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# An Overview of the Design and Technical Aspects of Teleconferencing

**Chris Acton**  
**Educational Communications and Technology**  
**University of Saskatchewan**

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"The concept of distance education is that there can be effective learning environments other than the traditional classroom."  
(Lochte, 1993)

## Introduction

Compressed video and one way satellite teleconferencing are two of numerous delivery systems used in distance education. The current educational climate seems to be one of access, borne from the development of communication technologies. Compressed video conferencing consists of technologies including a codec (coder-decoder), cameras, audio, and often multiple media inputs. The University of Saskatchewan's television studios and broadcast capabilities are used in this paper as an example of one way satellite conferencing.

Technological aspects of teleconferencing need to be addressed when trying to maximise learning. This paper will cover, technical constraints, advantages of using teleconferencing, instructional design, evaluation procedures, effective research and the future of teleconferencing.

The late 1950's and 1960's saw extensive research in instructional principles that were applied when using television for interaction in the classroom. It is interesting to note that similar instructional principles developed and used nearly 4 decades ago are still practised in today's learning environments. Technological advancements in this area have certainly superseded the actual level of use in the classroom. For example, television production techniques developed in the 1960's are still employed in classrooms today.

This research addressed such instructional design elements as questions, pauses, eye contact with the camera, lecture and discussions. These are also critical instructional design elements used in teleconferencing today. For the ease of reading, this document has been divided into sections dealing with each of the previously mentioned components. The paper concludes by taking a look at the possible future regarding the technological aspect of teleconferencing; that being the advent of digital technology.

"Test results showed that students did significantly better when they viewed the lessons that demonstrated planned visual continuity, contained visual reinforcement, and had been the result of a team approach to make effective use of the television medium."

(Chu and Schramm, 1967)

## Compressed Video Teleconferencing

Teleconferencing is most often employed utilising compressed digital video. This form of teleconferencing transmits video and audio simultaneously over Integrated Services Digital Network (ISDN) telephone lines. This delivery method allows for two-way video and audio interaction. The quality of video is determined by how much a given educational institution wants to pay for long distance charges. Using one telephone line is the least expensive method, but transmits the poorest quality video. Three lines are expensive, however, this increases the quality of the transmitted video. There is rarely a concern regarding the quality of audio transmission as it is nearly always strong. The context of the instruction is another determining factor when deciding on the quality of the video transmission. For instance, if the session was on small engine repair that requires a clear video signal, three ISDN lines would be desired. However, an English class would not require top notch video and one ISDN line would probably suffice. Compressed video conferencing is a relatively inexpensive option for educators since no special production studios are required. It can include multiple media inputs so long as they can be converted into a video signal. When using multiple inputs, switching to the sources can become confusing and frustrating for the instructor. An audio video switcher with an external operator is a good way of making sure that the correct image and audio are being transmitted. This does increase the cost of teleconferencing. However, if a technician is required to be present throughout the transmission he/she could be trained to operate the audio/video switcher. My experience with multiple input teleconferencing over ISDN lines has shown me that a video switcher operator who is adept at anticipating the needs of the instructor can prove extremely effective. This frees the instructor from technological constraints and allows him/her to focus purely on instruction. This can also help to minimise, or cause the seamless appearance of, the existence of the technology. This is particularly necessary when the instructor has a class or group at the host site. However, the instructor must pay special attention to not disregard the students at the remote sites. This is more of a design element that is discussed and described later in the this paper. Despite the advantages of using an operator, most compressed video users in education limit the multimedia inputs so it can easily be controlled by the instructor.

Compressed video, if required, can allow the host site to control the camera and audio at the remote locations using a control touch pad. The remote site camera can be preset to show a medium close-up of each of the students at the remote site. This eliminates the need for a technician at the remote sites as any teacher or janitor can turn the system on. However, if any technical problems occur before or during transmission, the remote site may miss the session. Because of this uncertainty, many teleconferencing sessions ensure that a technician is present.

