The First Virtual Environment Design Studio

SCHNABEL, Marc Aurel[1]; KVAN, Thomas[1]; KRUIJFF, Ernst[2]; DONATH, Dirk[2]
[1]Department of Architecture, The University of Hong Kong, Hong Kong, China, [2]Chair Computer Science in Architecture, Bauhaus-University Weimar, Germany
http://courses.arch.hku.hk/vds/veds01/db

Since 1993 schools of architecture all over the world conduct in various forms of Virtual Design Studio (VDS). They have become an established part of teaching design within the digital realm. They vary in task and structure, are purely text-based or include various forms of interactive, synchronous or asynchronous collaboration. However, 'virtual' always refers to the method of communication and exchange of design and ideas. Students have never designed within immersive virtuality. This paper describes the first successful attempt to conduct a Joint Design Studio, which uses Virtual Environment (VE) as tool of design and communication between the remote partners. This first VeDS focused on how architectural students make use of this particular different approach to design within immersive three-dimensional VEs. For example, the students created 3D-immersive design proposals, explored dependencies to textual description of initial intentions and communicated between local and remote team-partners in immersive VE as well as text-based communication-channels. The paper subsequently describes the VeDS, its set-up, realization and outcome. We discuss frameworks and factors influencing how architectural students communicate their proposals in immersive VeDS, and how this new approach of design studio enables new forms of design expressions.

Keywords: *Immersive virtual reality, collaborative design, joint design studio, preliminary design*

Introduction

Virtual Design Studios (VDS) are a widely used method of architectural design teaching. Lessons learned from academic contexts have been employed in commercial settings (ACS, 2001). While some have been successful, various problems have been reported, e.g. a lack of communication and collaboration (Kvan, 2000); technology overhead (Kruijff, 1998); and potential contributions to design outcomes (Wojtowicz and Butelski, 1998). In all these design studios, virtuality has been defined as not physically together. Virtual has not yet referred to an immersive Virtual Environment (VE) per se. Instead, students used quasi-virtual environments by the choice of design and communication media:

computers, CAAD-programs (2D and 2.5D), VRML, projection screens and automated databases. (Donath, et al. 1999). Shared immersive virtual spaces have been employed for design reviews (Davidson, et al. 1996) but not for active design interaction. The next logical step to develop the VDS is, therefore, to establish joint design sessions where users can collaboratively create, interpret and communicate design ideas within an immersive Virtual Environment Design Studio (VeDS) and to examine if this context offers any new opportunities or solutions to problems encountered.

VeDS 2001 aimed beyond the initial idea of a VDS by introducing new dimensions to the participants. We wanted first to see if a virtual studio can be run in an

immersive environment. Secondly, we wanted to see if the use of immersive VR-design-systems shifted design and its communication to a different mode or level. It has been suggested, for example, that participants in a VE might express and communicate their intentions, ideas and designs not only in a different but also in an improved manner (Dorta & LaLande, 1998). We hypothesized that the VeDS would have a positive impact on the development of design, its communication and understanding.

Ping Pong – the experimental conditions

This experiment springs from and builds upon virtual studios in which The University of Hong Kong (HKU) and Bauhaus University Weimar (BUW) participated in earlier years (Bradford, et al. 1994; Donath, et al. 1999; Kolarevic, et al. 2000; Kvan, et al. 2000; VDS HKU). Teams on the two sides worked together on the same design task and finished their project within a single day. The design ideas, proposals and modifications were exchanged with the remote partner in short and frequent intervals, reminding us of a ping-pong match. Each side had the authority (not ownership) over parts of the design. Co-ordination became necessary in order not to obstruct the team partner's activity. This setup simulates a typical scenario where architects and specialists contribute to an overall scheme in sequential and parallel activities that form typical collaborative work (Wojtowicz and Butelski, 1998, Kvan 2000).

