Teaching with Internet and Multimedia Technologies:

Insights from an Online Seminar on Industrial Modernization

Philip Shapira and Jan Youtie

ABSTRACT

This article discusses experiences in teaching an online seminar course on industrial modernization that combined conventional and distance learning methods with Internet-based communications and other multimedia technologies. Four versions of the seminar course have been offered, with each round using different combinations of teaching methods and technologies. The article discusses the seminar's objectives, modes of teaching, technical design, operation, and student evaluations. The strengths, weaknesses, and requirements of online teaching are considered, and practical guidelines and insights are offered to faculty interested in developing such courses.

Philip Shapira is associate professor and director of graduate studies in the School of Public Policy at Georgia Institute of Technology, Atlanta; ps25@prism.gatech.edu.

Jan Youtie is a senior researcher with the Georgia Tech Economic Development Institute and an adjunct associate professor with the School of Public Policy at Georgia Institute of Technology in Atlanta; jan.youtie@edi.gatech.edu.

INTRODUCTION

The opportunities and challenges associated with using the Internet in teaching have come to the forefront of debate with the rapidly increased awareness and use of this technology in recent years. The Internet has its origins in decentralized networks of inter-connected computers linked together through data-transfer protocols to support military communications and advanced research. In the 1990s, this system was transformed into a global and publicly accessible network of government, education, and business computers. About 200 million people, over one-half of whom live in the United States, are now connected to the Internet.[1]

Most faculty and students at American universities and colleges are, by now, familiar in some way with the Internet. Indeed, leading U.S. universities pioneered the development of the Internet's predecessors, and are today in the forefront of building the next generation of Internet systems. Academic researchers commonly use the Internet for electronic mail (email) communication, electronic document transfer, or remote computer access. Similarly, the World Wide Web (or the "Web") has emerged as a significant Internet-based research tool for accessing and disseminating information. Increasingly, the Internet is also being used in teaching. A recent study finds email in use in 44 percent of U.S. college courses. Almost one quarter of all courses assigned Web pages for class materials and resources (Campus Computing Project 1998).

In addition to sending text-based messages, sharing files, or displaying Web pages, the Internet can broadcast audio and video content and support virtual electronic conferencing. For broadcasting, sound and moving images are sampled and compressed by software algorithms and then transmitted via Internet digital data streams. End-users

can thus hear and view Internet broadcasts in real time or on-demand, without waiting for large files to download. At present, Internet-based broadcasting and conferencing technologies are still in their infancy: quality and fidelity are poorer than conventional television, satellite, or cable broadcasts, while network congestion resulting from high Internet usage demand can hamper reliable reception. However, significant improvements in the performance, speed, and features of Internet broadcasting are anticipated in the near future.

The refinement of Internet-based broadcasting promises fundamental changes in how higher education is delivered to students. In the U.S., the part-time student population has doubled in the last two decades, full time students increased by nearly two-fifths over the same period, and 40 percent of American adults are reported to participate in education or training annually (Speer 1996). For educational administrators, the Internet offers new ways not only to meet this demand, but also to reach additional students (including students outside the United States). Numerous universities are adding Internet-based technologies to existing distance learning programs offered through videotape, CD-ROM, cable television, and microwave and satellite transmission.[2] Internet-based learning technologies are also being promoted for campus-based students, for instance by using the Internet to broadcast and retrieve multimedia course content. These trends are coupled, at an expanding set of institutions, with matriculation requirements for students to posses multimedia computers, and by new investments in campus computer networks and access points in classrooms and residences. At the same time, new competitors are emerging. Already, new virtual "cybercolleges", private vendors, and institutions outside the United States are expanding

their offerings of online distance courses.[3] By one estimate, in 2002 more than two million Americans will be taking at least one college course using the Internet (International Data Corporation, cited in Thornton 1999).

While the arrival of Internet technology generates new possibilities for educational institutions and businesses, it also raises a series of critical pedagogic, usability, and resource issues. For example, can Internet courses effectively involve students in remote locations, off-site from the traditional classroom? What are the equipment, software, skill, time, and financial requirements? What additional technical support is needed? How will teaching methods change in new networked learning environments less constrained by physical space and institutional boundaries? How can Internet-based courses be compared with traditional courses in terms of university credit and degree requirements? Will institutions, faculty, and students who do not - or cannot - embrace these new technologies be sidelined? And, most fundamentally, is student motivation, learning, and understanding actually improved by using new Internet and multimedia technologies?

Contrasting responses to the kinds of questions raised above are already apparent. In many ways, they are not entirely new questions. Over the last twenty years, other technologies applied to education, such as televised lectures to remote students, have stimulated similar debates. However, the rapid and pervasive spread of the Internet is generating a further, hotly contested round of controversy. Advocates of greater Internet use in teaching suggest that it can improve group-based instruction, as well as self-paced learning (Chute, Sayers, and Gardner 1998). The Internet can speed communication and information flows, and make courses more engaging by adding sound and video content

(Ellis 1997). It also offers the potential for virtual classrooms that reach geographically dispersed learning communities (Neal 1997). One university's vision is that thousands of future students will be able to "take courses and earn degrees free from time and space constraints" (Center for Distance Learning 1998).

Not all educators are as sanguine. Garson (1999) worries that the additional faculty time needed to develop online courses may reduce student mentoring. He also highlights the difficulty of meeting user expectations, negative impacts on academic quality and traditional scholarship, and issues raised by inequitable access to online opportunities. Other faculty and students voice concerns about the technological transformation of university education, the rise of 'Digital Diploma Mills', the severing of links between students and teachers, and the negative effects on student inquiry (Noble 1998; Winner 1998; Hara and Kling 1999).

In public policy and urban planning programs, the use of Internet tools in teaching has increased rapidly in recent years, especially for posting syllabi, resource links, discussion comments, and assignments on course home pages, for individual and group email interaction, and for Web-based research.[4] A handful of universities now offer online masters degrees in public policy (Stowers 1999), while several institutions offer distance learning courses on geographical information systems and other planning subjects. Nonetheless, it remains the case that few faculty members at conventional universities have so far attempted to use the broadcast and multimedia capabilities of the Internet in their courses. Even fewer faculty have offered a full Internet-based multimedia course in the fields of public policy and planning education. Significantly, the complex problems and multiple perspectives embodied in many policy and planning

issues present stringent challenges for new educational technologies. Interaction and dialogue are crucial. Technological approaches that simply impart information, transfer fixed solutions, or allow only one-way conversational flows are unlikely to foster the learning situations that policy and planning educators and students seek.

