Design collaboration strategies

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ABSTRACT

How can we best use computer technology to facilitate remote design teamwork? From looking at virtual studio collaborations, we propose that multiple solutions exist rather than a single one. In examining both published results and own student projects, we identify the following factors to be considered in finding the best fit between technology and group design: 1) Collaborators’ profiles; 2) Mutual value of produced information; 3) Collaboration structure and 4) Logistical opportunities

1 INTRODUCTION

The availability of Internet communications makes it possible for a wide range of participants to benefit from sharing design ideas and working together. While the accessibility of web authoring, application sharing and desktop video-conferencing applications makes it simpler to communicate, getting the most utility of the exchange is not guaranteed. Five years of arranging design collaboration projects have clarified conditions and activities that lead to vibrant and useful collaborations. Our most recent efforts involving collaboration novices in Web-based exchange of design ideas point out the benefits and pitfalls of low-cost Internet partnering.

This paper will explain the logistical and technical issues involved in design collaboration and how to address them strategically in setting up effective projects for design, teaching and research. Rather than positing a single technical solution, we believe that the technical means must be tailored to specifics concerning the task and participants.
2 CONTEXT: SOURCES OF OBSERVATION

Observations are taken from both published papers on collaborative design (for example, Kaga, Comair and Sasada 1997, Morozumi et al 1997) and from our own experiences with student collaboration projects (for example, Cheng et al, 1994, Bradford, Cheng and Kvan, 1994, Kvan 1997b). The latter have taken place in a variety of settings: exchanges within a single campus, within the same city, same time-zone region and across international boundaries. The participants have variously been enrolled in design studios, digital media and research seminars in which the exchange of ideas with outsiders would be beneficial. The projects were structured to maximize sharing, building on previous virtual design studio projects (Dave and Danahy 1998).

Recent architectural classroom efforts have engaged students in generally available media and channels, such as e-mail, web pages, listservs; with shared whiteboard, application sharing and desktop video-conferencing used for the remote partnerships. These studio-based activities have been complemented by controlled laboratory-based experiments in which subjects have used whiteboards, text chat or voice, sometimes supplemented by video communication. The range of projects used in these various settings has explored a variety of design opportunities and collaborative strategies.

For example, at the University of Oregon, we have run these digital studios:
1) Winter'00, Visualizing Bernard Maybeck Designs: a two-school project sharing digital model components, building models and renderings
2) Spring ’99, Connections: a three-school collaboration pairing pairs of students in reciprocal client / designer relationships. Students describe, then enhancing the sense of place
3) Fall'98-Fall'99: in-school effort involving 14 first and second year design teachers to institutionalize Web portfolios. Students share building case studies and city reports for design studio and technology class, share 3D model data for CAD classes
4) Spring ’97, Connecting Virtual Places: three-school collaboration pairing students in reciprocal client / designer relationships. Students describe a virtual place then work together creating a transition from one to another
5) Fall '96, From Screen to Screen: two-school project pairing students to redesign each other's designs for a wooden folding screen. Students compared digital file exchange with the exchange of computer generated laser cut pieces.

3 DEFINING RELEVANT ISSUES

By examining cases of Virtual Design Studios, we can see what shapes design collaboration and plan how to use these factors strategically. In these collaborations, we bring together individuals to work on a common design task. We ask them to use particular methods for communicating their design concepts.
In deciding what technologies are appropriate, we need to look at the profile of the participants, the outcomes that we seek and the logistics of team structure and timing. These factors are described by Kalay (1997) in his P3 framework that proposes representation for the Products of collaboration (artefacts created), their Performance according to different criteria, and the Process of design. The participants’ background includes their expectations for creating certain products that together satisfy their personal performance criteria. The expected outcomes are the idealized goals of the performance criteria. And the arrangement of the time schedules and team structure shape the dynamic group process. This triad is similar to a model of technologies presented in Vera et al (1998) in which it is noted that the selection of technology should depend upon the task (i.e. design, meeting, conflict resolution, social interaction, etc., Kalay’s Product), types of collaborators (i.e. relative knowledge, social/hierarchical relationship, etc., Process) and outcome measures (i.e. quality of output, solution of problem, individual satisfaction, etc., Performance).

