Net-enabled Collective Design Authorship

Branko Kolarevic
University of Hong Kong, China

Edward Y Y Ng
National University of Singapore, Singapore

The paper describes an experiment in collective design authorship conducted within a semester-long virtual design studio. Students at two geographically distant institutions were asked to design a "Place2Meet on the Water," a small floating pavilion to be assembled from hollow-section steel components. The first part of the studio was devoted to a study of precedents, done in teams of five students from both institutions, who worked both synchronously and asynchronously over the Internet. The students' work was continuously reviewed through virtual crits conducted using web pages and video conferencing. The second part of the virtual design studio, devoted to the actual design of the pavilion, was divided into five closely related phases. After each phase students had to place their designs into a common database. They then had to browse through submitted designs and choose one to develop further; they were not allowed to continue with their own designs. That way, students implicitly formed teams and engaged in collective design authorship that was enabled by the network and supported by the design database. The design-centered research project presented in this paper also examines the issues of teaching methods and whether the quality of design could be improved in a networked design environment based on collective authorship and how such an environment can affect the nature of the produced designs.

Introduction

The Information Revolution, like the Industrial Revolution before it, is not only challenging what we are designing but also how we design. Collaboration between participants in the design process, who are often in different locations around the world, is increasingly becoming crucial. In some disciplines, such as automobile and aerospace industries, designers have already taken advantage of the remote collaboration among design teams on global basis with notable successes. Remote collaboration is now becoming a reality even in smaller architectural firms.

The technology itself, however, is not central to remote design collaboration. Design involves frequent making of choices, and underpinning this process are the values and the beliefs of the designer or a group of them. To truly come to terms with designing in a global context, issues such as social, cultural and ideological differences have to be further understood. What makes the geographic, cultural, or ideological cross-boundary collaboration difficult and interesting is the human dimension of trying to work together towards a common goal.

This paper describes a virtual design studio as an experiment in remote design collaboration that explored the issue of collective design authorship that is now made possible by computer technology. Teachers and students in Hong Kong and Singapore worked on a common design project ("Place2Meet on the Water") using traditional and digital media, a central database, World Wide Web, and video-conferencing.

Background

Contemporary architectural practice relies extensively on collaborative work. As offices grow to cope with bigger and more internationally oriented projects, the need for internal and external communication increases. Not only that architects have to work with consultants located in other cities or have branches elsewhere in the world, they themselves are increasingly moving beyond their local and geographical strongholds and are becoming global and international (Wurman 1996).

In structuring a global organization, two models are commonly used (Lucas et al 1994). The vertical integration model is quite simple and is widely practiced. In this model, branch offices are set up and closed as projects come and go. Basically, each of the offices manages its own projects and offers a complete range of services. Transfer of knowledge and expertise between offices is limited. The horizontal integration model, however, is more sophisticated. It makes use of the geographical, economic and social advantages of different branch offices to maximize their throughput. Offices are specialized and the model relies on a concerted effort of almost all the branches to complete a project (Popova 1997). For example, the design team in London takes advantage of the high level of design skills available to offer services on conceptual or initial design studies. The production teams in Germany and in Japan take advantage of the technical know-how and the availability of suppliers and manufacturers to detail the building. The execution team in Hong Kong takes advantage of the excellent communication infrastructure and management know-how to administer the project. Finally, the site office in China carries out the supervision of the project.

The vertical integration model is expensive. Staff has to be relocated and the entire operation has to be set up extremely quickly to cater for one or two projects, resulting in high initial cost. When the projects are completed, the exit cost is also high. On the other hand, the horizontal integration model is cheaper to set up but it requires the support of an excellent and cost effective communication protocol for collaboration among geographically distributed teams. Traditionally, remote collaboration is made possible by expensive courier services, long distance telephone calls, and traveling. The main concern is to separate different stages of the project in order to enable a more effective communication, information flow, and decision making process.

Apart from the communication problems, researchers have already identified the need to

look into the social implications and consequences of the horizontal integration model (Winter and Taylor 1996). Culture, language, social norms, time differences, values and practice are some of the issues identified. "Empirical studies of design have demonstrated that design is a social activity as much as it is an individual practice" (Vervenne 1994). Therefore it was concluded that "supporting the social communication is as important as supporting communication about the design problem." Previous studies (Poh and Myers 1994, Sasada 1994, Wojtowicz 1995, Mitchell www, Maher et al 1996, Cicognani and Maher 1997, Schmitt 1998) have cast some light in this direction. However, the findings are far from conclusive and the interactive dynamics is complicated and yet to be fully understood.

Last but not least, for architects, there is a need to look into issues related to the design process (Lawson 1980, Schon and Wiggens 1992, Schon 1996). Design is "a process which is in continual flux, moving between asynchronous and synchronous activity where group membership over the life-cycle of the design is dynamic and transitory" (Rutherford and Maher 1993), meaning that a large number of the constituting parameters are changing during the development of the design. Different people are involved over limited periods. In order to follow the changes, the design information system has to be sufficiently open to incorporate new participants, including their preferred means of representation.