In this article, we discuss our experience in teaching an online seminar course in the policy and planning field of industrial modernization. Four versions of the seminar course have been offered, with each round using different combinations of conventional and distant learning methods, Internet-based broadcasting and other multimedia technologies. Nearly 50 in-class and distant students have taken the seminar, which has also involved in-class and remote experts. The course has been taught in a synchronous (live) mode, as well as in asynchronous modes that use replayable content modules. The online course described in this article was among the first to use Internet-based broadcasting capabilities at a leading technological university. Our budget was limited. But with good institutional support and a pragmatic approach to technology, we employed Internet-based technologies to offer an interactive environment that has motivated student learning. At the same time, our particular experience illustrates that using the Internet for teaching has drawbacks as well as benefits, including technical glitches and significantly increased time commitments from faculty and staff.

In following sections of the article, we discuss the objectives of the seminar on industrial modernization, its technical design and operation, methods and modes of teaching, and student evaluations. Single cases cannot be used to resolve the very fundamental questions that the rise of the Internet is now provoking about the interaction between technology and education. However, we hope that the insights and practical

experiences that we gained from offering the course will be useful to others considering the strengths and weaknesses of using Internet-based teaching technologies.

SEMINAR OBJECTIVES AND STRUCTURE

We developed our online seminar to provide students with an introduction to theories, practice, and debates related to industrial modernization and its linkages with technology and innovation policy, economic competitiveness, and regional economic development. The seminar builds on our research projects and networks in the industrial modernization field.[5] Through the seminar, students examine concepts of technology diffusion and explore the barriers and opportunities to the use of new technologies and operational methods in industry. The course also considers the rationale, development, and impacts of policy intervention in the modernization field. Attention is paid to best practices of industrial modernization programs in the United States and other countries, and to the evaluation of the performance and outcomes of these programs.

Students who took the course for academic credit were required to complete short electronic assignments based on course readings and seminar presentations, and to write and present a major seminar paper on a theme related to the course. Expectations for written assignments and papers were similar to those in conventional courses, with the provisos that papers were submitted electronically and could be shared with other participants. Active participation in class discussions, including online discussions, was required. For the first offering of the seminar, distant students were also registered as continuing education students. These participants did not receive academic credit but they were expected to regularly "attend" virtual seminars, read course materials, and

participate in class discussions. Distant students were able to receive continuing education credit, which could be counted towards professional continuing learning requirements.

ORGANIZATION AND TECHNICAL OPERATION OF THE FIRST SEMINAR

The first online seminar on industrial modernization was taught in the Spring Quarter of 1997. We sought to use the Internet's capabilities to offer a course through which regular full-time students could interact with distant participants and external experts. We anticipated that this would provide an enhanced learning environment to consider both the conceptual and practical issues involved in industrial modernization. Considerable organizational and technical challenges were presented by this approach, due to the live format and the fact that it was our first attempt to use the Internet to reach distant participants. This section of the article considers the development and operation of the initial seminar.

Seminar Development

Planning of the content and technical specifications of the online seminar began about six months beforehand. A live Internet course had not been run before on the campus. It was important that distant participants could take the course without buying special equipment or software. Additionally, we wanted distant participants to be able to take the course from their office or home using the Internet, without traveling to a fixed satellite broadcast downlink location that would be less convenient and more costly. Meetings were held with university computer and distance teaching specialists who

helped in defining facility, hardware and software requirements. Assistance was received from computer science department colleagues who were also experimenting with Internet teaching.

After testing competing streaming media products, we selected RealServer.[6] This encoding and server software allows users with the complementary RealPlayer to receive live (or recorded) audio and video broadcasts in an on-demand stream through the Internet. However, it was not practical to stream live video for reasons that included the limited Internet bandwidth available to users and the extra challenges involved in producing video broadcasts able to maintain the interest of distant participants.[7] Thus, we chose an audio-visual approach, integrating live voice transmission and the simultaneous display of slides with accompanying text and graphics. For feedback, distant participants could use either the telephone or an online chat room.

Small awards from the university's foundation and the Manufacturing Extension Partnership of the National Institute of Standards and Technology provided resources for a Web server, additional hardware, software, visiting seminar speakers, software, and limited staff support for Web design and course administration. No extra salary support or course release was received by the principal faculty instructor (the first-named author of this article). Additionally, considerable technical, staff, and facility support was provided by other university departments, particularly the university's distance learning center, without direct reimbursement. The university's distance learning center also supplied a multimedia classroom and installed additional classroom computers for live media streaming and chat room hosting.

Seminar Web Site and Student Enrollment

Prior to the start of the course, we created a Web site for the online seminar (see http://www.cherry.gatech.edu/sim).[8] This site contained a course description and outline, student requirements, and registration information. All required course readings plus many additional readings and links were posted to the Web site. Materials with copyright restrictions were posted to a password-protected area available only to registered students for their fair educational use. The site offered instructions on downloading required software and provided demonstration media files for participants to test their computer configurations. We posted announcements about the course at the university and to faculty colleagues, industrial modernization contacts, and economic development groups around the country. Most external announcements were emailed, on the theory that distant students should already have an Internet connection and use email as a pre-qualifying condition for taking the course.

The first seminar course was taken by 17 in-class students and by registered distance-learning participants at 18 locations in the United States. At some remote sites, more than one student participated in the course (other non-registered students also took some of the modules). The in-class students were drawn mostly from graduate students in public policy and city planning, with additional representation from management, history, and engineering. The distant participants included technology transfer professionals, industrial extension agents, economic developers, and graduate students from other universities. While all on-campus and off-campus participants had substantive interests in the course content, there was undoubtedly a greater then normal interest by course registrants in Internet-based learning. (This enthusiasm should be

remembered when reviewing evaluation results.) All students and distant participants had access to Internet-connected computers. Generally, in-class students were more experienced in computer use. More than half of the in-class students had previous experience with streaming audio software, compared with only one-fifth of distance participants. Over half of the in-class students were already using the Internet more than 10 hours a week for study or work.

