DOCUMENT RESUME

ED 384 828 CE 069 589

AUTHOR Stammen, Ronald M.
TITLE Using Multimedia for Distance Learning in Adult, Career, and Vocational Education. Information Series No. 362.
INSTITUTION ERIC Clearinghouse on Adult, Career, and Vocational Education, Columbus, Ohio.
SPONS AGENCY Office of Educational Research and Improvement (ED), Washington, DC.
PUB DATE 95
CONTRACT RR93002001
NOTE 85p.
AVAILABLE FROM Publications, Center on Education and Training for Employment, 1900 Kenny Road, Columbus, OH 43210-1090 (order no. IN362: $8).
PUB TYPE Information Analyses - ERIC Clearinghouse Products (071)

EDRS PRICE MF01/PC04 Plus Postage.
DESCRIPTORS Adult Education; Career Education; *Computer Mediated Communication; *Computer Networks; *Distance Education; Educational Technology; Educational Television; Hypermedia; Interactive Television; *Multimedia Instruction; *Telecommunications; Teleconferencing; Vocational Education

ABSTRACT

This paper explores how educators are using multimedia for distance learning, beginning with definitions of the concepts of multimedia, hypermedia, hypertext, distance education and distance learning. Three types of telecommunications technologies are described: multimedia with broadcast television, multimedia with interactive video (television), and computer-mediated communication networks. The educational opportunities opened up by the Internet and the emergence of the virtual classroom provide examples of the multiple options available for delivery of distance education. The paper examines some of the problems and issues raised by electronic influences and the technical, structural, and attitudinal barriers raised by resistance to technological developments. Instructional challenges and responsibilities that arise as these new technologies alter conceptions of teaching and learning are addressed. Suggestions for using multimedia with telecommunications technologies are presented. Options for using an overhead optical viewer and descriptions of experiments around the United States provide detailed examples of creative uses of multimedia. Finally, the paper suggests what adult, career, and vocational educators need to know in order to use these technologies for effective instruction. The degree of facilitator skill and knowledge and the time and resources available all contribute to the effectiveness of distance instruction. Most important perhaps is the imagination required to envision the new ways of expanding human potential that these technological tools afford. (SK)

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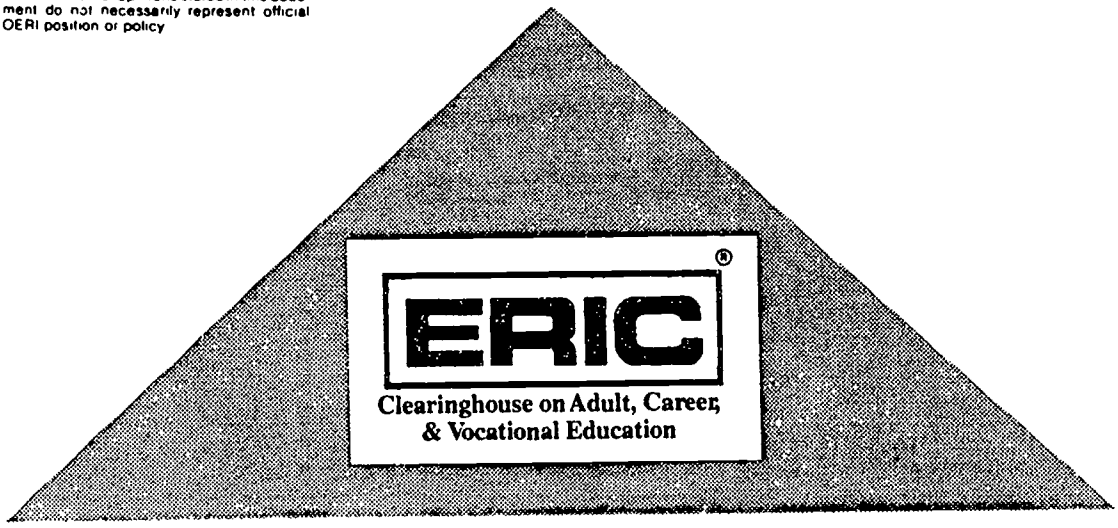

CENTER ON EDUCATION AND TRAINING FOR EMPLOYMENT
COLLEGE OF EDUCATION
THE OHIO STATE UNIVERSITY

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Center on Education and Training for Employment
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Columbus, OH 43210-1090

1995

Funding Information

Project Title:	ERIC Clearinghouse on Adult, Career, and Vocational Education
Contract Number:	RR93002001
Act under Which Administered:	41 USC 252 (15) and P.L. 92-318
Source of Contract:	Office of Educational Research and Improvement U.S. Department of Education Washington, DC 20208
Contractor:	Center on Education and Training for Employment The Ohio State University Columbus, Ohio 43210-1090
Executive Director:	Ray D. Ryan
Disclaimer:	This publication was prepared pursuant to a contract with the Office of Educational Research and Improvement, U.S. Department of Education. Contractors undertaking such projects under government sponsorship are encouraged to express freely their judgment in professional and technical matters. Points of view or opinions do not, therefore, necessarily represent official U.S. Department of Education position or policy.
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Foreword

The Educational Resources Information Center Clearinghouse on Adult, Career, and Vocational Education (ERIC/ACVE) is 1 of 16 clearinghouses in a national information system that is funded by the Office of Educational Research and Improvement (OERI), U.S. Department of Education. This paper was developed to fulfill one of the functions of the clearinghouse—interpreting the literature in the ERIC database. This paper should be of interest to adult, career, and vocational education practitioners and students.

ERIC/ACVE would like to thank Ronald M. Stammen for his work in the preparation of this paper. Dr. Stammen is Assistant Professor at North Dakota State University and Tri-College University as well as Administrative Consultant to the North Dakota Educational Telecommunications Council. He teaches graduate and continuing education courses in the organization and administration of educational telecommunications, using the Macintosh as an educational tool, interactive television for consortia, and instructional computing. He has served as chair of the Policy and Planning Board of SENDIT, North Dakota's K-12 statewide computing network; executive member of the North Dakota Information Network; and member of the five-state WINSM Taskforce on Telecommunications and Education.

The following people are also acknowledged for their critical review of the manuscript prior to publication: Mark Rossman, Professor, Walden University; Jill Ellsworth, Senior Partner, Oak Ridge Research; and Aaron J. Miller, Professor Emeritus, and Chuck Lynd, Information Specialist, the Ohio State University.

Publication development was coordinated by Susan Imel. Sandra Kerka edited the manuscript, and Janet Ray served as word processor operator.

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Executive Summary

As distance education technologies become more widely available, opportunities for combining multimedia and telecommunications for delivery of adult, career, and vocational education are expanding. This paper explores how educators are using multimedia for distance learning, beginning with definitions of the concepts of multimedia, hypermedia, hypertext, distance education and distance learning. Three types of telecommunications technologies that are driving the distance education phenomenon are described: (1) multimedia with broadcast television, (2) multimedia with interactive video (television), and (3) computer-mediated communication networks. The educational opportunities opened up by the Internet and the emergence of the virtual classroom provide examples of the multiple options available for delivery of distance education.

As accessibility widens and compatibility across networks increases, however, problems and issues involved in educational telecommunications become more acute. The paper examines some of the implications of electronic influences that are unbound by geographic location and the technical, structural, and attitudinal barriers raised by resistance to technological developments. Instructional challenges and responsibilities also arise as these new technologies alter conceptions of teaching and learning. The review suggests that the more important barriers may not necessarily be technical or economic, but conceptual and organizational.

With these cautions in mind, suggestions for using multimedia with telecommunications technologies are presented. The varying degrees of difficulty involved in using a variety of computer programs and presentation tools for projecting multimedia images at a distance are stressed. Options for using an overhead optical viewer and descriptions of experiments around the country provide detailed examples of creative uses of multimedia.

Finally, the paper suggests what adult, career, and vocational educators need to know in order to use these technologies for effective instruction. The degree of facilitator skill and knowledge and the time and resources available all contribute to the effectiveness of distance instruction. Most important perhaps is the imagination required to envision the new ways of expanding human potential that these technological tools afford.

Information on multimedia instruction and distance education may be found in the ERIC database using the following descriptors: *Computer Mediated Communication, *Computer Networks, *Distance Education, Educational Technology, Educational Television, Hypermedia, Interactive Television, *Multimedia Instruction, *Telecommunications, Teleconferencing. Asterisks indicate descriptors that are particularly relevant.

Introduction

The widespread availability of distance education technology is having an effect on the ways multimedia can be used for many aspects of adult, career, and vocational education. Distance education technologies have become more prevalent in the United States due to shifting economic and demographic patterns. Declining populations have forced small, rural schools and their communities to choose distance education as an alternative to further school consolidation or transporting students or teachers longer distances (Cahill, D'Amico, Hawkes, and Karim 1994; Hezel 1994; Nachtigal 1992). States have increased requirements for curriculum, graduation, and teacher training as colleges and universities have toughened entrance requirements (Cahill et al. 1994; Office of Technology Assessment 1988). College admission standards requiring high school foreign language are a major reason many statewide efforts were initiated to establish telecommunication networks (Cahill et al. 1994; Corporation for Public Broadcasting 1993).

