Supporting Collaborative Design Groups as Design Communities

David Latch Craig and Craig Zimring

College of Architecture, Georgia Institute of Technology
Atlanta, GA 30332-0155

This paper explores computer support for unstructured collaboration. A web-based online environment used in conjunction with a graduate-level architectural studio was investigated, with special attention given to patterns of online behavior and the perceptions of those who used the environment. It was assumed that asynchronous collaborative environments like the one studied naturally alleviate certain problems like evaluation apprehension and production-blocking, but do not on their own motivate contributions to a group in an unstructured setting. It was hypothesized that open participation hinges on the development of a sense of community, which itself depends partially on environmental factors intrinsic to the support environment. The environment studied failed to promote open interaction and did not appear to sustain a strong sense of community. Environmental factors thought to have played a role include page structuring, page-naming conventions, and the spatial clustering of text-based exchanges.

Keywords: *collaboration, design education, virtual environments, online communities*

The use of computers to facilitate collaboration in design education is becoming increasingly practical as networked computing becomes cheaper, faster, and more graphical. This paper maintains that computer systems can indeed be used to help students aid each other but argues that, to be effective, they must take into account both the nature of design and the nature of interpersonal communication, preferably in a connected fashion. An understanding of design is assumed to be important in setting communication goals, while an understanding of communication itself is assumed to be important in getting students to construct and interpret exchanges such that those communication goals are actually met. Based on the notion that a set of goals may look vastly different to a student than to a researcher or studio instructor, the latter assumption essentially holds that design students must be properly situated if communication between them is to unfold in a desired way.

While students might be situated simply by being told what they should say and what they should listen for in their exchanges with other students, this paper argues that a stronger and more pervasive effect can, in certain cases, be achieved by shaping the context of communication rather than communication directly. The problem with telling students what to do is that the goal of communication might not be well defined and, as a result, might be hard to grasp for students. This, of course, may not be a problem for collaborative systems that define the goal of communication as one of coordinating and establishing consensus between team members.[1,2] Our investigation, however, has a different focus: it considers systems aimed at supporting collaboration when teamwork is not an explicit requirement. The goal of communication in this case is ill defined precisely to the extent that architectural problems are ill defined; the goal, that is, is to help students move forward in their conceptual thinking, but which direction is forward is impossible to pin down at the outset.

Collaboration without shared goals—what we refer to here as unstructured collaboration—minimally requires an open exchange of ideas and issues between participants. Unfortunately, as some teachers have commented, this kind of interaction is usually lacking in the studio. Since students compete for grades and status they may be afraid to expose their fledgling ideas. As a result, they miss out on the opportunities their peers provide for expanding the way they view problems. Situating students to facilitate unstructured collaboration thus requires overcoming their default situation, namely the existing studio community. To do this we start with the idea that online environments can provide contexts for communication that are to some degree autonomous from offline contexts and can potentially support independent communities on their own. If well-guided, an online environment used in conjunction with an existing studio might thus be able to provide an alternative context for supporting open interaction. Of course, there is no guarantee that a sense of community will emerge online at all, not to say one that supports productive behavior within the constraints imposed by the activity of design itself. The aim of this investigation is to better understand how the structure and features of online environments influence the social realm and, by extension, to see how they might play a role in supporting unstructured collaboration.

What follows is split into three parts. The first part explores the benefits and potential pitfalls of unstructured design collaboration by looking individually at design and group thinking. In an effort to then get at the relationship between a collaborative design community and the environment that supports it, the second part of the paper looks at how an existing system was actually put to use by a group of architecture students. Finally, the last part of the paper puts forth a few ideas regarding the design of collaborative design environments in general. Throughout all of this, the educational studio serves as a convenient area of focus, where the traditional emphasis on grades and portfolios seems to always lead to some degree of individualism. The conclusions we draw, however, are meant to apply to all areas of design: unstructured collaboration is not something that needs to replace existing, more team-oriented collaborative processes; rather, it is something that can augment them.

1. Unstructured Design Collaboration

The first task in understanding unstructured design collaboration is characterizing architectural design, in this case as it takes place in the educational studio. Generally,

design in the studio centers on one project for an entire semester or quarter (3 to 4 months), with general requirements laid out in a problem statement provided by the instructor. Most architecture students engage in individual projects, though occasionally they team up, in some cases by choice and in others as required by the instructor. Much like design problems posed in the domains of engineering and software development, though perhaps to an even greater extent, educational problems in architecture tend to be open to considerable interpretation on the part of the designer, whether they are couched as 'real-world' problems or as pedagogical exercises. Issues both unique to the problem itself (i.e., pertaining to what is explicitly required of the design) and generic to the domain being considered (i.e., pertaining to what makes for "good" architecture in general) are often open-ended, requiring the design student to impose his or her own order on the project. One task a design student faces is thus to shape and clarify the problem—that is, to define it—by identifying, researching, and articulating issues thought be relevant.