Touch operated microphones seem to be the best option for controlling the audio flow. Using this system soon becomes habit for the participants. Vermont Interactive Television, (VIT) integrated voice activated switching into their system. This allows the video source to be automatically selected in accordance to the highest audio level. If used militantly the system can work well with the touch microphones. This induces a smooth conversational flow to the session. However, human error can break up continuity. As examples, if a participant leaves the microphone on and taps the table, or if the instructor was to start coughing into their microphone, the video signal switches to those accidental audio sources. The flow is soon disrupted and VIT quickly determined that this became frustrating and confusing for the instructor and learners. Compressed video can have some technological constraints such as a one second audio delay which occurs because of the time it takes for information to compress, travel, and decompress. (Gottschalk, 1995). Reed and Woodruff, noted that this can be remedied by:

- finishing statements with a conclusion,
- avoiding interruptions, and
- using visual clues such as nodding to affirm.

Video constraints are most common when dealing with motion because so much information is being processed every time movement occurs. This problem decreases if several ISDN lines are used. The instructor must consider this when designing a teleconferencing session so that the problem is not excentuated. Image break up, ghosting or image softness occurs with high visual information flux. The decreased frame rate, or number of video images per second, can be compensated for by avoiding rapid motion, wearing plain TV friendly colours, and hanging a pastel curtain, or using a plain background. The codec is used to convert analog signals into digital signals for both transmission and relieving. Codecs, like most other communications technologies, are decreasing in price. Therefore, compressed video teleconferencing a viable option for all educational institutions interested in

distance education.

## Satellite Teleconferencing

Communication satellites used for video conferencing are primarily the geostationary type. Satellite broadcasts accommodate full motion video at 30 frames per second NTSC. The Saskatchewan Communications Network (SCN) transmits both broadcast signal and narrowcast signals. Narrowcasting means reaching specific sites that have paid to receive the signal. This is the method used in SCN's satellite teleconferencing programs. The two second time delay of the signal experienced with satellite narrowcasts can disrupt interaction. When a student is interacting with the instructor via telephone, the delay of the signal can cause one person to speak too soon and the result is an overlapping of conversation. To rectify this, pausing slightly at the end of each conversation allows for the delay.

Satellite technology is expensive and requires numerous technicians and operators to oversee production. It seems that satellite technology will soon be matched with full motion video by other teleconferencing mediums. However, its ability to reach remote locations without "piped" communication lines is where some experts believe its future lies. Richard Gustin, (1997) acknowledged that the face of satellite technology in Saskatchewan will change to fit the needs of the learner. "What we need is bandwidth. Where is the pipe that gives us more bandwidth particularly in the north and into rural areas? We have some microwave through the air. In the meantime, we can do a great deal with satellite and I think it will be here for many years to come -- especially in an environment like Saskatchewan where you have a very diverse population, often in a geographically hostile environment." (Personal communication, December 8, 1997)

Currently the cost of laying ground connections to remote locations is less cost effective than the cost of relieving a satellite transmission.

Satellite teleconferencing is an excellent means of causing the technology to appear transparent and seamless because the video switching is done by the producer. In some instances, the instructor may have to control some elements such as a document camera or computer assisted presentation materials. One limitation of satellite conferencing is that the time allocated for the course must adhere to the session because the next time slot on the satellite feed is likely booked for another transmission.

Satellite technology is a massive financial burden for educational institutions and is often supported by multiple funding organisations. Also, the nature of the delivery leans towards areas with a geographically disperse population. Often, these sparsely populated areas can not secure the necessary finances on their own.

Satellite conferencing is maximised when supported by broadcast quality cameras, switching equipment and, most importantly, tapes for roll-ins and recording. Roll-ins are defined a videotape used for playback purposes.