The growing availability of bandwidth[1] and access to ever-improving networks are influencing school districts and higher education institutions' adoption of telecommunications. Competition in the telecommunications industry has become more acute due to a rapidly expanding market in excess of more than $2 billion per year. The availability of economically accessible telecommunication systems has also increased usage: organizations have been established in all 50 states to provide telecommunication links or distance education technology support for educators (Hezel 1994). Likewise, all 50 states have networks connected to the Internet (Ellsworth 1994).

[1] ***Bandwidth:*** the amount of information that a cable or electronic circuit can transmit or carry at one time.

The search for efficiency and effectiveness has caused many school districts and higher education institutions to change their focus from consolidation to redesign. Thus, they become central players in community development and sustain their viability through two-way interactive video networks with neighboring

schools or institutions, sharing specialized instructors electronically every period of the day (Jacobson 1995; Nachtigal 1992).

The purpose of this paper is to explain how educators are using multimedia for distance learning with these distance education technologies. The paper explores multimedia usages with new technologies for distance education in terms of their type and form as they relate to systems that have evolved from the technological mix of electronics, communications, telephones, computers, and television. The first section defines and explains these technological aspects as they relate to multimedia and distance learning and then addresses their relationship to distance education technologies currently available for these purposes. These technologies are categorized as broadcast television services, interactive video (television) networks, and computer-mediated communication systems. The Internet, which is also beginning to enable voice, video, and interactive data exchanges, is promoted as an ideal tool for adult, career, and vocational education.

The second section briefly outlines the issues and barriers involved in accessing distance education services and provides philosophical support for distance learning as a viable resource for adult, career, and vocational education. The purpose is to synthesize issues surrounding these evolving educational services and suggest that intelligent opposition must be seriously taken into account when promoting the use of multimedia for distance learning.

The third section presents some suggestions regarding the extent to which multimedia can be employed over telecommunication systems to achieve the best possible learning objectives. Actual practices and experiments are described.

The paper concludes by drawing some practice implications for adult, career, and vocational educators. This includes suggestions about what one needs to learn in order to use multimedia for distance education purposes. Ideas are advanced about the role imagination plays in developing the right multimedia presentation for the desired learning event.

The intended audience for this paper is primarily the adult, career, or vocational educator who wants to understand or know more about what is involved when using multimedia for distance education. The focus throughout this paper is on instructors or facilitators using multimedia while personally interacting with students or learners over distance education media. Acker and McCain (1993) and Avery (1994) found that the role multimedia interaction plays in distance education research and distance learning theories is not yet taken into account in current empirical research.

Consequently, this paper reflects what current literature explains is occurring and evolving in regard to such use; however, it is written by one who has extensively used these telecommunication technologies for educational purposes either as a student, instructor, researcher, or developer. These experiences include training teacher educators to use CompuServe; co-developing SENDIT, a popular K-12 statewide computer network; initiating a graduate program and teaching adult inservice courses over a statewide interactive video network; and serving as an administrator for a statewide educational telecommunications council (Dyrli 1993; Norton and Stammen 1990; Stammen 1991, 1993, 1994; Stammen and Vetter 1994).

Multimedia and Distance Education Technologies

This section provides background information necessary for a fundamental understanding of multimedia, distance education, and related technologies that bring about distance learning. Three types of educational telecommunication delivery systems are described: broadcast television services, interactive television networks, and the evolving computer-mediated communication systems. The latter encompass online commercial services and the Internet, which provide universal access to opportunities and various research and educational resources for adult, career, and vocational education. The conclusion summarizes how a combination of these tools provides a multitude of options for educators to use multimedia as an interactive communication tool for distance learning purposes.

Multimedia

Multimedia is a powerful tool for making an instructor more effective. It increases the instructor's power of communication within a learning environment to convey a message more forcefully. Multimedia is an innovative way to share information and motivate learning (Holsinger 1994; Rosenborg et al. 1993). Its definition has evolved from an assortment of connected audio-visual tools to the way computers are used to present and combine text, graphics, audio, and video (Busch 1994; Hofstetter 1995; Krol 1994; National Information Center for Educational Media 1981; Schwier and Misanchuk 1993).

Charp (1995) cites portions from Hofstetter's (1995) latest book, ***Multimedia Literacy***, which lists four qualifiers essential to defining computerized multimedia. First, there must be a computer that can coordinate what is seen and heard and provide a

means of interaction. Second, there must be links that connect the information. Third, there must be navigational tools. Finally, there must be ways to gather, process, and communicate one's own information and ideas. "If one of these components is missing, you do not have multimedia. For example, if you have no computer to provide interactivity, you have mixed media, not multimedia. If there are no navigational tools to let you decide the course of action, you have a movie, not multimedia. If you cannot create and contribute your own ideas, you have television, not multimedia" (Charp 1995, p. 4).

For the purposes of this paper, multimedia constitutes the use of one or all of the following systems for distance learning by adult, career, and/or vocational educators:

- A mix of audiovisual tools connected to an interactive video (television) studio console
- The retrieval of presentations containing a mix of text, graphics, audio, animation, and video via online computer-mediated communication
- A computerized multimedia system used with telecommunication technologies

Hypertext and hypermedia technologies are categorized with multimedia technologies in this paper even though specific technological definitions may differ (Vetter 1994). *Hypertext* is a nonlinear way (more than one way) of presenting information that allows users to access related documents from a single computer screen. Hypertext documents are linked to other textual documents stored in computer files. These documents have word(s) that are highlighted so they can be selected (clicked on using a computer mouse) to access additional information about selected word(s) on subsequent pages. *Hypermedia* is an extension of these hypertext files because they can also provide graphic pictures, images, and audio clips. Full-motion pictures can also be accessed through hypermedia (Vetter, Spell, and Ward 1994). Discrete hypertext uses specific indicators to denote the existence of additional related information; the learner activates the indicators by using a computer mouse to point and select (click) in order to access additional information. The learner can choose to continue to explore the additional

information or return to the point of departure and continue the original path (Schwier and Misanchuk 1993).

Multimedia technologies have great potential to empower learners' mastery of higher-order thinking skills. The leverage that sophisticated multimedia provides stems not from any single characteristic but rather from a synthesis of multiple attributes such as the following (Dede 1992):

- learning via structured discovery;
- motivational power;
- ability to tap multiple learning styles;
- weblike representations of knowledge;
- enhanced mastery through learner authoring materials;
- the collection of rich evaluative information; and
- technology-supported collaborative inquiry.

In essence, distance education instructors can be empowered to extend their presentations beyond linear (one-way delivery) multimedia capabilities available in their studios. They can develop new types of instructional strategies by taking advantage of computer-based, nonlinear hypermedia technologies that provide immediate access to interactive presentations containing sound, video, text, and graphics upon command (Dede 1992; Stammen 1995).

Distance Education and Distance Learning

Distance education and distance learning are different terms that are often used interchangeably. Basically, distance education is a structural term that refers to the hardware, the school building architecture, the equipment in the classroom, and all the "things" of production necessary to deliver instruction. Distance education also involves the policies and regulations that dictate choice, access, and usage, which form a structure in which teachers teach and learners learn (Cahill et al. 1994). Silvery and Cochenour's (1993) literature review found scholarly, but conflicting, perspectives regarding distance education definitions, so they developed their own comprehensive definition:

> We define 'distance education' as an academic discipline dedicated to an organized system of transferring (delivering) purposive educational information and materials to a receiving individual(s) and/or group(s), for a planned educational experience or result; through a medium (technical, mechanical, electronic, or any other) other than the conventional face-to-face (interpersonal) classroom relationship. There may or may not be immediate two-way communication, and the recipient(s) will not be under the continuous immediate direction of the sender (facilitator or teacher), nor in the same classroom. Progress of the learning (individual(s) (receivers) may or may not be monitored and/or evaluated, depending on the existence of any contractual arrangements. (p. 37)

Distance education, for the purpose of this paper, conforms to this definition, but the emphasis is on a form of instruction characterized by the physical separation of instructor (resource person or educator) from student (leader or learner), except for the occasional face-to-face meeting possible during some projects. It allows opportunities for instructor interaction, whether live or mediated, as well as for learner interaction (Keegan 1986; Zigerell 1984).

Distance learning is the learning that results from instruction that enables learners who are physically separated from the instructor to interact with that instructor, and possibly with other learners, through a range of technologies. These technologies empower learner and instructor with the interactive capacity to acquire needed feedback. This includes the opportunity to hold discussions to clarify, illustrate, and assess instructional materials or activities that are specifically targeted toward the distance learner (Cahill et al. 1994). Distance learning is a broad term encompassing technology that extends the learning community beyond the classroom walls and refers to the actual learning process(es) that goes on in the distance education environment (Woronov 1994).

Distance learning in the context of this paper involves the delivery of instruction via telecommunications technologies. These distance education technologies have the capacity to integrate

and use multimedia technologies that are either part of the instructor's interactive (video) television console or an integral part of a computer attached to network media.

Distance education has become a way to provide access to through a variety of telecommunications technologies to diverse learners who are place bound, bound by distances, or bound by economic efficiencies and/or policies (Johnstone 1991). Efforts to transform electronically the ways in which people communicate with one another are continuing to gain momentum and simultaneously enlarging the nation's capacity to educate (Adams 1993).