The studio focused on the initial design stages of design, comparable to brainstorming and concept finding activities; we did not intend for participants to produce elaborated final designs. As in a moderated discussion session where the microphone is passed to speakers, the Head Mounted Display (HMD) was passed between the teams and the resultant design sketches were produced within the VE in the course of the alternating sessions described below. To support the design process more fully, text communication was also provided (Wong & Kvan, 1999). We wanted to capture the design intent so we used a modified "think aloud" methodology by establishing a design team of two at each end, one team member wearing the HMD and the other taking notes and chatting with the remote team to convey design intent (see Figure 1). The text records also provided a protocol to be analyzed later.

In addition to participation in earlier VDS, HKU and BUW have independently conduct research within VE. These experiences proved crucial in the success of VeDS, a process inherently plagued by tremendous technical and operational difficulties. Issues such as collaboration and co-ordination, technical matters of bandwidth, file transfers and communication, have to be tackled as well as tuning of equipment, ensuring equal opportunities for participants and the availability of facilities. Although in the past our goal has been to engage in heterogeneous environments, with each participant using whatever equipment they wish, the problems of VE collaboration precluded such freedoms. In this experiment, both universities

Figure 1 (left): Teamwork: while one student is designing within VE, the others watch the action and communicate with the remote side
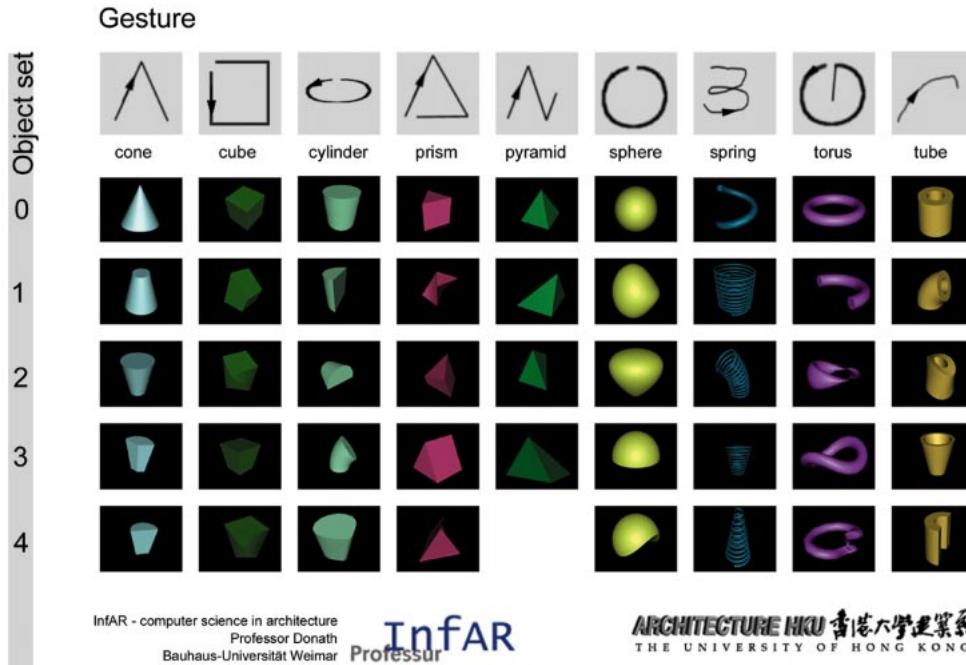
Figure 2 (right): Setup of Equipment: to the left, the HMD with tracking-device; to the right, the PC with communication software and image from the HMD

Figure 3:Gesture Reference Guide.

employed very similar configurations of immersive virtual reality (VR) equipment, as shown in Figure 2: a Pentium III computer, connected to a broadband internet connection, monitors, Kaiser Proview 60 HMD and a Polhemus Fastrak magnetic tracking device and a Stylus. The Virtual Reality Architectural Modeler (VRAM) developed by BUW (Regenbrecht, et al. 2000) had been modified and added new input features based on gestures. Comparable to input for PDA-devices, the users now gesture with the stylus and their movements are translated into basic 3D primitives (Figure 3). A second PC was used for the communication-channels (ICQ), Internet (IE), Web-based database and other presentation-software (AutoDesk 3DStudio VIZ and Adobe Photoshop).