While we were confident that we could offer a good seminar for the in-class students, the Internet-based distant learning element was admittedly experimental. We thus requested a largely nominal distant student enrollment fee ($49), which included a volume of readings and access to all course presentations, electronic materials, and to the faculty instructor. We offered a money-back guarantee if not satisfied, although no refund requests were made. (Revenue from distance learning students was used to offset the expenses of visiting speakers.) The university's distance learning office handled the enrollment of distant students and collected the course fee. Regular students enrolled in the normal way, through the university registrar. We had allowed for a third possibility: that students at other campuses within the state's university system could enroll for academic credit under existing exchange procedures. Although at least one student tried to do this, it turned out that the procedures were too complicated to implement in a timely way (this student took the course as an auditor.)

Technical Requirements

By design, the online seminar used available computer technologies with software that participants could obtain without additional expense. Students were required to have

an Internet-connected computer (Pentium 90 MHz or faster, or Macintosh equivalent) with a sound card (16-bit or better) and speakers (or headphones). A minimum modem dial-up speed of 28.8 kilobytes per second was recommended (many distant participants had faster office network connections).

Participants were required to have installed five types of software. (1) A Web browser, such as Netscape Navigator or Microsoft Explorer. (2) Email software able to receive electronic file attachments. (3) Adobe Acrobat Reader – a Web browser plug-in available by free download (see: http://www.adobe.com). This allowed users to click on course Web site links to open varied electronic documents posted in a standard format. (4) RealPlayer - the streaming media player needed to listen to live seminar presentations and discussions, and to replay recorded seminar modules. The software automatically configures as a browser plug-in and is downloadable without charge (see: http://www.real.com). (5) Internet chat software - to ask questions and to communicate with other participants during live seminar sessions. Unlike email, typed messages exchanged by chatting are displayed instantaneously to all those logged into the chat room, thus allowing rapid feedback. We used Internet Relay Chat (IRC) shareware, which offered multi-user, keyboard chat capabilities over different operating systems.[9]

The In-Class Seminar

The in-class seminar was held in a multimedia classroom operated by the university's distance learning center. Classroom facilities included fixed and mobile radio microphones, an overhead projector, a whiteboard, large-screen television monitors, speakers, telephone access, video cameras, and an Internet connected computer.

Separated by a glass window was a control room, equipped with two additional Internet-connected computers and facilities for sound, video, telephone call-in, mixing, and monitoring (Figure 1).

Before each live seminar, the faculty instructor posted a seminar program to the course Web site. This contained an outline of discussion topics for the class, speaker presentations, papers, and biographies, links to slides and reading materials, and a time-line for each session. We aimed to avoid over-long presentations and dead time with nothing being broadcast, and to maximize the time available for participant discussion. For most classes, we also pre-arranged for in-class and distant discussants to comment immediately after each presentation (after which open discussion was encouraged). Photographs of speakers, in-class student presenters, and the seminar room were posted to the program page on the Web.

The physical meeting of the seminar was held once a week, as a three-hour class for in-class students. For the first half-hour of each class, in-class students presented and discussed short assignments based on their prior readings. This was followed by the main session of the class, lasting for about two hours, during which instructors and invited experts gave presentations, discussed case studies, and participated in discussion. More than 25 prominent national and international guest lecturers participated in seminar sessions. Some of these guest speakers were physically in the class. Others participated from remote locations by telephone. Included among the remote guest speakers were business executives (calling in from their factory offices), congressional and federal agency staff (calling from Washington, D.C.), and program managers and researchers (calling from their offices around the U.S. and in Canada).

Generally, guest speakers were asked to prepare slides before the class and transmit them electronically to us. Presentation slides were numbered and transformed into linked Web pages. In-class and distant participants were able to listen to presentations in real time, view slides as speakers referred to them, make comments, and ask questions. The student assignment and discussion section and the main presentations were broadcast in real-time over the Internet to distant learning participants. The last one-half hour of each class was reserved for in-class discussion, including discussion of assignment allocations, readings, and technical issues.

The Virtual Seminar

Distant participants at remote locations logged into the seminar via the Internet, listened to the live audio feed, and selected the sequence of Web pages to simultaneously view slide presentations. Audio from in-class microphones and remote telephone participants was mixed, then fed to a control-room computer server, encoded into compressed digital form, and made available for Internet transmission by the RealServer software. A link from the seminar Web site to the control room server made an automatic connection to the audio stream allowing distant participants to listen using RealPlayer. Another control room computer, configured similarly to an Internet participant's, allowed control room staff to monitor the received RealPlayer sound quality (Figure 1).

During the live seminar, questions and discussion comments to faculty, speakers, or other students could be made in three ways. First, in-class students could ask questions or comment, using radio microphones. These interventions were broadcast to all Internet participants. Second, distant students could call in to the class on a toll-free

telephone number. At least half of the distant participants had access to a telephone separate from their Internet connection. Telephone comments could be heard in the class and were re-broadcast to other Internet participants. Third, distant students could type comments through the Internet chat room. Chat room comments could be viewed by all other distant chat room participants, and could be viewed in the classroom on large video monitors. A computer was set up in the front of the seminar room connected to the chat server. One individual managed the chat room and facilitated remote participant discussion.

Initially, the "back channel" flow of chat-room comments visibly distracted in-class speakers and students. This problem was minimized by re-orienting monitors out of direct lines of vision in the classroom and by encouraging attention to etiquette by chatters. In discussion periods, the faculty instructor fielded (and prompted) questions, alternating between in-class and distant students. Questions posted on the chat room were re-read aloud, allowing distant students not using the chat-room and remote speakers to hear what was being asked. Sometimes, speakers would skip some slides, or go backwards to earlier slides. However, using the chat room, we were able to continuously indicate to remote participants the slide number a speaker was referring to.

Sound quality was a challenge in the live sessions. Overhead microphones in the multimedia classroom proved too sensitive. Higher quality was achieved by using personal radio microphones for faculty and speakers and a hand-held radio microphone for in-class students. The trade-off was some loss in spontaneity, as in-class students had to signal for the mike before speaking. At the same time, student questions were generally well prepared - although, without doubt, a few students were apprehensive at

first about having their comments broadcast live over the Internet. Interestingly, the clearest sound quality was often obtained from remote presenters speaking directly into telephone handsets, with the telephone audio input being fed through a sound mixer and broadcast directly by RealServer.

For remote participants, the idiosyncrasies of individual computers, sound cards and Internet connections affected audio fidelity. Distant students could adjust hardware and software settings to achieve some improvements. Nonetheless, periods of poor sound quality, including sequences of lost words, did affect several distant participants at least some of the time.