Technology's growing capacity to facilitate instruction at remote sites could well produce a watershed for education in the 1990s (Jacobson 1994). This phenomenon is being enhanced by educators who advocate live, two-way video connections that can bring "virtual" classroom experiences into learners' homes, workplaces, and other settings (Vetter 1994). Throughout the nation, state agencies are cooperatively developing telecommunication infrastructures to meet their various educational needs (Hezel 1993). This is being achieved as policy leaders strive to overcome technical, structural, and attitudinal barriers in local, state, and national environments (Hakes, Sachs, Box, and Cochenour 1993; McNeil 1990).

Telecommunication Technologies

What are the telecommunications technologies that are driving the distance education phenomenon? Gufstason (1989) outlines how Johnston, a pioneer in television and telecourse research, developed categories for new communication technologies by promoting the following three classifications:

1. Telecommunication technologies that are passive and linear (one-way delivery) such as radio, audiotape, broadcast television, and videotape, are classified as Level I.

2. Level II classification is for telecommunication technologies that are interactive (two-way communications) such as radio-correspondence, telephone, computer and modem, interactive videodiscs, instructional television fixed service (ITFS[5]), two-way audio and video via satellite, or electronic mail between microcomputers.

3. Level III-classified telecommunication technologies are an integration of passive linear and interactive communications such as using videodiscs with full-motion video that can query and respond or combining computer conferencing with a correspondence course.

[5] ***Instructional Television Fixed Service:*** a set of microwave frequencies that have been designated for use by educational facilities; allows television transmission over about 20 miles.

Distance education technologies can be categorized according to the type of technology and the form of delivery. The type and form affect the degree of instructional interactivity. Distance education delivery may be one of these types: two-way audio/two-way video, two-way audio/one-way video, one-way video, one-way video/one-way audio, or telephone/modem. The form of delivery is sorted according to such technologies as microwave, satellite, optical fiber, cable, and telephone (Cahill et al. 1994).

The form of telephone delivery can be defined in accordance with the size of the line (bandwidth) and the speed rate at which various data can go through these transmission lines. Telephone companies lease digital compressed video via T-1 and DS-3 conduits for two-way interactive video services. One T-1 conduit uses the capacity of 24 telephone lines, whereas the DS-3 conduit uses the capacity of 28 T-1 lines to transmit various forms of video/sound/data services. Some telephone companies can lease cable connections that use analog fiber optic cable. A fiber optic cable is a thin glass or plastic filament surrounded by a plastic jacket or cladding that can be used to transmit data by placing a controllable light source at one end and a light-sensitive receptor at the other end (Helmers 1989).

Some terms used here are defined or explained as follows:

- A *communication channel or circuit* is a path for the movement of electrical signals. It is also called a line or a link and can be several inches or several thousand miles long.
- The carrying capacity of a circuit is called the *bandwidth*. It is usually expressed either in bits (binary digits) per second or hertz.
- An *analog signal* is one whose (wavelike) amplitude varies continuously over time, and it is illustrated as a sine wave.
- A *digital signal* is a set of two discrete values that are electronic amplified characters in the form of 0 and 1, denoting off or on signals.
- All electrical signals are subject to attenuation (weakening or becoming thin in consistency), noise, and other transmission impairments.
- Although digital signals are quite resistant to corruption from noise and attenuation, the degree to which the circuits are insulated and protected minimizes these impairments.

These technological descriptions are basic definitions. Educators and facilitators interested in more intricate technological details should rely on detailed explanations provided by the technicians and engineers familiar with such services in their geographical area (Van Horn 1995b). The key factor in determining the type of telecommunication technology for distance education services is to match the size and type of geographic area to be served with the telecommunication service deemed appropriate for the needs of the educational units involved (Corporation for Public Broadcasting 1993).

The current evolution of telecommunication services for distance education draws upon the capacity of three industries that previously had not been so dependent upon each other. The industries involved with computers, television, and communication have brought about a convergence of their technologies that resemble functional system building blocks. They are merging computers, imaging, communications, and television into new distance education technologies (Hodge 1995). This evolution has resulted in three types of instructional delivery systems: broadcast television systems, interactive video (television) services, and computer-mediated communication networks (Barnard 1992; Stammen 1995). The following sections explain the nature of these three distance education vehicles that can use multimedia technologies.

Multimedia with Broadcast Television Services

Broadcast television services are those distance education services which originate from studios providing one-way video transmission and limited two-way audio interactivity. The productions are most often developed with the instructional design, format, and presentation technologies used in commercial television programs. The format is designed for large audiences located over vast geographical areas. A distinguishing feature of broadcast services is that the teachers (facilitators) cannot see the students (learners) (Corporation for Public Broadcasting 1993).

These services have been referred to as long, long distance education particularly because the microwave distribution covers a wide area transmitted through the following forms:

- Locally or regionally via towers
- Regionally or nationwide via satellite
- Worldwide via a combination of carriers

The satellite distribution area is referred to as a footprint. A wide area could cover the entire world if the microwave configuration is developed by the providers to link a variety of transmissions over satellites and towers to make the microwave connections. The public is familiar with commercial television's

ability to establish contact anywhere in the world during live newscasts. These broadcast systems use the type of delivery acquired from studios that send their one-way video signal by satellite, coaxial cable, or long-range terrestrial microwave transmission. Microwaves are analog signals that are transmitted through the air, between pairs of microwave antennas mounted on towers, the only requirement being that the antennas must be in sight of each other. A satellite link is a microwave connection with one of the repeaters[5] in orbit around the earth (Helmers 1989).

[5] ***Repeater:*** **device that receives an electrical signal, boosts it in order to increase the possible transmission distance, and retransmits it.**

Due to the high costs of two-way audio and video over great distances, educational broadcast forms of technologies typically have provided only full-motion, one-way video to the receiving sites where the students (learners) reside and view the instructor (facilitator). The instructor can hear, but cannot see the students. However, in most long-distance situations, oral feedback to the instructor is minimal or selective via telephone connections. The programming often emulates commercial or public television broadcast quality. There are many ways to develop one-way multimedia presentations, with the assistance of instructional designers, support staff, and studio technicians (Corporation for Public Broadcasting 1993). Other than these additional support services, broadcast television services employ the same multimedia concepts used for interactive video (television) services.

Multimedia with Interactive Video (Television) Services

Interactive video (television) services generally use the type of telecommunication technologies over closed networks provided by full-duplex technology (synchronous two-way video and audio). This means real-time extension of the regular classroom situation whereby all participants—both local and remote—can communicate or fully interact during classroom activities (Hakes et al. 1993).

Multimedia technologies are standard equipment for interactive video (television) transmission across most postsecondary or

local area vocational distance education systems. An instructor's console is standard studio equipment in distance education classrooms providing two-way interactive video (television) services. (Figure 3 on pg. 48 depicts a multimedia console.)

These consoles have a switch panel to control the video format shown on the system's television monitors located in classrooms throughout the network. There are attachments to connect computers and a document camera or overhead optical viewer capable of illustrating three-dimensional objects or displaying photographs, charts, maps, and any type of information from books. The camera that captures these documents has a zoom capability that can enlarge the tiniest object to be shown across a full television monitor (Tykwinski and Poulin 1991).

This same two-way interactive video network panel has switches to activate a videocassette recorder, slide transfer system, film transfer system, microscope camera, videodisc player, character generator, and a chalkboard or Marlite board. A fax machine, laser printer for the computer, and a regular telephone are located near the instructor's console.

The computer connections to an internal video output can make it possible to use computer-generated presentation software in full color and high-quality digitized sound. It can also connect to other peripheral devices such as a CD-ROM in a microcomputer or a modem to access data through telephone lines. In some networks, the studio consoles can be wired to a university's ethernet[5] with direct connection to the Internet in order to retrieve and illustrate video and sound presentation stored in computer files located somewhere in the Internet-connected computers in other states (Stammen 1995).

[5] *Ethernet:* a popular local area network technology developed by Xerox that interconnects multiple computer workstations.

The heart of regionalized telecommunications networks is the local telephone companies and cooperatives, usually called local exchange carriers (LEC). There are approximately 1,400 LECs in the United States including 22 Bell operating companies (BOCs). Although the latter are in urban areas, they connect rural LECs to AT&T and other long-distance carriers. BOCs serve about 80 percent of the households in the United States, but most rural areas are served by 1,400 independent (non-Bell)

telephone carriers. Consequently, seven different national associations plus a number of state associations exist and are concerned with the politics of policies, standards, and rates (Parker, Hudson, Dillman, and Roscoe 1989).

The access to two-way interactive video (television) services is no longer confined to closed- circuit networks. Kinko's, a retail chain of photocopy centers, is linking its stores nationwide with a Sprint videoconferencing and data network using both desktop and group videoconferencing systems from PictureTel. A customer is able to open a video link with another store or with any of the 3,000 public or private videoconferencing rooms located in 38 countries. This means a person can dial a toll-free number and pay a fee per half hour to operate the system, which provides the capability of presenting multimedia information during the distance conference ("Videoconferencing Comes to the Corner Store" 1994).

