Requirements for an Effective Distributed Design Review

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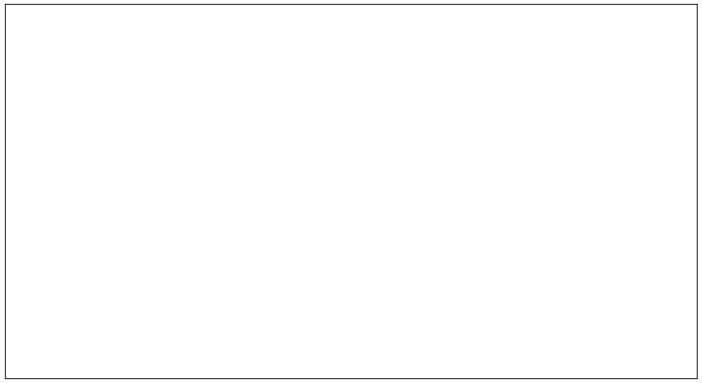
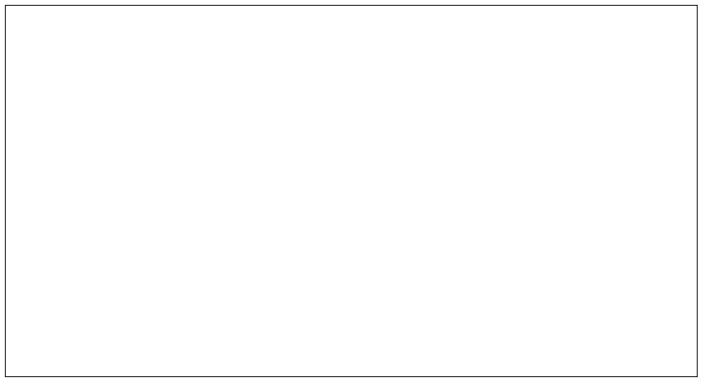
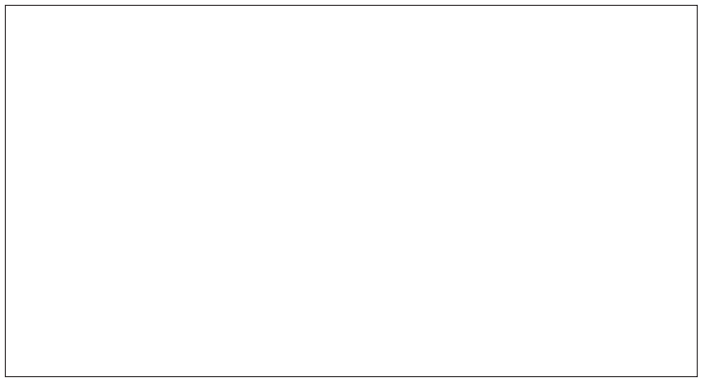
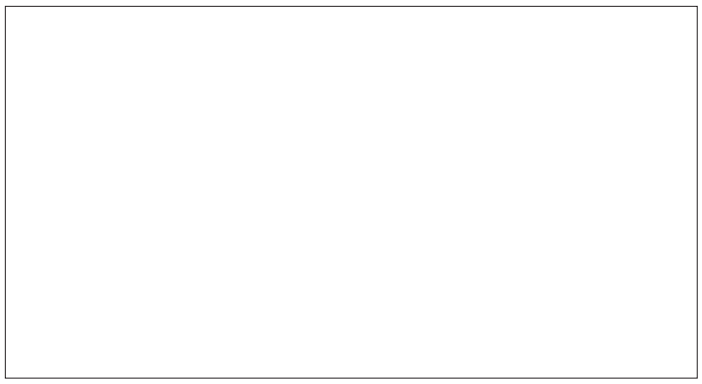
Abstract

With the wider availability of high-bandwidth communication networks and the maturity of commercial collaboration software, schools of architecture are experimenting with computer-aided distributed design reviews. A distributed design review enables geographically-distant participants to discuss a common design project using computer-supported collaborative technologies such as videoconferencing, voice over IP, and shared applications. While potentially beneficial to students, and attractive to teachers, there are a number of challenges facing the integration of synchronous distributed design reviews into the design studio by technically inexperienced faculty without significant technical support. This paper seeks to make it easier for faculty to make routine utilization of such reviews by examining our own experiences with a number of such reviews, in a variety of contexts, distilling out a set of guidelines for future reviews.