A slight time lag was observed in audio broadcast reception - due to the buffers used to encode and decode the broadcast data streams. By fine-tuning, we managed to reduce the delay to about 3 seconds - the time it took for a remote Internet user to hear words after they were first spoken in the class. However, these voice delays did not present major problems since most conversation involved only one speaker or caller talking at a time rather than simultaneous multi-voice discussion.

After each class, we transferred a digital copy of the audio feed to the seminar Web site and edited these files. The presentations could then be replayed on demand. It was then also possible to automatically link the audio feed and slides in the actual sequence used by a speaker, to allow a full multimedia replay.[10] We further learned the value of independently videotaping in-class sessions. In a couple of the early classes, RealServer crashed - which meant not only a loss of broadcast to distant participants, but also a loss of a few minutes of stored digital soundtrack until the server was re-booted. A separate video record allowed us to use the sound track on the videotape to restore a full

archive copy of each session. Additionally, the video sound track was useful for editing. The digital soundtrack that is made "on-the-fly" is already compressed and sampled, which reduces the size of files. But it is then difficult to enhance periods of poor sound quality. In such cases, we reverted to the video to re-master new digital tracks. Finally, video taping allowed us the option of posting some of the presentations as replayable modules using RealVideo.

Seminar activities continued between classes in several ways. A group electronic mailing list (listserv) was established, to which all in-class and remote participants were subscribed. Group mailings were used to discuss issues raised in the seminar, describe upcoming classes, and disseminate electronic student assignments for review and further comment. Separate email messages to distant participants were also used to offer technical guidance on such topics as how to better use the chat room software or improve sound quality. We also established a discussion area on the seminar Web site (although, we found that the listserv was a better method of group communication). The faculty instructor maintained real and electronic office hours, meeting in-class students in-person for one-on-one discussions and using email with both in-class and distant students for dealing with individual questions and comments.

SUBSEQUENT ROUNDS OF THE SEMINAR

After the first synchronous seminar, the recorded content was used as the basis for subsequent classes that were offered with asynchronous learning modes where students accessed Internet-based content independently, not in a simultaneous group environment. Thus, a second seminar was offered in the Fall Quarter of 1997. This course was again

experimental, this time without any advertising beyond a simple departmental listing. Five students enrolled, mainly due to interest in the subject, although curiosity about Internet teaching and the attraction of fewer fixed class meetings also played a role. In a weekly course module, with elements taken at any point during the week, students were required to read assigned materials, replay audio presentations, and view presentation slides. Each week, every student had to complete an electronic assignment based on the content of each module. These were reviewed, with comments, and returned electronically by the faculty instructor. About every two weeks, students met with the instructors in a physical seminar (usually of between 2.5 to 3 hours) to discuss the content of prior modules, raise issues and questions, discuss assignments, and present seminar papers.

The third and fourth offerings of the seminar occurred under special conditions while the faculty instructor was on a research assignment in Germany. In the Winter quarter of 1998, two U.S.-based students at the instructor's home university in Atlanta wished to take the course. The students were enrolled as special topics students (a procedure which allows students to pursue individual special topics with a faculty instructor). The mode of seminar operation was similar to the second round, except that no physical meeting was possible. Instead, the students took the course modules, completed the electronic and seminar paper requirements, and maintained ongoing email contact with the faculty instructor. Internet-based electronic meeting software (Microsoft NetMeeting, with two-way audio, chat, and whiteboard capabilities) was used for group discussion and paper presentations. Subsequently, in the Spring quarter of 1999, a fourth seminar was offered using a mixture of teaching modes with re-edited and new course

content. The instructor held four initial classes in Atlanta, then returned overseas on continued research assignment. Students were then assigned a series of re-playable audio-visual Internet modules and Web-accessible reading materials. Four live seminar classes were also held using ISDN (Integrated Services Digital Network) videoconferencing for two-way video and audio links between the U.S. and Germany. In these live video classes, NetMeeting was used in a supporting role to project slides and to provide a back-channel chat capability. As in earlier seminars, electronic assignments and frequent email interactions were employed. Four students enrolled in the fourth seminar for academic credit. Five additional students in a seminar at the Vienna University of Economics and Business Administration, Austria, also used the replayable Internet modules and participated in some of the live classes using NetMeeting.

The experience of these follow-up seminars was positive. As one student in the second seminar commented: "Amazingly, listening to lectures on the Internet was much more stimulating than sitting in the class." This student liked the ability to review (or skip!) particular sections, and to access modules at any time. Similarly, a student in the third seminar remarked: "It is kind of nice to have the flexibility of accessing the course through the Web rather than attending class in a physical building."

Students in the second and third seminars reported spending from 11 to 19 hours a week for the class, a range that included time on the major final seminar paper. Of this, from 4 to 11 hours a week was Internet-related (viewing online presentations, reading online course materials, and doing electronic assignments). This data draws from a small student sample (six in all). Nevertheless, these reports suggest that students typically invested more time in the online seminar than in a conventional course - even though the

online seminar had fewer scheduled class meetings. Very little time, if any, was spent in the university library (the median time in the library building was zero). Such data gives little comfort to those anxious about the preservation of physical libraries in an age of easily accessible (albeit variable quality) online information.

In the second seminar, the holding of physical meetings every two weeks greatly reinforced learning. At these sessions, it was found that students had excellent recall of the material they had listened to and read, and that they were very keen to enter into substantive and informed discussions. The regular assignments and frequent individual student-faculty email communication reinforced learning. The third seminar had all these elements, except for the physical meetings. It was found that electronic meetings were not as good or lively. To an important extent, this was due to technical reasons - mainly the poor quality of the transatlantic Internet connections available to the distant faculty instructor. The ISDN connections used for the fourth seminar's electronic meetings overcame these problems, and excellent transatlantic audio and video interactions resulted.[11]

As students undertook paper assignments, the faculty instructor connected students with external experts and practitioners in the U.S. and other countries. The electronic nature of the course allowed students to readily use email to send paper outlines and drafts to these experts for comment. The instructor moderated these interactions so that no individual expert was overloaded. Invariably, experts and practitioners responded generously to the students, given them valuable feedback and points of reference.