The second and more obvious task that a design student faces is to generate potential solutions to the problem. This need not wait until the problem has been thoroughly defined and in fact often takes place interactively with that task.[3,4] What in part makes generating solutions problematic is the fact that it is not always feasible to decompose a solution exactly as the problem is broken down into issues. That is, different issues, although often defined separately, cannot always be addressed separately. To a certain extent, this means that the designer must constantly move back and forth between problem and solution: a solution concept generated in response to one issue (say, energy efficiency) might not fare well in response to others (say, material costs), and hence have to be modified or reconsidered. New issues can emerge at this time, and existing issues can be explored in more detail, effectively expanding and clarifying the problem as the solution itself is articulated, evaluated and revised.

Since neither the task of defining the problem nor the tasks of generating and evaluating potential solutions can be logically deduced from the initial problem statement, design students must rely heavily on their ability to retrieve, apply and revise concepts of the problem and its potential solution. Presumably they start with rough concepts—in other words, first impressions. Although research on design,[5] as well as on creative exemplar generation[6] and analogical reasoning,[7] all suggest that such initial concepts play a constraining role as objects of fixation, ideally they will be flexible enough such that the problem and its potential solutions can be developed laterally and hierarchically without overt bias as new kinds of information and new arguments enter the designer's consciousness. Towards this end, Goel argues that the semantic density and ambiguous nature of representation systems like sketches and natural language help keep existing concepts open to continuous development.[8] We argue that unstructured interaction with others can potentially produce the same effect.

Brainstorming serves as a general model of the kind of unstructured interaction we are talking about. Brainstorming is a contrived activity where participants, in candidly sharing and discussing their ideas, are assumed to stimulate one another and ultimately further thinking within the group. Applied to design, brainstorming would, at a minimum, ensure that certain interpretations of a problem and certain design alternatives were made available to those who would not have otherwise thought of

them. More significantly, however, it might result in the formation of altogether new avenues for developing new concepts.

One reason for believing that unstructured communication about a design problem can promote conceptual change is that communication is rarely perfect. Participants must constantly revise, reinterprete and clarifify their ideas in order to "make" an argument. While this might only suggest changes in the outward appearance of ideas, empirical studies have, in fact, shown a correlation between improvement in internal conceptual structure and levels of reflective and corrective speech.[9] A second reason for believing that interaction might help is that by sharing evidence and argumentation, individuals are given more cognitive resources, with which they can form broader and more coherent concepts.[10] Several empirical studies in fact show strong correlations between the quantity of evidence and hypotheses exchanged within a group and group performance on inductive reasoning tasks..[11,12] Okada and Simon, for example, actually demonstrated that the whole of group activity can be greater that the sum of its parts—arguments and evidence, that is, were shown not just to be shared, but shared and multiplied. While such studies do not address design specifically, they are applicable for two reasons: first, they address fixation, and, second, to the extent that they involve science-like tasks, they address collaboration absent the need for explicit consensus and coordination.[13]

While we believe that group thinking has real potential and is in fact a common constituent of everyday reasoning, a number of contextual factors may limit group productivity. Research on brainstorming has specifically shown that three factors may come into play: evaluation apprehension, free-riding and production blocking.[14,15,16] Evaluation apprehension, which could arise in the studio if students think that others in the group know more than they do or that the group is being judged by the instructor or other reviewers, may limit the freedom with which ideas are offered. Free-riding, which could arise if students feel that their contributions are not essential, may result in the weakening of individual efforts. Finally, production blocking—the cognitive interference caused by turn-taking—might mean that students will lose ideas as others talk.

The severity of these three losses depends, of course, on the context of communication. Online environments, particularly asychronous online environments, are useful in that built in constraints can serve to reverse contextual factors found in more traditional communication environments. From a purely functional perspective, asynchronous communication of any sort provides an obvious means for dealing with production blocking, since turn taking is eliminated altogether. The other two factors, although also addressable with asynchronous online communication, are more complex, and require closer examination.

The use of online communication for dealing with evaluation apprehension and social constraints in general, has been addressed at length by Sproull and Kiesler.[17] They hypothesize that in traditional brainstorming sessions, perceived social hierarchies have a strong effect on the perceived significance of statements, leading to apprehension for those lower in the hierarchy and ultimately to a socially-defined chain of agreement that narrows the focus of group thinking for all. They suggest, however, that the lack of social cues in plain text and the apparent ephemerality of online messages can

diminish the social weight of online exchanges. With less awareness of social boundaries, people may be more open to the contributions of others and, at the same time, less likely to follow along in an uncritical manner. While asynchronous text-based interaction is not a guarantee that social constraints will be diminished, as a host of other contextual factors are likely to come into play,[18,19,20] several empirical studies have, consistent with Sproull and Kiesler's argument, shown that online communication results in more egalitarian participation, more ideas, and less centralized leadership.[21,22]

The third factor—free-riding—is a question of motivation: if individuals are expected to freely participate in online discussions it will be important that they feel that their contributions are worthwhile. While Rheingold optimistically suggests that "the infectious spirit of voluntary collaboration"[23] is enough to lead people to contribute to a group endeavor, the collaborative "spirit" likely depends on the extent to which people feel they are a part of and have a long-term stake in that to which they are contributing. Specifically, in lieu of more immediate goal-oriented rewards, it might help if participants feel that by interacting with others they are contributing to a community. When participants see themselves as members in a community, unsolicited contributions may be encouraged for two reasons: first, contributions may be seen as strengthening community norms and in turn the value of the contributor's membership, and second, they may be seen as a form of personal expression within the group.[24] It is important, of course, that community membership be clearly associated with productive exchanges. After all, traditional studios often entail a clear sense of community, but one that would seem to do little to promote unstructured collaboration. While having a utilitarian focus is not, in and of itself, a weakness—studies have in fact shown that even the most work-oriented online environments can support a strong sense of community[25,26]—enhancing the social aspects of a group does not necessarily hurt either. As Bruckman and Resnick have observed in their own research on collaborative communities, "Serious exchange of ideas often takes place because of, not in spite of, more informal social interaction."[27]

