PARTICIPATION, INTERSUBJECTIVITY, AND PRESENCE IN A DIGITALLY MEDIATED WORKSPACE

A Participatory Design Studio between Pennsylvania State University and Carleton University

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Abstract: A paradigm shift in the world of architecture brought by the recent developments in visualization and communication technology not only offers us drastically different ways to collaborate, but also questions traditional location dependent collaborations. This new technology offers us new possibilities for a more phenomenologically rich mode of creative activity and participation. The goal of the Participatory Design Studio was to allow architecture students in multiple locations to collaborate in real-time by sharing computational resources, geometric datasets, and multimedia content including high-definition video. The technologies involved in this research include the National LambdaRail (layer 3, PacketNet with 1Gb/s connection) and CA*net 4 (Canadian broadband layer 2 with 10gb/s lightpath connectivity) allowing Standard Definition videoconference, utilization of Deep Computing Visualization, Remote Visual Networking (RVN) and Web Service access and control of the APN devices through the dashboard solution that makes integration seamless to the workflow and transparent to the user.

Keywords. design: collaboration; tele-presence; visualization; broadband.

1. Introduction

The rapid globalization of architectural practices in the 1990s, in conjunction with the rise of the Internet, has resulted in diverse forms of remote collaboration. Geographically distributed and digitally mediated work environments exacerbate the complexity of the design process but simultaneously provide fertile ground for the research and development of systems and methodologies for improving collaboration. While visualization and communication technology advances, its failure at collaboration and communication becomes ever more critical. The sharing of understanding is a necessary condition for the success of any collaborative effort.

During the spring semester of 2007, an experimental design studio was held between the Immersive Environment Laboratory (IEL) at Pennsylvania State University (PSU) and the Carleton Immersive Media Studio (CIMS) at Carleton University (CU), Ottawa, Canada. The goal of this experiment was to create an immersive and information-rich environment for dialogue, group problem-solving and participatory design, and to provide workflow that will be flexible, robust and relatively transparent to users. This "proof-of-concept" and "capacity building" phase of the PDS, was implemented through a series of collaborative design environments, each of which comprised a loose assemblage of geographically distributed platforms (or "scenes"), including traditional architecture studios at both PSU and CU, immersive media labs, multiple communication and visualization technologies, and a web based network-enabled platform (NEP).

2. Background on the digitally mediated collaborative design studio

Since W. Mitchell coined the term 'Virtual Design Studio' (VDS) in 1993 (Wojtowicz, 1995), many Architecture schools have conducted various experiments on VDS (Bradford et al 1994). The first example was attempted at the University of British Columbia in collaboration with Harvard, Cornell, MIT, Washington University and Hong Kong University (Cheng et al, 1994; Kalay, 1995). Due to the lack of available collaboration technologies, they had to rely heavily on asynchronous communications such as e-mail, message bulletin boards ("digital pinup boards"), FTP, and the Internet. With insufficiently powerful and crudely coordinated tools, collaboration was primarily in an asynchronous, task-based working process that did not allow for full participation by members of the design teams (Mitchell, 1997). As a result, participation was reduced to "simply submitting and giving oneself over" (Vaitkus, 1991) to the process and other participants.

Although the development of synthesized networking and media technologies has led to significant progress in enhancing collaborative environments in academic settings since then (Stanford University, University of Strathclyde, University of Sydney, MIT Media Lab, U.C. Berkeley, etc.), truly collaborative digitally mediated design studios are still rare. Maher described the development of a shared understanding among the participants, which is most critical to the success of any VDS, was still hard to achieve within the given technology.

The transformative nature of new network infrastructure with higher bandwidth, lower latency connections and effective media technologies has barely been tapped in design fields. Furthermore, there is hardly any research done that speculates on how such a paradigm shift in the world of architecture brought by the recent development in visualization and communication technology, opens up different modes of collaboration. (Maver and Petric, 2001; Maher, 2006).

3. Mediation and Collaboration

Access to a high bandwidth Research and Education network allowed for low latencies and high-speed transfer rates to create a "next door phenomenon" thus effectively consolidating resources distributed across the two locations. Design collaboration is to "work together in a meaningful way, not just working together efficiently, but stimulating each other to contribute to the design task…toward mutual understanding and maximizing outcomes that satisfy not only own respective goals, but also those of other participants" (Achten, 2002). A main goal of this "proof-of concept" PDS was to determine effective thresholds to accomplish a phenomenologically complex participatory experience.