The major trend in telecommunication technology is the merging of voice, data, video, text, and graphics in a single stream of electronic communications. This integration through digitization is leading to many technological opportunities for educational institutions via desktop multimedia, video fileservers[5] for on-demand video, video transfers on the Internet, and data and voice handling by cable operators (Hezel 1994). For example:

> Integrated services digital networks[6] (ISDN), frame relay, and asynchronous transfer mode (ATM) are examples of digital transport systems and protocols that improve educators' abilities to transmit instructional messages at faster speeds using the public networks. Just in the last year, states and educational institutions have made swift moves to enhance digital services. Tennessee, North Carolina, and California are just a few states that have begun to use ISDN at various levels of education. Florida and North Dakota are both developing frame relay capabilities, and Florida and North Carolina are moving toward ATM uses. (p. 7)

Analog video networks are still considered the medium of choice for secondary schools due to the appropriateness of having a

[5] ***Fileserver:*** **a device that stores and distributes files to each computer on a local area network.**

[6] ***Integrated Services Digital Network:*** **a digitized telecommunications network allowing transmission of video, voice, and data over the same channel.**

monitor for each participating classroom. Such systems provide supervision. Voice-activated, compressed video[4] networks have only one monitor showing the receiving site that is speaking (Hakes et al. 1993; Hezel 1994). Major improvements are raising the level of educators' acceptance of compressed video media, especially in higher education, in such states as Vermont, Wyoming, Georgia, North Dakota, and 15 others. New generations of higher-power digital satellites are evolving for widely dispersed, rural populations that are not easily served by these modernized land systems. A number of states such as Georgia and Louisiana have distance education systems developed through a partnership with the Public Broadcasting Service known as the Satellite Educational Resources Consortium (SERC), begun with federal Star Schools funding. Likewise, the public broadcasting agency is the coordinator for video telecommunications in Kentucky, South Carolina, Nebraska, and Hawaii (Hezel 1994).

[4] ***Compressed video:*** video that is reduced to lower the amount of space needed to store and transmit it.

Video teleconferencing systems are two-way, interactive video units that are not permanently fixed in a classroom or conference studio. Video teleconferencing is closed-circuit television typically transported over a telephone network and/or a local-area digital network. The use of pictures, graphics, and visual cues categorizes video teleconferencing as a distance education/multimedia telecommunication technology. Portable units that include a television monitor attached to peripherals enable the video and voice images captured by a video camera to be compressed and transmitted across telephone lines equipped with Switched 56[5] compressed transmission equipment. In a video teleconferencing system, one can use a computer mouse to point and click on a phone book image on a monitor, selecting and automatically dialing a person's number. When that person answers, the caller sees his or her live video image in a small window on the monitor screen. (The person receiving the call also sees the caller on his or her screen.) If the unit is a desktop video teleconferencing system, all computer documents can be made available for viewing on the respective screens; they can be annotated to express ideas, files can be transferred, and the incoming calls can be logged in (Rosenborg et al. 1993). Another development in video teleconferencing is a large blackboard-style portable screen unit (LiveBoard ©Xerox) containing

[5] ***Switched 56:*** Transmission network operating at 56 Kilobits per second (Kbps) that allows dial-up videoconferencing.

a computer and its peripherals along with an infrared emitting pen than can be used for computer input by either touching the screen or actually writing on it. Whatever is written on this simulated blackboard can be saved in a computer file. LiveBoard can also display (video/computer/sound) input received from remote LiveBoards connected via modems and phone lines, enabling real-time video conferencing among users (Schuster 1995).

Simple video teleconferencing uses such systems as the AT&T VideoPhone 2500 between two locations. Video and computer technologies overlap each other as computers edit video and video is used to help communicate a message through computers. This has created the phenomenon known as the desktop video. It is the marriage of video and computers and is still in its infancy. It captures still video images, the input and display of full-motion video from a VCR, the taping of computer images overlaid on one video source and recorded on a VCR, and the digital storage (and retrieval) of compressed video signals (Rosenborg et al. 1993). QuickTime is an example of desktop video that runs on a medium-performance Macintosh (Thornburg 1994). "QuickTime is a system software extension that establishes a common file format that can fit different software and hardware applications. This capability makes QuickTime one of the most important breakthroughs for Macintosh-based multimedia" (Holsinger 1994, p. 37).

For cost comparative purposes, QuickTime system attachments for microcomputers cost about $200 and VideoPhone systems cost less than $1,500 as opposed to NEC's experimental virtual-reality teleconferencing system enabling three-dimensional viewing across DC-3 (ATM) lines at about $150,000 per station (Krasilovsky 1995; Rosenborg et al. 1993). Middle cost range for a fundamental video teleconferencing spectrum is the Hitachi DP-2000 videophone and PictureTel—between $15,000 to $20,000 with upgrades for multipoint capability over ISDN or Switched 56 compressed transmission over telephones at around $60,000 ("Videoconferencing" 1994).

Distance education telecommunication networks use such technological forms as uncompressed digital video, DS-3 (28 T-1

lines), analog fiber optic lines, or telephone compressed video (T-1) lines. Some networks combine terrestrial (land-based), digital, and analog networks. This form of delivery generally provides full two-way audio, video, and multimedia display capabilities. Terrestrial microwave with point-to-point receivers at specific schools (or "broadcast" to receivers at schools throughout the area) provides partial interactivity, which is known as Instructional Television Fixed Service (ITFS) or one-way video and multimedia presentation with two-way audio. However, recent enhancements have made it possible to provide full two-way interactivity. Options for interactivity are expected to grow with the increasing use of very small aperture terminal (VSAT) satellite technology for the return of data and voice communications from schools to distance learning program providers via satellite.

The same holds true with emerging long-distance point-to-point and multipoint videoconferencing systems. These telephone-television (compressed video) conference units use the telephone infrastructure with its dial-up capabilities. Multimedia presentations are provided by connecting microcomputers and/or an overhead optical viewer with ports for computers and related peripherals such as the optical overhead viewer, which is explained elsewhere in this paper and featured in figure 3 (p. 48).

Computer-mediated Communication Networks

A computer communication network is a group of computers connected together in some way so that they can send information back and forth among themselves (Ellsworth 1994). The transmission of text or multimedia data from computer to computer(s) over telephone lines, coaxial cable, fiber optics, and microwave signals via satellite links, or any combination over these transmission lines constitutes the computer-mediated (tele-)communication category. Computer-mediated communication gained wide acceptance in the past decade because of the Internet (explained later in this section) and the following commercial online services (Seguin and Seguin 1995):

DELPHI Internet, (800) 695-4005; INFO@delphi.com
e-World by Apple, P.O. Box 4493, Bridgeton, MO 63044-9718
GEnie, (800) 638-8369
America Online, (800) 827-6364, ext. 4857
Prodigy, (800) 448-8000
CompuServe, (614) 457-8600; (800) 848-8990

These services enable an individual with a personal computer to interconnect with various microcomputer and/or mini-mainframe computers to transmit electronic messages via modem over telephone lines and/or through direct connections over high-speed conduits. Participants at any number of sites can engage in real-time (synchronous) interaction by entering messages at the keyboard and reading messages as they appear on the screen. Messages can also be held by a computer host until the user checks in to retrieve these messages (asynchronous). Such information can be in the form of text, graphics, or data, video, audio, or any combination (Jacobson 1995).

The most commonly used type of computer communication is the text-based bulletin board among members of a computer network. In 1994, there were over 600 national services aggregatively providing several thousand bulletin boards that can be accessed online by the public, particularly from the nationwide networks (the Internet) developed by the government in conjunction with university and college systems (Ellsworth 1994). This does not count the private or closed-circuit bulletin boards used in corporate/business environments. The service may involve only a microcomputer and modem transferring messages with a connection to an online network. The category also includes computer conferencing[5] (text-based) systems, library search and retrieval, exchange of computer application programs, access of CD-ROM or stored hypertext, and other types of computer hypermedia presentations (Barnard 1992; Ellsworth 1994). The transmission technology for all these types of computer-mediated data is digital, which is becoming the prevailing mode for multimedia telecommunication technologies (Burger 1993).

[5] ***Computer conferencing:*** **linking of computers via telecommunications networks to a common space for discussion, exchange, and other activity.**

An important trend affecting the advanced usage of computer-mediated communications is the formation of the virtual or electronic library. This evolution has been brought about because computers are cheaper and faster, are shifting focus to the needs of general users rather than technicians, and have the ability of advanced applications to make extensive use of multimedia objects (Kline 1994). Examples of objects are word processors, presentation programs, video editors, page layout applications, and data management software. In other words, distance education multimedia objects are tools used to manage and manipulate information with a computer that is online and connected to other computers through whatever connection is made available to whatever network the computer is attached to at the time (Barnard 1992).

When its physical location is identified by an access path, information can be stored and retrieved virtually anywhere. A library may be a method of access to information regardless of where it is and what form it is in. A virtual library has sometimes been referred to as a "library without walls," "digital library," or a "logical library." The key to a virtual or electronic library is the transparency of use and the ease of connecting libraries through the Internet (Goodrich 1994).