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1 Background and Motivation

Design education relies heavily on various types of conversation between design students and their instructors or mentors, including lectures, small group discussion, and design reviews. Design reviews are one of the most important forms of pedagogical communication between design instructors and students (Cuff 1993). These conversations between the designer and one or more reviewers fall into two broad categories: desk crits and formal reviews. Desk crits are informal (but not necessarily casual) exchanges, usually held on a regular basis, where the studio instructor examines the student's recent work and discusses strategies, plans, and challenges. It is commonly held at the student's desk. The conversation is primarily between these two principals, but may expand to include others. That is, while nominally private, eavesdropping is encouraged.

In contrast to desk crits, reviews are formal events, generally held at important project development milestones (including end of term). They often take place in special review rooms or areas and involve formal (stand-up) presentations that each individual or group has worked hard to prepare. The principals include the presenting student(s) and a group of invited guests (the jury). Conversation sometimes strays from consideration of the current project, involving give and take between guest critics. Classmates of the presenting student(s) are expected to pay active attention to the discussion.

Both types of design review are collaborative conversations. That is, they involve the input of and communication between at least two individuals: the student and the instructor, with appropriate turn-taking, both verbally and graphically. In fact, justification for the design studio teaching strategy often relies on the aggregate studio culture created by successive shared and overlapping design conversations.

Studio instructors occasionally travel or support practices in two cities, taking them out of town on a weekly basis. They might well wish to follow and review their students' work from afar, rather than compressing or eliminating studio hours. Conducting some or all of the normal desk crits via Internet connection would be a great boon to these faculty and their students.

Formal reviews benefit tremendously from guests who bring with them informed and articulate alternative views. These special viewpoints may be essential to all phases of the design development for a community-based project or a design for a different culture. However, financial and logistical difficulties, which are common enough when trying to invite local jurors to one's design review, are often insurmountable when the potential jurors are at any distance. The ability to use the Internet to involve remote expertise at a minimum cost would significantly expand the pool of candidate reviewers.

With the wider availability of high-bandwidth communication networks and the maturity of commercial collaboration software, schools of architecture are experimenting with computer-aided distributed design reviews. A distributed design review enables geographically distant participants to discuss a common design project using computer-supported collaborative technologies such as videoconferencing, voice over IP, and shared applications.

While potentially beneficial to students and attractive to teachers, there are a number of challenges facing the integration of synchronous distributed design reviews into the design studio by technically inexperienced faculty without significant technical support. This paper seeks to make it easier for faculty to routinely utilize such reviews by examining our own experiences with a number of such reviews, in a variety of contexts, distilling out a set of guidelines for future reviews.

The use of distributed design reviews also introduces students to an environment which challenges them to construct effective and communicative presentations consistent with likely future professional requirements, but quite different from traditional, paper-based presentations. Donald Schön has identified talking and drawing as the two most fundamental components of what he termed a language of design (Schön 1983). A distributed design review provides a means to study the interconnectivity of talking and drawing and to compare it to what usually happens in traditional design settings. This paper concentrates on these two activities as they occur during distributed design review sessions.

2 Related Work

In this project, we are interested in two main issues: 1) Making optimum use of the Internet to link remote jurors to a formal review by identifying the most important features of their interaction, and 2) Simplifying and rendering more natural the process of turn taking in both the verbal and graphical exchanges during reviews, minimizing the attention required by the interface. This work builds on that of a number of other researchers.

While this paper concentrates on design reviews, a narrow and well-defined activity within the design studio, the work is part of a larger interest in researching the requirements for an effective distributed collaborative design studio–or what William J. Mitchell referred to in 1992 as the *Virtual Design Studio – or VDS for short* (Wojtowicz, Davidson and Mitchell 1992). The general requirements for an effective computer-supported cooperative

design system have been outlined by several researchers (Tang and Leiffer, 1988; Jabi, 1996; Turner and Cross, 2000). The VDS oeuvre has described many of the opportunities and pitfalls of Internet-based collaboration. In the first VDS experiment, students at two different institutions were asked to co-design a project, review and exchange comments using e-mail, and conduct an electronic, long-distance design review. The authors viewed asynchronous digital correspondence as vital to the collaborative process but de-emphasized the use of synchronous tools. This may have been due to the duration of the project, the difference in time zones as well as the relative immaturity of real-time synchronous tools at the time the experiment was conducted. In 1994, a year after the completion of the first VDS studio, a second VDS studio included students and tutors from six different institutions and five different time zones (Wojtowicz 1995). VDS 94 clearly illustrates the use of synchronous videoconferencing as an effective tool for collaboration. Yet, asynchronous communication remained an important tool for the VDS project. Wojtowicz said it simply and clearly: “E-mail exchanges were the life-blood of the Virtual Design Studio.” Later researchers have pursued various aspects of design collaboration, including comprehensive collaboration and review environments that have been created to support VDS projects (Wenz and Hirschberg 1997; Kolarevic et al. 1998; McCall et al. 1998; Maher and Simoff, 2000).