STUDENT EXPERIENCE

Throughout successive rounds of the seminar, many informal personal comments and emails were received from participants on the content and technical organization of the seminar. No special log of informal comments was kept, although emails were retained. In addition, formal evaluations were conducted. In-class participants in the first two rounds of the seminar completed written mid-session and end-of-session evaluations, in addition to the official university teaching evaluation. During the first seminar, distant participants were encouraged to complete a brief online evaluation at the end of each session to provide immediate feedback on technical and content issues. A final evaluation was also conducted with the distant participants. In the second, third, and fourth seminars, students also completed end-of-session evaluations. Overall, formal and informal feedback was received from nearly 50 students, which provides a reasonable basis for inference. However, three of the four courses had small class sizes, so results specific to individual courses should be interpreted cautiously.

Student views of technologies used in the seminar

There were differences in how in-class and Internet students viewed the various technologies used in the class. In formal evaluations of the first seminar, in-class students most highly valued two traditional approaches: classroom presentations and in-class discussion. Telephone presentations and electronic posting of assignments were also highly rated. Speakers overheads were less important to in-class students, while the chat room was poorly ranked. In contrast, the distant participants highly rated the slides and overheads in the Web browser, followed by electronic readings, group mailings, and

RealAudio. The distant participants' high rating of the Web slides indicates the importance of at least some visual stimulation to those who are not directly in the classroom. The chat room facility received a medium rating. While in-class students missed few classes, none of the distant students listened to all ten sessions, although all but one student listened to half or more of the sessions (the range was from four to eight sessions). Six of the eight distant participants reported replaying at least one session.

In evaluations of the second and third seminars, high ratings were given to Web-based readings and resource materials, electronic assignments, email communication, the final seminar paper, and in-class meetings. Students in these seminars were less happy with the audio quality, the overhead slides, and - for the third seminar - live Internet conferencing. In the fourth seminar, the use of better quality ISDN lines led to greater satisfaction with live video classes.

Overall student assessments of strengths and weaknesses

For the first seminar, in-class students most frequently said that the best things about the course were access to expert resources and speakers brought into the classroom, the electronically accessible library of class and speaker presentation materials, and interactive discussion and question-and-answer sessions. In-class students also said their learning was enhanced by the real world knowledge of the Internet students (most of whom were practitioners in the industrial modernization field), enhanced student-instructor communication, and the electronic assignments. In their evaluations of what they liked about the course, the distant students most often mentioned the seminar content, access to expert speakers, interactive discussion and questions-and-answers, the

newness and innovativeness of the technique, and the convenience of taking the course from their desk. Other benefits mentioned include the ability to replay classes and the well-organized nature of the course.

Technological glitches related to sound quality topped the list of aspects that hindered learning. Some in-class students without their own computers reported difficulties in accessing on-line reference materials, as university student-cluster computers restricted printing of materials to save paper. (We observed that most students preferred to print out online materials, rather than read them on-screen.) A few in-class students said the in-class period was too long, while distant students complained about office distractions.

Students suggested a broad range of improvements for the seminar. In-class students most often gave suggestions related to content, followed by increasing discussion and interaction, shortening the length of the seminar or allowing a break, adding more microphones, and incorporating more assignments into the course design. It should be noted that although some in-class students wanted more interaction and discussion, others wanted less. The distant students indicated that addressing the technological glitches that hampered sound quality and better managing speaker presentations would improve the seminar. Other suggestions for improvement by distant students included employing video, managing the diversity of background and experience among distant participants, and expanding the course content.

In the second and third seminars, students most highly valued the flexibility offered by the class, although recommendations were made to edit the presentation modules. Second seminar students also highlighted the in-class discussions as a strength.

But several students noted the workload involved in listening to class modules and preparing for class discussions. In the fourth seminar, highly enthusiastic comments about the value of hearing a speaker and viewing overheads were matched by observations that in several cases reading a presenter's paper was just as useful.

Effects on Understanding and Comparison with Traditional Courses

Overall, in-class and campus based students were more likely to positively rate the seminar's effect on improving their understanding of the subject matter than were distant students. In the first seminar, in-class students uniformly gave the course the highest rating (all reported the course greatly improved their understanding of the field). In the second and third seminars, a majority of the campus-based students strongly agreed that the seminar improved their understanding of industrial modernization. In contrast, only two distant students in the first seminar said the course greatly improved their understanding of the subject matter; four students said their understanding was moderately improved; and two students said their understanding was slightly improved. The more diverse nature of the distance participants in the seminar, their more varied expectations, and their prior professional experience contributed to the more mixed reception these participants gave the course.

There was no traditionally taught version of the seminar on industrial modernization with which student experience could be compared. So in-class students were asked to compare the learning process in the seminar with other courses that used traditional teaching techniques. For the 13 students in the first seminar responding to this evaluation question, six rated the course "much better"; two rated the course "slightly

better"; three rated the course "about the same"; and two rated the course "slightly worse". For the second seminar, three of the four respondents rated the course as better.

FACULTY AND INSTITUTIONAL PERSPECTIVES

From faculty and institutional perspectives, Internet-based multimedia teaching has a variety of implications. Multimedia and Internet-based teaching does affect faculty-student interaction, course content, how material is taught, course discussion, the pace and style of teaching, and resource requirements. The effects are positive in some respects, negative in others. The particular set of benefits and costs varies according to whether synchronous or asynchronous teaching modes are employed. (See Table 1.)

When students are not physically together in classrooms, immediacy with faculty and other students is obviously lost. There is a diminishment in classroom spontaneity, although when the quality of live communication is high (as in the fourth seminar), the reduction in spontaneity is relatively small. At the same time, there are compensating gains. The first seminar was much enhanced by the penetrating comments and practical experiences offered by its diverse distant participants. In the subsequent three seminars, students studying multimedia course materials prior to live meetings came to those meetings very prepared, with a high degree of recall, and were keen to enter into substantive discussion about the material. The use of pre-recorded course content by national and international experts also allowed students to encounter a wider range of viewpoints and perspectives than might normally be the case. As noted in other studies (Ellis 1997), students highly valued the flexibility to self-pace learning offered by asynchronous modules. Additionally, with much course content obtained asynchronously

by students without in-class faculty instruction, class and electronic faculty-student interaction followed an intensive tutorial approach characterized by discussion and dialogue rather than one-way lecturing. Indeed, in all four courses, there was a high level of faculty-student interaction outside of scheduled live or electronic class meetings. Mostly, these interactions occurred on an individual basis, using frequent email and rounds of comments on assignments and papers. Many students noted in their evaluations that personal interaction with faculty was actually greater than in traditional courses.