In the "virtual" classroom, the facilitator and learner are both at different times and different locations. Such virtual classrooms are being enhanced by unique computer programs (Frand 1994). Computer authoring programs, object-oriented programming, and multimedia/hypermedia programs are powerful representational architecture that support visualizations involving computer graphics and video. They can be combined to create a richly detailed virtual world in which interconnections among data can be made visually explicit. As these kinds of multimedia environments become more common, instructional designers will face new types of challenges to match a mixture of textual, auditory, visual, and psychomotor presentations to varied learning styles (Dede 1992; Vetter 1994).

Due to the rapid growth in technology, instructional applications are gradually shifting away from tutorials, simulations, games,

and drill-and-practice to multimedia/hypermedia environments designed to motivate and guide exploration. These environments can mimic real situations to enhance learning by reaching a broader range of student learning styles than any single medium. Learning situated in these virtual worlds can be similar that in to real-world settings. The knowledge and skills being applied will be more likely to transfer and be strongly motivating when designers incorporate elements that stimulate fantasy, challenge, and curiosity to increase emotional involvement.

Broader ranges of sophisticated uses for distance education will develop when the telecommunications capabilities are enhanced with widely distributed high bandwidth. This will constitute a synthesis of artificial (virtual) realities beyond the current capabilities of moving images, broadcast and narrowcast television, videotapes, videodiscs, multimedia, and hypermedia technologies (Dede 1992). The current limitations do not reside in computer and telecommunications technology, but rather in the lack of bandwidth that makes circuit connections from one location to other distant locations (Gilder 1994).

The Internet

Computer-mediated communications became widespread in education because of the Internet. Internet connections were originally developed with funds from the National Science Foundation (NSF) to transfer research data over long distances using the capacity of supercomputers. Transmission of text-based messages evolved during this development early in the 1980s and gradually became the main reason people used the Internet, making it easy to communicate between colleges and universities throughout the United States and many other nations. Figure 1 illustrates the extent to which the Internet was used throughout the world in 1994. (This map was accessed with FTP[8], a computer file transfer protocol application from Internet resources and printed when it appeared on the computer monitor in the author's office.)

[8] ***FTP (File Transfer Protocol):*** **process that allows a user linked to one network host to access and transfer files from another host.**

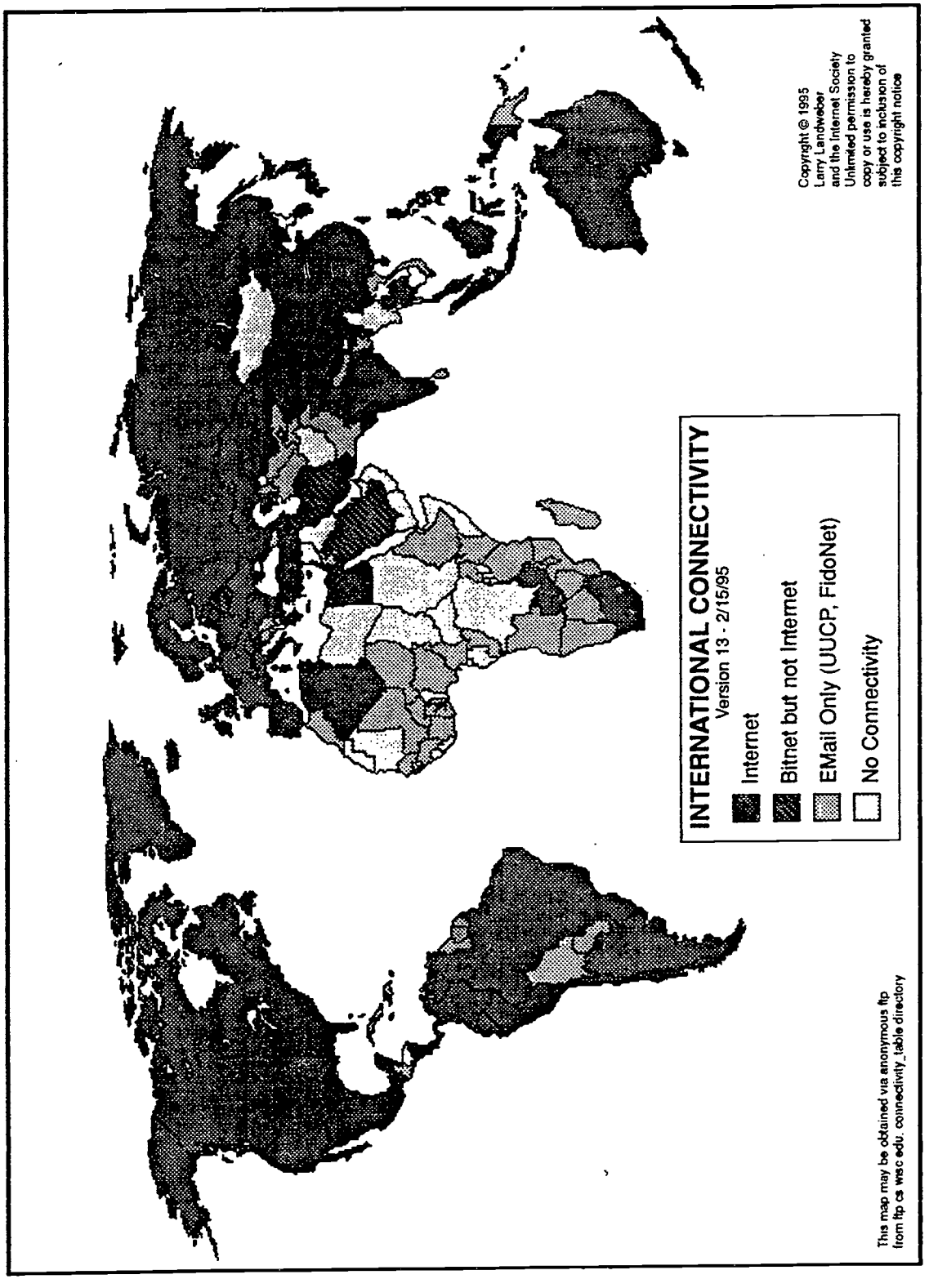

Figure 1. Worldwide use of the Internet, 1994

Distance education courses using text-based documents transmitted by electronic mail, listservs, newsgroups, computer conferencing, and other computer online services are prevalent in the Internet computer-mediated communication environment (Krol 1994). Figure 2 shows an example of how adult education opportunities are being communicated over the Internet via listservs. This particular message provided considerable detail about the content of the courses being offered over the Internet.

>From: dubie@tnpubs.enet.dec.com ("I, Dubious: LKG1-3/L12, DTN 226-5144 16-Feb-1994 1318")
>Message-ID: <9402161813.AA11034@enet-gw.pa.dec.com>
>Subject: Online Courses at the University of Western Ontario
>Date: Wed, 16 Feb 94 10:13:25 PST
>X-Received: by usenet.pa.dec.com; id AA25790; Wed, 16 Feb 94 10:13:58 -0800
>Please respond to the sender of the original note.
>
>** ***
>* ##### ##### ##### ##### * The University of Western Ontario *
>* #   #   #   #   #   *   Faculty of   *
>* #####   #   #   ###   * Part-Time and Continuing Education *
>* #   #   #   #   *   **************************** *
>* #   #   ##### ##### *   *   WESTERN ONLINE   *   *
>*   *   *   Winter 1994   *   *
>** ***
>
>The following online courses are non-degree credit courses offered by
>The University of Western Ontario. The courses offered are:
>
> 1) Connect With The World: Computer Communications
> 2) Basics for Your Job Search
> 3) Writing for Fun and Profit
> 4) Navigating the Internet
> 5) Shareware Secrets and Free Finds
> 6) PC Exploration and Troubleshooting
> 7) Introduction to Unix
> 8) Programming the Bourne Shell
>
>Short course descriptions follow.
>
>For more information about these courses please feel free to contact:
>
> Mike Baycroft - baycroft@uwo.ca

Copied online from an e-mail program and pasted here without any change

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Figure 2. Example of an Internet message advertising adult education opportunities

The Internet offers a series of multiple connections among all sizes, models, and shapes of computers. The various long-distance connections between these computers are most often via telephone lines that have been installed in various sizes to accommodate the electronic traffic being transferred from one point to another or from many points to many points. To use the Internet, an individual needs to find an Internet access provider and get an account with the provider (Ellsworth 1994).

Krol (1994) states that it was easy to define the Internet 5 years ago. At that time it was composed of all networks using the Internet protocol, which formed a seamless network for the collective users. This included various federal networks, a set of regional networks, campus networks, and some foreign networks as illustrated in figure 1. Now, through innovations and technological advances, the Internet is able to transfer all sorts of multimedia, hypermedia, and related telecommunication packaged audio/video services (Vetter et al. 1994).

Even though ownership is changing as the private sector becomes more involved, there is no single authority over the Internet as a whole. Krol (1994) describes the system by answering the question "Who pays for it?" as follows:

> No one pays for "it"; there is no Internet, Inc. that collects fees from all Internet networks or users. Instead, everyone pays for their part. The NSF pays for NSFNET. NASA pays for the NASA Science Internet. Networks go together and decide how to connect themselves together and fund these interconnections. A college or corporation pays for its connections to a regional network, which in turn pays a national provider for its access. (p. 17)

Although someone pays for every connection to the Internet, many researchers, educators, and students use publicly funded connections between schools, colleges, universities, and other government agencies. This has perpetuated the myth that the Internet is free. The fastest growth areas for the Internet are probably small businesses and individuals, and these users are

very aware of the price (Krol 1994). Many nonprofit regional Internet networks have been purchased by private industry as government subsidies subside. Commercial Internet services are being offered by AT&T, M.C.I, Sprint, regional Bell operating companies, and many others (DeLoughry 1995).

