Collaboration in the Large:
Using Video Conferencing to Facilitate Large Group Interaction

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1. Introduction

Large group collaboration is a strategic component of many research and development (R&D) efforts today. New, innovative solutions to complex problems may often be best addressed by collaboration among experts who combine knowledge from different disciplines and use a variety of resources including scientific instrumentation and methods. Indeed, national agencies, such as the US National Science Foundation (NSF) and the National Institutes of Health (NIH), have established grant programs such as the Science and Technology Center program, Industry-University Research Center program, and the National Computing Research Resource program that provide funding to large multi-disciplinary and multi-institutional R&D groups to address complex problems.

Typically these groups may have 50 to 100 or more participating faculty, undergraduate and graduate students, postdoctoral fellows and industry members. Because these groups are geographically distributed with members who typically retain their primary affiliations to their home departments and institutions and not all members may have interacted with each other previously, it can be difficult to establish and maintain collaboration among members.

To address this challenge in the NSF Science and Technology Center for Environmentally Responsible Solvents and Processes (NSF STC-ERSP), we are applying an action research approach (Stinger, 1999; Whyte, 1997) that considers social/organizational and technical aspects of large group collaboration when establishing mechanisms to facilitate collaboration among group members. This approach is evolutionary in nature and strives to provide a rich social/organizational and technical infrastructure that enables and empowers collaboration within the center. It builds on and enhances existing social and technical infrastructures, and continues to explore new ways to facilitate collaboration. This paper describes these efforts using large group video conferencing technology and "best practices" in particular.

An important thing to realize is that problems of transition from one site to multi-site meetings using video conferencing will occur and the benefits of broader participation may only be realized when time and resources are invested to notice what does not work, or what is not happening, and to explore and evaluate alternatives. This requires investigating and exploring ways the social and organizational infrastructure of the center and the technical infrastructure at the participating universities can better facilitate large group collaboration. At the NSF STC-ERSP this investigation yielded new social and organizational practices, including: facilitation before, during and after video conference meetings; the adoption of visual aids to match video conference technology constraints; and the adaptation of participant, or audience, etiquette. It also yielded new technical practices including: upgrades to video conference equipment; the use of separate networks for broadcasting camera views, presentation slides, and occasionally voice; and implementing new technical operations practices to support dynamic interaction among participants at each location. These new practices have enhanced the effectiveness of video conferencing, leading to its adoption within the center and enabling frequent and needs-based meetings across distances.

2. Social and Organizational Infrastructure

2.1. Social and Organizational Setting

The Science and Technology Center consists of four geographically dispersed universities (although three of them are located within an hour's drive of one another.) At each university, there are approximately 10 to 37 undergraduate and graduate students and postdoctoral fellows, and 6 to 10 faculty who are members of the center, for a total of 110 members. These members do not work full-time for the center; students are in degree programs and must take courses, etc., and faculty may teach and conduct research outside the center.

At the time we began this work, the center was organized into 4 physical science research teams. Each team consisted of 6 to 9 faculty members; and three of the four teams had faculty members from each university. Each team also had 6 to 29 student and postdoctoral fellow members. Many students and postdoctoral fellows were asked to be members of two teams, and each team had student members from each university.

Similar to other centers and organizations, there was limited interaction among center members before the center was established. For example, data reported in a sociometric survey completed by members[1] indicated that only 22.9% of center members had interacted with other center members prior to the establishment of the center. Thus the center is a large, geographically distributed group whose members are not full-time participants and who may have previously had no or limited interaction with each other. In this respect the center is typical of the emerging genre of federally funded, university-based research centers.

2.2 Types of Video Conferences

Three types of meetings in the STC-ERSP are held using video conferencing: center-wide meetings, group team meetings, and faculty (principal investigator) meetings. *Center-wide meetings* are held infrequently (e.g., once every 6-8 months); these meetings include all members at all universities and have been used to share information among all center members (see Figure 1.) For example, a center orientation meeting was held that introduced the center's mission, organizational structure and center-wide activities several months after the center was established. At these large meeting, as with most large meetings, interaction among members is somewhat limited due to the number of participants and time limitations.

Figure 1. A center-wide video conference meeting

[1] Response rate for this survey was 60%.