This VeDS was part of an elective course for students in Hong Kong for the Master of Architecture course. At BUW, the students were in an architectural design studio. The students had acquired both a broad training in IT and CAAD as well as an advanced background in architectural design. A small exercise was given to the students prior to the VeDS to instruct them in the functions and aspects of immersive VE and VRAM.

Each university had access to only one set of VR equipment; thus, only two teams could work at the same time. The intent was to engage the students in rapid design exploration akin to brainstorming so sessions were completed in one continuous cycle. HMD use is limited in its effectiveness (Wong, 2000)
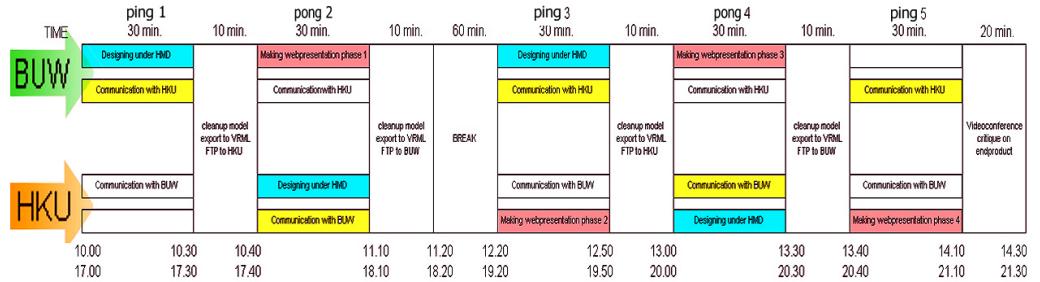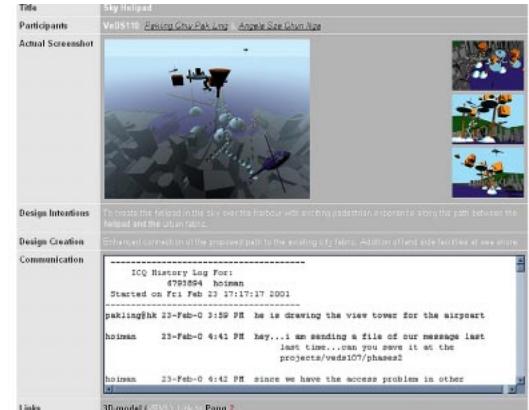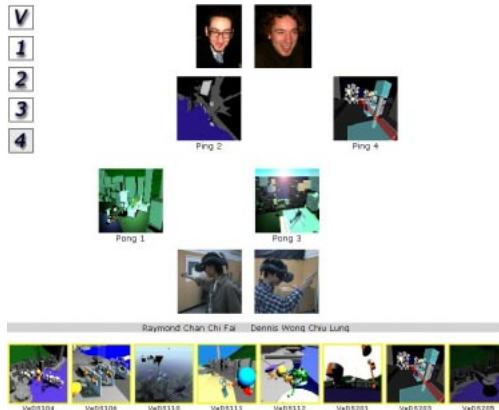
Figure 4: Time-flowchart

Figure 5:Screenshots of Database. left: overview of output by one team, right: presentation of work in one phase with text annotation [http://courses.arch.hku.hk/vds/veds01/db]

so each phase was set to 30 minutes (called ping or pong) during which they had control of the model (Figure 4).

While one team member was designing, the other was taking notes and annotating the design. Then they wrapped up their design, cleaned the model of unwanted elements and placed the model and the text into the database (modeled on Hirschberg, et al. 1999) where they prepared a short presentation explaining design intentions and achievements of that phase (Figure 5). The remote side then took over the model and continued the design work. After alternating four times, the exchange concluded with a final phase where the work was presented within the database. This phasing allowed for potential problems in file transfer or temporary bandwidth constraints.