The direct additional monetary costs of mounting four online seminars were relatively modest. About $8,000 was spend on hardware and software by the faculty instructor, including roughly $5,000 for the course Web server and $2,100 for the RealServer educational license. In the fourth seminar, around $1,500 was spent on ISDN line charges. Such additional expenses fit within the budgets of instructional awards or special equipment grants available at many universities. There were no extra hardware or software costs for students (if they already had access to the necessary equipment).

Yet, these low marginal costs are deceptive. For example, dedicated multimedia classrooms as used by the seminar can cost $200,000 to fully equip with required microphones, video cameras and monitors, monitoring and mixing equipment, computers, telephones, fast Internet connections, and control facilities. For live teaching, with in-class and remote students and high levels of interaction, these facilities are essential. Moreover, extensive technical and in-session staff support is required. Without prior equipment investment and university-provided technical support, it would be difficult, if not impossible, for a regular faculty member to mount a comprehensive, broadcast

Internet course. (A much less costly standalone multimedia computer workstation with sound and video mixing equipment could be used to produce pre-recorded content for Internet distribution, although the quality would likely be poor and technical support would probably still be needed for recording and editing.)

The amount of faculty and support time involved in developing and teaching the first live course was considerable. Although no track was kept of this time, it was far more than would be involved in a traditional course. The lead faculty member was assisted by a colleague who also served as an instructor and operated the in-class chat facility. Both spent much time in preparation and authoring Web site content. For the live class, one or two staff members from the university's continuing education and distance learning department provided control room, mixing, and monitoring assistance. At various times, other staff from the university's computing, continuing education, and academic units also provided substantive help, ranging from dealing with technical issues and Web site operation to marketing and editing.

Furthermore, prior to the course, and during the first few sessions, much time was spent with distant registrants to assist them in downloading software, configuring their computers, and resolving problems. The intensive online nature of the seminar also generated considerable individual and group electronic communication, as well as requiring regular routines of Web posting course materials. At the same time, the greatly increased faculty effort and attention in the first class resulted in a course that was highly prepared and organized, and this in itself certainly contributed to an improved student learning experience.

In the second and third courses, additional technical support was not needed to run the seminar, nor was it necessary to purchase additional hardware or software. On-campus students were able to master the necessary software with little additional assistance. However, time had to be spent in loading and preparing the Web site for asynchronous sessions. There was also considerable up-front faculty and student assistant time in re-editing and renewing asynchronous content. The fourth seminar required technical staff in both Karlsruhe, Germany and Atlanta to support the ISDN video conferencing link. Additionally, for all courses, faculty interaction time with students was greater than in traditional classes.

Nonetheless, despite these investments of resources in both asynchronous and synchronous modes, student expectations of audio and video quality were higher than we were able to meet. Technically, we could have raised quality and production levels, particularly for the asynchronous Internet-based modules. But this would have required the availability of a larger budget and even more technical assistance to produce and edit modules than we were able to obtain. It remains to be seen whether Internet-based teaching technologies and facilities will evolve to the point where regular faculty (and their institutions) can obtain very high quality sound and visual quality, yet still afford to teach (or "narrowcast") to specialized classes, with students dispersed over space and time.

CONCLUSIONS

One of the underlying principles of the industrial modernization field is that new technology must be viewed pragmatically. The small and medium-sized mature

companies that typically lag in using modern manufacturing methods are often advised to carefully consider the risks, further development needs, and training costs that are involved in a leapfrog into the newest, most advanced technologies. In such cases, tried and tested off-the-shelf technologies, combined with the upgrading of existing approaches, provide workable and more affordable solutions that can subsequently be built upon as part of a strategic approach to improvement (National Research Council 1993; Shapira 1998).

This philosophy guided our use of technology in teaching the seminar on industrial modernization. The seminar on industrial modernization made pragmatic use of available Internet technologies and low-cost/no-cost software. No new software was developed; the expenditure on new equipment to teach the course was modest; and, with access to an Internet-connected computer with a sound card and speakers, students did not need to spend money on any new hardware or software. The course employed multimedia methods of content presentation, using Internet audio streaming broadcasts and slides (the latter prepared using commonly available presentation software). Internet broadcasting was coupled with conventional technologies and methods. For example, we made frequent use of the telephone to provide an easy feedback loop for distant students and to allow the live Internet broadcast of remote experts during the synchronous teaching mode. (In so doing, we learned that combining remote telephone presentations with visual materials is an effective method that can be used for non-Internet courses at low added cost.) We eschewed Internet video streaming because of current Internet bandwidth constraints for distant participants. However, our success with ISDN videoconferencing in the most recent seminar illustrated that live video can be usefully

deployed once higher Internet bandwidths become universally available. Nonetheless, we readily appreciated that greater use of video not only raises cost but also complexity in order to produce interesting and high quality presentations (i.e. not "talking heads").

Yet, despite our pragmatic approach, our experience emphasizes that teaching an Internet-based broadcast course requires considerable faculty learning costs and more preparation time than typical for a conventional course. Moreover, while our marginal hardware and software costs were low, we benefited greatly from access to university multimedia classroom and broadcasting facilities developed, at considerable expense, for satellite and cable television teaching (but easily converted for Internet broadcasting). We also received a great deal of support from technical staff in this facility. While future technological developments may make the necessary technologies easier to use and more portable, at present broadcast teaching via the Internet still requires prior and ongoing institutional investment in facilities, training, and technical support.

Our experiences in Internet and multimedia teaching offer insights of relevance to planning educators. Policy and planning schools are likely to follow broader university trends in offering a greater number of online continuing education and degree programs to off-campus students. We have shown that discussion-oriented policy and planning courses can successfully use distance learning technologies. These technologies also allow the learning experiences of regular and off-campus students to be enhanced by interaction with practitioners and remote experts. Although, the diversity of distance students we encountered presented some teaching difficulties, this is a challenge that should be welcomed. As additional distance courses come online, there can be better matching of course content and distant student needs. Our experience suggests that

Internet technologies can be used to offer specialized policy and planning courses to numerically small yet geographically dispersed distant students in the U.S. and elsewhere for academic credit and continuing education. However, we are cautious about the scaling-up our experience to the subject of offering entire policy and planning degrees through distance teaching. Extensive investments and institutional support would be required to develop high quality programs. Collaborative online course development and teaching by groups of schools might be a feasible way not only to spread the costs, but also to leverage the interactivity, expanded resource base, and broadened perspectives that Internet-based teaching offers.