Group team meetings are held weekly; all center members are invited to attend these meetings. However, students and postdoctoral fellows are strongly encouraged to attend these meetings when the presentations are given by members of their team. Each meeting typically lasts 1.5 to 2 hours, and includes 20 to 30 participants. During this time, members (primarily students and postdoctoral fellows to date) present and discuss their work. Students are required to present their work once or twice per year at these meetings. In addition, these meetings have been used to present outreach activities and opportunities and illustrate/teach how to use video conference related technology. Each presentation during these meetings typically lasts 20 to 45 minutes with integrated discussion. Thus these meetings are a vehicle for bringing people together to share, learn, raise problems, offer solutions, and perhaps achieve other, as yet undetermined, outcomes. As faculty and student members reported:

> *I always learn something. Even if everything in [the other] group team meeting isn't interesting to me, I can … read a manuscript and still listen to things that seem separate from what I am interested in and I will pick up something that I didn't know.*
>
> *By attending these conferences and listening to explanations from other people, I [began to] understand research much more clearly.*

Faculty, or principal investigator (PI) meetings, occur on an as needed basis, typically once every 4 to 6 months. These meetings are typically used to plan upcoming projects and activities and are organized by the center directors or by faculty. Initially these meetings were held using audio conferencing only, but faculty are beginning to hold these meetings using video conferencing.

2.3 Facilitation of Video Conferences

Irrespective of the type of meeting being held via video conferencing, each meeting has a facilitator or moderator. For the group team meetings, a student from each project group is assigned the role of facilitator. This responsibility rotates among the students approximately every six months. Although the center directors, in consultation with the faculty and students, determine the dates of student presentations, a facilitator has the following responsibilities:

(a) Compose an e-mail message to all center members announcing the upcoming meeting topics. Talk abstracts are included in this message when available. Other center-wide announcements and norms regarding the video conferencing may be included in this message. An example is provided in Appendix A.

(b) At the beginning of the meeting, welcome everyone, verify audio and video communications are working from the audience's perspective, and ask if there are any general announcements.

(c) If there are any technical problems at any time, the facilitator is responsible for informing the video conference technical staff and relaying the status of the

technical problems to all locations. Often, the technical staff are located in an adjacent control/operations room, and the facilitator may use a dedicated headset to talk with the staff.

(d) Introduce each presenter; manage the question/answer period as needed.
(e) Provide a 10 to 15 minute break between presentations. The break also allows participants who cannot stay for a subsequent presentation to leave with minimal interruption.
(f) Close the meeting, thanking participants.
(g) After the meeting, the facilitator publishes the highlights of the meeting. These are one to two paragraphs in length and are sent to all center members via e-mail and published in a secure area of the center's web site.

It can be tempting for facilitators (and presenters) to forget there are very interested people at other locations who want to participate in the discussion. The participants at remote locations may need to be reassured that they are part of the meeting and encouraged to speak.

Initial ideas regarding these responsibilities emerged from observations of video conferences and discussion with center members and technical staff at each location by a social science research team. A meeting was held between research team staff and the student facilitators and technical staff to discuss and refine these practices. Thus students and staff participated in their formulation.

Participants have responded positively to these practices. For example, the e-mail announcements and summary messages facilitate interaction in several ways. Because some topics cross project team boundaries, these announcements make it possible for anyone who is interested in the topic to know when to attend. They also allow center members to get a bird's-eye view of research progress within the center, increasing their awareness of center activities. As one participant reported:

> *The beauty of the videoconferences is the way they send the titles out in advance and then you can go to different [group team meetings] and see what you want to see. That helps so much. If you don't know what the titles are going to be then you might… only go to [your] own [group team meeting]. So if I'm a simulator and I see somebody's giving a talk in one of the other [project team meetings regarding] something I'm interested in I just go [to that video conference.]*

Furthermore, the facilitator role provides students an opportunity to practice leadership and meeting management skills; skills sought by prospective employers. It also fosters interaction among the student facilitator and presenters. Albeit this interaction is minor in nature, in this context where students are not co-located and have previously never interacted with one another, these types of formal interaction mechanisms are a first step towards more meaningful and sustained interaction.

2.4 Adaptation of Visual Aids

Visual aids, such as slides, can increase retention of material, however these aids often need to be adapted for use in video conference settings due to constraints imposed by the technology. Use of TV monitors in video conferences, for instance, instead of the large screens commonly used for the display of overhead slides or a PowerPoint presentation in conference or classroom settings make a difference—text and graphics that are very readable on a large projection screen may be difficult to read on a monitor, where the monitor is some distance from those trying to read the screen. Guidelines for Microsoft PowerPoint presentations/transparencies typically suggest a minimum of 20-point for headlines and 16-point for other text (Ross & Dewdney, 1998). While this works well in most presentation situations, it is too small for the TV monitor situation. We consequently advised presenters to go bigger. We found that 28-point text was readable from the back of our videoconference rooms.

