></td>
<td><img src="backward.png" alt="Image" /></td>
<td><img src="turn_left.png" alt="Image" /></td>
<td><img src="turn_right.png" alt="Image" /></td>
</tr>
</tbody>
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*Figure 5. Behavior transform.*

For intuitive purpose, the interaction in our system is based on body movement as shown above. By glancing at visual perception and using body as the input interface, the natural behavior can be provided and sensed by our display system. The natural behavior as walk, step to forward, backward, leftward and rightward can be sensed and tracked.
5.1 System framework

The system for over-sized display is called Immersive Virtual Design Simulation (IVDS) which is comprised of display, sensors and computing engine. The system framework is shown in Figure 6. Sensors for providing the interface of navigation, presentation and modification are based on both DDR Dance pedal and Joytokey. The display is mainly the projector with large screen. The computing engine is implemented in Form Z using Form Z SDK. The Artefacts are mainly the Form Z geometries with Import / modification functionality.

![Figure 6. The system framework.](image)

5.2 Display

The oversize display is a projection based Form Z 3D software system that has been developed for flexible presentation tasks and deals with a variety of functions. Based on commodity hardware, it significantly reduces the time and money needed to develop and present Immersive Virtual Environment (IVE) applications while simultaneously expanding the options available compared to similar systems. The system structure is shown in Figure 7.
5.3 Software

The platform used for large-display is based on extension structure of Form Z 3D (auto-des-sys 2004) software environment. The glue between DDR pedal and Form Z is based on joystick device with Joytokey software. These tools make it possible to easily create any form, real or imagined. The plug-in realizes an Oversize Display working bench that supports designing and modeling under the form Z virtual environment.

6. AN EXAMPLE

Communication problems rise up the time designer would repeat. Such as, client’s languages might not completely describe the requirement and be understood by designer, or designer’s terms or drawings are not understood by client, either. Further, terms and drawings could not be touched, felt and working as the real objects in the design. For a client, it would be more difficult to understand.

For example, when clients like two photographs the following paragraph. But they don’t understand the kitchen size whether it is suitable in them house. The designer will be planned in accordance with the style that the client is choosing after being thought to measure the size of the kitchen in them position. But can only experience the proportion sense of the kitchen and space after the kitchen installs finishing in the client's position.
7. CONCLUSION

We therefore reasonably conclude that the oversize display can help designing communication process between designer and client and perceiving in the physical space. The primary finding of this research is that it is possible to use oversize display environments to gather data about user perception in the real world.

8. REFERENCES


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