High resolution for visual clarity is ensured when using broadcast quality production facilities. This standard is especially important for recording purposes. The high resolution video also ensures that VHS copies of the session are acceptable by learners. This way, a student who missed a class can view the tape without any difficulty and at his or her leisure. One large cost saving aspect to high resolution recording is the ability to rebroadcast the sessions. If any changes need to be made to the tape, for instance updating factual information, they can be edited in or out. This rebroadcast procedure is sometimes used when establishing long range budgeting plans for a teleconferencing course. The initial year of instruction will be expensive. However, by rebroadcasting in succeeding years from tape, little studio expense is incurred, fewer technicians are involved, and the instructor does not spent as much time instructing and preparing. Rebroadcast from tape limits interactivity during the presentation of materials. To ensure the interactive component of the session, most instructors include an interactive period after the session has concluded.

## Instructional Design Phase

Teleconferencing requires considerable preparation to ensure smooth delivery and maximum effectiveness of

instruction. The instructor can often be overwhelmed by the existence of the technologies. Teleconferencing is different than regular classroom instruction and the instructor must take necessary measures to accommodate for the technology.

Utilising the visual element of teleconferencing, instructors can effectively demonstrate new environments to the learner. Garland and Loranger stated that visual aids help instructional design. "With both the instructors' and the adult students use of the podium video presenter, videotapes, slides, and the computer interface technology, more innovative and engaging teaching techniques can occur" (Garland and Loranger, 1995-96, p. 251). In the classroom, a teacher may have to spend time locating audio visual aids. The technology for the teleconferencing instructor should be readily available. One example of a visual aid is the document camera. It can image slides, transparencies and work as an electronic blackboard. Visual aids such as computer presentation programs need to follow several basic design rules. These rules ensure that the learner will clearly see the presentation. For example, using large font size and "TV friendly" colours, will increase the clarity of the presentation for the learners. There are many more techniques that will ensure this quality, however, the type of technology used is the determining factor in the selection of these techniques. In other words, some design elements must be used specifically in conjunction with the technological system used for teleconferencing. Body language also increases the clarity of the communication and being able to see the other participants is an advantage of compressed video over satellite conferencing.

The instructor must ensure that his/her eye contact is focused on the camera lens. This is especially relevant when an instructor also has students at the host site. Many instructors either forget about, or do not realise, that eye contact with the lens includes the students at the remote sites and increases the effectiveness of their instruction. Increased eye contact provides the students with a more subjective rather than objective experience; the experience becomes more personalised.

"Computer animation can assist in focusing learner attention on changes to important elements and when highlighting topics" (Wetzel, Radthe and Stern, 1996, p206). It is important to avoid detailed backgrounds and any unnecessary razzamatazz that may dazzle the learner. My experience as both a technician and learner have shown me that computer animation is particularly effective in situations where flow or development needs to be visually demonstrated. Showing how air currents flow through a home cooling system, for example, would be an appropriate time to use computer animation. Some studies argue that over visualisation of processes limits a person's intellectual capacity to visualise. It is argued that it is too passive. This becomes a pedagogical decision for the instructor.

Good visual presentation practices used by instructors are the same types of principles that should be used for video roll-ins. Why carefully plan an interactive, engaging lesson only to roll-in a talking head on video for 30 minutes? Roll-ins should enhance what the instructor is trying to emphasise. The technologies in both compressed video and satellite conferencing often encourage the instructor to control the video roll-ins. The instructor can interrupt the program and create discussion around the topic. This style of VCR use is often referred to as actively viewed video. "It can serve as an inexpensive tool that teachers can use to select portions of programs, replay them, and bring the thinking procedures of the students into the viewing experience" (Chen and Marsh, 1998). Again, the instructor must decide which medium is the most effective for presentation of materials and also fits into their budget.

Video allows content experts to provide specific information to the learners. By having the technology available in the teleconferencing classroom, instructors are more likely to take advantage of content experts and pertinent video. This is certainly a benefit of teleconferencing technology. The content expert, in both compressed video and satellite teleconferencing, could also be included in the sessions via compressed video; live shots from the host site or by telephone. "For example the technology will enable students and faculty to interact with guest experts from around the world without having them physically present in the classroom" (Teleconferencing, linking Lafayette and Lehigh, 1998).