While our small-scale project concentrated on more traditional presentation techniques (still and video images using Microsoft PowerPoint and simple web pages), others have described the potential and pitfalls of multi-modal, 2D and 3D immersive techniques. For example, Daily et al. describe in their paper an integrated immersive virtual reality environment that supports multi-site connections using avatars, high-fidelity audio, and shared artifact manipulation. They conclude in their research that while it is possible to communicate design concepts and ideas with a natural, intuitive interface over great distances, a key future goal would be to overcome the widely disparate interface modalities they encountered (Daily et al., 2000). Gross and Do have described a number of shared drawing (Qian and Gross 1999) and design annotation systems (Jung et al., 2002), while Johnson has described a formal review tool used in online competitions (Johnson 1999). Kalisperis et al. also report that Virtual Reality (VR) setups can be affordably constructed and implemented in the initial phases of the design process (Kalisperis et al., 2002). Their research intersects ours in that we are both interested in an immersive and natural environment for design presentation. We both believe that the technology belongs in the studio and should be made available to students throughout the design process. However, their work concentrates on the visualization of design, rather than the conversation of the remote reviews. Rather, we have researched several commercial interactive screen technologies which we will report on below.

3 Setup

We looked for affordable, off-the-shelf, collaboration software that allowed shared audio and video, and shared network sketching. Within the presentation space, we made use of a large interactive whiteboard (Smart Technologies, Inc. SmartBoard 580) as the display surface (Figure 1). The SmartBoard enabled the students to interact directly with the large projected image, without requiring use of a mouse or keyboard.

The review events involved about 15 students, two or three co-located jurors, and one remote juror. Since our aim in this experiment was to concentrate on inexpensive software and hardware, we selected essentially free, off-the-shelf, collaboration software from Microsoft Corporation (Windows Messenger and NetMeeting). The Windows Messenger software allows participants to share almost any Windows-compatible application, which in our case was Microsoft PowerPoint, which the students used to assemble their presentations. Sharing simply means that the remote participant can view and optionally control a single graphical user interface, visible in both locations. Effectively, the remote participant can follow a presentation as it progresses, can see the marks and annotations being made and can (optionally) take control of the presentation and create his own marks. The software also provides an audio channel both ways. We connected the computer to speakers so students could hear the remote participant’s voice, and used a microphone to transmit our voices. After experimenting with a shared microphone as well as multiple microphones, we concluded that one high-quality, omni-directional microphone is sufficient to capture all voices within a medium-sized room (approximately a 12-foot radius). Since the software also provides a separate video channel, we experimented with the use of video through webcams, but found it to be of little use other than to initially introduce the participants to each other. As Donald Schön predicted, all that was needed was the combination of talking and sketching. Coupled with voice, this technique was effective in carrying out a fluid design discussion.

In order to engage the local jurors and audience, we increased the size of the presentation through projection. This also mimicked traditional stand-up presentations in which the presenter stands in front of and points to the presentation board. The SmartBoard provides a projection surface. It also acts as a large digitizing tablet. The software creates a virtual transparent layer on top of the projected image, on which one may mark using one of three color-coded inkless pens. The software recognizes, through a sensor built into the board, what pen is being used and creates marks on the screen of the correct color. An *eraser* works in a similar, but reverse fashion. The fact that the marks are projected back onto the screen and spatially aligned gives the illusion that the user is sketching *in situ* with virtual ink. Alternatively, if the user presses with his/her finger instead of a pen, the SmartBoard simply passes it through to the operating system, which treats the action as a mouse click or drag and responds accordingly. The resulting effect is a flat

2-dimensional version of a hybrid physical-virtual environment–a cybrid (Anders 1998).

The remote juror is not required to have a comparable setup. At a minimum, a standard Windows desktop PC with a mouse and keyboard is required. If available, the juror would benefit from the use of a small digital drawing tablet (e.g. Wacom) which provides a much more natural interface for the juror to annotate and sketch over the drawings.