Apart from the design process, the working environment is also a subject of consideration. A traditional design studio is a much more creative environment than a typical office (Harrison and Minneman 1990). A considerable amount of material (pictures, sketches, old projects, personal things), more or less related to the current project, is usually pinned on the wall somewhere. In a traditional studio discussion, the designer can refer to these materials. In a virtual discussion, however, that environment doesn't exist. Although video-based solutions have been proposed (Harrison and Minneman 1990, Lindsay and Grant www), the implications of this apparent lack of an appropriate environment are far from being resolved. It is indeed an interesting question whether a virtual (artificial) environment could replace the traditional ("natural") environment of design studios.

Ultimately, questions had to be answered as to whether or not the horizontal integration model could yield better design services. Much of the previous studies on virtual design studios have been focused on various aspects of enabling technology, communication, social dynamics and design process, but these are only means to en end; to client and end users, they have no tangible values (Maver 1997).

The studio presented in this paper is an attempt to examine some of these issues related to the use of the horizontal integration model in design, namely communication, social and design issues. In contrast to most of the previous works and virtual design studios, this studio was a semester-long program, with properly formulated pedagogical, academic and design agendas. Throughout the studio, design issues were emphasized and technical requirements like structure, construction, detailing, material and siting were discussed. The studio tried to mimic, as much as possible, the design flow of an architectural practice assuming a horizontal integration model.

In addition, addressing the shortcomings of previous virtual studios, the studio was structured to limit possible variations and contingencies due to culture, time, language, and academic differences of the teams. The University of Hong Kong and the National University of Singapore made an almost ideal pair in that respect. Students of both Universities are Chinese in origin and from a similar cultural background. They are in the same time zone. Both universities use English as a medium of instruction and they have similar academic structure. By relying on these similarities, the idea was to minimize the distracting elements (the "noise") and to concentrate on the few identified critical issues.

The studio also examined the issue of teaching pedagogy. Tutors in design studios are like clients or experts in the real world (Schon 1985).

Previous studies have experimented on real and virtual tutors as incremental, discrete and separate identities. However, the real world is far more sophisticated than that. For example, it is very unlikely that an architect would interface with the client entirely in virtual fashion. It is therefore important to see the client/architect and tutor/student interface as a continuous and dynamic process, subject to various modalities of interaction. The studio experimented with four modes of teaching, namely "real" tutor, "real/virtual" tutor, "virtual" tutor and "reverse virtual" tutor, described in more detail later in the paper.

Studio Program

In the first part of the studio, which was three weeks long, students were required to analyze some precedents and present their analyses as web pages (Figure 1, Appendix A). They had to study the following aspects of the selected buildings: design concept, structural behavior, assembly process, details, building materials, building services, and the integration of architectural design and technology. Students worked in teams of five, made up of two students from Hong Kong and three students from Singapore. They were asked to seek methods to collaborate and to work together as a team to prepare the precedent studies. They had been advised to pay attention to and seek, on their own, efficient communication and information protocols to work with each other.

In the second part of the studio, students were required to design a "Place2Meet on the Water" over seven weeks in a collective, collaborative fashion (Appendices B to F). The collaboration, however, took a different form in this part of the studio. It was modeled after previous, weeklong experiments conducted at the University of Hong Kong with various partners around the world (Kolarevic et al 1998). The project was divided into five phases, each one or two weeks long. At the end of each design phase, students placed their work into a common design database, a "digital pinup board" (Wojtowicz 1994), which was accessible through a web browser (Figure 2). Then, at the beginning of each phase, students selected the best work they could find in the previous phases by browsing

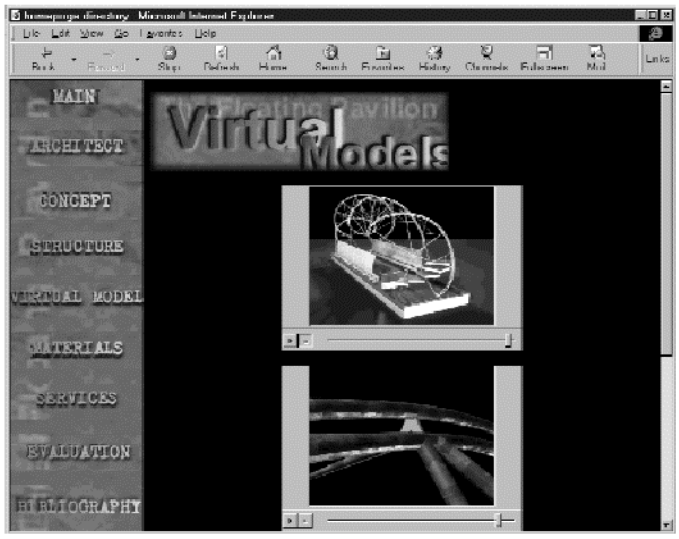

Figure 1. Precedent studies presented as web pages. Students had to study the following aspects of the selected building: design concept, structural behavior, assembly process, details, building materials, building services, and the integration of architectural design and technology.