As stated earlier, distance learning is enhanced by interactivity. The telephone is certainly the quickest way to achieve interactivity. Electronic mail and facsimiles, though they may operate over telephone lines, do not allow for "real time" interactivity. This delay can be frustrating for learners. The most common complaint from teleconferencing students is the lack of personal communication. The instructor can accommodate for this by making sure that interactivity occurs. Interactivity is more difficult in satellite teleconferencing as only the phone

line is used for "real time" interactivity. "If used passively- instructional effectiveness can be limited" (Gottschalk, Guide #5, 1998.) In comparison, compressed video can function interactively just like a regular classroom.

Satellite conferencing is comparable to television. This can make changing peoples "ingrained" viewing habits a difficult task. Quality video, slick graphics and the quick pace of television keeps viewers engaged. It is extremely difficult and costly to attempt to mimic these television production techniques with educational teleconferencing. Viewers ability to tune out and passively watch television makes the transition of using satellite teleconferencing for education a difficult one, particularly when viewers are required to become participants.

"Frequent interaction increases understanding and encourages more personalised instruction" (Reed and Woodruff, 1998). Interactive teaching strategies will help motivate learners by making them active participants. Reed and Woodruff, 1998 ascertained that assigning a pre-session activity or starting the lesson with a discussion are two ways to encourage conversation. "Teachers using two way video must challenge basic learner preconceptions and set new expectations to maximise learning"

(Reed and Woodruff, 1998). They also noted that, on the bright side, good teleconferencing instructional strategies are also good classroom strategies and therefore serve dual purposes.

Advance preparation of instructional materials and good instructional design in teleconferencing are particularly important because video tends to amplify problems. Instruction and learning are enhanced and more natural when the session goes smoothly and soon the technology becomes less intrusive. (Farhad, 1997)

Instructors who are accustomed to physically pacing while teaching must learn to minimise their movements. Using compressed video the signal is delayed and movements made by the instructor will appear choppy and interfere with the learning. In satellite teleconferencing it is necessary for the camera to follow presenter, however, this may cause students at the remote sites to feel a little sea sick.

Some teleconferencing sites allow users to share computer applications, with several sites seeing and editing a document simultaneously. Feedback is in "real time" and greatly enhances collaboration on projects.

Variety in instructional strategies and planned breaks are other effective instructional design elements that, when used correctly, engage the learners. Focusing attention away from the television monitor and assigning group activities breaks up the session. This allows the learners to focus their attention away from the monitor and return refreshed when instruction resumes. Taking short breaks throughout the session allows students to relax, stretch and talk . "The educational value of techniques encouraging learner involvement and participation has clearly been shown in a long history of film and television research." and "by promoting overt behaviours, such as responding aloud to questions posed in a program ITV shatters the myth of cognitive passivity" (Chen and Marsh, 1998). Questioning is a particularly effective method for encouraging interaction. However, the questions should elicit correct answers for optimal learning" (Wetzel, Radthe and Stern, 1994, p203).

"Advances in technology facilitate students' roles as presenters, discussants and active learners in a multi media classroom environment"

(Garland and Laranger, 1995-96, p. 251). Learning how to use the technologies available in teleconferencing can be a learning experience in itself. In our current high technological climate, exposing learners to new presentation methods and feeling comfortable around technology are valuable skills.

## Evaluation of Teleconferencing

Because teleconferencing is a relatively new addition to education, evaluation is an important procedure to rectify problems and build on its advantages. Saskatchewan Education (1984) uses a model for curriculum development that includes evaluation as one of the four components in the model. Even though evaluation is the fourth and final component in this model, evaluation is threaded throughout the entire development process. I believe this is a necessary step to consider when working in the field of distance education. Not only does evaluation allow for a measurement of this field's successes and shortcomings, but it also provides the necessary accountability required for the funding of endeavours of this type.

Typical Lickert scale questions asked when evaluating a teleconferencing session include:

- Material was more effectively presented than in non - ITV courses.
- The professor was competent in the use of ITV technology

Without the ITV technology students would have limited access to courses" (Garland and Loranger, 1995-96, p. 255) As new technologies are developed and put into practise teleconferencing will continue to redefine its position in education. Evaluation is an nessecary component in monitoring it's position.