Achieving a sense of community around the work of the studio is not trivial. A sense of community, that is, is not guaranteed by opportunities for interaction but, rather, must grow out of interaction. Along these lines, several suggestions for fostering the community development have been made based on first-hand experience. Godwin, for example, suggests that online communities should be front-loaded with talkative people.[28] Unfortunately, this is difficult when communities, like those that might be associated with design studios, are fairly small. Communities can also be established through ongoing opportunities for shared meaning-making—, for example, by creating community traditions and dealing with ongoing problems of everyday life. However these strategies are problematic for the sorts of groups being considered here; an architectural studio might simply be too short-lived for such things. Bruckman and Resnick's also suggest that online environments provide "natural opportunities for casual, social interaction."[27] Sproull and Kiesler's suggest that they provide "diverse forums through which people can work together."[17]

The perception and awareness of others is also important to the design of collaborative environments as communities. For one thing, it would seem important that the identities of those who participate persist over time[29]; hence, some kind of consistent

signaturing may be important. Also, as Ostrum points out in a study of face-to-face communities, it is important that individuals have a sense of who might make use of collective resources[30]; hence, perimeter boundaries need to be clearly articulated. Finally, as pointed out by those working in the constructionist paradigm,[31] participation in activities that entail personal expression may be motivated by one's perception of an appreciative audience; hence, evidence that others are around may be important.

2. A Collaborative Community in Action

The argument put forth above is that design students can help each other in an unstructured way provided that they are properly situated. An online system might reduce social constraints (particularly evaluation apprehension) by masking the status of participants and might limit communication bottlenecks (particularly production blocking) by being asynchronous. To motivate students to share ideas with a group, short of making their grade depend on it or forcing them to enter into explicit contracts, may, however, require something more—namely, a sense of community centered around sharing and discussing design issues. Although several qualitative suggestions have been made by others regarding the formation of online communities, it is not entirely clear how the structure and features of an online environment, particularly those that would be useful for communicating design ideas, might affect a sense of community. This section analyzes how one particular online design environment was constructed and put to use as a way to better understand the relationship between an online community and the props that support it. .

In winter 1998, a traditional architectural studio taught at the graduate level at Georgia Tech was given use of a shared website called CoOL Studio (for Collaborative On-Line Studio) with the hope that it would, consistent with the concept of group thinking, be used to "open up and reshape the discursive space within which design takes place."[32] In this regard, the studio was similar to earlier "virtual design studios" that aspired to "democratize" the studio by using communication technology to bring in people who would not have otherwise been able to participate.[33] One notable difference, however, is the level of technology employed. Whereas CoOL Studio used the web for its flexibility and relative openness, other studios have employed more sophisticated technology like video conferencing with the aim instead being to make distant students feel "as if they were working at adjacent desks."[34]

Aside from having access to the online environment, the studio investigated here was conducted in a normal fashion. Students met in class roughly twelve hours per week, spending much of the time either working alone, talking individually with the instructors or participating in informal class reviews. Each student was responsible for developing a single design concept over the course of the quarter. As part of the development process, they were minimally required to research the problem given to them, experiment with abstract solutions, and, in the end, produce a fairly detailed specification of their final solution.

Ten graduate students were involved in the class. All were assigned the problem of designing a federal courthouse. Five of the students chose to work independently, with the remaining five splitting off into two multi-person teams. In addition to the students, six critics—individuals who possessed some professional expertise related to the design of courthouses—were invited to participate. Most of the critics were

geographically separated from the students. The one critic who happened to work locally was not otherwise involved with the studio. Apart from the critics, two local instructors led the class. One instructor focused on helping the students with their research and offered his own expert advice, while the other focused on helping students advance and articulate their design concepts.

The shared website, called CoOL Studio, was unique in that its content could be readily annotated and extended from a standard web browser.[35] This meant that anyone viewing a page could edit it, create links or create new pages on the fly. Each page thus existed as a shared document that could be changed without restriction. To provide initial content, students were asked to create web pages consisting of scanned drawings and text to present their research and design concepts to the other participants (see Figure 1). Although HTML tags could be used in the documents, the server accepted plain text as well as a few simple commands for adding hyperlinks and inline references and for creating new pages. Given this flexibility, students could easily add content and customize their pages as the quarter progressed, and all participants could annotate what others had posted (see Figure 2). Participants could also add new pages and create links between existing pages, leaving a unique structure as they went. Once the projects were underway, the critics were asked to comment on them either by annotating the students' pages directly or by using their own centralized "critique" pages.