Figure 2. The VDS database accessible through a web browser. The browser window is split into three parts (frames). "Buttons" in the frame along the left edge permit viewing of the projects produced in each phase, which are shown in iconic form in the frame along the bottom edge. The selected project can be then reviewed in the main frame.

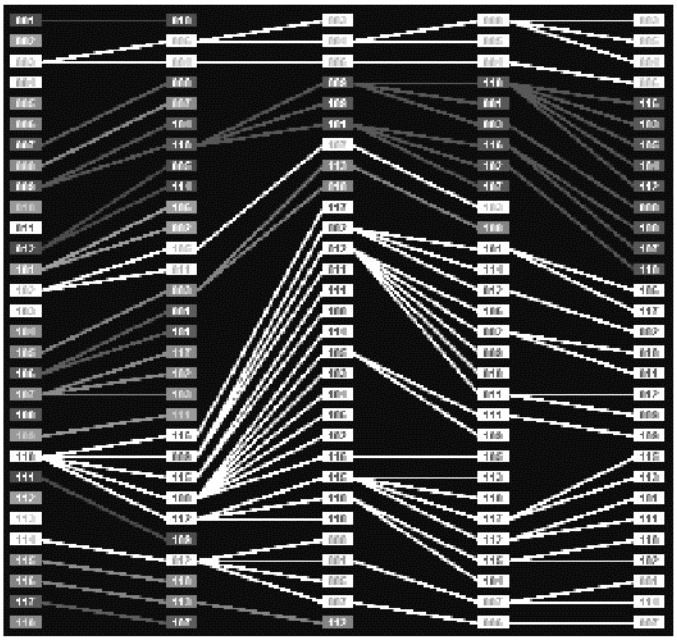

Figure 3. The genealogy of designs. Note that there are four identifiable "families" of designs at the end of the "evolutionary" process.

through the database. They were not allowed to continue with their own design. They could contact the authors of the selected design and inquire about their design intentions in each phase. Since in each phase they had to select someone design, they implicitly formed design teams (Kolarevic et al 1998).

The final results were design projects with shared authorship that could be traced back to the contributing authors and co-authors using the database (Figure 3). In this process of "evolutionary" design, the authorship was not a question, as the contribution of all students involved in the design was recorded in the database (Kolarevic et al 1998).

People and the work environment

Twelve second-year students from the University of Hong Kong teamed up with eighteen students from the National University of Singapore. While students from Hong Kong were in general proficient with CAAD, most of the students from Singapore who opted for the studio had little prior knowledge and had to be taught afresh.

Students met with their tutors twice a week. Specialists, part-timers and critics were brought in as and when required. Instructions from the tutors were posted on the web site and also circulated using email. All presentations were web based. Virtual and real critique sessions using Microsoft NetMeeting and the web were scheduled throughout the session. Taking advantage of the Internet, it was possible for a student in Hong Kong to present to a crit panel in Singapore and vice versa. Two 'high quality" PictureTel-based video conferencing sessions were conducted towards the end of the studio.

The 12 students in Hong Kong worked in a traditional design studio setting. They shared the use of networked PCs in the School's studios and labs. The PCs in the studios had video cameras and NetMeeting installed for desktop video-conference sessions. AutoCAD and 3Dstudio VIZ were the two main modeling programs used. Students also had an option to connect their notebooks to the School's network at their desks. The 18 students in Singapore worked in a specially constructed Digital Design Studio. Each of the 18 students had the sole use of a computer workstation for the entire semester. The workstations were networked and fitted with video conferencing cameras and sketchpads. Various software programs were installed. Students could "personalize" their computers. They could install freeware and customize the systems to suit their own unique styles of working. The idea was to provide a conducive and creative environment similar to a real architectural office.

A web server (a "digital pinup board") was established in Hong Kong for the project. The studio database was especially developed for this project by Tim Yeung in Hong Kong. It was modeled after the "Phase[x]" database developed at ETH in Zurich (Hirschberg and Wenz 1997), which was also used in 1997 and 1998 VDS experiments that involved several universities (Kolarevic et al 1998).

Surveys

Two questionnaires were used to collect

responses from students. The surveys were designed to capture feedback related to the key issues that were investigated in this studio, namely modes of communication, collaboration, collective design, social processes, and pedagogy. Recognizing that the use of technology in the design process is a matter of critical judgement rather than a fact, the questionnaires included sections where respondents can explain the rationale behind their choices. Two general essay type questions were also included to capture some of the general observations about the virtual design studio. Apart from this more structured approach, informal inquiries were conducted during the studio sessions to collect views and feedback. We also monitored the design progress through the VDS database to formulate observations on the collaboration process as well as the design evolutions.

Observations, findings and discussions

A sociotechnical perspective

Earlier virtual studios were conducted with either a technical or a behavioral approach to information technology. Recent researches in information studies indicate that no single perspective effectively captures the reality of information systems. Problems with systems and their solutions are rarely all technical or all behavioral (Lucas et al 1994). The challenge of the information systems field is that it requires an appreciation and tolerance of many different approaches. For example, at times, it might be necessary to "de-optimize" technology to accomplish the behavior of the individuals (Yamaguchi www).

