Distance education has advanced rapidly (perhaps more rapidly than many in the field expected) over the past few years. There have been literally hundreds of published studies investigating its relevancy and educational effect. With regard to the relevancy of technology in distance education, most of the more current literature is overwhelmingly positive concerning the potential of a variety of technologies to be powerful components in accomplishing current educational visions. Such visions include helping students develop a broad, deep, and creative understanding of community, culture, economics and international politics, past and present, and acquire the social skills to work across differences and distances (Reil, 1993). This is accomplished by providing an array of tools for acquiring information and for thinking and expression (allowing) more students more ways to enter the learning enterprise successfully. These same experiences provide the skills that will enable students to live productive lives in the global, digital, information-based future they all face (Dwyer, 1994).

In addition to the visions described, it is also true that distance students must feel comfortable with the tools of the Information Age (Peck & Dorricott, 1994). Individuals need to learn at higher rates of effectiveness and efficiency than ever before because of rapidly growing bodies of relevant information and the escalation of knowledge and skill requirements for most jobs (Alavi, 1994).

Technology is a factor in the blurring of the boundaries between distance education and the traditional classroom. Education has received a much-needed boost in the form of distance learning, and a key catalyst for the growth of distance learning is video communications (Walsh & Reese, 1995). Although the literature tends to deal with distance education applications of technology and traditional classroom applications of technology separately, many of the goals, techniques, and actual uses of technology overlap across the two domains and will probably do so to an even greater extent in the near future. As students within both traditional and virtual “classrooms” make greater use of the interactive power of computers, the boundaries between traditional education and distance education are becoming indistinct. Concepts such as “learning without limits” and computer networks to extend educational opportunities and communications opportunities for people of all ages apply to all computer mediated communications learners, wherever they are situated.

Studies of technology in the distance education classroom have tended to focus rather narrowly on very specific learning outcomes. Also, such studies rather frequently forget (at least at the onset) to take into account the need for ongoing support to the teachers, although almost all reports on technology in the classroom end up mentioning this factor in their discussion sections. It has become clearer over the past decade that simple motivational and short-workshop schemes are vastly insufficient to enable veteran
(and even new, computer-generation) teachers to teach differently, and to teach well with distance education technologies (Hawkins & Honey, 1993).

What happens to higher education when every student has a link to a flood of words and images of every imaginable kind from around the world, and when every teacher and every student can reach out to each other at all hours of the day and night (O’Donnell, 1996)? Distance learning has become a core educational strategy in the 1990’s, with a reach that extends to a broad cross-section of institutions and curriculum providers around the world (Walsh & Reese, 1995). Distance learning is not dependent upon time or place and in many ways it can be more flexible than the traditional model. Groups of students may form naturally because of common interests at a given point in time, largely independent of decisions made by any single educational institution, overcoming a major weakness of conventional educational provision, namely the long reaction time required by institutions to adapt curricula and content to the changing needs of society (Romiszowski, 1993). He also notes that the costs of telecommunications are falling whereas the costs of educational space, staffing, and transport are rising. The issue of cost effectiveness in distance education was also addressed by Perraton (1994) who looked at 16 tertiary institutions in various parts of the world and determined that the cost per student is lower for distance education programs when compared to conventional systems.

Proof that the technology works is in the consistently high scores that distance learners get on examinations says Weiss (1994) in a report on a variety of video applications for distance education, which range from the “tried-and-true to the highly experimental.” Technology-enhanced distance education environment facilitates collaborative learning, active learning, and independent learning and exceeds the traditional classroom in its ability to connect students and course materials on a round-the-clock basis. Swan and Mitrani (1993) state that computers can change the nature of teaching and learning at its most basic level. We need to ensure that we are using our current knowledge about the application of technology in education as a basis for proceeding in the future.

**Evolution: Tools Available for Distance Education**

The past century has seen phenomenal growth in avenues in information development and dissemination. The earliest form of distance education simply involved people reading what scholars had written on a variety of topics, and was almost exclusively the province of the upper class, who could afford both the time away from survival-oriented tasks, and the cost of individually hand-crafted manuscripts.