We would be the first to admit that online teaching is no substitute for face-to-face interaction between faculty and students - indeed, three of the four versions of the course did build in face-to-face contact. Yet, our judgement, supported by the informal comments of students and formal evaluations of the seminar, is that a pragmatic approach to online teaching works and that student learning is enhanced. In general, students were highly motivated to participate in an online electronic learning environment, through which they could access presentations from experts around the country, required and supplementary readings, participate in electronic discussions, submit assignments, and pursue links for further research. Possibly, student interest in this mode of learning is temporal and will decline, as Internet-based teaching becomes more common. More fundamentally, we believe that the considerable extra effort we put into the planning, preparation, organization, and teaching of the online seminar, and in student interaction (on and off-line), was the greatest factor in delivering a course that motivated student participants. In this sense, while Internet technologies offer new possibilities for

teaching, these technologies offer few short cuts to educators and administrators if the goal is an improved student learning environment with high interactivity.

Authors' Note: The online seminar courses described in this article received the support of several units at Georgia Institute of Technology, including the Office of Distance Learning, Continuing Education and Outreach, the Ivan Allen College, and the Economic Development Institute. The authors particularly wish to acknowledge the assistance of Robert Albright, Joe Boland, Matt Corey, Joseph S. DiGregorio, Ami Feinstein, Walter Gonzales, Ron Hutchins, Ken Knoesppel, Chris Lindsey, Mike Luttrell, Alfie Meek, Paul Manno, and Loping Wei. Grateful acknowledgements are also due to the Manufacturing Extension Partnership of the National Institute of Standards and Technology and to the Georgia Tech Foundation for awards that helped to sponsor the first online seminar, and to the Fraunhofer Institute for Systems and Innovation Research for providing facilities to conduct the third and fourth online seminars.

NOTES

1. NUA Internet Surveys, August 1999. 24 Sep. 1999 <http://www.nua.ie/surveys>.
2. For information on university initiatives in distance education, see <http://www.uwex.edu/disted/index.html>, <http://www.worldcampus.psu.edu>, and <http://www.alliance.usg.edu>.
3. For example, the University of Phoenix Online <http://online.uophx.edu> is part of the second largest private university in the US and has several thousand students enrolled in online degree programs. The United States Open University

<http://www.open.edu> represents a British initiative to attract American distant students.

4. A selective listing of urban planning college courses using Web outlines and materials is available at <http://www.sppsr.ucla.edu/crane/syllabi>. Many other Internet-related urban planning resources are listed at <http://www.cyburbia.org>.

5. For details of this research, see the Georgia Tech Policy Project on Industrial Modernization at <http://www.cherry.gatech.edu/mod>.

6. RealServer was purchased with an educational license for up to 70 simultaneous users from RealNetworks Inc. at <http://www.real.com/>.

7. The Internet bandwidth available through telephone dial-up was 28.8 to 33.6 kilobytes per second (KBPS) when the first seminar was planned in 1997. Modems with 56 KBPS download speeds are common today, but this still limits the quality and size of streaming video. Better video quality can be achieved with higher cost ISDN connections (128 KBPS or faster) or T1 lines (1.544 MBPS or million bits per second). The very fast cable modems and Asymmetric Digital Subscriber Line technologies (download speeds as fast as 1.5 MBPS using existing telephone lines) beginning to be available from 1999 should make high quality video transmission feasible at low user cost.

8. For Web authoring and hosting, we acquired Microsoft FrontPage, but many other Web hosting and authoring packages are available. Other purchases included a color scanner and Adobe Acrobat Exchange <http://www.adobe.com> to create electronic document files viewable by the Adobe Reader plug-in.

9. IRC chatroom software can be downloaded without charge for MS Windows at <http://www.mirc.co.uk/get.html> and for Macintosh at <http://www.ircle.com>.

10. For an example of a presentation linking slides and voice, see R. Combes, "The development of industrial modernization at the state level: Georgia's experience," Seminar on Industrial Modernization 1997, <http://www.cherry.gatech.edu/sim/module/combes_fr.htm>. Requires an Internet-connected multimedia computer, Web browser, and RealPlayer.

11. Two bonded pairs of ISDN channels were used to give a bandwidth of 256 KBPS. Transatlantic ISDN charges of about $200 an hour were incurred.

REFERENCES

Campus Computing Project. 1998. Colleges struggle with IT planning. *National Survey of Information Technology in Higher Education.* 10 Sep. 1999 <http://www.campuscomputing.net>.

Center for Distance Learning. 1998 (October). Overview of recent developments in distance learning at Georgia Tech. Atlanta, Ga.: Georgia Institute of Technology. PowerPoint presentation transmitted by email.

Chute, A., P. Sayers, and P. Gardner. 1998. Networked learning environments. CEDL Published Articles, Lucent Technologies Center for Excellence in Distance Learning, 24 Sep 1999 <http://www.lucent.com/cedl/networked-learning.html>.

Ellis, B., compiler and editor. 1997. Virtual classroom technologies for distance education: The case for online synchronous delivery. DETAC Corporation. 24 Sep. 1999 <http://www.detac.com/solution/naweb97.htm>.

Garson, G.D. 1999. The role of technology in quality education. Raleigh, N.C.: North Carolina State University. 24 Sep. 1999 <http://hcl.chass.ncsu.edu/sscore/garson2.txt>.

Hara, N., and Kling. 1999. Students' frustrations with a Web-based distance education course: A taboo topic in the discourse. CSI Working Paper, Indiana University, Bloomington, Ind. 10 Sep 1999 <http://www.slis.indiana.edu/CSI/wp99_01.html>.

National Research Council. 1993. *Learning to Change: Opportunities to Improve the Performance of Smaller Manufacturers*. Washington, D.C.: National Academy Press.

Neal, L. 1997. Virtual classrooms and virtual communities. Proceedings of ACM Group 97 Conference, Phoenix, Ariz.: November 16-19. 10 Sep. <http://www.lucent.com/cedl/group97.html>.

Noble, D. 1998. Digital Diploma Mills: The automation of higher education. *Science as Culture* 7(1): 355-368.

Shapira, P. 1998. Manufacturing extension: Performance, challenges and policy issues. In *Investing in Innovation*, eds. L. Branscomb and J. Keller, 250-275. Cambridge, Mass.: MIT Press.