A sociotechnical system perspective has been adopted in this studio. It is believed that it is essential to allow flexibility for individuals to seek means to construct their own communication protocols (Winter and Taylor 1996). While it has always been assumed that higher bandwidth and resolution will lead to an improvement of communication (Chen and Maver 1996, Chiu 1997)), our findings indicate otherwise. The availability of technology allows but does not necessary change the established behaviors of the users. A number of communication models or roles were identified:

"Philosophers" - They generally prefer slower, simpler and more direct communication methods. They use email to compose their thoughts and prefer a lag between dialogues. They use web pages to publish their thoughts. But the pages are composed seriously, slowly and with a particular purpose in mind. They participate in synchronous exchanges only when it is absolutely necessary.

"Misers" - They prefer using and maximizing a particular means of communication. They perceive communication as necessary but generally prefer to work and contribute quietly. For them, the meetings should be over very quickly. The only thing they want to achieve is what needs to be done next.

"Party goers" - They like meeting people and being seen. Their outgoing characters mean that they also generate the most of the activities on the network. They like experimenting with various means to communicate. And they can spend hours on ICQ or NetMeeting. To them, communication can sometimes be an end in itself. The usual excuse is that they need to understand the other parties better before they could proceed.

"Followers" - They communicate to maximize their own work. They generally position themselves at the receiving end of the communication chain. They like to be on-line to ensure that they don't miss anything. Therefore they prefer communication modes with "channel", "alert" and "agent" functions. They like asking questions so that they could get useful answers and information.

"Initiators" - They are the opposite of followers. They try to "sell" themselves. They are at the front end of the communication and always wish to broadcast their ideas and contributions. These are the friendly souls who would provide help to ensure that everybody in the team gets their message. They like instant feedback so that they could have an excuse to contribute more.

"Loners" - These people have their agenda somewhere and do not normally wish to be

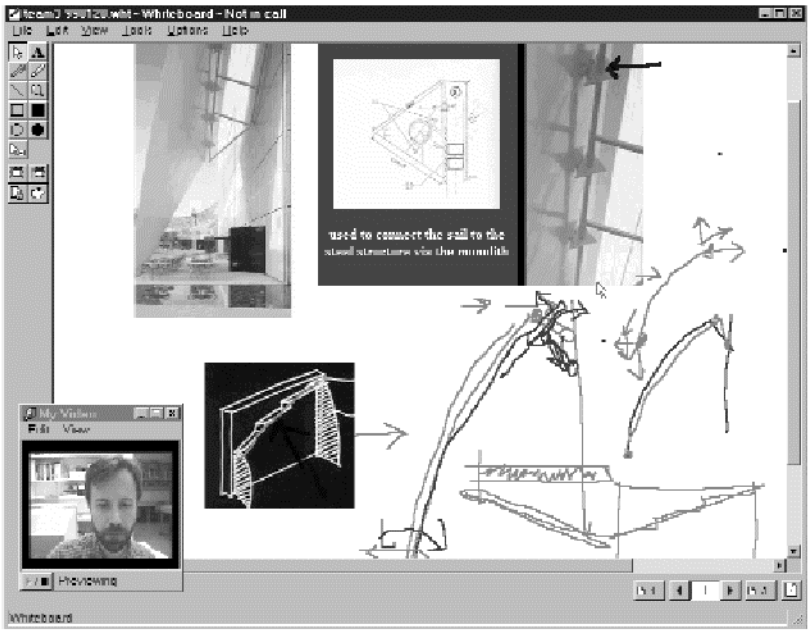

Figure 4. Whiteboard was used to share images, drawings, and sketches. Students prepared their presentations as web pages. Images were copied from web pages into the whiteboard software as underlays for sketching.

bothered. The other party is there as a matter of some administrative arrangement. Communication has little purpose except to put various "individual" contributions together. For them, high bandwidth and resolution is a waste of time and energy.

From a system-design point of view, we had to take the various needs equally seriously. It is important that in the pursuit of higher technology, such as video wall, virtual reality and so on, that one does not neglect these needs for "primitive" and yet highly desirable modes of communication. One such possibility is to develop a more effective communication protocol for the "loners". Another perspective is that, true to the spirit of the socio-technical model, the design of the communication protocols could be used to affect the behavior of the designers. However, exactly what behavior is worth cultivating is a matter of debate and further studies.

The choice of technology at any one time of the design process is not entirely a technical decision. ICQ ("real-time chat" software) has been the most preferred communication protocol among the different user styles (for 83% of the survey respondents). Two thirds of surveyed students (68%) thought it essential for VDS collaboration and communication. Students found it "the most convenient way to communicate", "informal", "fast", "instantaneous" and welcomed its low system overhead, autosave and built in file transfer features. However its text based interface poses limits to support design activities. Whiteboard feature in NetMeeting was used extensively to supplement ICQ for its ability to share graphical information (Figure 4), and more importantly to exchange sketches, which is important in design (Gross 1996, Jabi 1996). One third (32%) thought that the whiteboard is essential for VDS.

Email was the least preferred technology for two thirds of surveyed students, as it was perceived to be "formal", "only good for giving instructions" and "slow". Surprisingly, half of the students who were surveyed thought that it was barely need-

ed. It was used mostly when it was understood that other party was not there.