Using this sequence, a complete cycle of VeDS was finished within four hours and could be repeated daily over one week in order to accommodate several teams. With this method 18 groups in total took part in the studio. After the last teams completed their work, a final critique was arranged in which all teams came together presenting their work to each other, instructors and external examiners in order to discuss the different outcomes and the new approach to design.

The HeliPad

A design task was specified that presented the students with an assignment appropriate in scale, content and effort to the medium available. Factors taken into account included technical constrains (tracker range, room size), the scale of model and

points of view (gravity, birds-eye view). The task defined was a small landing-ground for helicopters in Central, Hong Kong. One the one hand, the Hong Kong Government is searching for a design of a new Helipad at the location, on the other, the task fits the constrains and opportunities of VE. In this task, the designer can work in a virtual model of Hong Kong from the viewpoint of the pilot or of the passenger waiting to embark. The task was split therefore in two parts, one for each team: the land- or the airside of the helipad. Additionally each part of the task had one static and formal, the other dynamic and path focused, which had to be addressed in the design proposal:

Landside:

Check-in/waiting enclosure for passengers ‡ static

Driveway/parking >> dynamic

Airside:

Control tower for Air controllers and tourists ‡ static

Apron/flying >> dynamic

Each step during the process was recorded and collected. All participants filled out a questionnaire, in which we enquired about the participant's individual IT- and VE-background and experience of this VeDS. Those and all other collected data were recorded for later analysis and further research.

Results

Most importantly, we demonstrated that it is possible to implement a collaborative virtual studio in an immersive environment. Teams did engage in collaborative work, building at each step on the work of the previous efforts.

Secondly, the resultant designs surprised participants in their ingenuity and presentation, as participants noted in the chat line communications. It appears that an immersive VE permitted students to experience their ideas differently from non-immersive environments. They reported that the interaction of idea and creation was direct, that each stroke had an immediate impact on the design. It seemed for the students that they communicated directly with their model, being part of it and not only the distant scale-less designer. They told us this led to new forms and new arrangements.

Collaboration was possible. The interaction within the team worked out much better than anticipated. Communication problems of earlier VDS did not occur (Donath, et al. 1999; Kolarevic, et al. 2000). The teams engaged in intense discussions about design, concepts and form. Due to the nature of the task and application the groups had to formulate their actions to the remote partners to be able to develop further their scheme. In addition the participants developed a personal interest to share their experience and their creation with their colleagues and other teams. We noticed that participants from BUW tended to deal with conceptual schema while HUK students tended to be factual, specific and describe in tangible terms, possibly reflecting the educational characteristics of the two institutions. It is notable that the VE environment supported these differences and the collaboration was successful with such distinctions (Figure 6).
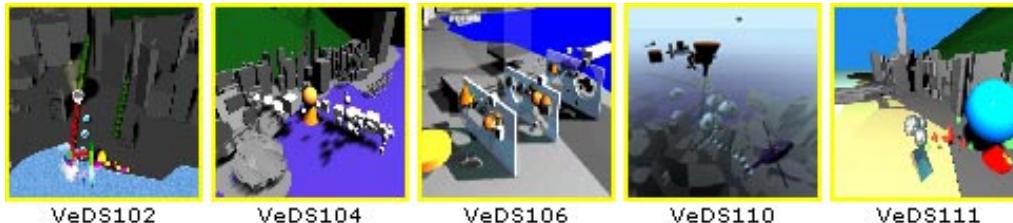

VeDS102   VeDS104   VeDS106   VeDS110   VeDS111

Figure 6:Screenshot of some results

Conclusion

This VeDS has demonstrated that an immersive virtual studio can be implemented. While problems remain in the technologies, the rapid asynchronous manner successfully enabled students across the world to participate with immediacy in joint development of a design solution.

Acknowledgements

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