Gutenberg’s invention of the printing press was perhaps the earliest example of technology revolutionizing distance education. The written work could now be mass-produced with relative efficiency. Coupled with the emergence of international postal services, correspondence courses began to appear. Through the latter half of the nineteenth century and up to the middle of the twentieth century this was distance education. A much larger segment of society had access to the thoughts and ideas of their fellow men.

The next great advance was radio. In the space of a few decades, programs and materials were available which greatly reduced the barrier of distance. Much more revolutionary was the advent of instructional television. Technology seemed to have provided a mechanism to duplicate the classroom setting, in a medium that could be sent right into the learner’s home. But both of these technologies had significant drawbacks. First, they were one-way mediums of communication. The learner remained essentially enrolled in a correspondence course, but with some useful supplemental materials. Second, the broadcasts were only available “live.”

With the development of the phonographs, audio, and videotapes, and xerographic equipment, all of these course materials could be duplicated with relative ease. Production costs declined, more varied course schedules could be accommodated, and review of materials became commonplace. In addition, with the widespread availability of telephone communications in some parts of the world, distance learners and educators finally began to be able to provide fairly rapid feedback and communication.

The development of microwave and satellite technologies greatly expanded radio and television coverage. Signals could be broadcast farther, to more locations at reduced cost compared to terrestrial systems. In the past 10 to 20 years, as the cost of reception equipment has declined, and the variety of programs available has increased, there has been a significant increase in television-based distance education courses. But this remained a one-way means of communication. Critics complained that distance education programs should be more than a passive transmission of academic information.

The big change needed was interaction – starting with two-way communication between the learner and the instructor. Five fundamentals of an effective program were put forth:

(a) contact between the student and the learner, (b) active learning through writing out answers, (c) timely feedback to the instructor on students’ comprehension, (d) timely feedback to students on work done, and (e) opportunity for students to make revisions to work done and learn from their mistakes.

Currently, one of the biggest movements is the provision and expansion of two-way video communication, whether through satellites or communications networks. Most of these are an expansion from the one-many paradigm. The instructor can see the students, and the students can see and respond to the instructor. This sort of full presence system is becoming the minimum standard required for such distance education programs.

Without connectivity, distance learning degenerates into the old correspondence course model of independent
study. The student becomes autonomous and isolated, procrastinates, and eventually drops out. Presently, we can accommodate many, many communications that permit interaction not just between the learner and the instructor, but among the learners themselves.

One of the limitations of satellite technology is its continuing emphasis on geographic dependence. Satellite classrooms are constructed, to which learners must travel. While the distributed nature of the system permits a much wider instructional provision, it is not well suited to providing educational programs and resources to move remote users or to those who are unable to attend at specified time-slots set by the instructional facility.

The Internet, or information superhighway, is providing mechanisms for fundamental changes in the way people learn:

1 **Electronic Mail:** Email is an important tool of the Internet. As has been discussed, it is a simple, portable, inexpensive mechanism for rapid communication between individuals and groups. It serves as the foundation for almost all other network tools.

2 **Discussion Lists/Limited Conferencing:** Organized topical mailing and discussion lists (listservs and USENET newsgroups) have repeatedly proved their value to users worldwide. There are now over 20,000 such lists facilitating discussion and collaboration on myriad fronts. Some institutions make heavy use of them for instructional support. They are heavily utilized in support of all levels of distance education, as they provide a mechanism for concurrent information dissemination as well as facilitating discussion among learners, a principle weakness of many distance education technologies.

3 **Telnet:** Along with email, Telnet is a standard application available to all Internet users. It negotiates interactive connections with remote computers, in many cases communicating with database search engines. One of the most popular uses for Telnet is to access library catalogs during research.

4 **FTP and Gopher:** FTP and Gopher are protocols for storing and retrieving files from remote computer systems. With FTP, items need to be transferred to the user's local computer for perusal. Gopher incorporates the file transfer capabilities of FTP, and adds a hierarchical menu structure to simplify navigation. Users can also read test files as they go. Keyword searching is fairly straightforward, and it is generally a user-friendly interface.

5 **World Wide Web:** The Web incorporated the capabilities of most early tools and added the ability to handle various media types in a much more usable graphical hypertext environment. Interfaces on the Web exist on all computer platforms, and are easy to use – so much so that Web usage has exploded in the past year, and the amount of academic and commercial information available is increasing at an almost exponential rate. The amount of information available from a desktop computer provides incredible support for research on a variety of topics, including distance education.