The use of web technology was, on the other hand, enthusiastically endorsed. Sharing and obtaining information have been the main motives behind its support. Beyond the technological need to exchange information, the existence of a common design database somewhere provided a psychologically comforting proof of the existence of the teams.

The mixed feeling expressed in whether or not it is important to "see" the face(s) of the party was illuminating. Contrary to popular belief, our findings indicate that seeing the others is not an essential feature needed for effective collaboration. According to our survey, only 4% found it essential, while 32% though it is not important (16% thought it was often needed, 28% sometimes, and 20% barely). There are some concerns of privacy here, but the main reason given is that seeing the work is more important than seeing the face(s). However, at this point, it must be pointed out the students "prefer" seeing the face(s) of their tutor(s) during tutorial and review sessions.

A Design perspective

Whether or not design could be improved with the horizontal integration model was another inquiry of this studio experiment. Design is a response to a situation thus it is difficult to develop objective measurements to quantify its quality (Schon 1996). What this study investigated instead is whether or not the horizontal integration model could be "perceived" to provide a more conducive environment for better design.

Design has been traditionally seen as a continuous and integrated process (Schon and Wiggens 1992). In an idealized situation, the designer, like an artist, would wish to have the control of the entire process. A good design has always been seen as one that has a coherent concept throughout. It is therefore not difficult to understand that some students would express disjoined feeling of the idea of shared authorship. Two thirds of the surveyed students stated that they could accept some "sharing" but not all. For some students it was "difficult to work on others' ideas while they still had their own in mind", i.e., to "shift from one's initial design framework into somebody else's." On the other hand, some noted that collective design provides an opportunity to try out different approaches to the project and to discover potentially interesting ideas which might not be noted if one was working alone.

Discussion with the students and surveys revealed that most of them tended to choose designs that were "similar" to theirs for further development. Only a few of them admitted that they chose the design because it was different and "better". One assumption of the shared authorship concept is that designs would evolve for the better and that the fittest would survive. However, underlining that is another assumption that the rules and principles of what could be considered good design have been established and understood. This was not the case in this studio. It would therefore be interested to see if the evolution theory of design holds in a more objectively defined design situation.

One observation gained by browsing the web database is that not many students chose the designs by the students from the other university in subsequent phases of development. One answer given by the students was that it is more difficult to understand the designs of students of the other university than one produced locally. And that the "other designs" did not have the same emotional stir or "kick". This is an interesting point. Our original intention to limit possible contingencies by putting together teams with similar background and language did not yield a desirable outcome. On closer examination, it was revealed that there was a subtle difference between the meaning of language used and the intrinsic shared value contained in the messages. For example, Singapore students spent most of their presentation on conceptual exploration whereas Hong Kong students were somewhat keener on pragmatic issues. This gave rise to their own unique ways of presenting their ideas that may not be appreciated by the other party. This phenomenon seems to be more problematic in an art based design environment than engineering one. It also explained the

established observation that collaborative working environment and the horizontal integration model had been successfully used in the automobile, software and product design industries but not in advertising, fashion and other creative industries (Roach 1988). It might be speculated here that the major challenges ahead for the horizontal integration model are social and cultural.

On the positive side, feedback on whether or not the virtual studio could yield a richer and more diverse design and learning environment has been reasonably positive. For example, more than two thirds of the students thought that having to work on somebody else's idea was a good learning experience; one quarter could imagine being thought design in that fashion alone. In summary, an enlarged knowledge pool and the availability of a large database of different ideas were seen as a valuable learning resources. This observation is in agreement with Schmitt's and Hirschberg's earlier observation in their "Phase(X)" and "fake.space" experiments (Schmitt 1998, Hirschberg 1998).

A teaching perspective

As mentioned earlier, teachers are like clients and specialists of architectural practices. In general, during the tutorial and review sessions the need for communication is very different from that of the collaborative process. Thus it is important that the two needs of communication be differentiated.

Having informal tutorial sessions between tutees and tutors are similar to an architect having consultations with his specialists. The need is for the student to share his proposal and ideas as clearly as possible in the hope of obtaining information for its improvement. Tutors, unlike team members, are not expected to contribute towards the project in a material way. In terms of communication, there is a need to use technology that would allow for "downloading" very efficiently a vast amount of information for an effective presentation. The need for "uploading" feedback can be relatively "cheap", technologically speaking, as most are verbal or sketch based. However, this differential in downloading and uploading various forms of information for different reasons is exactly why technology developed for effective collaboration might not be useful for consultation.

During the review sessions, tutors, or the clients, do not normally draw (Schon and Wiggens 1992). The way information is transferred is mainly through verbal means and facial and body expressions. And more importantly, feedback is spontaneous. This means that the bulk of the information flow is intangible, perishable and unrecorded. It takes an instant for the information to be captured and another for it to be gone forever. To better understand this dynamics of information flow, four styles of teaching/tutorial were experimented with:

"Real" - tutors tutoring physically in a well-experienced and understood process.