For text on the screen, we advised using keywords or short phrases over sentences as do others. That is, presenters are asked to avoid including everything that they wished to say on the display. As others have noted, we found that all UPPER CASE TEXT was harder to read than lower case (with capitalization as appropriate) on the screen. Size was an issue for graphics too. Many presenters included multiple charts, graphs, etc. on a slide. This can be an effective way of placing related views of data together to show the 'shape' of what happened in an experiment comparatively. It is not an effective way of communicating details. By moving from overview to details—that is, a larger full screen view of a single graph, the audience can better see the details (e.g., units of measure). This effect could also be achieved by zooming in on the details of a graph or creating follow up screens that blow up the details.

The traditional black text on a white background of many presentations is not as effective a color scheme as a dark background with text in a light color. **A dark blue background with yellow header and white text** is a color scheme that provides better visual clarity, especially on a TV monitor, than black and white. Red text tends to look blurry on a TV monitor. A template for slides with these guidelines in mind was developed and distributed to center members through e-mail and included on the center's web site. However, printing slides from this template can be problematic, especially when printing in black and white. Although Microsoft Powerpoint has an option to view slides in "black and white," some slides may require modifications to produce a quality "black and white" print version.

Before electronic white boards were installed (see section 3.2 below) we found that paper copies of slides worked better than transparencies when the overhead camera was used to project the slides because they minimized the reflection from the lights. The use of the overhead camera also allowed the presenter to zoom in to details of a paper slide, something that is not possible with an electronic presentation.

2.5 Participant Etiquette Practices

Because video conferences differ from face-to-face meetings, a set of participant/audience meeting etiquette practices have been developed. We envision these practices evolving further over time.

One practice focuses on self-identification. During video conferences, it is not always possible for the presenter and other audience members to see who is asking a question because anyone can ask a question and camera operators can not always switch camera focus and video displays fast enough to show who is asking the question. Knowing who posed a question sometimes provides clues regarding the best response and provides the presenter the opportunity to later follow up with the questioner at their discretion. Thus, we developed the common practice of questioners first saying their name and location, i.e., "This is Reto Bolliger from UNC at Chapel Hill." Initially others in the audience, including the facilitator, would prompt participants if they forgot to say their name and location. Now this practice is widely used without prompting.

There is also a need to explicitly communicate problems to video conference technical staff. If a participant (usually the facilitator) reports a technical problem, they give their location and state what the problem is and where it is coming from, e.g., "*This is Chapel Hill and we have no sound from Texas*." This is the type of information our technical staff told us they need to investigate and solve problems.

Another practice focuses on microphone awareness. In most video conference rooms, the microphones are always on; almost all sounds in one location can be heard in other locations. This includes whispers or side comments, munching on chips, sneezes and page turning. In response to this constraint, participants cover the microphone closest to them when sneezing, etc., and limit their page turning and other activities not directly related to the meeting.

In the frenzy of preparing a presentation a presenter may fail to realize that the presentation is an opportunity to advance their research. Thus, the main purpose of the presentation for many presenters may at times be to get it over with as quickly as possible. Yet, when this happens it is an opportunity lost, as this was an occasion to get help as the presenter helps others learn. One possibility is to encourage those present to consider problems encountered by the researcher by saying: "*Here is something that I've been struggling with. Do you have any suggestions?*" Similarly, it may be encouraging to those who aren't initiated in the mysteries of a particular experimental method or instrumentation to stop and say: "*Would anyone like me to discuss why we are using this experimental approach?*" or to help those in the audience who don't want to interrupt the flow of the presentation to say: "*Are there any questions*?" It is helpful to give the participants some time to respond along with these opportunities as it often takes a bit of time to formulate responses. Similarly, participants at remote locations need to offer feedback to let the presenters know when they are lost, cannot see important details on the screen or would like a more detailed explanation.

In some sense, these practices are simple and intuitive, making them relatively easy to implement. However, they were not self evident at the beginning. As a center, we had no common experiences with video conferencing, and we first applied our standard, face-to-face meeting practices in video conference situations. This was not necessarily effective because the constraints of video conferencing differ from those in face-to-face meetings. We needed to experience and learn about these constraints to find ways to modify our practices to better cope with them.