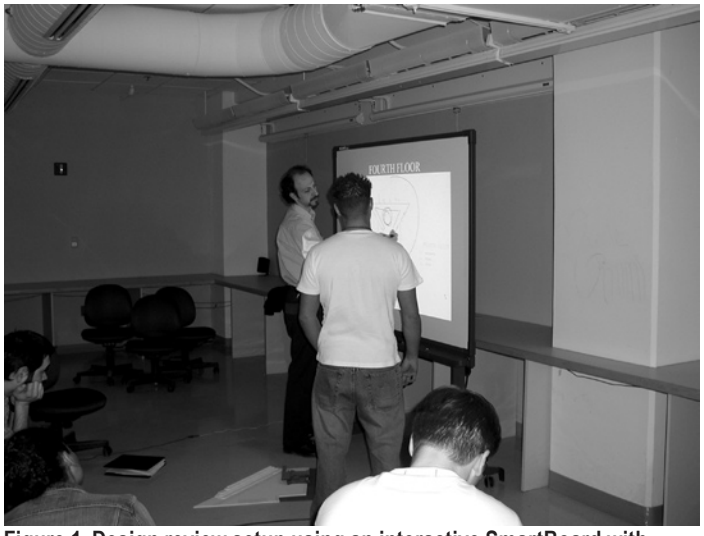

Figure 1. Design review setup using an interactive SmartBoard with projected image.

4 Case Study

As discussed above, design reviews tend to vary along two dimensions. The first dimension indicates the degree of formality while the other dimension indicates the geographic location of the participants. These two dimensions yield four possible design review settings as illustrated below (Figure 2). The setup described above has been used and documented via still photography and digital video for one semester in third year studio in three different settings. The SmartBoard was made available in studio for weekly informal use for desk crits. It was also used in studio for more formal design reviews that did not include a remote juror. Finally, the setup was moved twice to a review room to be used for a formal design review that included three or four invited jurors–one being a remote juror. The fourth alternative, informal distributed desk crits, was not evaluated in this sequence. It is expected to be the subject of future research.

4.1 Informal Local Desk Crits

In studio, the SmartBoard was used occasionally as a replacement for trace paper and pens. Although no remote capabilities were utilized, the studio instructor and student would stand in front of the board, discuss and sketch over the drawings. This proved to be an effective method in discussing the project at hand and did not require a lot of preparation. The media used included static images stored in folders, PowerPoint Slides, AutoCAD drawings, 3D Studio MAX models, AVI animations, and Spherical Panoramas. Control of the interface, while involving new paradigms, proved to be intuitive, and the ability to non-destructively sketch over any image or model proved to be useful. All students positively mentioned the use of the SmartBoard in their end-of-term evaluation form.

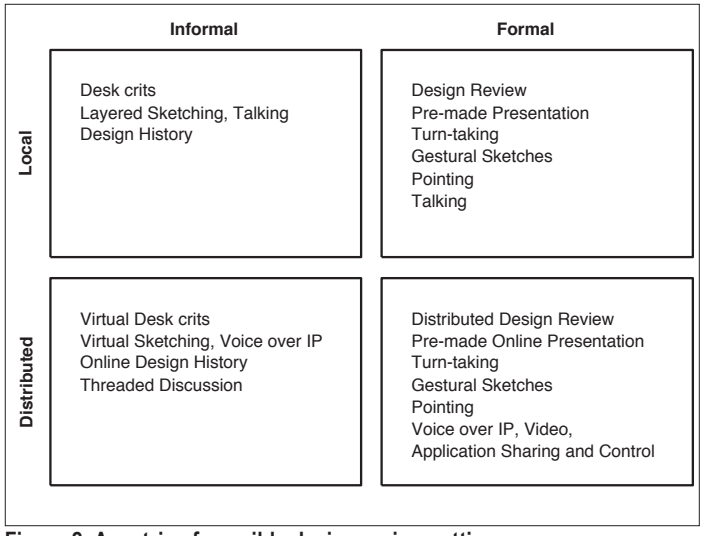

Figure 2. A matrix of possible design review settings.

4.2 Local Formal Design Reviews

In studio, the SmartBoard was used occasionally for design presentations. The students prepared PowerPoint slides and used the board mainly as a projection screen. Again, the added ability to non-destructively sketch over the drawings in a natural manner enabled a more fluid presentation. The ergonomics were improved since the student did not have to fiddle with a mouse and keyboard and could stand in front of the screen and face the audience in a natural position.