The Internet is becoming a standard across the nation for exemplary computer-mediated communications activity. Newbarth (1995) provides a list of documented examples showing the extent to which this medium is receiving public attention, its explosive growth, commercial activity, and controversial issues. He cites how leading newspapers and magazines throughout the nation are providing an exceptional amount of coverage in the form of articles, ads, and cartoons about Internet activity. World Wide Web[5] capabilities have brought multimedia into the forefront with distance education opportunities for adult, career, and vocational education activities.

[5] ***World Wide Web:*** **a hypertext-based system for finding and accessing Internet resources.**

With the Internet providing the capability to "ask an expert," adult, career, and vocational educators' prime benefit is networking among colleagues, facilitators, and learners. The Internet has enabled communications to an extent that was not possible ever before on an international scale. As educators gain access to the Internet and commercial online services, the applications and potential for lifelong learning are evolving. Financial constraints have kept educational networking at the low-end, text-based communications level even though much attention has been given to the high-end projects being undertaken. The latter involve large-scale collaborations using high-performance computers, and graphics, video, and multimedia programs that convey complex information (***Realizing the Information Future*** 1994; Thornburg 1994).

There is a wide gap between those who know how to access online services with a computer and those who do not, as well as those who do and those who do not have access to the Internet. However, anyone with access to a telephone and funds to acquire the technologies and pay the telephone costs can access the Internet.

To enable people to use the technologies without computer training, the Microsoft Corporation in Redmond, Washington, is developing software to make it much easier for those who have little or no experience with computers. Microsoft "Bob" runs on Windows and has features to make computers more friendly at a cost of less than $100. The program uses "virtual desktop" screens that simulate rooms in a house. Colorful, cartoonlike characters guide users through basic computer tasks such as writing letters and accessing the Internet through e-mail. This development is even easier than the graphic user interfaces (the icons seen on the screen) that made Macintosh an easy-to-learn system (Associated Press 1995).

Internet users are bound by the capabilities of their equipment and the bandwidth of their telephone, cable, or microwave access. When providing resources on the Internet, it is often necessary to accommodate these individual differences and limitations.

Although it is easy to use a mouse, which controls an arrow to select (click on) icons, pictures, and words to access documents, it is not as easy as having "virtual" characters pop up to ask what is wanted and give directions as to where to "click" to acquire what is desired. Yet, although the virtual capacity is being developed, Internet users are bound by the capabilities of their equipment and the bandwidth of their telephone, cable, or microwave access. When providing resources on the Internet, it is often necessary to accommodate these individual differences and limitations. For example, the following directions to subscribe to an Internet service (Net-Happenings) were developed by Gleason Sackmann (Krumenaker 1995, p. 81):

> To subscribe to the net-happenings mailing list, send e-mail to majordomo@is.internic.net with the subject blank and "subscribe net-happening" in the message body. To receive the net-happenings digest (fewer messages per day), enter "subscribe net-happenings-digest" in the body instead.
>
> To search the net-happenings archive, telnet to gopher.cni.org, log in as "brsuser," and follow the directions. Postings to the net-happenings list are also available (and searchable) via Gopher at several sites, including guru.med.cornell.edu /Academic Computing/E-Mail Lists/Net-Happenings, and samizdat.unh.edu /The Internet/ InterNIC resource announcements.

On the World Wide Web, using a program called Netscape[5], you can search the net-happenings index at two sites:

http://www.internic.net/htbin/search-net-happenings
http://www-iub.indiana.edu/cgi-bin/nethaps

[5] ***Netscape:*** **one of several hypermedia browsers that enables users to access and integrate a variety of material via the World Wide Web.**

Educational resources are abundant on the Internet. Accessing data on the Internet takes little time to learn and is inexpensive for moderate users who are unable to have free access through an educational institution source. The ease with which to search and retrieve these resources is increasing as clients (users) are able to acquire information with one consistent interface that interacts with different types of servers on the Internet (Ellsworth 1994; Goodrich 1994; Krol 1994). A comprehensive resource for anyone interested in adult, career, and vocational education is Ellsworth's (1994) hands-on book of ideas, resources, projects, tips, addresses, and advice on using the Internet for educational purposes. Krol's (1994) user's guide and catalogue is a rich resource. Both of these texts and many others about using Internet are readily available at bookstores everywhere. The volume of courses, programs, and educators using the Internet is increasing rapidly.

DEOSNEWS, an online discussion forum, contains abstracts of articles from the ***American Journal of Distance Education***. This journal has been published three times per year since 1987 at the American Center for the Study of Distance Education at the Pennsylvania State University. Its stated purpose is to disseminate information and act as a forum for criticism and debate about the research and practice of distance education in the Americas. The focus is on the role of print, electronic, and telecommunications media and multimedia systems in the delivery of education in the universities and colleges, business and industry, the military, proprietary schools, and in the public schools.

Summary: Multiple Options

The combination of telecommunications technol gies and multimedia provides a multitude of options for delivering distance learning. Multimedia with broadcast television can reach a wide area and often emulates the quality of commercial television; the instructor can see, but not hear, the learners. Multimedia with interactive television provides two-way audio and video and can merge voice, data, video, text, and graphics; these systems range from high-cost, highly sophisticated PictureTel to less expensive QuickTime and Video Phone. Computer-mediated communications involving multimedia enable the virtual library or the virtual classroom; uses range from high- to low-end projects and encompass the full spectrum of user skills and equipment capabilities.

The following examples illustrate how instructors can select from these different options to meet various educational needs. An instructor, teaching over a two-way interactive television network, chooses to download a video program from a satellite dish for students to view over a two-way interactive television network. This approach could also include the options available to display computer graphics accessed online from computer networks and requires adult learners across the network to submit their reactions by e-mail. Another option would be when an instructor can retrieve video clips over the Internet to enhance interactive-video presentations over any of the telecommunication systems (Barnard 1992; Stammen 1995).

The University of Wisconsin-Madison's Continuing and Vocational Education department conducts distance education professional development seminars using basic telephone technology with considerable success for adult educators (Olgren and Kearsley 1994). Their courses involve a combination of print-based materials, online Internet communications, and a 2-hour long-distance telephone conference. For example, an audio conference seminar supplemented with Internet communications addresses the issues in using multimedia systems based on the question "What is the potential of multimedia for distance learning applications?" The distance education seminar addresses current capabilities and limitations and describes

examples of how systems are used for desktop and group learning with discussions about trends in CD-ROM technology and multimedia networking. Print-based materials and e-mail messages are provided for the adults to study and review prior to the telephone conferences.

First-time integrated multimedia (text, two-way audio, slow-scan video, and bit-mapped graphics) have been used to create a classroom environment across the country via the Internet (Vetter 1994). The Virtual Meeting (TVM) uses RTZ software to access a Macintosh-based conferencing system that can control multiple computers across a wide area. TVM can incorporate sound, graphics, program information such as spreadsheets, word processor documents and other scheduling software along with QuickTime video. The data must be resident at each computer at the onset of the conference; however, control data can be provided in real time so each user can see the same screen display (Rosenborg et al. 1993; Thornburg 1994).

These possibilities are being enhanced as more and more networks are acquiring nationwide access. The need for standards is addressed in a report titled ***Realizing the Information Future: The Internet and Beyond*** (1994). This report attests to how the National Information Infrastructure can widen access to all types of telecommunication networks. The purpose of this report is to explain what architecture is necessary for the recommended Open Data Network that can send information of all kinds from suppliers of all kinds to customers. As access widens and compatibility across networks increases, problems and issues surrounding the use of educational telecommunications become more acute. These issues are addressed in the next section.

Cautions about Using Educational Telecommunications

The impact of distance education technology on education grows in proportion to educators' understanding of how proper use can enhance and change distance education. With few educators knowing much about these technologies, the impact of technology on schools and education is, at present anyway, minimal (Van Horn 1995a). Multimedia technologies in themselves do not automatically change the nature of teaching and learning; rather, it is the way educators integrate such technologies into curriculum that brings about change. Equally important are the reasons such technologies are integrated into the teaching-learning process and how they fit into the wider goals of education. There must be a clear understanding of the benefits they are supposed to produce, their educational value, and what type of learning is enhanced through which medium. It is important to determine how best to use tools for education that combine high quality technology with high quality instruction (St. Clair 1989; Stoll 1995). Accordingly, this section provides a synthesis of the barriers, issues, and educational concerns as a basis for understanding the pedagogical challenges and responsibilities inherent in using educational telecommunications.

Multimedia technologies in themselves do not automatically change the nature of teaching and learning; rather, it is the way educators integrate such technologies into curriculum that brings about change.