Figure 2 The start of a typical project page

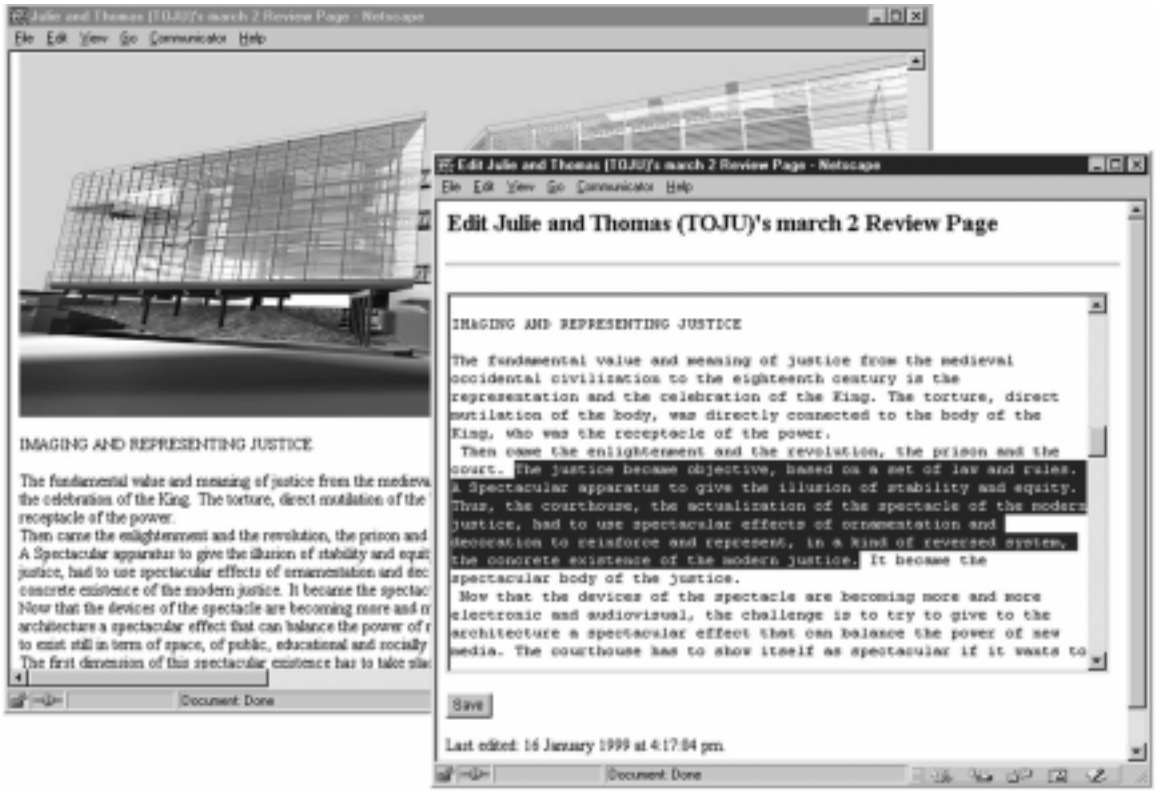

Figure 2 Editing a project web page from within a standard browser

Although the instructors asked the students to update their own pages and monitor the progress of their fellow students as often as possible, the critics were asked to participate only on three specific occasions. This guaranteed that when they connected to the site, everything would be as up-to-date as possible. If students were not able to anticipate impending critiques, the critics might have been led to comment on presentations that were still under construction. Since the critiques were formally scheduled, the students ended up developing three web pages apiece by the end of the quarter, one for each time the critics visited. The instructors asked the students to start each page anew so that the older presentations could be referred to if necessary. In addition to putting up pages describing their design concepts, students created online presentations of their research findings. The research pages and the project pages made up the bulk of the online environment. A few pages were created by the instructors themselves, mostly to provide information about the class. Although a few of the critics also added pages, most simply annotated project pages that already existed.

In order understand how the CoOL Studio participants came together as a community it is important to know how the participants viewed each other. In the following sections, the perspectives of the different participants are considered based both on close inspection of the activity that took place and on focused interviews[36] with nine of the students and three of the critics. (Because the instructors did not participate in the online environment in any significant fashion, their views are not considered at this time.) Although open-ended, the interviews minimally covered three topics: what was liked and disliked about the environment, what was thought of and expected from the other participants, and what was found to be particularly useful.

2.1 How the Critics Viewed the Students

The only bit of personal information the critics were given with respect to the students' personal identities were the students' first names. One critic who was interviewed felt that this was advantageous: "You take away the person and you're objectively critiquing the product rather than reacting to the person." Although he said that it simply did not occur to him to consider who they might be, he did concede that diction, grammar, spelling and overall coherence of what the students wrote influenced his view of them. He obviously had some concept of what a graduate student should be capable of and how seriously they should take their work and, in fact, disapproved when they fell too far below his expectations. When he thought one student was overusing academic jargon, he wrote a harsh critique only to lose it due to a network glitch. Incidentally, despite the potential for hostile behavior in online environments,[37] nothing of this sort ever appeared in CoOL Studio.