## Research into the Effectiveness of Teleconferencing

Research into the effectiveness of teleconferencing in education has generally shown that learners prefer the regular classroom setting. However, they felt that teleconferencing was an excellent alternative. This is particularly true when it provides a means for getting the courses they need.

Garland and Langer, in a study of adult learners conducted at the University of New Hampshire found that "adult students have generally positive attitudes toward their ITV classes. Essential to the success of distance education programs which use ITV in the training of both professors and students who will be involved in this emerging technology" (Garland and Laranger, 1995-96, p. 253). The study found that almost three quarters of the students evaluated, rated their teleconference course in the "excellent" range. The study also found that a slim majority of students preferred the traditional classroom setting. Approximately 30% of the students "strongly disagreed" that "presentation methods, discussions, student technical skills and cohesiveness amongst students were made more effective in the ITV classroom" (p. 256).

A positive learner comment from the Garland/Laranger study was that "it saves students travel, the university from duplication of courses at various sites, (and it provides) an interaction of ides from various regions" (p. 254).

## The Digital Future of Teleconferencing

The new language for compressed video and satellite teleconferencing is digital technology. It is important to understand the implications of this technological advancement as it effects not only the technical elements of teleconferencing, but also some aspects of instructional design. Digital technology has dramatically increased the amount of information that can be sent through delivery networks while increasing smoothness and quality of the video signal.

The current digital language is based on binary digits (bits) developed by computer scientists who needed to process information that was both accurate and fast. The binary code is expressed as information in zeros and ones. These bits are the "building blocks"for the coding unit called a "byte". A byte is a string of eight bits building a new language comparable to the alphabet. This language is the basis for most high quality high speed communication devices. "Back in the 1970's, long distance telephone transmission, started to move away from analog transmission and mechanical switching to digital technologies" (Ellis, 1992, p. 66-67).

Copper lines were first used for digital telephone transmissions, however, the implementation of fibre optic lines has increased bandwidth. The concern for teleconferencing now is the availability of bandwidth and the race is on for delivery networks to provide the train by which they can cry "all aboard".

The Canadian Cable Television Association (Ellis, 1992) predicts that by the year 2001 the unclaimed territory will be occupied. "Between the telephone industry (voice communication enhanced services) and the cable industry (broadcast, pay per view and specialty television) there exists a broad array of new services (the unclaimed territory) that can be distributed to in home and business users. These include information services and

enhanced entertainment services. As both the cable and telephone companies industries adopt newer technologies and add new services, the gap between them will shrink" (p. 194).

The mergence of delivery systems will provide many new options for distance education. As moving video images and interactivity become more commonly used, the access to educational courses and chances for interactivity seem limitless. One seemingly inevitable merge is that of computer platforms and television. "Todays technology allows networks to incorporate fibre optics, along with digital signal processing, switching and compression techniques. This merging of the technologies may result in the two sides "offering many of the same digital electronic services on a fee basis." (p.256)

## Conclusion

After looking at both mediums, it appears that interactivity is an essential part of distance education. This would suggest that compressed video is a more effective instructional medium over satellite conferencing. This will be considerably more relevant when bandwidth is increased in the near future. However, the location of learners, which fuels distance education, is the critical factor in determining which teleconferencing systems works best.

Compressed video and satellite teleconferencing are occasionally used in conjunction. Working to build networks which suit the learners' needs should provide adequate availability to educational programs. Teleconferencing enables more and more people to consider furthering their education. "Just in time training" is now common in the work place and can often be facilitated by teleconferencing.

Another advantage to teleconferencing is providing access to education for those who can not access it through the more traditional avenues.

"Interactive television will eventually provide easily accessible and affordable means of connecting classrooms with a faculty of education, promising to bring closer together educational theory, research and practice" (MacKinnon, 1995, p. 93).

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