Characteristics of Virtual Design Studios identified by Dave and Danahy (1998) fall into the categories we are proposing. They identify seven dimensions of these collaboration projects, giving priority to the Design Brief, defined as program and site in relationship to the participants. (i.e. one brief, one site vs. one brief and reciprocal remote sites vs. different briefs for the same site, etc.) We agree that the relationship of brief or task to teams is important and consider this relationship, along with collaboration pattern, duration and distances as part of the logistics of team structure and timing. Dave and Danahy’s categories of media (forms of representation), tools (for communication) and computing infrastructure enable group interactions, thus can be considered aspects of appropriate technology.

3.1 Collaborators' profiles

Participants bring their own expertise, perspectives and objectives to a task. Within the multi-faceted world of design, team members can be trained with different sets of references and vocabularies that enrich the design process but make communication difficult. Specific to computer-supported communication, attitudes towards technology and technical preparation can facilitate or impair communication. What tools work well can depend on both experience and attitudes towards new techniques. Technical neophytes are more likely to be nostalgic over qualities of conventional design media than early adopters interested in exploring technology. Preferences for live or asynchronous media relate to the participants’ working style (Kolarevic and Ng 1999). For those more introverted or prone to silent reflection, the efforts and costs associated with synchronous technologies are poorly utilized. Careful partnering can match complementary skills and attitudes for more effective teamwork. It can be postulated that design collaboration is in part a process of negotiation and, as Moore et al (1999) have noted, rapport has an effect on outcomes of negotiations. Although this is difficult to quantify in design contexts, it is a widely held belief.

Individual expectations for outcomes influence what is evaluated as a successful project. Those valuing interaction will count multiple interchanges as a positive mark. Those more efficiency-oriented, by contrast, could see frequent
communications as a deterrent to individual productivity. At a certain stage of the
design process, generating alternative solutions is a positive trait, but as the need for
design resolution increases, introducing wide-ranging alternatives can slow-down the
honing process.

3.2 Mutual value of produced information

Individual motivations need to be considered in planning the results of the
collaboration. Since alliances come together because of shared goals, their intended
group products should appeal to the greatest number of participants. Projects in
which individuals or small groups contribute to a larger whole provide an intrinsic
motivation and peer pressure for full participation. If the resulting information is
useful and accessible to both participants and outsiders, such as a Web-based
resource, efforts become even more worthwhile. Authors who spend long hours
crafting presentations work harder knowing that their efforts will be seen. The
Internet allows them to get outside feedback from professional, academic and
personal audiences and critique their own work in the context of their peers'.

In an example of using information as incentive, Dave and Danahy asked
students to design projects for each other’s location. Students were compelled to
interact because each needed crucial site information from their partners. For similar
reasons, we have paired students as clients for each other. In addition to reciprocal
exchange, we have found that creating shared resources returns a great value for
effort. At Oregon, we found sharing precedent case studies and kit of parts model
components more valuable than recording early design work: the shared resources
give incentive to use the web sites. We have also found that starting off design
collaborations with site research to be more successful than more open-ended design
collaborations because 1) the activity results in a more lasting resource, 2) individual
responsibilities can be easily defined and 3) less personal investment is at stake in
negotiations.

Resulting projects can be presented to reflect the teaching philosophy of the
instructors. Instructors can selectively highlight or reward the best work online to
show off quality or provide neutral display of all submissions. In the latter case,
students’ awareness of standards can be raised through either through in-class
discussion of the results or on-line votes for awards.