6 **SLIP and PPP:** These acronyms refer to two standard protocols for utilizing a graphical interface to the Internet through a regular telephone line and modem. Previously, users had to travel to a central location if they wanted to use tools, which relied on graphics technologies – much like the similar need, required utilizing satellite conferencing technology.

7 **Advanced Conferencing Software:** Conferencing software is still very much in the early stages on the Internet. NetPhone from Electric Magic permits real-time transfer of audio across the Internet, much like a telephone call. CU-SeeMee is an experimental one-many and/or many-many video repeater. It is an experimental tool using standard network protocols to provide video feeds to anyone who wants one. Videoconferencing from the desktop will be feasible once more network lines have been upgraded to higher signal capacity. Where fiber-optic cable has been installed, the capacity is already far beyond that provided by satellite. Another drawback to computer solutions is the limited image resolution currently available. Now the hardware and software need to take the next step into utility and viewability.

8 **Proprietary Software vs. Open Standards:** Many information service companies are offering purpose-built proprietary software for specialized applications on the Internet. Those, which fail to incorporate the ability to utilize standard network communication protocols, will achieve very limited market penetration. Tremendous amounts of information on every subject imaginable are being provided on servers throughout the Internet. They are following standard protocols, which are constantly under creation or revision. Software that is not able to speak to or query these resources is crippled when it comes to actual utility.

9 **Virtual Reality:** The next big direction to be taken along the Internet pathways will be the development of virtual reality into a functional network tool. This has the potential to be an order of magnitude more effective than any mechanism previously developed. The potential for the Internet to revolutionize the field of distance education lies in the comparative simplicity of the tools available; (a) the ease of document authoring; (b) low cost compared to satellite technologies; (c) the continuing trend away from mainframe servers and towards increased power on the desktop; and (d) the continuing trend away from mainframe servers and towards increased power on the desktop; and (d) the theoretical ability of anyone, anywhere to utilize it. Previously impossible institutional mandates for distance education programs are now becoming practical within the geographic, social, and economic restraints placed upon them.

A summary of computer networking advantages over other distance education technologies include:

1 standardized cross-platform tools for multimedia and hypertext access, notably World Wide Web browsers
2 rapid revision and dissemination of instructional programs
3 increased freedom of time and location for learners
4 world-wide network expansion
5 increased instructor-student interaction and feedback
6 network-capable desktop videoconferencing
7 much lower transmission and delivery costs
8 completely digital environment, with few limitations on transmission of data in any form.

Fundamentally, the Internet expands service provision to the desktop level. Tools developed for the Internet can be utilized from any location, so those learners can be freed from the requirement of traveling to a specific location for instruction. The idea is not new, but the tools being developed make its implementation much more viable. Successful waves of support tools will be increasingly simple to use, moving towards transparency of computing technology. This will be aided by the growing technological literacy of the user populations—a literacy, which is not a foregone conclusion for all users.

While some users are attempting to run completely Internet-based distance education programs, most of those involved are using the Web to supplement classroom instruction. One user praised the dynamic nature of the Web information, as data (e.g., syllabi) can be rapidly modified as the circumstances change. However, this capability implies that learners will need to have full Internet access from hand-held units so that they do not rely on printouts for accuracy. The field is already looking beyond what had been anticipated (desktop access), and calling for a more comprehensive version of the anyone, anytime, anywhere education provision model.

**Which Technology is Best?**

Although technology plays a key role in the delivery of distance education, educators must remain focused on instructional outcomes, not the technology of delivery. They key to effective distance education is focusing on the needs of the learners, the requirements of the content, and the constraints faced by the teacher, before selecting a delivery system. Typically, this systematic approach will result in a mix of media, each serving a specific purpose. For example: (a) a strong print component can provide much of the basic instructional content in the form of a course text, as well as readings, the syllabus, and day-to-day schedule, (b) interactive audio-or videoconferencing can provide real time face-to-face (or voice-to-voice) interaction which is also an excellent and cost-effective way to incorporate guest speakers and content experts, (c) computer conferencing or email can be used to send messages, assignment feedback and other targeted communication to one or more class members; it can also be used to increase interaction among students, (d) prerecorded videotapes can be used to present class lectures and visually oriented content, and (e) fax can be used to distribute assignments, last minute announcements, to receive student assignments and to provide timely feedback. Using this integrated approach, the educator’s task is to carefully select among the technological options. The goal is to build a mix of instructional media, meeting the needs of the learner in a manner that is instructionally effective and economically prudent.