Barriers and Issues Involved in Distance Education

Karl P. Sauvant (1989), then acting assistant director of the United Nations Center on Transnational Corporations, emphasized the following during a lecture series sponsored by the Batelle Institute in Columbus, Ohio:

> The point is that if you cannot see it, hear it, and are not involved in it, you have no idea as to the magnitude nor

> the extent to which the world is beginning to be served by instantaneous integrated interactive telecommunications. Transnational corporations use their electronic satellite systems for daily accounting, financing, banking, and inventory control/replacement. It collapses time and space for information intensive services and offers tremendous potential for multinational trade and services. If we are allowed to freely do what these mechanisms can do, we have a new range of opportunities that all can take advantage of no matter where they are in the world. (p. 1)

The interconnectedness of complex telecommunication systems in and out of the educational circles, and particularly within the corporate world, enhances national and global interdependence between multiethnic and multicultural societies (Benjamin 1989). As familiarity with technology is becoming commonplace, it is easier and more enjoyable to travel around the world through communications, microelectronics, and transportation. This helps to create a global interconnected society in which biological, psychological, social, and environmental phenomena are all interdependent. Cumulative increases in the rate of change due to increased knowledge have been the decisive factor in the making of the present modern world. Knowledge itself undergoes rapid restructuring and will continue to do so as it doubles and doubles again as it has during the 20th century.

Social consequences in regard to the evolving information age are not based on locality. Future electronic "unbound" geographical influences may become a dominant influence on individual behavior. This implies that changes occurring in those interactions may not simply be extensions of the mass society trend, as has been the case in recent decades, but the move might be toward satisfying individual wants with customized products and media. New technologies are seldom neutral in terms of human consequences and tend to carry with them the seeds of opposition that may stop or limit their development by those who do not accept the fact that transformations are occurring with distance education and multimedia (Dillman 1985; Jacobson 1995).

Stoll (1995) cautions about educational use of computer networks without the aid of tutors, particularly regarding the use of interactive videos and remote broadcasts, emphasizing that they "are no substitute for studying under a fired-up teacher who's there in person" (p. 118). As educators begin to learn more about the telecommunication industry, they must exercise caution in order to evaluate the relationship between the technological "innovativeness" of schools and the social components of the school system, human resources, management, and organization. This will enable better understanding of how changes in technical structures precipitate and demand changes in social structures and vice versa (Perelman 1988).

Surveys and focus group data indicate that computerized technologies now in educational institutions are underused as tools for integrating the teaching-learning process (Van Horn 1995a). Many educators lack not only training in multimedia applications and the forms of assistance this technology offers, but they do not have the time, the resources, nor the opportunity to explore their creative capabilities. Those educators who do implement such projects must work harder, concentrate more, and embrace larger pedagogical responsibilities to acquire considerable additional knowledge and skills for effective use of emerging multimedia technologies (St. Clair 1989; Van Horn 1995a).

Those educators who do implement such projects must work harder, concentrate more, and embrace larger pedagogical responsibilities to acquire considerable additional knowledge and skills for effective use of emerging multimedia technologies.

Once the decision is made to adopt and implement multimedia technologies for actual use in the classroom, there must be continued use or collaboration to reinforce the decision while it is becoming a real part of the teaching-learning environment. Educators must be provided time and training to become comfortable with new procedures. Such support rarely exists in school districts or in teacher education programs. Organizers and administrators who implement distance education telecommunication technologies must be fully aware of the barriers involved in the process, primarily barriers incorporated within the technical, structural, and attitudinal domains involving resistance to technological developments (Corporation for Public Broadcasting; McNeil 1990):

- **Technical.** Technical barriers include the lack of standards, incompatibility between hardware and software, lack of proper instructional software, and instructional requirements.

For distance learning, there are two inherent problems: providing the student with sufficient educational resources and providing timely feedback from the instructor to the learner. Other technical barriers involve the pace of change, inequitable access to telephone service, access to computing, inadequate software design, and complications with support services.

- **Structural.** Structural barriers constitute budgeting policies, lack of incentives, lack of training or technical support, poor support services, software development, financial resources, access or disproportionate access, extra time required to use technology, and underuse. For distance education there is a need for collaboration regarding rules and regulations, particularly transmission across state boundaries, access to libraries, and lack of accessing skills. States, localities, the federal government, and the private sector all have roles to play in planning, funding, and implementing distance education. A government report contended that future development will require involvement of the following (Office of Technology Assessment 1988):

  —telecommunications policy;
  —research, evaluation, and dissemination;
  —the instructor's role; and
  —the infrastructure for distance learning.

- **Attitudinal.** Attitudinal barriers involve reluctance to use mechanical or technological tools and faculty resistance to public exposure and off-campus learning, plus fear of poor marketing orientation. In the distance education enterprise, the role of the learner, social-technical phenomena, and leadership are important influences on attitudes (Acker and McCain 1993; Perelman 1987).

Policymakers at all levels of government need to focus their attention on expanding the amount and capability of technology in schools; providing training and support for educators; encouraging innovation in educational software; and supporting research, development, demonstration, and evaluation, with emphasis on ties between research and the classroom (Hezel 1994; Office of Technology Assessment 1988).

Telecommunications policy affects costs, capacity, and the types of services available to distance education. Congress has yet to review and shape policies that reflect the nation's educational needs. Where no clearly stated educational technology policy exists, planning tends to be scattered and technologies are often implemented more haphazardly. However, where technology planning is unified by policy, the likelihood of unified funding and cost reduction is enhanced (Hezel 1990; ***Realizing the Information Future*** 1994).

Nationally active groups are the U.S. Department of Education, Council of Chief State School Officers, other such central organizations, and various federations of interested individuals. National economic and funding considerations, technology planning, and implementation of policies and guidelines combine with individual state governance issues to create a complex composite of issues needing attention.

Solutions for these issues might be easier if priorities were established for a coherent federal policy that supports and assists states in planning and funding technology development. These priorities include state-supported projects in which institutions share and cooperate innovatively with an openness to divergent technologies and demonstrate an affirmative commitment to evaluation followed by an interest in sharing research data and results. Other priorities are encouraging expansion of consortia, establishing publications, and holding dissemination meetings for further adoption of technology and telecommunications (Hezel 1990).

States are resolving many of these issues by making it a high legislative-executive priority to include all aspects of governmental telecommunication in cooperatively planning and developing infrastructures to meet the demand for distance education technologies (Hezel 1994).

Mody (1989) provides advice garnered from her active research and worldwide involvement in distance education. The following is synthesized from an address giving generic guidelines for using the various modes of telecommunication media, as well as producing material for telecourses broadcast by satellite or transmitted over land-based microwave:

- Understand the technology that is delivering the telecommunications.
- Understand how to tailor and customize for special groups.
- Understand the capacity of the endeavors undertaken.
- Understand how to structure the content for the programs.
- Understand that education has a political and economic context.
- Understand that the active dimension of programming for an audience is simplicity with an active audience asking questions.
- Understand that telecommunications requires formative research, segmentation, and augmentation.
- Understand that telecommunications offers an opportunity to rewrite and reconsider content in order not to deliver more of the same in a new medium.

Technological and structural issues and barriers can most often be solved with proper funding. However, the attitudinal issues (politics) and barriers are generally overcome through exploring all possibilities by reading, visiting, and attending conferences to understand how to use multimedia technologies over telecommunication networks (Lynch 1994; McNeil 1990).

Pedagogical Challenges and Responsibilities

Computer-mediated telecommunications technologies are changing the nature of today's classroom as they are able to link more computers into a worldwide communications network. With a relatively modest investment of time and money, instructors can create a "global classroom" in which the world and its people become an integral part of the students' learning environment (Kurshan and Dawson 1992). The following quote by Ohler (1990), electronically "pasted" into this document without ever being retyped since it left Alaska via telecommunication media, captures the essence of electronic distance education telecommunication delivery systems:

> In the industrial age, we go to school. In the information age, school can come to us. This is the message implicit in the media and movement of distance education. (p. 1)

However, adapting these tools of technology to the field of education will not be an easy task (Van Horn 1994). St. Clair (1989) explains:

> It will require time, resources, and creativity. Educators lack training in the application and forms of assistance that technology offers. The monumental problem for our schools is that the tasks of planning, curriculum, and instruction are viewed as relatively static. (p. 67)

Changes that can be enabled by technology include the growth of informal professional groupings among educators, collaborative learning projects conducted throughout regions and across national borders, connections between homebound students and ongoing classroom work, and "distance learning" that puts instructional experts in touch with students located thousands of miles away (Hezel 1993, 1994; Mecklenburger 1989).

These long-desired ideas are now made feasible because technology—electronic networks, fax machines, and telecommunications via microwave, satellite, and fiber optic equipment—has conquered logistical obstacles. The use of distance education services is developing rapidly and becoming cheaper as the technologies become more powerful. Consequently, technology has been enlisted more and more to meet the needs of geographically isolated schools. Schools are using computer-mediated communication based on video text, two-way interactive television based on voice and video, and a variety of combinations that are based on video text, videographics, video, and/or voice. Factors influencing usage depend on demographics, economics, and distance (Corporation for Public Broadcasting 1993; Office of Technology Assessment 1988).