An example of team synergy took place in the Spring 2000 project for
visualizing the work of Bernard Maybeck. Students were encouraged not only to
share components, such as trusses, windows, furnishings and lighting fixtures, but
also to work with each others’ room models and renderings. They used the room
models either for graphic comparisons of architectural aspects or to create fantasy
compositions or animations. In sharing these products, students’ high regard was
evident when the most successful efforts were incorporated into other student’s work.
The strongest products were reused many times and contributed to the visual richness
of the class’s work. Weaker pieces were mercifully forgotten.
Successful collaboration is characterized by a high quality of interaction that advances joint objectives. For this to occur, structuring of both time and team organization must occur. The schedule must provide time for participants to develop a level of trust. The schedule should clarify the timing of actions and expectations for deliverables. A scheduling framework can keep expectations for performance realistic. For example,
in monitoring the work of the second year design students, one critic found that he
needed to explain when he would be able to look at their work, planning for a twice a
week review. Otherwise, the students were expecting that as soon as they posted the
work, they would receive instant feedback. To avoid disappointment, interaction can
be given according to a planned schedule.

In planning a collaboration, logistics of the team structure and role definition
must be considered. Group work requires careful coordination between members to
reach a common goal and minimize redundant or contradictory efforts. To make full
use of available resources, the work needs to be divided and individual
responsibilities clarified. The work can be divided according to time (sequential turn-
taking), location (separate territories in a quilt) and team structure (roles), or a
combination of the above. Wing (1999) describes how to organize group design
problems with a mixture of these methods:

1) "free-agent fragments" viewed together, 2) puzzle pieces creating a larger
whole (territory), 3) unique contributions to a whole (roles) and 4) progressive
collaboration. In progressive collaboration, individual efforts are consolidated into
larger and larger groups, allowing relationships to form gradually over time and
special abilities to come to the fore.

The Virtual Design Studio project began in 1993 and 1994 following Wing’s
simplest model of free-agent fragments: local teams worked in parallel from different
locations, sharing observations and results. In 1995, we tried to create teams with
members from two schools (Universities of British Columbia and Hong Kong), but
the partnerships were a forced fit as students had already begun design scheming.
Students ended up either creating independent projects or working with local partners
with carefully split design territories. In spring 1996, assigned students to
complementary roles so that their contributions would have less redundancy. We
gave foreign students a local contact for designing a Monument to Hong Kong’s 1997
cchangeover and we put programmers and designers together to facilitate use of the
Web.

The logistical difficulty of working with many schools lead us subsequently to
simpler partnering arrangements. We have arranged a number of two and three
school collaborations in which students only have to deal with one partner (fall 1996,
spring 1997) or one local partner and a remote pair (spring 1999). Within the short
time frame of several weeks available for most of the projects, participants find it
easier to create a working relationship with just one or two remote partners. With
fewer partners, tasks and roles can be parsed more casually and results can be
coordinated more easily.

One project done with students at a neighboring school, Chinese University of
Hong Kong in 1995 confirmed others’ findings that face-to-face meetings much
improve the rapport achievable with computer-supported interactions and accelerate

To ease the process of large group team dynamics, progressive collaboration
can be used. We did this in Fall 1999 when five sections of second year design
students at Oregon shared responsibilities for documenting the downtown area of the
small city of Corvallis, Oregon.
Each student was responsible for contributing to a type of site documentation (physical model, digital drawings) and Web reports about a particular theme. Within each class, there were team leaders for the models, the drawings and the Web. Within each class, the subgroups worked on documenting one block of the site and researching the theme of their report, afterwards submitting them to class leaders to be consolidated onto the Web. From the results, students could download dimensioned drawings in either raster or vector form and read about aspects of the city (i.e. outdoor space, uses and users, etc.).

3.4 Logistics

While collaboration is easiest if schedules, objectives and participant backgrounds are similar, an exact match is neither likely nor necessary. We have found that varied amounts of computer-supported engagement can be valuable.

Shared interests and agendas start collaborations; logistics of time, equipment and support shape the actual form of collaborations. In practice, differences in schedules, methods and agendas can limit the duration and scope of joint projects. Furthermore, outside clients or civic partners may require adjustments for sporadic availability. Fostering projects requires creative logistical thinking to get around these constraints. For example, in scheduling with other schools, we have found that a short phase of intensive interaction can be enriched through preparatory or follow-up asynchronous phases done at the convenience of each party.
Creating partnerships that vary from casual, low-investment critiques to highly structured technology-intensive interchanges can expose students to a spectrum of design perspectives and collaboration possibilities.