4.3 Distributed Formal Design Reviews

As mentioned above, the SmartBoard and collaboration software setup was used twice during the term to conduct formal reviews. The first session (mid-term) was conducted with a remote juror in the same country, but with a 3-hour difference in time zones. The second review session (conducted at the end of the term) involved a remote juror who resides in a different country with a 7-hour difference in time zones. In both cases, the remote reviewer was connected via voice and application sharing. Below are some brief observations on those two sessions:

A slight operating system incompatibility necessitated the use of an older version of the collaboration software to initiate the review session. While workable, this solution was not

immediately obvious and probably represents a weak point for the less technically experienced. We are also concerned that Netmeeting/Messenger is platform-specific, but find such software to be more integrated and functional than available platform-agnostic counterparts.

Initially, the remote reviewer had microphone problems. This was resolved through the use of a mobile phone, but the lack of projected audio transformed the review into a one-on-one desk crit because the audience could not hear what the remote reviewer was saying. This was so unsatisfactory that we suspended the remote review, resuming it after the remote juror located and connected another microphone to his computer. There is a lag inherent in voice-over-IP technology. In addition, the remote microphone may pick up some of the audio signal and play it back to the speaker. Due to the lag, it arrives back at the speaker's end 1.5 to 2 seconds later. Initially, this caused critics and students to speak much more slowly and deliberately –artificially slow. Adjusting the volume and exercising the ability to mute the microphone when not speaking solved that problem. While testing prior to the second review session, we discovered that network security implementations (firewall) prevented the collaboration software from functioning properly. Network administrators could not solve the problem in time. However, we were able to address the problem by issuing the remote reviewer a temporary password, allowing him to establish a Virtual Private Network (VPN) connection that allowed his computer to behave as if it was placed on our local network behind the firewall. In session #2, the remote juror felt it necessary to speak faster, keep comments short and to the point, ask permission to start speaking and clearly indicate that he was done speaking. However, the exchange did become more fluid towards the end of the review with natural interruptions, juror-juror comments and jokes.

In session #2, the local jurors almost never went up to the board to sketch and/or gesture. Instead, they either used the shadow of their hand in front of the projector or a laser pointer. Obviously, these gestures are not transmittable. Thus, the remote juror could not easily follow what parts of the drawing the local jurors were commenting on. This indicates that we need to find a way to remotely, wirelessly, and easily enable local participants to affect the screen. To compensate, the manager of the review tried as much as possible to follow the laser point with the cursor icon. In contrast, the student presenters used the SmartBoard to its full potential with sketching and interactive mouse clicks. Animations embedded in PowerPoint caused a major delay and breakdown. However, we shared the AVI files separately, and the remote juror reported that they worked reasonably well although a bit choppy on his side.

Video (headshot) was tested and worked, but found to be unnecessary for an effective review. It consumed too much bandwidth, and voice was enough to convey meaning. Video was mainly used to introduce the remote juror and give the audience a view of who he is (to become more real to them).

Students and faculty informally reported that the whole process, while a bit strange due to its newness (e.g. one juror referred to the remote juror as "the voice"), was useful and informative. The remote juror did not clearly know who was speaking so, he referred to that person as "the critic who last spoke, or I agree with the comment made..." It might be helpful to have individual microphone channels that, when activated, display the speaker's identity on the screen.

One juror complained about the glare coming from the hotspot generated by the projector. We are hoping a rear-projection system, as illustrated below, will solve that problem along with the shadow problem commonly associated with front-projections (Figure 3).

5 The Ten Commandments

Figure 3. Rear Projection SMART Board 3000i (left, photo courtesy of Smart Technologies, Inc.) and An *RPS/Complete* Rear-Projection System (right, photo courtesy of Draper, Inc.)

Based on our experience with design reviews, we have derived Ten Commandments that we believe can help avoid some of the most common pitfalls associated with conducting distributed design reviews and make them productive conversations:

1) Start early (plan ahead): While it may take only a matter of minutes to establish the review connection in the end, it may take several days, or even weeks, to verify the preconditions for the review (room reservation, camera function, software, microphones, speakers, etc.). Similarly, it is necessary to get placed on the remote reviewers' calendar early, to make sure that they have allowed adequate time with a minimum of distractions.