2.6 Evolution and Dissemination of Practices

Initially video conferencing was met with reluctance from some center members and technical staff because it required people to do familiar things differently and the social and technical infrastructure was in a beginning stage of development. As one member reported:

> *Early on I thought [the group team video conference] was a complete waste of time.*

An important thing to realize is that problems of transition from the one site to multi-site video presentation can be overcome and the benefits of broader participation realized. However, participants should invest some time to notice what does not work or what is not happening and use what is not working to suggest alternatives. Participants were encouraged to reflect and offer constructive feedback.

The video conference meetings are a particular kind of communicative event (Saville-Troike, 1989). Among the center's communication structures, it is a vehicle for bringing together people with a broad common interest in one of the thrust areas to share, learn, raise problems, offer solutions, and perhaps achieve other as yet undetermined outcomes. If what is happening is not what the administrators, presenters or other participants wish to happen, it is within their power to raise that as an issue and seek solutions. For example, when discussing ways to utilize video conferences in the future a student commented:

> *Maybe I can discuss my [research] problems through the video conferences if I encounter any.*

Changes to group practices need to be discussed with all participants. We have done this using multiple methods, including presentations and discussions at meetings, publication of group practices on the center's web site, the inclusion of "tips" in announcements of meetings, and training sessions to illustrate and teach the use of video conferencing technology. Center management also took a lead role in facilitating the adoption of these practices by consistently using these practices in meetings and encouraged others to do so.

Overall, there is a need to avoid letting video conference technology get in the way of what needs to happen for both the purposes of the participants and center in general. A

well-organized and managed meeting can be effective despite the technology; however, technology cannot make a poorly managed meeting better. The videoconferences can be whatever the participants wish them to be, but only with reflection and constructive action.

3. Technical Infrastructure

3.1. Technical Setting

Each university participating in the center has video conferencing facilities that were established to primarily support distance education programs. Each facility is maintained and operated by a combination of full-time staff and part-time (student) staff, and there is variation with respect to technical capabilities between the facilities. The staff are trained to support distance education courses that primarily use a lecture-based format and are broadcast to locations within the university's state.

Three of the four universities, located in the same state, participate in a state-wide educational video conference communications network. The network is centrally controlled/operated, and uses proprietary analog technology to provide video and audio links among universities (and community colleges and high schools) in the state. As a result, most video conference technical staff at the universities in this state primarily interact with the centralized staff.

We decided to take advantage of existing university video conferencing facilities, and work with the video conference technical staff to purchase additional video conferencing equipment and establish new operational practices to enhance the technical quality of video conferences. In this way, we leveraged our funding dollars, and provided some benefits to everyone who uses video conference facilities at the participating universities.

Patience and persistence were sometimes required in working through administrative procedures that were originally established to support distance education courses broadcast from a single university location. For example, at several of the participating universities, courses are given priority in scheduling the use of large video conference rooms, and the course schedules are often planned 3 to 5 years in advance. A workaround involved establishing one and no credit courses for the weekly group team meetings and to schedule as many of these weekly meetings in advance as possible. Of course, each university has it owns scheduling process. Coordinating scheduling across four universities is not necessarily a trivial matter.

An alternative approach includes establishing and maintaining separate, independent video conference facility at each university. This approach will provide more control over the design and use of the video conference facility. However, establishing and maintaining an independent facility will typically cost more in terms of equipment purchases and ongoing operating expenses. In addition, unless there are sufficient funds to staff technical support personnel at each location, quality, customized and advanced

video conference capabilities that currently require more than turning on a switch to operate could not be supported.

3.2 Video Conference Room Layout

Figure 2 illustrates a physical layout typical of many of our video conference rooms. This layout was developed in collaboration with university video conference technical staff and has some commonality with the video conference layout developed at Argonne National Labs (Childers, Disz, Olson, Papka, Stevens & Udeshi, 2000). To provide a maximum view of participants, two large screens are used. At one location these screens are 120" large (along the diagonal) and are wall mounted. To reduce noise, the LCD display projectors for these screens are ceiling-mounted. Typically, one screen has a quad-split screen display that shows three of the remote locations. The other screen is a large display of another location; each location is periodically displayed, however, when the presenter is at a remote location, typically more time is devoted to show the presenter and the presented materials.