Aside from the personalities of the students, which apparently did not play a significant role in how they were perceived by the critics, there is also the issue of how the critics saw the students as receivers of their comments and advice. Generally, the critics commented that they were never sure if what they posted had been read by the students. Since they only viewed the material on a monthly basis, they could not easily tell if a student had developed his or her design in consideration of anything they had said. In some cases, in fact, it appeared that the critiques were disregarded by the students. One student, for example, cut and pasted text from an older presentation into a newer one despite the fact that sharp challenges to the material had been posted by the critics. Also, it seemed that whenever a critic posed a question directly to a student (which, admittedly, did not happen often), the question was never answered directly, again most likely because of the long delay between student postings. Frustrated with the one-way dialogue, one critic mentioned that when he hit the "save" button to upload his comments, he felt like he was "sending them off into the ether, where they might drift forever."

2.2 How the Students Viewed the Critics

Interestingly, several students who were interviewed said that they found few of the critics' comments to be directly helpful, although positive feedback was generally considered a source of encouragement. Some students commented that the critiques were useful in trying to gauge how clear their presentations were and whether they conveyed their intended meaning. Students felt this was important since their projects were eventually to be mailed to an international design competition. Regarding the lack of direct help the critiques were thought to provide, it might have been that the posted remarks simply did not speak to the issues the student happened to be grappling with at the time. When focusing on certain issues in the development of a design concept, the designer may very well see some features as underdetermined and hence unimportant, even though they are included in sketches. For example, if a student is working out the arrangement of spaces within the courthouse, it might very well be that the placement of trees around the outside is incidental to the overall design concept. If the critic happens to make a suggestion about the placement of the trees, his or her comments may go ignored.

As a result of his frustration with the critiques, one student who was interviewed suggested that it would be better if questions could be emailed directly to the critics. Given that each critic possessed a unique expertise, questions could, in fact, have been individually directed. Such a remark reveals, however, that the student did not view the critics as true participants in the collaborative community, at least not anymore than, say, a library book would be considered a participant. If this view was widespread, students may have lacked the motivation to fully develop their project pages. Interestingly, the one student who seemed to put in the most effort in getting his pages online was expecting a remote friend to view and comment on his work. The pre-existing social tie may have, in this case, provided a sense of trust that was lacking between the students and critics in general.

2.3 How the Students Viewed Each Other

Although students were encouraged to create online discussions amongst themselves, no student ever posted a comment about another student's project. Thus, it would seem that students did not perceive each other as interacting members of an online community at all. The simplest explanation for this is that students did not see any benefit to posting comments online when they spent so much time in close proximity. Unfortunately, as one instructor pointed out, students participating in a normal studio are not likely to start a deep discussion with other students in any case. One student commented that, since considerable leeway was allowed in interpreting the problem, interests tended to diverge from day one, making substantive interaction increasingly difficult as the quarter progressed.

2.4 How the Critics Viewed Each Other

The outside critics involved in CoOL Studio were likely aware of each other's presence simply because a list of all participating critics was given on the instructions page. For those critics who chose to enter their comments on their own pages, interaction with other critics was probably negligible. Those, however, who posted their critiques in the body of the students' pages likely saw what other critics (at least those who had also posted in the body of the students' pages) had written before them. These critics often, in fact, established continuity between remarks by making agreement explicit or by providing complementary arguments. One of the critics who posted comments in this fashion said that he was initially worried that the critiques might be completely incoherent, particularly if each was written at a different level of abstraction and from a different point of view. Noticing that in the end the remarks seemed to fit well together, this critic suggested that there may have been "some unwritten etiquette…not to make waves."

Another critic who was interviewed offered similar comments, adding that, for him, one of the most interesting aspects of CoOL Studio had been seeing what the other critics said. Interacting with the students was not, obviously, as rewarding as it could have been, particularly given that some may have felt they were being treated as sterile sources of information. Interacting with the other critics, by contrast, might have been interesting for a variety of reasons: it could have served as a chance for the critics to network, to see what other like-minded people were up to or to simply participate in a stimulating exchange.

3. Factors Influencing Online Behavior

While CoOL Studio benefited students in many ways—for example, by getting them to clearly articulate and track their design ideas—it did not seem to provide a fertile ground for unstructured collaboration. Those who participated in CoOL Studio did so with revealing perceptions, some likely influenced by the online environment and how it was structured, some by external factors. In this section we consider a number of things in an effort to account for the perceptions of participants and patterns of participation we observed.

3.1 Feature-Based Environmental Constraints

One obvious constraint the environment placed on interaction was that all messages had to be typed out. Even though scanned images could be posted in CoOL Studio, not being able to physically refer to them (say, by pointing) and not being able to answer questions quickly meant that the students had to be thorough in their textual descriptions. Most of the project pages were linear in form, using text to lead the viewer through a series of pictures. Although it was expected that the critics would have a difficult time understanding exactly what the students were talking about, the critics who were interviewed never felt that this was a serious problem. Students, on the other hand, may have seen speech as an obvious economical alternative to text-based communication, limiting their use of CoOL Studio for peer collaboration.