2) Test. Test. Test: Complex modern systems of software and hardware often involve many layers of data exchange

and encoding, plus filtering by internet routers and firewalls. They are also a moving target as university staff work to control hacking, or software piracy, and vendors sometimes rush products to market before they are ready. While it has become significantly easier to get/make viable connections in the real world, including those between heterogeneous systems, each component should be adequately tested to assure run-time viability for the review. An OS update may leave you unable to use your camera driver, or you may have to establish how to get NetMeeting and Messenger to talk to each other.

3) Know thy neighbor: In the normal course of a face-to-face review, presenters and reviewers each have a part to play and each knows their part. Nonetheless, a significant amount of adjustment may take place due to the exchange of social cues. Remote reviewers may not be familiar with the local "scene." It may be necessary to address some of these issues in advance, in an explicit form, or protocol which sets out the timing of the review, the order of the students, the amount of time each has "center stage", the biases or "spins" being supplied by the studio mentor(s), and so on. These help set the stage for responding to the student work.

4) Use back-channel diplomacy: During the review event it may become necessary for a remote reviewer to communicate with the host about the review. While it may be necessary to break in on the presentation or conversation then underway, it is quite disruptive to do so. Having an alternative "back-channel" communications means (email, un-projected chat window, phone, etc.) provides for this kind of communication.

5) Adjust expectations: Remote reviews take longer than their face-to-face counterparts. In the face-to-face review process, each student receives the focused attention of the reviewers for a period of time, but it is still possible to handle three to four reviews an hour. During remote reviews, you should expect to do two or three in an hour, rather than three or four.

6) Keep it cozy: These technologies are not well suited to large-scale reviews. In particular, reviews involving multiple remote reviewers are ill-advised because the social cueing that is necessary for a smooth conversation is disrupted by the time-lag found in voice-over-IP. For one remote reviewer it is likely that an informal "wait" protocol will evolve–analogous to that seen on TV when a reporter is half-way around the world–using long silences to signal conversational turn-taking. With two or more remote reviewers, there is no good means of cueing turn-taking between the remote end-points, with the result that the reviewers will often collide with and talk over each other.

7) Know thy software: In an environment as dependent on technology as a remote design review, it is important that all participants have experience with the software and the specific way it will be used during the review. Each student, supporting faculty and the remote reviewer should practice with the software prior to the review. During this time it is possible to discover "glitches" (playing movies in PowerPoint, etc.) which profoundly affect the presenter's plan.

8) Encourage symmetry: One-way mirrors may connect two occupied spaces, but they don't provide both occupants with the same sense of social presence. It is important that the tools be set up and configured in such a way that every participant feels they are part of the exchange.

9) Use big pipes: While viable reviews can certainly be completed using slower speed or even asynchronous review protocols, additional bandwidth provides the flexibility to conduct a review without carrying quite the same cognitive load that slower-speed connections require. At the same time, almost any connectivity speed can be overwhelmed by an overly ambitious project (e.g. 1024x768x30fps animation).

10) Have a plan B. . .and C (a.k.a graceful degradation): You should expect one or more aspects of your setup to fail. To the extent that it is possible, have backup plans in place for continuing the review (placing PPT files on the web, with telephonic, chat or email reviews, having a reserve of redundant equipment, etc).

6 Concluding Remarks

Despite the inherent technical difficulties associated with introducing new technologies and processes, we firmly believe that the ability to regularly conduct distributed design reviews is an invaluable opportunity for both faculty and students –if implemented with care. One fundamental challenge is to understand the degree to which a distributed design review is, or is not, similar to a traditional face-to-face studio review. For example, one may find fault in the apparent linearity of online presentations. Yet, business presentations and lectures are generally linear as are most, written works. The ability to move laterally between images and components can be improved by running multiple types of software in parallel and by displaying the slide sorter screen to which critics may refer. While face-to-face reviews and many distributed reviews occur at the same time (synchronously), asynchronous web-based design reviews have also been gaining popularity as a way to continue design work outside normal studio hours and at a distance, include a larger set of viewpoints, compensate for time-zone differences, and acknowledge varying connection speeds. Yet, one of the described case studies points to a benefit to conducting synchronous design reviews across different time zones. Specifically, the use of multiple time zones may actually facilitate synchronous reviews because a critic may be available at a time when he/she might otherwise be teaching a class. As most design studios require consecutive large blocks of time

(generally three to five hours), this would then overlap available time slots when working with critics in other time zones. So this process may actually expand the pool of available critics, all without significant time spent on travel to and from remote locations. As we conduct more review sessions, we will continue to develop, refine, and report our findings such that we may benefit others when setting up and utilizing such environments.

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