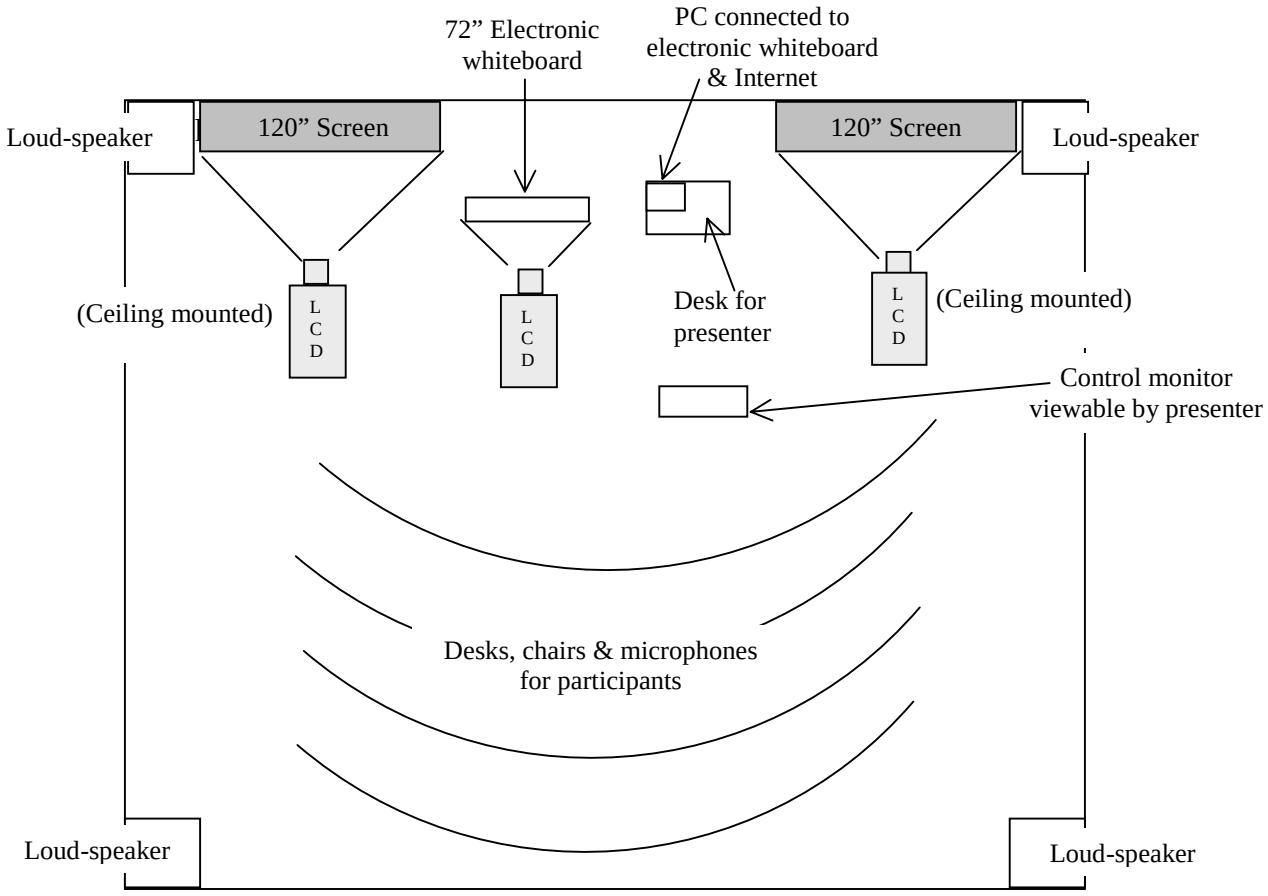

Figure 2. Example of a Video Conference Room Physical Layout

In addition to these large screen displays, a large touch-sensitive electronic whiteboard is used to display the presenter's slides. The presenter, and anyone in the audience at any location, can write on their local electronic whiteboard and the result is transmitted to all locations (see Figure 3.) This allows participants to highlight aspects of their slides, create notes in real time, and to save these notes for later reference. Our locations use a SmartBoard from Smart Technologies and an LCD projector connected to a personal computer (PC) to provide this capability. Alternative technologies include rear projection systems that eliminate projector shadows and plasma displays that operate more quietly than projectors. We currently do not use rear projection systems due to cost and space constraints, and we do not use plasma displays due to current size limitations of the technology. An overview of additional video conferencing room layouts and technology options can be found at the NSF Center for Biological Timing website at http://www.cbt.virginia.edu/videoconf/videoconf.htm.