Earlier work by Johnston, Chu, and Schramm, pioneers in instructional television evaluation, affirmed research findings that media can teach effectively (Avery 1994; Gufstason 1989). An early study conducted by Carlisle (1987) involved extensive interviews with 158 teachers, school administrators, and media coordinators or library media specialists in 70 communities in 12 midwestern states. His findings provide in-depth insight into how school library media centers are adequately using a variety

of "stand-alone" technologies for supplementing classroom instruction. His study implies that this expertise serves as a prerequisite to venturing into "network" technologies that reach beyond the classroom. Educators' knowledge and subsequent use of microcomputers precedes most endeavors to use telecommunications technologies that extend beyond the classroom.

New technologies have less to do with efficiency as a teaching tool than with the way they alter the conception(s) of learning and teaching. Such new communication developments are often touted more than the educational benefits (Randall and Hite 1994). Hypermedia (a multimedia mix of data, sound, and video) may become merely "hyped media" unless good teaching applications are developed to use its capabilities more effectively. Along with providing some significant examples of technology use in educational settings, White (1989) emphasizes that the following questions must be addressed when deciding to use technological tools:

Hypermedia may become merely "hyped media" unless good teaching applications are developed to use its capabilities more effectively.

- What is the educational value?
- What type of information is best presented through which medium?
- How will we get more tools for education that combine high quality technology with high quality instruction?

Landauer (1988) supports White's concern: "It does not involve so much how education will be changed by technology as how the wisdom of education ought to influence technology" (p. 50). Telecommunications and multimedia technological tools can enable an educator to cope with the knowledge explosion (Van Horn 1995b; White 1989). However, educators who choose to use them must accept that they entail larger pedagogical responsibilities than if they merely assign text chapters and seat work.

Cohen (1988) emphasizes that educators who develop technological products (such as multimedia presentations) must have considerable technical knowledge and skills to use them effectively. Educators must, for instance, deeply understand the material and grasp how students think about what is presented. They must be able to comprehend learners' interpretations of problems, their

mistakes, and their puzzles. They must have the capacity to probe thoughtfully and tactfully to achieve the purposes intended and solicit feedback that checks for understanding. Cohen emphasizes that "the products educators produce must be presented in ways that engage learners' minds in order to help them frame fruitful hypotheses and discard unfruitful ones." (p. 240) The essence is the human interaction, which can create a social impact resulting from the widespread adoption of the information technologies; that is, technologies that provide speed, capacity, fidelity, miniaturization capability, range, and the ability to select along with the relative importance of telecommunication transmissions. Included is the impact of its potential ability through artificial intelligence (computers making decisions) to conceptualize problems and possible solutions in ways beyond individual human capabilities (Dillman 1985).

Looking at this challenge another way, the most important barrier to this technological opportunity (revolution) is not necessarily technical or economic, but conceptual and organizational; unless controlled, the outcome of these changes may be undesirable. Educators must begin shaping the uses of these emerging technological tools to ensure a bright educational future (Dede 1989; Gibson 1992). The greatest challenge facing education is not technology, not resources, not accountability—it is the need to discover with students a new way of thinking. Perhaps by understanding and taking advantage of the concepts of "cognition enhancers" and "artistic use of hypermedia," one can combine computer and telecommunication (information) technologies to achieve this end. Cognition enhancers combine the complementary strengths of a person and an information technology (Crowell 1989). They provide ways to empower the environment and simulate long-term memory within the hypermedia capabilities of storage and retrieval (Dede 1989).

The greatest challenge facing education is not technology, not resources, not accountability—it is the need to discover with students a new way of thinking.

The heart of this technological revolution is not technological, it is intellectual as it is a new tool for the human mind (ibid.). The essence of these new information technologies is that they can change how mental operations are affected or supported, how information is represented, how problems are viewed or analyzed, and subsequently how decisions are made. This affects long-range planning, predictions, and publishing, and it

enhances the mental tool of imagery to the status of a new language. This implication poses the question, "How shall imagery be taught as a powerful tool of the mind?" (White 1988, p. 7).

Telecommunication media as distance education tools are ideal for individual criterion-referenced (heuristic) learning and class norm-referenced learning. Although there is a difference in time and expense between these alternative educational performance-based paradigms, modern telematic technology is intrinsically and progressively heuristic—it both facilitates and demands learning through successive cycles of trial, error, and evaluation (Perelman 1987). The ultimate goal is for learners to become instructor-independent thinkers, lifelong learners, and problem solvers. The general aim is to create tools that enhance the chances that learners adopt a self-aware state of mind and that they be provided with transferable access skills, heuristic strategies, and a sufficiently rich taxonomy of problem types for each domain of study to make the application of technological tools that facilitate heuristic learning worthwhile (Pea 1988).

Using Multimedia via Telecommunications

The technological difference between using multimedia for instructional purposes in a regular, traditional classroom as opposed to a virtual, distance education classroom is the "connection" to some type and form of distance education, telecommunications technology. This section describes how multimedia tools can be used over such telecommunication networks while providing services in adult, career, and vocational education settings. Multimedia options used for these educational services pertain to the following distance education telecommunication connections:

- Interactive video (television) networks (IVN or I-TV)
- Computer-mediated (tele)communications (CMC)

The variety of technological equipment providing most of these multimedia services is extensive. For the most part, generic terms are used rather than vendors' product names when explaining how to use multimedia over the networks.

Suggestions for Using Multimedia with Telecommunications Technologies

Showing videotapes, laser disks, and/or computer illustrations over a video network is a matter of plug in, turn on, and play. Interactive presentations produced by a computerized slide presentation application or a slide projector on an interactive television console may not be easy to develop, but are relatively easy to use over most networks. The art and skill involved in using various multimedia productions for distance education range from the simple to the complex depending upon the nature of the lesson and the sophistication of the telecommunications device used during the process. Creating or developing

multimedia-based instructional tools to present what is to be learned over networks requires mastering skills and knowledge about computer applications and basic audiovisual peripherals and, to some extent, basic knowledge of instructional design to present the content graphically. The level of skill, knowledge, and degree of difficulty vary in proportion to the sophistication of the technological tools being used. The following examples describe distinct differences in technological difficulty in this regard:

1. **Easy**. Attaching a video camera to an overhead optical display unit (documentation camera) to show students, over an interactive video (television) network, a video about relevant subject matter that was prerecorded by the instructor because students miles away cannot be there to see these events in person. This could include showing course-specific multimedia presentations purchased from vendors who specialize in preparing such educational multimedia productions. Another example is sending to students e-mail instructions that contain visuals and sounds from a properly equipped computer workstation.

2. **Moderate**. Creating computer presentation slide shows that capture video clips, sound, and graphics to supplement textual data that can be panned in various colors in order to support lectures or events being portrayed over the network. Another example is to develop a similar product that can be put on a World Wide Web page so students can retrieve it over the Internet or commercial online service.

3. **Difficult**. Creating and integrating digital video, sound, and graphics into computer-mediated presentations and publications for use over distances. This involves learning how to converge integrated spreadsheet programs with data objects to project variances or options that depend upon programmatic results. This could be in conjunction with hypermedia or presentation programs with the capability of incorporating other computer peripherals to illustrate a learning objective appropriately. The latter could include incorporating advanced features such as chart animation, precision timing, and synchronization tools. These products could be displayed while video conferencing with learners.

4. **Expert user, very difficult.** Creating an interactive course in which the media application has high developmental costs. These applications include using professional instructional design techniques, conducting prototype trials, selecting the appropriate authoring tools for specific tasks, structuring text-based data, using the best media elements (color, sound, lighting), tagging and coding documents, compiling, testing the product, and preparing documentation and online help. The core skill areas include content expertise, writing, graphic design, illustration, audiovisual production, and authoring system expertise (Lynch 1994).

Authoring programs or combinations of programs (object-oriented types) can be used to develop interactive multimedia instruction with various components of the media. Hypercard is an entry-level authoring program tool that is categorized as a playback system capable of providing easy elementary presentations as well as difficult, detail-scripted productions (Thornburg 1994). Authorware™, Macromind Director, and Toolbook are software programs that can provide instructors or developers with the capability of creating high-powered, interactive demonstrations or courseware (Holsinger 1994). Large computer workstations can be used to develop tailored, authoring-system products with expert-level programming tools such as NextStep©. NextStep© is one of the desktop UNIX[5] operating programs used to create multiple applications or multimedia/hypermedia-type services. This particular system uses object-oriented programming to perform desired functions in the created application.

[5] *UNIX:* one of the most popular computer operating systems that allows multiple users and multitasking.

An object-oriented program uses modular, premade pieces of computer code or objects to create a program. The multimedia features are relatively simple for the average user because of an easy-to-understand icon-menu user interface (command pictures a person sees on the computer screen). The system has a complex UNIX-based computer platform that has programming processes for those super-users who are trained in computer programming. This type of process eliminates months of programming time because each object is a preprogrammed application similar to a multimedia tool kit. NextStep©, once only available for NeXT workstations, is now available on all high-end 486

operating computers (Cardon 1994). ScriptX Works was developed in a joint venture between Apple Corporation and IBM as an object-oriented scripting language. The intent is to have a multimedia program developed on a Macintosh or PC computer and saved as a ScriptX document so it can play back on any computer or multimedia device that supports a ScriptX playback (runtime) environment (Holsinger 1994).

The following is a partial listing of ideas for using computer programs and presentation tools to project multimedia images over distance education technologies (Rosenborg et al. 1993; Thornburg 1994; Van Horn 1995b):

- