Fruitful Exchanges: Professional Implications for Computer-mediated design

Thomas Kvan

The Department of Architecture
The University of Hong Kong
Hong Kong

The paper reviews experiences in using computer tools for collaborative design projects in the light of the lessons learned from implementing CAD systems in practice.

Keywords: computer-aided design, professional practice, computer-mediated design

1 Introduction

The prospect of virtual offices and digital collaborations are seducing many and spawning considerable output describing the mechanics and experiences of collaborative design. Indeed, multimedia tools for interaction are presented as the panacea for our frustrations with prior experiences in the difficulties of integrating computers into design work - what works graphically must be suitable for design applications.

Since we are still in the early stages of experimentation, most of this research in collaborative design exists outside the professional context and describes instead experiences in teaching settings. When tested against professional practice, however, many of the expectations of computer-mediated collaborative design appear to be excessive. Some fundamental capabilities have not been provided and some aspects need additional investigation for the benefits to be realised.

The success of computer implementation in professional practice is less dependent upon the software and hardware features provided than by the compatibility of the software to the strategies of practice pursued by the professionals applying the software [1] and the managerial strategies followed in the implementation [2]. What then do these lessons mean for our investigations of computer-mediated design?

This paper explores what happens in a design project which promotes 'good' design and how techniques of computer mediated design can be used to enhance the design process, not just replicate it. I draw upon three threads of research: research into excellence in professional design [3]; studio teaching experiences with computer mediated design [4] and critical examinations of CAD in practice [5].

2. Excellence in Practice

Collaboration is inherent in good design, much to the disappointment of those who subscribe to the image of the isolated genius painted by Ayn Rand in The Fountainhead. As Charles Moore noted, "Rejecting any sorts of attitudes of secrecy or doing work in isolation is important. And speaking out against the attitudes in The Fountainhead every chance one gets is important." [6] Collaboration then is at the heart of our work yet often denied by the strictures imposed by our teaching traditions. The work on computer-mediated collaborative projects is therefore doubly interesting as a didactic issue but we should think too about the questions raised in professional implementation as well.

Good design does not arise from quiescent collaboration, however, neither is it a serial exchange of ideas in which layers are sequentially added by participants. Analysis of successful design outcomes (such as that by Cuff [7] and the American Institute of
Architects [8]) suggests that successful collaboration thrives on "warm, almost familiar relations among the actors, as well as conflict and, at times, tension." (Cuff, p234). When it works (as Cuff notes), it is characterised by "a team-like sensibility bonded the central players who struggled together to create the excellent outcome, but these individuals did not necessarily participate equally or collaboratively. Instead, key participants played key roles; their talent and authority was reported to be essential to the building's success."

The American Institute of Architects sponsored in 1989 a series of roundtable discussions, workshops, panel discussions and conferences on the subject of excellence in design. Although there are rightly multiple definitions of excellence [9] and likewise many hypotheses on how excellence is achieved, a broad consensus evolved from this effort about some of the conditions for producing design excellence, some quite obvious yet easily ignored.

In general, excellence is achieved when the designer knows the participants and the problem well and when this leads to a shared definition of the problem with the other participants. In order to reach such a shared definition, the participants of the roundtables noted that they work both individually and collectively to understand the issues and to explore solutions. Indeed, a group of signature firms [10] identified that excellent design projects were characterised by substantial time being spent on the processes of exploration and gaining trust of those involved in the project, this period of the project being known as "pre-design work [11]."

Establishing the confidence and respect to support such collaboration is a struggle in any design team, even when they work within one office and using media familiar to all participants. In computer-mediated design over long distances, this problem presents itself as a very real and substantial problem.

3. Studio Experiences in Computer-Mediated Design

Recent exercises with studio design problems help to shed some light on the role of computers in collaborative design. In 1994, six schools of architecture in five different time zones and three continents joined together and brought together a group of design students to tackle a common problem. Schools of architecture in Barcelona, British Columbia, Cornell, Harvard, Hong Kong, MIT, Washington in St. Louis joined together for two weeks to devise new housing models for an area of Shanghai scheduled for redevelopment. In 1995, we repeated the exercise again with the University of British Columbia and the University of Hong Kong as the primary participants. These exercises, known as the Virtual Design Studio (VDS) [12], thus introduced time zones, culture and geography as variables with which the students had to deal.

In both exercises, the students used as tools for communication and collaboration a variety of systems, reflecting the concerns and direction of the individual schools. Each school handled the design task as they wished -- some formed teams while others allowed the students to tackle the problems individually. A server was set up in Vancouver to which files for sharing were posted -- a digital pin-up board. Scanned images, structured CAD models and ASCII files were posted to be downloaded using ftp when convenient. Access to the pin-up was unrestricted for participants -- anything could be uploaded or downloaded as needed. This interaction was supplemented by e-mail, Collage, vat and CUSeeMe. In 1995, we employed the conventions of the World Wide Web as a means of communication, using Netscape and html tools to package the images but we still relied on ftp for file transfers as the significant bottlenecks for digital traffic from Hong Kong meant that a detailed homepage could take up to 2 hours to download.

In both experiences, we followed a similar format. Students were asked initial to exchange ideas for design solutions using any media they chose, to comment on each others solutions and to encourage a discussion of approaches. The second half of the exercise was then used to develop more detailed models and renderings to describe particular design solutions promoted by each team (or individual). An original intention to create generate interaction over the designs failed, for reasons explored below. At the end of the two weeks, we held a video conference call bringing together all the participants for an intercontinental presentation and review.

In the pressure of a design deadline, participants reverted to tools with which they could communicate fluently. In the end, participants tackled the design problem locally, typically off-line, drawing upon a wide variety of media to explore and express notions.
These were then repackaged digitally when necessary (by scanning, digital photography, or recreation in a modelling system) to send to the pin-up board for open discussion. In particular, we noted that collaboration failed to occur when insufficient opportunity was given for participants to establish a familiarity and dialogue which helped to illuminate local interpretations and assumptions.

An experience during the 1994 Virtual Design Studio illustrated the power of personalisation in communication. The Barcelona students undertook a very formal, algorithmic approach to design, generating a matrix of permutations which looked forbidding. Students used to less formal approaches to design found it difficult to react to this work. For example, Barcelona's students established an identity and character for open interaction, for fun, by posting images of candy distributed during a carnival which took place during the time of the VDS, supplemented with quotes taken from various texts. This helped recipients of their more intellectually challenging (and forbidding) messages react openly when these came later. These ephemera crated an attitude which video cameras or audio connections could not have done, especially in a multilingual (in our case, Spanish and Cantonese), multicultural experiment as we held.

4. Critical Examination of CAD in Practice

From the perspective of those involved in the design and creation of software for computer-aided design in architecture, the impact of computers in practice has been very disappointing. Our research and experimentation always points to a better future than we see realised. It is frustrating to us to see the majority of practices using the tools simply as an automation of manual methods. As noted above, however, the frustration arises not because the software does not contain the best interface nor tools needed. Instead, the problems can be traced more often to the implementation strategies and philosophies of practice rather than technical problems. For example, Lewis et al noted "The relative clarity of individual's roles and [implementation] program purpose both matter significantly. The better each are, the better the implementation." [2]. Similarly, Kalisperis & Groninger [1] noted a clear correlation between firms satisfied with their CADD systems and their philosophy of practice -- firms satisfied with Autocad were Pragmatic firms [13] while firms classifying themselves as Design/Theory firms were more satisfied with other types of CADD system. This is not because Autocad is not a good system or lacks features offered by the other systems, but more that the assumptions made during design of the software about ways of working favour particular kinds of firms.

In Asia, we find a stark picture of a singular approach to the use of computers. Let me describe in some detail the situation which pertains in Hong Kong, an image of practice which holds true, I believe, for most of Asia (where most of the world's construction is taking place today). What is interesting in this picture is the homogeneity revealed, almost a herd mentality in professional strategies.

In the spring of 1995, we sent a survey to all practices listed in the Hong Kong Institute of Architects register; 122 survey forms were distributed, 51 valid returns were received, Care us a 42% response rate. Our survey was designed to identify patterns of use for software in a variety of applications. One respondent noted that it would be better for the profession if all architects used the same software. While we disagree with the sentiment, it is interesting the degree to which this situation already pertains in Hong Kong. For example, 46% of the respondents use MS Word for word processing and 34% use WordPerfect -- that is 80% covered by just two very compatible systems. Similarly, 46% use the Excel spreadsheet and 22% Lotus, again a highly homogenous situation. The status with CAD systems is even more consistent - 90% use Autocad (only 4 firms reported using Intergraph and one used Minicad). Autocad also dominates the market for 3D modelling systems and rendering systems. By comparison, 43% of the firms in the US use Autocad [14].

What was less assuring was the extent to which systems are not used for management activities. There are few accounting systems reported to be in use. 52% of firms reported no accounting system in use, with the most common system being Excel spreadsheets (8%) or bespoke software (8%). Similarly, firms do not appear to use software for managing project progress -- 88% of respondents do not use software for manpower resource planning and 66% do not use systems for project scheduling. The lack of systems in these three areas suggests a more casual attitude to firm management than
observed in practice in the US or Europe. This is even more surprising given that 98% of firms in Hong Kong use computers and that most firms in Hong Kong are management conscious to the exclusion of design. Clearly, the singular focus is on producing drawings rather than in managing the firm.

The emphasis on producing work is reinforced by replies to our section asking firms the extent to which they used computers in each of the six contract phases of a project. 86% noted using systems in the inception phase, 88% in feasibility studies, 96% in schematics, 98% in project design, 96% in construction documents and 96% in construction management. This use is not light, either; 70% of the firms identified heavy use (over 55% of their effort) of computers in project design and construction documentation phases and 54% noted heavy use in construction management. What is a little surprising is the reported heavy use of systems in schematics by 46% of the firms, indicating a higher application of system use than we expected. This intensive use of systems appears to be supported in the manner in which workstations are located within offices. 57% of firms state they now place computers on the desks of those who need them, not in central computer areas.

What we see in this survey is a picture of very "Pragmatic practices dividing up the work at hand, choosing to tackle the projects with teams of specialists (project managers, designers, technicians), following a team structure modeled on Taylorist principles. Our survey found that 60% of firms classified themselves as pragmatic firms focusing on getting the work done, 26% provided design distinction and 7% handled more complex work requiring client interaction. This is significantly different than in the US, where only 34.5% classified themselves as Pragmatic, 13.8% as Design and 51.7% as Other (called Service firms in The Coxe Groups Superpositioning model [13]). The Pragmatic firms typically organise themselves into departments based upon task and train specialists to carry out these tasks. These differences in practice philosophies manifest themselves in differences in computer implementation.

When asked in the survey how computer use could be improved, firms noted a variety of ideas, but one message comes forth most clearly – there is a real need for those who use CAD systems to really understand architecture. This is very consistent with findings elsewhere. All around the world, the pattern has typically been that CAD system are brought in to a firm for use by CAD operators. Over time, firms realise that the quality of the information coming out is constrained by the understanding of those putting it in. Thus, the best way to improve CAD output, both in terms of quality and quantity, has been to ensure users understand the particular needs of architecture. For many firms, this has meant getting rid of "operators" and letting professionally trained architects use the systems directly without naming them CAD operators exclusively (this point is clearly brought out in Lewis [2]). Whatever the strategy, the users of systems do have to be trained to understand both architecture and CAD systems as well as an offices particular needs.

This model of working is probably most common in Asia, perhaps because the shortage of trained professionals places a premium on their work which requires a significant number of para-professionals to support the effort. For collaborative work between different cultures, this poses a significant problem, since the ways in which work is carried out in two collaborating teams is substantially different.

5. Lessons Learned

It would be wrong to imply that collaborative design does not exist outside computer-mediated design. Much of the work in Asia today is in the form of joint ventures which bring together practices from many parts of the world, collaborating with whatever means they can to complete the projects. More indirect collaboration, time-phased with manual exchange of drawings, allows different philosophies of practice to succeed together without exposing the teams to the differences in approaches. Thus, different professional approaches can coexist and support the same goals without clashing. With synchronous collaboration, however, these differences can be profoundly disruptive. Successful collaboration must find its way around these differences and provide means to accommodate them.

To enhance the opportunities for computer mediated collaborative exchanges in a setting such as practice in Hong Kong, therefore, we will need more than simply multimedia workstations with digital cameras on top. Where the introduction of CAD systems exposed the difficulties of communication and the division of work within offices, computer-
mediated collaborative design will expose the participants to the peculiarities of their collaborators.

The greatest problem encountered so far has not been technological -- those problems have been niggling issues which certainly have prevented the potential from being realised but have not fundamentally undermined the notion of collaborative design. The real problems have been encountered in establishing a level of trust and acceptance between the participants, a trust which is fundamentally important to shared design effort. These issues of intersubjectivity have been discussed by Vintkus [15] and applied to the collaborative design process in Kvan [3].