In the case of the Maybeck project, Oregon students received input from a Maybeck scholar/builder in the region, local architectural and computer graphic experts, and their peers at the University of Washington. Students’ inter-school exchange was limited to peer Web site critiques and shared model components due to
scheduling conflicts that prevented live video exchange. Instructors shared educational resources such as scans of original drawings and digital design resources. In this situation, e-mail critiques allowed ideas to be diplomatically worded and the relative anonymity provided the benefit of a level playing field. With a very low level of technical investment, students at both sites benefited.

We anticipate that as telecommunications technology becomes more ubiquitous, opportunities for low-threshold projects will become more common across the curriculum.

4 TUNING TECHNOLOGY TO FIT

In determining what technology will be employed, a task's complexity and how it involves site, form and program all shape what tools work well. Technical tools are tuned for the representation of particular parts of the design process and particular content areas. For example, cultural meaning is easily delved in detail with text and still images, whereas composition questions can benefit from dynamic interaction with graphic elements. Text-based methods fit smoothly into many aspects of the design process because of their ease of use. The act of articulating designs from graphics into words encourages thoughtful reflection. (Kvan 1999).

Different phases of a project need different kinds of support. In the earlier phases, ambiguous phrases and sketches stimulate consideration of new possibilities. In construction detailing, the need to carefully examine proportions and assemblies and produce detailed construction documentation steers the project more towards CAD vector representations.

We can also consider techniques according to whether they support live or asynchronous interaction. Live techniques such as video-conferencing and application sharing allow spontaneous interaction. By supporting direct interchanges, video-conferencing supports a level of familiarity unavailable through other means. Live discussion can bring faster or different resolution to issues that would otherwise take many e-mail exchanges (Tang and Isaacs 1993, Morozumi et al 1997, Morris et al 1999).

Synchronous interaction in video appears to provide no positive contribution to the design product itself when compared to text. Especially for visual tasks, seeing non-verbal responses of partners is less crucial than responsive audio accompanying shared task graphics (Dave and Danahy 1998, Tang and Isaacs 1993, Gabriel and Maher 1999). When audio and video channels are available, they are often filled with extraneous communication (Vera et al 1998).

Simpler asynchronous methods can be very suitable for group work. Work gets done when individuals are tackling tasks, not when they are in meetings (Poltrock 1999) and asynchronous methods allow individuals to work at their own pace without interruption. Indeed, graphic images can, at times, constrain exploration of the problem space when compared to text only (Kvan Yip and Vera 1999). In comparing face-to-face, text and audio/video design collaborations, both content and attributes of interactions are influenced by the medium of exchange (Gabriel and Maher 1999)
Because live methods are dependent on available bandwidth and do not demonstrably provide much benefit, we have not used them as much as we anticipated when we first started virtual studios. This echoes the under-use of videophones that have been repeatedly re-introduced in the past thirty years, each time to a lukewarm reception. Neither low-bandwidth IP techniques nor more expensive ISDN methods have been satisfactory. Low-cost Internet methods have been disappointing due to the variability of the network bandwidth. ISDN connections have been too expensive for spontaneous interaction, limiting their use to more formal scheduled sessions. Lack of spontaneous access to quality audio and video has limited our ability to evaluate its utility over an extended project. Improved compression algorithms and the faster connections such as the Internet2 may make IP conferencing more viable.

5 CONCLUSION

Many institutions are undertaking to support distal collaboration in design, either in teaching contexts or professional offices. Typically, these efforts proceed with the installation of expensive technologies for communication and visualization. Our experience in teaching virtual studios and related research suggests that setting up the scenario with people whose needs and resources match can be much more important to a successful collaboration than high-tech equipment. People who are motivated to interact will work around technical difficulties. Often technical systems support ancillary and non-beneficial activity. The success of a virtual studio depends upon the definition of the task, the expectations of the participants and methods of engagement.

6 REFERENCES


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