**Compressed Video**

Compressed video is a two-way video, two-way audio medium that reduces the bandwidth of the video image. Through a coding, decoding process, the signal is converted for transmission over telephone lines and fiber optic cables. The process provides a more cost-effective way of holding meetings and delivering training and educational programs than other types of two-way video/audio transmission. The quality of the compressed video picture, the amount of video “lag”, and the cost of the connection, depends on the bandwidth that is used. A higher bandwidth results in better picture quality, less “lag”, and a higher cost. The most commonly used bandwidth spectrum ranges from 112 kila bits per second (kbps) at the low end to 336 kbps at the high end. The use of compressed video can provide significant reductions in travel expenses, time spent traveling and traveling risk for both instructors and participants. Compressed video is also a flexible medium that can be expanded by adding additional components: (a) print materials, (b) cameras, (c) monitors, (d) document cameras, (e) video/audiocassette recorders, (f) audioconferencing, (g) audiographics, (h) presentation software, and (i) fax, as well as (j) computers for using CD-ROM and for access to email and the Internet. Because compressed video is two-way video and two-way audio and can interface with a wide variety of other technologies, it is potentially a very interactive medium. Compressed video is the appropriate medium to use if: (a) remote access to your meeting, program, or course is important, (b) two-way video and two-way audio are important for your purposes, (c) your institution has compressed video and its use fits into your budget, and (d) the remote sites you wish to reach have compressed video units.

Teaching via compressed video is different from teaching in the traditional classroom in some respects. Effective compressed video instructors adapt their courses, with the assistance of instructional design teams, taking into consideration the potential and limitations of the medium and the remote nature of their students. When well designed, learning via compressed video can be as effective, if not more effective, than learning in the classroom. In addition, techniques learned in adapting formats for compressed video can be used by instructors to enhance classroom teaching.

The videoconference room itself is the only portion of the technology that most who use the system will ever see or know anything about. Therefore, the overall level of comfort this room engenders will determine the success of the installation. The perfect videoconference room is a room that feels as much like a normal conference room — for a given corporate or educational setting — as possible. Those who use the room are not intimidated by the technology required, rather, they feel completely at home. The technology is almost hidden, or transparent to their use.

Videoconference room sizes and shapes run the full spectrum. Customers have installed systems in everything from the smallest closet to the great outdoors. The size and shape of the room must be selected to be consistent with the intended use of the room. A “typical” videoconference room is about 25 feet deep by 20 feet across. This will provide space for a medium sized videoconference system and conference table for approximately seven people. There are three elements to good lighting in a video conference room: (a) light levels, (b) light angles, and (c) light color. The
objective is to provide even light of the right color at levels, which allow the video camera to render a natural scene. There are four elements to proper acoustics in a videoconference room design: (a) ambient noise level, (b) reverberation time, (c) microphone and speaker placement and, (d) the method of the echo cancellation to be used.

A number of consulting and trade organizations are available that are well positioned to provide a complete service. Most are able to assist with the up-front research into the needs of the potential use base, help with vendor selection and network design, and overall project management.

There is no doubt that videoconferencing is here to stay. There over 20,000 systems installed worldwide, about three-quarters of which are in the United States. The growth rate is around 40% per year. Technologies on the horizon, such as the picture phone and desktop-based videoconference devices, will continue to move digital compressed video into out day-to-day activities.

Computer
The computer is different from the other technologies in the distance education toolset in one fundamental way: it is a comprehensive, virtual environment for delivering a wide variety of technologies which we are accustomed to thinking of as discrete, including text, still graphics, animation, audio, video, and (increasingly) interactive programming. The additional hypertext functionality of the computer – which creates a linked or “webbed” environment instead of a linear one and permits easy and direct movement among related resources regardless of where in the world they are – provides substantial added value to computer-based programming. The computer is a completely asynchronous environment accessible from any Internet-connected personal computer, providing a great deal of flexibility to the learner while maintaining easy, central management of the learning resource and straightforward, immediate correcting or updating of content. The computer currently integrates with other Internet resources including email, list servers, news groups, and “chat.” The World Wide Web “browser” is incorporating access to these other Internet resources into its functionality and will, in the future, incorporate additional functionality, notably some form of desktop videoconferencing. It engages the learner and, by its very nature, encourages the use of learner-centered teaching strategies. The computer is rapidly emerging as a universally recognized environment for information management, education, entertainment, business and commerce, as well as many other uses.