Figure 3. A student using an electronic whiteboard during a video conference

Two to four speakers strategically placed around the room broadcast sound. Each presenter uses a wireless microphone, and microphones to capture comments from the audience are typically installed on every other desk. The microphones on the desk are always on, and sometimes unintended whispers and sounds from paper shuffling are broadcast.

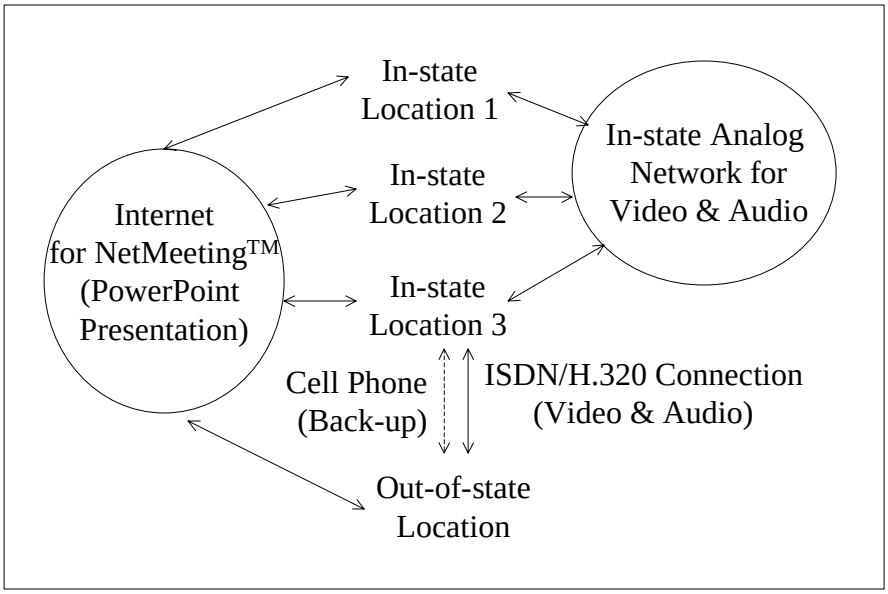

Figure 4. Current Telecommunications Network Configuration

3.3 Telecommunications Infrastructure

Several network communications technologies are used to support the video conferences (see Figure 4.) As previously mentioned, a centralized state-wide video conference network is used among three locations. This network uses proprietary analog microwave technology. The fourth university (in a different state) uses ISDN video conference communications technology. This ISDN signal is transmitted to one of the three universities in the same state and is broadcast to the other two in-state universities from that university.

The audio signal is sent together with the video signal over these networks. This does not always work well; audio quality can be poor and audio can be lost completely. As research has indicated (e.g., Olson, Olson, & Meader, 1995; Patrick, 1999), audio quality is typically more important than video quality so poor quality or no audio is not conducive to effective meetings. We have been working with video conference staff to resolve this problem. An ISDN conference phone has been purchased in an effort to upgrade audio quality, and cellular/digital phones with speakers have also been purchased to provide auxiliary audio capabilities when needed. A detailed discussion of additional telecommunications network configurations to support video conferencing, including desktop video conferencing, can be found at the Center for Advanced Video Network Engineering and Research website at http://www.cavner.org.

Most presentations during meetings use PowerPoint slides running on a PC connected to an electronic whiteboard and the Internet. This allows a Microsoft NetMeeting session

to be established among the PCs at all locations. PowerPoint (and other applications as needed) are executed within this NetMeeting session. Access is controlled by IP addresses, i.e., only computers with the pre-specified IP addresses can participate in the NetMeeting session. Previously the PowerPoint display was first processed through a scan converter and then broadcast over the video network described above. However, the (NTSC) video picture resolution is only 525 lines, or 500 x 400 pixels, and this low resolution is problematic in large rooms. We achieve a higher resolution using NetMeeting over the Internet. Transmission delays due to Internet traffic variability have not as yet been a problem because we are only broadcasting slides that do not change frequently.

3.4 Technical Operations

As mentioned previously, we collaborate with each university's video conference technical staff. From the onset, we were asking them to work with each other and us, doing new things to make video conference meetings successful. This requires "buy-in" from technical staff at every location. A common pitfall to avoid is the attitude: "You're not from my department, I'm just doing you a favor letting you use my video conference room." Specifically we asked the technical staff, in some instances for the first time, to manage multiple types of audio and video signals, provide and maintain high quality audio and video among all locations throughout the entire meeting, dynamically operate cameras, and add or upgrade technology in their video conference rooms.