Another distraction is the issue of video connections. In collaborative design, seeing the hand that traces the line is not as important as seeing the potential for change in the line. Thus, video-based exchanges such as the Media Space of Harrison and Minneman [16] demand substantial band width with little added value derived. The richness of design comes from the unexpected opportunities seen in the documentation of the design, a process akin to "Joycean communication, leaping to allusions, returning to earlier forms and worrying over details" [3]. This is the kind of interaction which occurs in face to face crits and design charettes.

It is important to consider ways in which such computers can improve the design process, not simply replace (with such process as knowledge systems) or replicate it (as with automated design tools). From our experiences, we see that a virtual studio can be a more exciting place than even face-to-face meetings. Mimicking manual methods and encoding these conventions into systems has not served us well with CAD systems. As noted by Cheng et al [4] "we should explore the rich potential which might come from computer-mediated design processes ...collaborative design leads to interesting results often because of fortuitous misunderstandings... Should not the development of computer-mediated design places encourage such ineffable communication".

From these observations we propose implications for computer-mediated design and we can identify shortcomings and areas of fruitful improvement. The results of these areas of research suggest, among others, that:

(a) design is a social activity more than an isolated process and collaboration needs to facilitate the social aspects as well as promoting communication
(b) tools which promote critical exchange support design are essential to the success of computer mediated design
(c) the effectiveness of visual communications are over-rated as they don’t promote critical exchange
(d) professional modes of practice must be considered before implementing computer-mediated design
(e) professional models of practice will change to accommodate computer mediation but probably more slowly than we think they will

Specific changes which will make a difference are:

users need:
(a) to learn to identify themselves in remote interactions, to give themselves character and not be lost behind the anonymity of digital data
(b) to not fear the introduction of tension and learn to manage this remotely while practices will need to:
(c) break themselves from the stratified and rigid structures which segment work into its pieces
(d) train professionals to interact with this technology directly, as it is the design decision makers who need to participate directly, not through technicians

and some changes are needed to CAD computer tools to allow us to:
(a) interact with the same model locally and in the foreign location
(b) edit and investigate the local model without disrupting the shared model (rather like picking up a physical model during a crit without changing the student’s presentation)
(c) send a specified view to the collaborators without disrupting their model ("look at this")
(d) transmit edits or view controls with very efficiently with minimal data transmitted
(e) permit collaborators to use any software they wish for local editing (support a
heterogeneous environment)

While many practices around the world are already working in ways sympathetic to
computer-mediated design, it is far from the norm. If these changes can be made, the potential
richness of computer mediated design can be realised.

6 Acknowledgements

The work described in this paper was carried out using the facilities of the Department of
Architecture under research grants from the University of Hong Kong.

7 References

[1] L N Kalisperis and R L Groninger, CADD Utilization in the Architectural Design Process:
[2] B J Lewis, G P Shea & T Kvan, Managing Change in the Design Process Caused by
Implementation of CADD in Consulting Engineering Firms, Proceedings, Consulting Engineering
Conference, Toronto, October 1990
[3] The ideas developed here have been discussed at greater length in T. Kvan Reflections
[4] These teaching experiences are more fully documented in N. Cheng, T. Kvan et al, Place
Time and the Virtual Design Studio, in Reconnecting, ACADIA '94.
[5] Data for this section were gathered by the author with a postal survey of architectural
practices in Hong Kong spring 1995.
[9] The problems inherent in defining 'excellence' in architecture are clearly discussed in R.
[10] The AIA organised two roundtables - one for 'signature firms' (those in which an
individual talent leaves a unique mark on a body of excellent work) and another for 'star' firms
(those firms which have left a consistent body of good work, stemming from stable management and
design methodologies). These two approaches cross-checked findings and led to strong consensus on
preferred approaches to achieve excellence.
Search of Design Excellence, op. cit.
[12] Several years of Virtual Design Studio experiences have been documented in Virtual
Design Studio, ed. J. Wojtowicz, Hong Kong: Hong Kong University Press, 1994
[13] Kalisperis and Groninger are using a modified version of a classification of firms
developed by The Coxe Group and described in W. Coxe et al Success Strategies for Design
[14] Kalisperis op. cit. reported 43% while other surveys have reported similar but slightly
higher numbers.
[16] S Harrison & S Minneman "The media space: A research project into the use of video as
a design medium" in Proceedings Conference on Participatory Design 1990, reprinted in R. Baecker
Kaufman 1993