Another obvious characteristic of the environment was that it was designed to support asynchronous communication. Given the asynchronous format, some participants took the time to carefully compose their narratives in a standard text editor before posting them. One critic noted that this encouraged "intimate" reflection, commenting that, "It's a little like musing, or talking to yourself." The same critic also pointed out, however, that the asynchronous format put a damper on the spontaneous building of ideas that might have taken place between participants in face-to-face meetings. Once a comment was posted in CoOL Studio, there was no guarantee that it would get an immediate response. To make things worse, often several weeks passed between when the critics posted their comments and evidence of the students' responses appeared because of the presentation schedule. Lacking any control over the pace of interaction, the critics may have felt that they were outsiders to the real activity of the studio.

Performance characteristics, like the organization, speed and stability of the environment, may have also influenced interactivity. Although the site was slow and prone to crashing, the biggest problem was that it became increasingly difficult to navigate as the quarter progressed. If someone, for example, wanted to refer to an old page when critiquing a new one, a considerable amount of searching may have been required. While the CoOL Studio environment could be searched for text strings, no map or menu bar existed to show where different things might be found. The instructors were initially interested in seeing what kind of structure would be established by the students on their own. By the end, however, it was clear that little effort was put into structuring the site at all. Some simple navigation tools might have been useful in this regard.

3.2 Structure-Based Environmental Constraints

At a higher level of abstraction, one might consider how the organization of the pages influenced social perceptions within the online environment. In one sense, the project

pages seemed to have been set up and perceived as fishbowls. Students, for example, seemed to see their pages as one-way displays—in one case explicitly referring to the critics as "THE OBSERVERS"—suggesting that while there was some interaction, it may as well have proceeded through a closed window. The use and perception of project pages as fishbowls may have also had a negative impact on communication amongst the students. That is, if the web pages were perceived as one-way digital submission boxes, students may not have had a strong sense that the environment was there to support exchanges amongst themselves.

The structure of the pages may have also created a tension between what was public and what was private. All of the pages created by students—those that presented research findings and those that presented design concepts—were named after the students who created them. It may have thus seemed that any comments posted in those spaces by other participants were the sole possession of the original authors, who could then do with them whatever they pleased. This may have contributed to the fact that the students never directly responded to anything posted by a critic. It may have also been that participants perceived comments they posted in pages other than their own as "intrusions." Interestingly, in an undergraduate computer science class that used the same type of collaborative web site in conjunction with a more traditional newsgroup to support class-related discussions, it appeared that communication was less constrained in the newsgroup than on the web. In newsgroups, individuals cannot insert comments inside other postings and thus a dialogue unfolds as a string of spatially discrete messages. In an editable web page, by contrast, two distinct comments can occupy the same space without any formal separation. Shared web pages thus may naturally cause users to feel that they are sharing space, which can potentially run counter to implied ownership and thus inhibit participation.

3.3 External Constraints

Although harder to account for, factors independent of the environment also likely had an impact on online behavior. For example, the manner in which the participants were brought into the project and the opinions they already possessed may have had a significant impact on how they perceived the community. The culture of studios in general, which are sometimes seen to be, as a matter of tradition, more competitive than constructive,[38] may, in this case, have simply been extended to the online environment.

Another, more technical, reason for the low level of interaction may have had to do with timing. It may have been that in the early stages of design, precisely when unstructured design collaboration was likely to be most useful, students were still getting to know the system, both in terms of how it worked and how it could benefit them. By the time they were more comfortable with the environment, they may have been more focused on pushing their design concepts through to completion than on exploring them.

Finally, the style of communication employed independent of environmental constraints may have influenced the level of interaction. Finding that individuals are, by their own accounts, more willing to share an informal idea than something more structured and tangible, Constant et al. argue that the willingness to share depends on whether individuals perceive exchanges as involving "expertise," which is more socially

gratifying, or "a product."[24] How an exchange is perceived, they argue, will depend to a certain extent on the form of the material being exchanged. A detailed drawing for example might be seen as a "product," whereas a sketch, even if it represents roughly the same information, might be seen as "expertise." In CoOL Studio, some presentations were formal, containing detailed drawings and renderings, while others were quite informal. Hence, although presentation style may have been a factor in influencing collaboration, it is not likely that it had a consistent impact.

4. Discussion: Moving Towards Improved Unstructured Collaboration

Based on our observations of how CoOL Studio was structured and used, we offer four general suggestions for the design of online environments to support unstructured collaboration in design, highlighting the pitfalls and tradeoffs one may encounter:

First, to motivate interaction, online spaces should support the perception that they are shared: presentations should be casual, and implied personal boundaries should be nominal (see, for example, Stefik et al.[39]). Of course, posting design ideas in a common space may require that they be simplified, at least in relation to traditional studio pinups. The presentations posted in CoOL Studio may have simply been too large to cluster together in any elegant way. Looking at a design problem one issue or one question at a time might be one way to address this problem. Exploiting newer technologies, particularly those like VRML that move from 2D to 3D spaces, might be another. And finally, as suggested by those who have dealt with similar online endeavors,[34] traditional pinups could be broken down into smaller pieces and reintegrated through extensive hyperlinking.