"Real/virtual" - tutors tutoring a team of real and virtual students in a single session.

"Virtual" - tutors tutoring virtually over the Internet.

"Reverse virtual" - tutor from Singapore virtually tutors from Hong Kong students in Singapore.

On the whole, and as expected, students preferred "real" tutors. Some concerns were expressed during "real/virtual" tutorials. The problem is more to do with the fact that while it is not difficult to tutor either virtually or physically, it has not been easy finding ways to teach both simultaneously. For example, for the benefit of the virtual tutee, a tutor might wish to speak slowly and use no body language. This restricted communication mode, however, is not very suitable for the "physical" tutee. On the other hand, it was difficult to ensure attention of the virtual tutee while the tutor talked to the physical tutee.

"Virtual" tutors were welcomed, as they were perceived to have brought with them additional expertise to the studio. However, students in general find them "remote" and more difficult to "engage". Spontaneity has been the major concern. Students generally feel that one of the

main differences between real and virtual tutors is the lack of spontaneity. Even with the aid of high quality PictureTel based video conferencing, it has been felt that there is a lack of intimacy. This perceived distance, entirely psychological, deterred students from attempting to build a relationship with the tutor. It has been felt that while video conferencing is useful in a lecturing environment, a tutoring environment is much more personal than that. Tutorial works the best when the students know the tutor personally; time is required to build that relationship.

Comments expressed by students towards "virtual" tutors shed some light on how "reverse virtual" tutors were received. It was of no surprise to note that students regarded the "reverse virtual" tutor almost as real as the "real" tutor. Previous relationships built between the tutor and the tutee obviously help here. On further examination and discussion with students, it was revealed that the missing body language was inferred, though past experience with the tutor, by the tone and rhythm of his verbal expression.

Conclusion and future works

The net-enabled collective design authorship is an instance of a wider concern for validating the effectiveness of the emerging horizontal integration model in architectural practice. Although the model has been used with some success by other, mainly engineering based, design professionals, its usefulness in supporting architectural design process is yet to be proven.

Architectural design process is solution-led and highly "wicked" (Lawson 1980). As such, there is a need for information to loop-back to the previous stages of the design process. A lot of these loops are unstructured and unpredictable. Our studio experiment demonstrated that flexibility in the provision of technology is more important than its optimization. It demonstrated that to facilitate and encourage the loop back mechanism, it is important to ensure that the information system is designed to cater for, or tolerate, minor and informal channels to exist within the more formal and structured framework. At present the two are rather dissociated. The challenge for future technological development will surely be in seeking ways to integrate them.

Coupled with the provision of technology is the social dimension of engaging technology for a purpose. People communicate for a need, and they will seek the best means to accomplish that need. This studio has identified some of the styles and needs of the individuals in the virtual world. However, this sociotechnical interface is a dynamic one, and behaviors will be affected by the development of new technologies. The challenge here is to continue monitoring and capture where the balance points are in the rapidly changing world of information technology.

The encouraging news is that the studio is perceived to have provided a more enriching environment for design. Unfortunately, it is still inconclusive as to whether or not this studio arrangement could yield better design. Design quality is judgmental and is experience based. The problem with this studio is that the designers are mostly inexperienced and may not fully appreciate the nature of architectural design process. To address the problem more adequately, a similarly structured studio should be conducted with more advanced students or even with design professionals.

The roles and styles of the teachers in the information age has been a subject of some debates by education theorists (Penz 1992, McCullough 1996, Popova 1997). Virtual design studios add another level of complications. Apart from some of the concerns expressed so far, this studio highlighted the need to 'know the tutor" at a more personal level as a pretext to the need for a more spontaneous exchange. If virtual tutoring is ever to be promoted to replace real tutoring, solving the contextual issue of what goes behind the tutorial session is as important as providing higher technology to enable the session itself.

Project website

http://home.arch.hku.hk/vds99/

References

Chen, Y and Maver,T. (1996). The Design and Implementation of a Virtual Studio Environment. In *Proceedings of 2nd East-West Conference on IT in Design*. Moscow.

Chiu, M. L. (1997), Representations and Communication Channels in *Collaborative Architectural Design*. In Proceedings of IFIP Conference. Sydney.

Cicognani, A. and Maher, M.L. (1997). Models of collaboration of designers in computers in computer supported environment. In *Proceedings of IFIP 97 Conference*. Sydney.

Coyne, R. (1995). *Designing Information Technology in the Postmodern Age: From Method to Metaphor*. MIT Press, Cambridge.

Harrison, S. and Minneman, S. (1990). *The Media Space: a research project into the use of video as a design medium*. Xerox Corporation, Palo Alto, CA.

Hirschberg, U. and Wenz, F. (1997). PhaseX: Memetic Engineering for Architeture. In *Proceedings of ECAADE 97 Conference*. Vienna.

Hirschberg, U. (1998). Fake.Space - An Online CAAD Community and a Joint Enquiry into the nature of Space. In *Proceedings of CADDRIA 98 Conference*. Osaka.

Jabi, W. (1996). An Outline of the Requirements for a Computer-Supported Collaborative Design Studio. *Open House International*, vol 21, no 1.