3.1. "STAGING" THE DIGITALLY MEDIATED ENVIRONMENT

Within the loose ecology of locations, facilities and communication protocols, we identified a series of "stagings" of the collaborative design environment. Each "staging" was a complex assemblage of geographically distributed platforms; the two immersive media labs with digital visualization and communication systems, broadband data networks, FTP sites, high-performance modeling, rendering and multimedia resources, as well as a range of group-to-group communications, including email, chat sites, phones and remote sketching applications.

3.2. DEFINING THE DIGITALLY MEDIATED ENVIRONMENT

We approached the "staging" of the digital collaborative environment as consisting of three primary "scenes": the IEL, the CIMS lab and, finally, the digital "scene" which, of the three, is the one that most urgently needs to be investigated and qualified. This third "scene" of is created through a dynamic interaction between the students and the two distinct technological interfaces. Within this third "scene", unique modes of communication, embodiment and subjectivity might emerge.

None of the three primary "scenes" exist as a purely physical or purely virtual space. The IEL and CIMS labs are partially constituted by their extensions into the digital realm. Likewise, the digital "scene" requires a robust physical substrate. The virtual and the physical are interpenetrated and the boundaries between the three "scenes" are very porous. Transgression across these boundaries – the passing of data-sets and assets, but also bodily gestures, expressions and ideas - is the creative activity that actualizes the digital collaborative environment.

4. Facilities

The IEL at PSU offers three six-by-eight-foot, panoramic, passive stereoscopic VR display and is supported by multi-platform graphics workstations and software to allow VR-like display of student designs. The IEL is also equipped with the Standard-Definition (SD) tele-presence system and is connected to the APN and its associated resources through a 1Gb/s layer 3 PacketNet connection to CIMS.

CIMS at CU has at its disposal a robust configuration of network and computer resources, a range of tele-communication platforms, displays and immersive environments. It is equipped with 10Gb/s connectivity utilizing User Controlled LightPath (UCLP) software for on-demand control and configuration of the optical network.

5. Participants and Projects

A total of 32 students (16 from each institution) participated in this project. They were all enrolled in the third year of professional degree programs in architecture at the respective institutions. Participants were all under 25 years of age, and four participants were non-native English speakers. The software used during the projects ranged from PowerPoint, PhotoShop, Form•Z, 3DS Max, Maya, AutoCAD, and other modeling software. The PSU students had intermediate level skill on Form•Z, while the CU students had entry-level skills that developed to an intermediate level through the duration of the project.

A total of two design projects were given during the semester; a small helicopter museum at Penn State (VLM), (duration: 6 weeks), and an addition and renovation to the School of Architecture at Carleton University (SoA), (duration: 8 weeks). The students were organized into groups of 4, with 2 students from each school for the VLM. For the SoA, some groups were combined or reorganized, resulting in a variety of group size (4, 6 and 8). The VLM utilized Access Grid (AG), while SoA exploited the potential of the National LambdaRail (layer 3, PacketNet with 1Gb/s connection) and CA*net 4 (Canadian broadband layer 2 with

10gb/s lightpath connectivity) allowing Standard Definition videoconference, Web Service access and control of the APN devices through the dashboard, and utilization of Deep Computing Visualization, Remote Visual Networking (RVN) solution.

5.1. PROJECT 1 (VLM PROJECT – PSU LOCAL SITE) WITH ACCESS GRID

Since the proposed project was located at PSU, the PSU students took responsibility for documenting the existing condition of the building and its existing context. They transferred these assets to CU students via FTP sites. The conveyed information consisted of Form•Z digital models, pictures of existing conditions, conventional architectural drawings in PDF format and video documentation.

Scheduled videoconferences were held once a week for the first three weeks and twice a week for the rest of the project. After the initial meeting session via AG conferences, the students communicated their design intentions to their counterparts, using primarily pre-prepared PDF format with images from Form-Z models and scanned hand drawings, as well as some AutoCAD and other modeling software.