Second, despite the need for closeness, one should also be aware of the tradeoffs between downplaying individuality and maintaining personal freedoms. Using an editable Web page, for example, in which one person can literally wrap his or her comments around another person's, people may be too close for comfort. While a sense of shared ownership may motivate people to contribute to a group, complete lack of separation may be inhibiting. Whereas the research of Sproull and Kiesler,[17] as discussed earlier, focuses mostly on the breaking down of social constraints in online communication, other studies[18,19] have indeed showed that downplaying individuality can be potentially restrictive. For example, when individuals are made anonymous by being put in separate rooms, Lea and Spears demonstrated that social constraints can be subsequently reinforced, depending on subtle contextual factors like the wording of instructions given to subjects and the formatting of exchanged messages.[18]

Third, a shared design environment should support the ill-defined nature of early design ideas. Although students participating in CoOL Studio may not have spent as much time as they could have trying to illustrate the concepts they were developing, it may have been that those concepts were still unformed and hence hard to fully express in a graphical format. If this is correct, a shared online environment aimed at supporting conceptual design may need to focus more on textual discussions between participants and less on project-centered visual presentations in order to make exchanges easier. Textual discussions and other open-ended representation schemes may enable participants to express their concepts even if they are difficult to pin down at the start.

Finally, fourth, if a shared online design environment brings in outside critics, it would probably benefit by making their visits as rewarding as possible. As it was, the CoOL Studio critics all donated their time to the project. Some made it clear that their participation was limited because it competed with their professional lives. Based on remarks made by one critic, it might help if participation included more substantive interaction between critics. Making use of the concept behind MediaMOO, a successful virtual environment established primarily to provide a way for media researchers to interact informally,[27] a shared design environment might actually be able to draw a large number of critics if it were promoted as a meeting ground for professionals. Again, textual forums might be useful in this regard, although some effort would have to be made to ensure that the discussions stayed centered on the students' work.

The central issue throughout these recommendations is representation. Representation impacts group thinking in design directly, in that it affects how ideas are externalized in a group and how they stimulate thinking once there. At the same time though, it affects how ideas are given significance in a social context and even how the social realm is itself perceived. While further single-factor research might help answer simple questions like whether text-based representations are better than image-based representations for getting ideas out and stimulating thinking in nonsocial settings, all of the factors mentioned here—from the cognitive to the social—interact in complex ways to influence the outcome Like any multi-dimensional design problem, this one calls for more exploration and experimentation, and a concerted effort to get beyond concepts associated with traditional studio presentations.

5. Conclusions

While much research has been done on unstructured online collaboration, particularly brainstorming, little has been done in the field of architectural design. At least three factors make online collaboration in architectural studios unique. First, while with most systems supporting unstructured interaction, little time is required to post an idea, a lot of time is required to represent an idea in architecture, spacing out interactions, and in turn reducing continuity between exchanges. Second, not only does it take a long time to represent an architectural idea, those ideas, at least as they are traditionally presented in the studio, are cumbersome, making it hard to reduce the boundaries between one person's ideas and another person's. Finally, educational studios bring together groups of individuals who are farther apart in age and experience than those that have been used as subjects in controlled studies; hence existing social boundaries between participants may be particularly strong.

The differences between unstructured collaboration in architecture and collaboration in other domains suggest the need for special studies. While the observations reported here are by no means conclusive, they may, as a first step, at least help to illustrate some of these differences and highlight where certain problems are likely to arise. Moving forward at this point will require developing new online environments and continuing the observational process. It should be pointed out that the findings presented here are not necessarily limited to the educational domain. Design offices probably already partake in unstructured collaboration; designers, that is, probably chat informally with others and seek advice from those who need not agree with them. In such cases, online environments might be used to amplify the benefits of informal interaction, just as they can in the educational studio.

1 Cicognani, A and Maher, M L 'Models of Collaboration for Designers in a Computer Mediated Environment' *The Third International IFIP WG5.2 Workshop on Formal Aspects of Collaborative CAD* (1997) pp 99-108

2 Gross, M D , Do E Y L, McCall, R J, Citrin, W V, Hamill, P, Warmack, A, Kuczun, K S 'Collaboration and Coordination in Architectural Design: approaches to computer mediated team work' *Proceedings of the First International TeamCAD Conference* (1997)

3 Schön, D A *The Reflective Practitioner* Basic Books, New York (1983)

4 Rittel, H W J and Webber, M M 'Dilemmas in a General Theory of Planning' *Policy Sciences 4* (1973) pp 155-169

5 Jansson, D G and Smith, S M 'Design Fixation' *Design Studies 12* (1991) pp 3-11

6 Ward, T B 'What's Old about New Ideas' in *The Creative Cognition Approach* ed S M Smith T B Ward and R A Finke. MIT Press, Cambridge, MA (1995) pp 157-177

7 Gick, M L and Holyoak, K J 'Schema Induction and Analogical Transfer' *Cognitive Psychology* Vol 15. No 1 (1983) 1-38

8 Goel, V *Sketches of Thought* MIT Press, Cambridge, MA (1995)

9 Teasley, S D 'Talking About Reasoning: How Important Is the Peer in Peer Collaboration' in *Discourse, Tool and Reasoning: Essays on Situated Cognition* ed L B Resnick, R Saljo, C Pontecorvo and B Burge, Springer, New York (1997) pp 361-384

10 Hutchins, E 'The Social Organization of Distributed Cognition' in *Perspectives on Socially Shared Cognition* ed L B Resnick J M Levine and S D Teasley. APA Press, Washington DC (1991)