Kolarevic, B., Schmitt G., Hirschberg U., Kurmann D., Johnson B. (1998). An Experiment in Design Collaboration. In *Proceedings of ACADIA '98 Conference*. Quebec, Canada.

Kvan, T. (1997). Studio Teaching without Meeting: Pedagogical Aspects of A Virtual Design Studio. In *Proceedings of CAADRIA 97 Conference*. Hsinchu, Taiwan.

Lawson, B. (1980). *How Designers Think*. The Architectural Press, London.

Lindsay, M. and Grant, M. (www). Research into the Performance of High Quality Video Conferencing and its Application to the Teaching of Architecture. http://www.strath.ac.uk/Departments/Architecture/abacus/gintro.htm.

Lucus, H. C., Roitman, D. B. and Roskies, E. (1994). The Role of Information Tehnology in Organisation Design. *Journal of Management Information System*, vol 10, no 4.

Gross, M. (1996). The Electronic Cocktail Napkin - working with diagrams. Design Studies, vol 17.

Maher, M. L., Simoff, S. and Cicognani, A (1996). *The Potential and Current Limitations in a Virtual Design Studio*. University of Sydney.

Maver, T. (1997). Added Value for CAAD in Education. In *Proceedings of AVOCAAD Conference*. Brussels, Belgium.

McCullough, M. (1996). *Abstrating Craft: The practiced digital hand*. MIT Press, Cambridge.

Mitchell, W. (www). Creative Design in the Computer Era: The Design Studio of the Future, MIT. http://sap.mit.edu/dsof/research/creative_design.html.

Penz, E., ed. (1992). *Computers in Architecture: tools for design*. Longman, London.

Popova, M. (1997). *IT and the Architect's role*. Division of Design Computing, Chalmers University of Technology, CTH-A CADLAB, Gothenburg.

Poh, L. and Myers, L. (1994). A Distributed Cooperative Model for Architectural Design. *Automation in Construction*, vol 3, no 2/3.

Rutherford, J. H. and Maher, M. L. (1993). Video Conferencing and CAD. In *Proceedings of the 27th Annual Conference*. Australian and New Zealand Architectural Science Association.

Sasada, T. (1994). Open Design Environment and Collaborative Design. In *Proceedings of ECAADE 94 Conference*. Glasgow, Scotland.

Schmitt, G. (1998) Design and Construciton as Computer-Augmented Intelligence Process. In *Proceedings of CAADRIA 98 Conference*. Osaka, Japan.

Schon, D. (1996). *The Reflective Practitioner: How Professionals Think in Action*. Basic Books, New York.

Schon, D. and Wiggens, G. (1992). Kinds of seeing and their functions in designing. *Design Studies*, vol 13, no 2.

Sohon, D.A. (1985). *The Design Studio: An Exploration of Its Traditions and Potential*. RIBA, London.

Vervenne, D. (1994). Interactive annotation processing for extraction of strategic knowledge. In *Proceedings of Management of Industrial and Corporate Knowledge Conference*. Compiegne, France.

Winter, S. J. and Taylor, S. L. (1996). The Role of IT in the Transformation of Works: A comparison of Post-Industrial, Industrial and Proto-Industrial Organisation. *Information Systems Research*, vol 7, no 1.

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

Wurman, R.S. ed. (1996). *Information Architects*. Graphics Press Ltd., Zurich, Switzerland.

Yamaguchi, S. (www). The Next-Generation Architetural Design Environment.
http://archigraf.kit.ac.jp/INT/Res.

Appendices

Appendix A (an abstracted version of the program for the precedent study)

To prepare you for the design stage of the studio you will do a detailed study of an assembly structure precedent. The aim of that study is to further reinforce your basic knowledge of building technology and to introduce you to broader aspects of design present in the work of accomplished architects. You will work in a team-like fashion and should select the subject of your study in consultation with other team members and with the approval of your studio tutors. You should choose a building that is similar in scale to your design task, i.e., a pavilion-like structure of small to medium size, preferably on water. Your work shall include studies of the following aspects of the selected building: Design concept, Structure, Building Materials, Building Services, Integration of architectural design and technology.

Appendix B (an abstracted version of the program for Phase I)

Phase I = P A R T I

Begin by trying to answer the following questions: What is a place to meet? Where do the people meet? Whom do they meet? How do they meet? Why do they meet? What do they do when they meet? Then think about the water and the properties of its surface, the floating condition, the bridge that links the pavilion and the land, etc. Write down your thoughts, make sketches, models...

As you have already discovered, there are many tempting beginnings when designer is facing tabula rasa, blank page or the screen. You can begin by sketching on paper, the computer screen, or both. You can scan a paper sketch and use it as an underlay in CAD software. You can create a printout of your drawing or model generated on the computer screen, and then sketch on top of it. Whatever the venue of exploration you choose, create an abstract 3D model of the parti. Once you have a concept, the basic scheme for the pavilion, present it as a series of web pages that will contain text, images, drawings, and/or 3D models. The

schematic, abstract model should be your main focus, however you can use text and images to comment and explain the ideas you tried to incorporate in it. Arrange the presentation with text and images to highlight the aspects of the model you find most important (and the process how it developed).