3.4.1 Multiple Types of Signals

In most distance education courses, the outgoing broadcast is typically a view of the instructor and their teaching materials, and the one incoming broadcast is typically a panoramic view of the remote classroom. Thus typically technical staff only need to manage one incoming video and audio signal, and the camera operation is primarily a "point and focus" task with occasional monitoring. Our needs required that they manage multiple incoming video and audio signals to allow each other location to see and hear the remote locations.

Furthermore, in our setting most distance education courses are in-state courses that utilize the centralized network. A single protocol and standard operating procedures are used throughout the network. Our center video conferences required the addition of a new network connection with a different telecommunications protocol. This required new equipment and introduced more complex operating procedures. For example, some equipment had to be re-positioned so that an operator could effectively reach the new combination of switches in the time allotted when managing a video conference.

3.4.2 High Quality N-way Audio and Video

"High quality" in our setting is defined by low latency, clear n-way audio among all locations, and "reasonable" n-way video among all locations. Both audio and video should persist throughout the duration of the video conference.

As other studies have illustrated (e.g., Olson, Olson, & Meader, 1995; Patrick, 1999), audio is more important than video for effective interaction during most meetings. Individuals can, for the most part, compensate for lack of video if audio is available, however, video can not make up for the lack of audio. Furthermore, we require high quality video throughout the duration of the meeting because participants at any time from any location may wish to ask a question or make a comment. Audio quality has been problematic. As one member reported:

> *We had a lot of problems with the sound…if that were a little smoother it would be nicer.*

To address this, technical staff now does a sound check with no one in the room 10 minutes before each video conference. This check helps to identify and resolve any problems. Because many of our sound problems occur with the ISDN connection, we will begin using a ISDN video conference phone and have a cellular phone as a backup at the location connected via ISDN.

3.4.3 Dynamic Camera Operation

To facilitate interaction among participants irrespective of their location, we would like all meeting participants to be able to see whoever is talking as much as possible. For example, if Sue is presenting at one location and Bill asks a question at that same location, the outgoing video should show Sue when she is speaking and switch to Bill when he is speaking. This requires constant active camera operation (or sound-activated camera control) throughout the video conference. This was not a standard operating procedure when we began video conferencing. It is generally common practice for technical staff to set up a camera with a wide shot of the audience, do a microphone check and then leave the scene completely. This has disastrous effects for spontaneous, interactive discussions.

Interestingly, the etiquette practice of speakers identifying themselves and their location helps technical staff to provide this capability. Those short preferences alert staff to the need to change the camera view and give them a few extra seconds to accomplish the task.

3.4.4 Equipment Modifications

As discussed previously, each university had video conference facilities before the center was established. We have worked and continue to work with the technical staff that manage and operated these studios to upgrade and provide new equipment that can facilitate our video conferences and be used in other video conferences that take place in these studios, creating a win-win situation. These upgrades and new equipment purchases have ranged in scope from upgrading PCs to support current versions of NetMeeting and PowerPoint to buying and installing SmartBoards and LCD projectors.

Several universities have also "matched" these purchases, providing additional components needed such as 120" screens.

4. Conclusion

Facilitating collaboration among a large, geographically-dispersed group whose members may not have met previously and whose membership changes is a complex challenge. The NSF STC for Environmentally Solvents and Processes approached this challenge investigating and implementing both social and organizational practices and technology, with an initial focus on large group, interactive video conferencing. Our work has been evolutionary and collaborative in nature. Social and organizational practices or infrastructure, such as the role of a facilitator during a video conference, use of visual aids, and participant etiquette, have evolved with insights from the literature and reflection on our experiences. Providing effective, interactive video conferences among multiple sites has also required the implementation of different technologies and, perhaps more importantly, the evolution of new technical operation practices, including active camera operation and high quality n-way video and audio.

The STC has one full time technical staff member who spends approximately 60% of his effort working with university technical staff to develop and coordinate the technical infrastructure and working with social scientists and center members to implement social infrastructure practices. The social scientists (two faculty members and one postdoctoral fellow) observe meetings and interview participants to suggest new practices with respect to video conferencing, in addition to conducting other action research initiatives in the center. Costs to upgrade university video conference rooms have ranged from several hundred dollars to $15,000. Our universities do not charge the center for use of video conference facilities when the in-state network is used or when the video conference is part of a course as in the case of the center's weekly group meetings. Otherwise, the cost for an ISDN connection ranges from $50 to $75 per hour; however, this type of charge can vary widely between telecommunications companies.