5.1.1. Observations from Project 1

The AG was easy to operate and robust enough to serve for presentation of ideas. The end of semester focus-group study indicated that audio delay had prevented team members from fully experiencing spontaneous idea exchange and generation, as counterparts had to wait to avoid talking over one another and students had to learn to speak slowly and clearly. Most importantly, poor visual quality interfered with productive collaboration in the tele-conferences in that subtle communications, such as gestures and facial expressions, could not be clearly conveyed. As a result, AG provided little opportunity for one pair to respond to their counterpart's design proposal, or to generate, represent and communicate revisions. This working process resulted in a predominantly asynchronous collaboration, in which each pair completed separate tasks outside of the tele-present meetings. Many PSU and CU pairs developed two parallel projects for several weeks and struggled to resolve their ideas into one shared proposal. In addition, as it is acknowledged in the previous studies on the differences between remote sketching and computer modeling software during the design process (Maher, 2005 & 2006), most of criticisms were that computer-based presentations tend to be formal and rigid, not allowing spontaneous exchange of ideas and interpretations necessary between participants, especially at the early stage of the design process.

5.2. PROJECT 2 (SOA PROJECT – CU LOCAL SITE) WITH CANET*4 AND NATIONAL LAMBDARAIL

The PSU and CU students now reversed positions regarding site information gathering/ conveying. Similar to the first part of the semester, this staging included previously listed items as well as remote sketching programs (Open Canvas, etc.). Most significantly, the connection between CIMS and IEL was switched to the 1Gb/s National LambdaRail PacketNet and CAnet4, allowing the group to deploy uncompressed SD Video using Pleora Technologies' EtherCast; PDS Web Service and Dashboard for ease of control and configuration of devices included in the APN such as the rendering farm located at CIMS and the communication platform; and DCV-RVN for real-time application sharing and high-performance visualization of assets. This PDS project is considered to be the first 'in the wild' real-life deployment of the components developed in Eucalyptus (Jemtrud et al., 2006).

The difference between the two settings was apparent; dramatic changes were observed in students' supplementary communications, as well as their creative use and appropriation of the tele-collaborative environment.

5.2.1. Videoconference

Although we could not utilize HD video for this experiment, SD video signal was more than sufficient for team members to observe each other's expressions and to establish effective team collaborations. Compared with AG, which was primarily passive observation, students quickly took advantage of the quality of the video feed by using physical models to explain their ideas and intentions and even sketched their ideas on paper and showed it to partners during the conference. The increased high-quality interactivity of the videoconference made it possible to discuss alternative approaches to their design and to explore their design issues more thoroughly. Their design adjustments became much quicker and were more easily achieved as they became increasingly accustomed to the environment.

As with every new technology, a number of difficulties had to be overcome. Although we have experimented in many different settings, the placement of the camera interfered with establishing seamless communication between teams. Since a camera is not placed inside the display screen (similar to iMac), we experienced an "eye-shifting" effect. This was particularly problematic with the IEL due to its screen size, although overall its large screen size changed the videoconferencing experience for the better.

Figure 1. S-D Videoconference session at the IEL

5.2.2. PDS Web Service and Dashboard

Figure 2. Dashboard

A human-centered interface and tool development process is essential for any computer-mediated environments (Shneiderman and Plaisant, 2004). Previously, there was no work being done to integrate and make the technology transparent, easy to use, and on-demand for the end users without large support and technical staff.

The PDS Web Service and Dashboard brought different tool sets that encompass and streamline almost all stages of the digitally mediated process by removing actions such as configuration, establishing protocols, and the logical launching of applications in a coordinated manner. (Jemtrud et al, 2006). The Dashboard is a customizable graphic user interface composed of floating ‘Widgets’ for functions such as text messaging, videoconferencing, and resource management, in which users access and engage people, resources and tools. The Dashboard will become a powerful multi-disciplinary collaboration enabler as more ‘Widgets’ are incorporated.

5.2.3. “Deep Computing Visualization” RVN

Although the available software at this point was limited to Maya, RVN immediately became an important element in our collaborative effort. Students were able to share 3D models of projects and examine and discuss design issues together. Manipulations of 3D models from either end were flawless even though the files were fairly large.

6. Conclusion

As Mitchell (1997) pointed out, previous videoconferencing tools often failed to facilitate distributed discussion and negotiation, and often lead to miscommunication between participants. The quality of audio/video feed is crucial to collaborative work sessions as they contribute greatly to the ways that people can relate to each other and build a foundation of shared understanding. The SD videoconferencing via 1Gb/s National LambdaRail PacketNet and CAnet4 sessions overcame these previous limitations and provided participating students with seamless, interactive group-to-group remote collaborations. As a result, projects emerged through a series of interactions between the members of the design team negotiating for a shared understanding via the aforementioned digitally mediated environment. Most importantly, it fostered a higher sense of working together, thus provided a true real-time collaborative opportunity for participating students.