Many problems exist in using the computer as an educational delivery environment, some of which have significant cost implications: (a) the learners must have access to Internet-connected computers with relatively high-end functionality, (b) provision must be made for providing computer support to students with widely varying degrees of skill in using computers, (c) relatively few faculty have the skills to develop course material for the computer, (d) sophisticated interactive and audio/video content ordinarily requires the assistance of a technician to develop, (e) video on the computer is primitive, (f) the tools for developing quality interactive material on the computer are only now being widely developed and distributed, (g) it is not well-adapted to teaching affective skills such as counseling, and (h) at a yet-undefined threshold, a large class making extensive use of email and list-servers for communication may place a substantial communication burden on teaching faculty.

Nevertheless, the computer – through its unique ability to provide a wide and rich variety of educational material to anyone, anytime, anywhere – is just about perfectly adapted to the needs of the older, employed student who may be married or supporting dependents and for whom traditional university education is problematic at best. As long as we do not obligate ourselves to provide learners with computers and do not accept responsibility for maintaining the learner’s computer, it is a cost-effective environment for teaching and learning. It is particularly cost-effective for: (a) text (which can be updated, changed, added, or deleted very quickly and be available to students as soon as it is modified), (b) audio (including audio “content” such as chest sounds as well as audio presentations), (c) multimedia features (video and audio clips, animations, graphics) integrated with text, (d) basis computer-assisted instruction as well as visually-enhanced CAI and simulations with moderate file size, (e) review quizzes, practice exams, and other self-evaluation tools, and (f) linking to related content on any computer server anywhere in the world; its tight integration with other Internet tools including email, list-servers, and news groups enhances its cost-effectiveness for communication and group processes and discussions.

Unlike traditional classroom or television approaches to teaching, teaching via the computer becomes increasingly cost-effective as a course is taught a second, third, or fourth time. Whereas the costs of interactive television increase greatly as additional remote sites are added, the addition of more students to a computer-based course actually increases its cost-effectiveness.

Trends/Conclusion
The most significant trend is still the merger of the computer and video into multimedia desktop terminals. The technologies that are converging are computing, television, printing, and telecommunications. Bringing them together results in the whole having greater impact than each individual part and is one of the industry’s most significant developments. The convergence of digital technologies and their use will impact the future of teleconferencing, distance learning, business, and entertainment. By joining television and computers, the best aspects of each technology are combined. The result is a powerful communications and information system that joins television’s ability to introduce and highlight a subject with the computer’s ability to provide in-depth information tailored to immediate needs. The computer changes existing media by helping one find, store, search, and reuse many kinds of information. The movement is still toward digital high definition television.

The trend will continue toward the miniaturization of videoconferencing to computers. There will be a continued move towards integrating multimedia with videoconferencing. The second generation of desktop videoconferencing prod-
products is making it sway into the market. There will be a continued drop in videoconferencing system prices due to lowered equipment costs and stabilized network rates.

The use of telecommunications technologies for distance education will continue to increase as educators deal with increasing numbers of students. It will become even more apparent that the ability to share resources through technology is a viable alternative to building more buildings. The need to retrain 50 million American workers and military personnel who have been mustered out will be a driving factor in the continued adoption of distance education. Distance education will be used to bring credit and continuing education programming into the school, workplace, and home. The impact of the new technologies will be felt in all areas of education and will take distance education to a different kind of level with the new desktop videoconferencing system leading students into more involvement with one another. It will help students develop a better sense of the world. As the new technologies stabilize, the expense will drop and make access to others as well as learning resources very cost effective. Computer and audio-conferencing for all educational organizations will become an important part of distance education. Instructional designers will need to learn how to weave the use of technologies into their methods. Overall, the technologies exist – what matters is how we use the technologies.

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