Speer, T.L. 1996. A nation of students. *American Demographics*, August, 32-45.

Stowers, G. 1999. Symposium on Internet-mediated learning in public affairs; Introduction. *Journal of Public Affairs Education* 5(3): 205-212.

Thornton, C. 1999. Back to school, Web style. *PC World*, July, 39-40.

Winner, L. 1998. Report from the Digital Diploma Mills Conference. *Science as Culture* 7(1): 369-377.

Figure 1. First Online Seminar on Industrial Modernization: Synchronous Teaching Mode

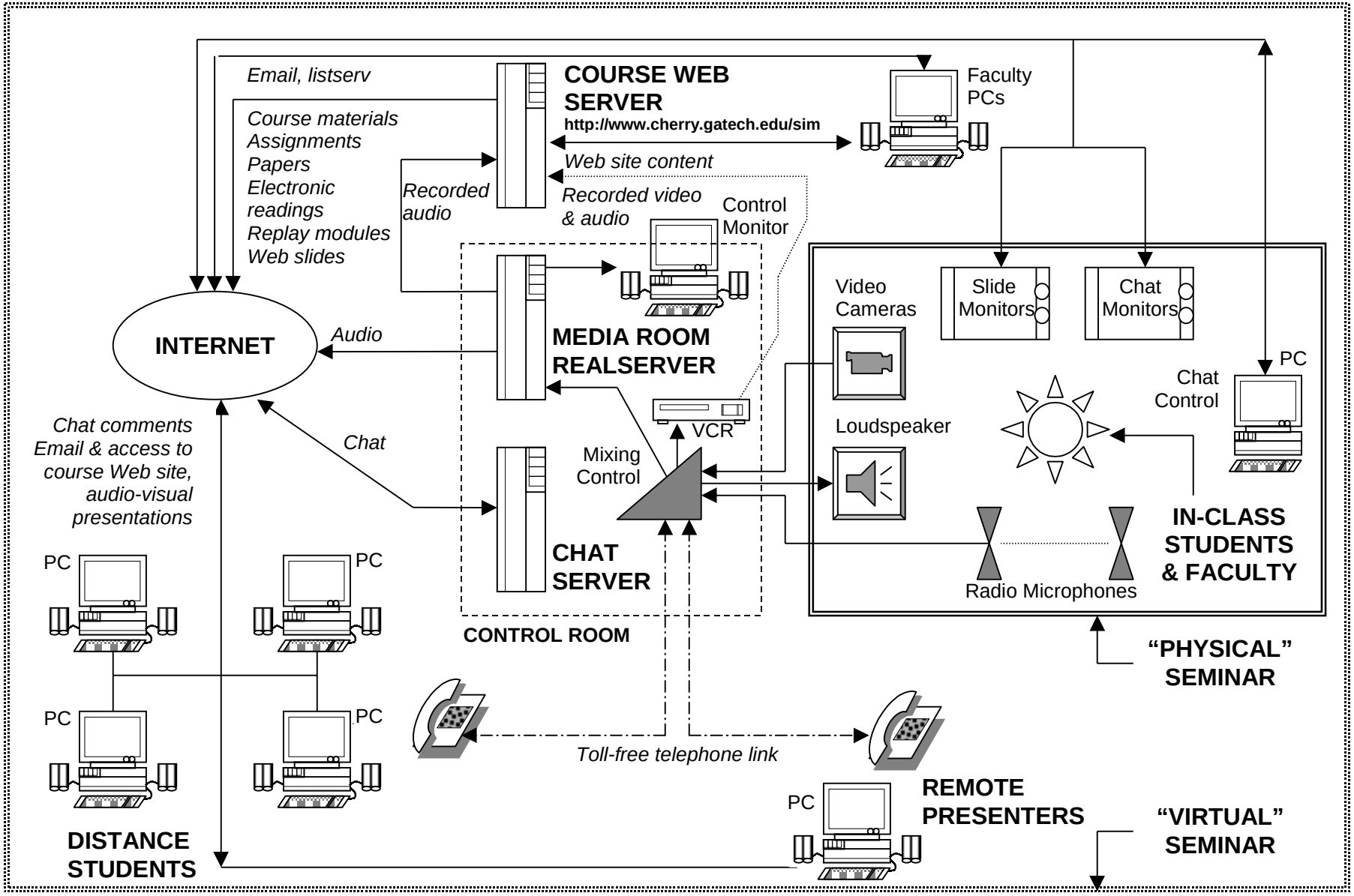

Table 1. Opportunities and Issues Associated with Internet-Based Multimedia Teaching

Internet Teaching Mode	Opportunities	Issues
Synchronous (live classes)	• Widened access to expertise brings new resources into the classroom • Can reach dispersed student audience beyond home geographical area • Lower monetary outlays are required than for other live distance teaching technologies • Allows multiple media to be used in presentations • Easily linked to electronically accessible library of class materials • Increased effort needed to organize leads to better prepared classes • Class content can be captured for replay or to reach students unable to be in live class • Newness of the concept (currently) motivates students	• Requires large up-front time investment in learning and preparation • Requires additional technical assistance and staff support • High quality broadcasting of classes requires equipped multimedia classrooms, content servers, and software • Internet technology still has glitches and is not 100% reliable • Audio quality can be variable • Good video quality needs very fast Internet links • Diversity of distant students poses extra teaching challenges • Less in-class spontaneity • Can be hard to engage remote participants
Asynchronous (with pre-recorded content)	• Students have greater flexibility and control • Student self-learning of content enhances student-teacher interaction and discussion • Faculty can spend more time in interacting with and tutoring students, rather than lecturing • Pre-recorded content can be used in more than one course, leveraging up-front course investment • Once content is recorded, does not require special multimedia classroom • Students can access from home or office using commonly available hardware and free software • Students cannot miss class – as modules can be replayed on demand • Newness of the concept (currently) motivates students	• Internet content server and software needs to be acquired and maintained • Traditional faculty-student classroom lectures are reduced or eliminated – requires adjustment in attitudes, approaches, and administration • Parallel investments in methods to facilitate questioning, discussion, and interaction are essential • Over time, pre-recorded content needs to be updated • Student expectations of video and audio quality are higher than regular faculty can meet, without technical assistance to produce and edit modules • Fully-electronic access to course readings and other materials may lower student use of physical libraries

Source: Authors' experience in teaching Online Seminars on Industrial Modernization, 1997-1999.