Our experimentation in ‘staging’ of digitally mediated collaborative environment will continue by acknowledging the multi-stage architectural design process: program development, schematic design, design development, etc. (Laseau, 1980). Each stage necessitates various requirements and different kinds of collaboration, thus different communication scenarios and the way tools are used in each situation need to be studied and evaluated. It is important that we use these opportunities to explore the unique dimensions of subjectivity, presence and the embodied interaction enabled only by *the digital medium*, rather than naively using these new technologies to simulate face-to-face interaction.

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References

Achten, H. H. (2002). "Requirements for Collaborative Design in Architecture." *Proceedings of the 6th Design & Decision Support Systems in Architecture & Urban Planning Conference*, pp. 1-13.

Bradford, J.W., Cheng, N. and Kvan, Thomas (1994) "Virtual Design Studios, The Virtual Studio", *Proceedings of the 12th European Conference on Education in Computer Aided Architectural Design*, Glasgow (Scotland), pp. 163-167

Cheng, N., Kvan, T., Wojtowicz, J., van Bakergem, D., Casaus, T., Davidson, J., Fargas, J., Hubbell, K., Mitchell, W., Nagakura, T., Papazian, P. (1994). "Place, Time and The Virtual Design Studio", *Proceedings of Association for Computer Aided Design in Architecture (ACADIA 94)*, St. Louis, pp.115-31

Elger, D, and Russel, P. (2001). "Net-based Architectural Design: The Difficult Path from the Presentation of Architectural Design in the World Wide Web to Teamwork in Virtual Planning Offices: A Field Report", *Proceedings of the 19th eCAADe Conference*, Helsinki, pp. 371-375.

Frucher, R., and Yen, S. (2000). "RECALL in Action", *Proceedings of ASCE ICCCBE Conference*

Jemtrud. M., Nguyen, P., Spencer, B., Brooks, M., Liu, S., Liang, Y., Xu, B. and Zhang, L. (2006) "EUCALYPTUS: Intelligent Infrastructure enabled Participatory Design Studio," Winter Simulation Conference Annual Meeting 2006.

Kalay, Y. (1995). "Multidisciplinary Collaborative Computer-Aided Design Studio", *Computing in Design: Enabling, Capturing and Sharing Ideas. Proceedings of ACADIA '95* (Association for Computer- Aided Design in Architecture), B. Kolarevic, L. Kalisperis (Eds.), pp. 383-403.

Kvan, T. (2000). "Collaborative Design: What is it?" *Automation in Construction* 9(4), pp. 409-415

Laseau, P. (1980). *Graphic Thinking for Architects and Designers.* New York: Van Nostrand Rheinhold

Maher, M.L., Bilda, Z. and Marchant, D. (2005). "Comparing Collaborative Design Behavior In Remote Sketching And 3D Virtual Worlds," in Proceedings of International Workshop on Human Behaviour in Designing, Melbourne, Victoria, Australia, Key Centre of Design Computing and Cognition, University of Sydney, pp 3-26

Maher, M. L., Simoff, S., and Cicognani, A. (2006). The Potential and Current Limitations in a Virtual Design Studio. Retrieved November 10, 2006 from <http://wwwpeople.arch.usyd.edu.au/~mary/VDSjournal/>http://wwwpeople.arch.usyd.edu.au/~mary/VDSjournal/

Maver, T., Petric, J. (2001). "MEDIA in MEDIATION Prospects for Computer Assisted Design Participation." Retrieved November 14, 2006 retrieved from http://cumincad.scix.net/cgibin/works/Search?search=maver+petric+2001&paint=1&_form=AdvancedSearchForm>

Mitchell, W. J. (1997). "Networked CAD: The Wave of the Future". *In: Dialogue*, November issue.

Sanders, K. (2000). "Why building information modeling isn't working ... yet", *Architectural Record* June 2000, pp. 167-173

Seichter, H. (2003). "Collaborative Augmented Sketching", *Proceedings of the 2nd International IEEE AR Toolkit Workshop*

Shneiderman, B and Plaisant, C (2004), *Designing the User Interface*, Addison-Wesley, 2004

Simon, H.A. (1981). *The sciences of the artificial*. 2d ed., MIT Press, Cambridge, Mass.

Vaitkus, S. (1991). *How Is Society Possible?* Dordrecht, Boston: Kluwer Academic Publishers.

Wojtowicz, J. (Ed.) (1995). *Virtual Design Studio*, Hong Kong: Hong Kong University Press.