Appendix C (an abstracted version of the program for Phase II)

Phase II = F O R M

In Phase[I] you developed a concept, a parti, and a 3D conceptual, abstract model of the place2meet. In Phase[II] you will actually design the place2meet, as a full expression of the parti you will select among submissions in Phase[I]. Begin by browsing the projects submitted in Phase[I], and choose a parti that you intend to fully evolve into your design. You should fully understand the author's intentions before proceeding with the design. If in doubt, contact the author of the original proposal, face-to-face (f2f), or through ICQ, email, or video-conferencing.

Develop the conceptual design selected in Phase I into a well-articulated design proposal. Think about the overall form and image; think about access, structure, shelter from wind, rain, and sun; think about circulation, use of the designed spaces, relationship to the water, etc. Make sure that your design clearly defines the three required elements: (a) the floating structure (partially or fully submerged), (b) the pavilion itself, and (c) the bridges, i.e., the connecting elements; note that (a) and (b) can be combined into a single structure if the design intentions dictate so. Keep in mind that you are designing a lightweight, hollow-steel assembly structure.

Appendix D (an abstracted version of the program for Phase III)

Phase III = D E T A I L

Regardless of how powerful the design ideas are, most people encounter architecture in terms of the details: how it feels to touch or sit on, how big the openings are, how they frame views of the surrounding environment, etc. If people meet in your place2meet, what do they touch and what to they see while they are waiting for the person(s) they will meet? Where and how do they sit? Lean? Look? Read? Eat? Drink? Listen to music? What do they see? What do they hear? How do these experiences support the overall experience of the design? How does light (or rain) enter the space?

Development of detail should support and reinforce the basic design goals of the selected project. Note that questions of "detail" confront issues of construction as well as form, so you should think about the structure (its elements and joints) and enclosure as a shelter from wind, rain, and sun (panels and their attachment to the structure) and their overall role as form-givers, think about circulation (ramps, staircases, railings, etc.), use of the designed spaces (café, performance space, chapel, etc.), relationship to the water (seating on the edge, leaning over the edge), etc. Make sure that your proposal clearly defines in detail the three required elements: (a) the floating structure (partially or fully submerged), (b) the pavilion itself, and (c) the bridges, i.e., the connecting elements; note that (a) and (b) can be combined into a single structure if the design intentions dictate so. Keep in mind that you are detailing a lightweight, hollow-steel assembly structure.

Appendix E (an abstracted version of the program for Phase IV)

Phase IV = M A T E R I A L

In Phase[IV] you will refine the details and if necessary redefine materials of the design that you will choose among projects submitted in Phase [III]. You will explore how different materials, such as glass (clear, sand-blasted etc.), stainless steel, wood, stone, copper, concrete, etc., affect the user's visual or bodily interaction with the elements of the floating pavilion. Use different materials to create designs with distinct ambiental, visual, and tactile qualities. Consider the effects of material properties such as color, texture, transparency, reflectivity, and specularity, on creating an environment that is appropriate for the act(s) of meeting. Explore contrasts such as bright and dark, transparent and opaque, reflective and matte, rough and smooth, and

how they relate to our visual perception; in other words, explore how various materials interact with light (and water) to create an environment with a particular atmosphere or mood. If necessary, make changes to the original model.

Note that your further development of details and articulation of materials should support and reinforce the basic design goals of the selected project. As in the previous phase, you will confront again the issues of construction as well as form. You should rethink the proposed structure (its elements and joints) and enclosure as a shelter from wind, rain, and sun (panels and their attachment to the structure) and their overall role as form-givers. You should reexamine the circulation (ramps, staircases, railings, etc.), use of the designed spaces (café, performance space, chapel, etc.), relationship to the water (seating on the edge, leaning over the edge), etc. Don't forget that you are detailing a lightweight, hollow-steel assembly structure.

Appendix F (an abstracted version of the program for Phase V)

Phase V = S I T E

Up until now the Place2Meet on the Water existed in a featureless void of the virtual space. In this final phase you will have to choose a site, a "place" that fits the selected design (in reversal to a norm in architectural design) and situate the chosen pavilion carefully in its surroundings. You will create composite images (simulations) showing the selected design in the context. If you want, you can show the simulations of the pavilion being placed in several different sites.

When rendering images of the pavilion, carefully adjust the viewing and lighting parameters in your model so they match the perspective and the lighting condition of the background image (a scanned photo or a slide of some site). Create a rendering with cast shadows and carefully combine it with the background image in Photoshop or some other image processing software. If necessary, touch-up the composite image to achieve convincing results. If there are objects in front of the pavilion, such as trees, people or sailing boats, copy them from the original image, and paste them into the composite image. If there is a reflection of the pavilion in the water, then try to simulate one. If necessary, use the Smudge tool to soften the hard edges of the pavilion's rendering. Use the painting and drawing tools to draw the shadows cast by the pavilion onto the water or some other ground surface or other objects in the background image. (Note that you can also create composite images of being in the pavilion and looking out.)