Future efforts include investigating strategies to help make the weekly group video conference meetings less formal. Students have reported they feel their talks at these meetings must be well rehearsed and thought out. Others have reported that they feel uncomfortable asking tough questions because they do not want to embarrass the presenter. Additional exposure and use of the technology may help reduce these perceptions of formality, however, this alone may be insufficient. One strategy is to have key faculty (i.e., recognized experts) present work in progress and have colleagues constructively criticize their work. This may show by example that informal discussions are appropriate in this venue. Another strategy includes having time allocated during the weekly video conference meetings for individuals and groups of individuals to discuss topics. For example, faculty and students interested in a particular type of instrumentation could use this time to share recent experiences and ask for advice. These types of informal information exchange require trust among participants and furthermore that trust must in large be part created and maintained using technology not previously used.

Future technical efforts include streaming the meetings over the Internet to allow interested individuals at corporations and national labs to participate in some video conferences from their desktop. To achieve this several challenges exist. For example, security practices must be implemented to restrict viewing to designated individuals, and full screen video viewing on PCs is required for slides and other details to be easily seen. In addition, telephone calls from each individual at a remote corporation or lab would have to be patched into, or merged with, the video conference audio to enable those individuals to interact during meetings.

We also plan to conduct an evaluation of the video conference meetings. Ideally, the evaluation will be an ongoing or period activity that will help guide the evolution of our social and technical infrastructure. Examples of questions to ask in the evaluation include:

> What impact, if any, have the videoconference group meetings had directly on you, your research work/your academic progress/your learning/your research team/the center?
>
> Do you see ways that the videoconferences might better support, or facilitate, your research [or studies] -- and the aims of the center?
>
> How do the videoconferences compare with other approaches to sharing information among group members?

We have received requests to extend the video conference capabilities to include additional locations, such as funding agencies, corporate sponsors, national labs and universities whose scientists collaborate with center members. We envision that technical and social challenges will continue to emerge throughout this expansion effort. For example, expectations regarding participant etiquette may need to be shared with first-time participants who, in turn, may suggest new practices.

In summary, many challenges emerge when facilitating collaboration among a large, geographically-dispersed group. Reflecting on and learning from our experiences and sharing that learning is one way to advance our understanding of these complex challenges. These new practices have enhanced the effectiveness of video conferencing, leading to its adoption within the center and enabling frequent and needs-based meetings across distances.

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Appendix A
Example of an E-Mail Message Announcing a Weekly Group Video Conference Meeting

Subject: Invitation Area D Meeting – 11/9/00
To: [All Center Members]

Meeting 11/09/00 Area D Meeting
Thursday November 9th, 2000, 9:30 - 11:30am (room at Univ-D: A-Hall room 332)

Preamble:
a. The schedules for 2001 group meetings and management meetings are now online! Go to [url].

b. If you have after the meeting any question to the presenter, use our WebBoard at: [url]. If you do not have a password or username, let me know at [email address]. Don't send email to the presenters!

c. Jackie Smith, State Univ, Area D Leader will moderate the group meeting.

Presenters:
[First Presentation: presenter's name, university and title of their talk]

[Second Presentation: presenter's name, university and title of their talk]

[Third Presentation: presenter's name, university and title of their talk]

Remember: This meeting starts at 9:30am ET

Have a good week - Jackie

Some pointers to improve the quality of our video conferences:
a. Font size for PowerPoint presentation: at least 28 pixel or more (download our PowerPoint template at: [url]).

b. Format: Just Landscape never Portrait (screen is in landscape format)

c. Black text on a white background is not an effective color scheme as a dark background with light text. A dark blue background with yellow header and white text is a color scheme that provides better visual clarity,
especially on a TV monitor, than black and white.

d. Sound problem: If you notice a sound problem, please report it immediately by saying your location first and then the location with the sound problem (e.g. "this is State, we can't hear NC"), not just "Tom, we can't hear you ..." this way the video technician doesn't have to first search and discover which location has the problem with whom.

e. Questions: Please start any question by first saying your name and location, e.g. "This is Eric from State."

f. Presenter: Place the microphone exactly in the middle and as high as possible of your shirt (very important).

g. For more suggestions: see [url].