11 Okada, T and Simon, H A 'Collaborative Discovery in a Scientific Domain' *Cognitive Science* Vol 21. No 2 (1997) pp 109-146

12 Laughlin, P R and McGlynn, R P 'Collective induction: Mutual group and individual influence by exchange of hypotheses and evidence' *Journal of Experimental Social Psychology* Vol 22. No 11 (1986) pp 567-589

13 Star, S L 'Cooperation without consensus in scientific problem solving : dynamics of closure in open systems' in *CSCW: cooperation or conflict?* ed S Easterbrook. Springer-Verlag, New York (1993)

14 Diehl, M and Stroebe, W 'Productivity Loss in Brainstorming Groups: Toward the Solution of a Riddle' *Journal of Personality and Social Psychology* Vol 53. No 3 (1987) pp 497-509

15 Kerr, N L and Bruun, S E 'Dispensibility of members efforts and group motivation losses: Free-rider effects' *Journal of Personality and Social Psychology* Vol 44. No 1

(1983) pp 78-94

16 Harkins, S G and Petty, R E 'Effects of task difficulty and task uniqueness on social loafing' *Journal of Personality and Social Psychology* Vol 43. No 12 (1982) pp 1214-1229

17 Sproull, L and Kiesler, S *Connections* (Cambridge MA: MIT Press 1991)

18 Lea, M and Spears, R 'Computer-mediated communication de-individuation and group decision-making' *International Journal of Man-Machine Studies 34* (1991) pp 283-301

19 Jessup, L M and Tansik, R 'Decision Making in an Automated Environment: The Effects of Anonymity and Proximity with a Group Decision Support System' *Decision Sciences* Vol 22. (1991) pp 266-279

20 Adrianson, L and Hjelmquist, E 'Group processes in face-to-face and computer-mediated communication' *Behavior and Information Technology* Vol 10. No 4 (1991) pp 281-296

21 Siegel, J, Dubrovsky, V, Kiesler and S, McGuire, T W 'Group processes in computer-mediated communication' *Organizational Behavior and Human Decision Processes* Vol 37. (1986) pp 157-187

22 Hiltz, S R and Turoff, M *The Network Nation* MIT Press, Cambridge MA (1993)

23 Rheingold, H 'The Art of Hosting Good Conversation' http://www.rheingold.com/texts/artonlinehost.html

24 Constant, D, Kiesler, S B, Sproull, L S 'The Kindness of Strangers: The Usefulness of Electronic Weak-ties for Technical Advice' *Organization Sciences* Vol 7. No 2 (1996) pp 119-135

25 Wellman, B, Salaff, J, Dimitrina, D, Garton, L, Gulia and Haythornthwaite M 'Computer Networks as Social Networks: Collaborative Work, Telework and Virtual Community' *Annual Review of Sociology* Vol 22. (1996) pp 213-238

26 Constant, D, Kiesler, S B and Sproull, L S 'What's mine is ours or is it?' *Information Systems Research* Vol 5. No 4 (1994) pp 400-421

27 Bruckman, A and Resnick, M 'The MediaMOO Project: Constructionism and Professional Community' *Convergence* Vol 1. No 1 (1995) pp 94-109

28 Godwin, M 'Nine Principles for Making Virtual Communities Work' *Wired* Vol 2. No 6 (1994) pp 72-73

29 Axelrod, R M *The Evolution of Cooperation* Basic Books, New York (1984)

30 Ostrum, E *Governing the Commons* Cambridge University Press, New York (1990)

31 Bruckman, A 'Community Support for Constructionist Learning' *CSCW* Vol 7. (1998) pp 47-86

32 From a handout accompanying the studio.

33 Wojtowicz, J, Davidson, J N and Nagakura, T 'Digital Pinup Board—The Story of the Virtual Village Project' in *Virtual Design Studio* ed J Wojtowicz, Hong Kong University Press, Hong Kong (1995), pp 9-23

34 Wojtowicz, J, Yen-wen Cheng, N, Davidson, J, Hubbell, K J, Kvan, T, McCullough, M, Mitchell, B, van Bakergem, D 'Learning and Teaching the Virtual Design Studio' panel presentation *ACADIA 95*, Seattle, WA (1995)

35 CoOL Studio was implemented using addressable web-server software called *SWIKI* developed by David Cunningham at Cunningham & Cunningham Inc. and Mark Guzdial at Georgia Tech.

36 Seidman, I E *Interviewing as qualitative research : a guide for researchers in education and the social sciences* Teachers College Press, New York (1991)

37 Kiesler, S, Siegel, J and McGwire, T W 'Social Psychological Aspects of Computer-Mediated Communication' *American Psychologist* Vol 39. No 10 (1984) pp 1123-1124

38 Anthony, K H *Design Juries on Trial: the Renaissance of the Design Studio* Van Nostrand Rheinhold, New York (1991)

39 Stefik, M, Foster, G, Bobrow, D G, Kahn, K, Lanning, S and Suchman, L 'Beyond the chalkboard: computer support for collaboration and problem solving in meetings' *Communications of the ACM* Vol 30. No 1 (1987) pp 32-47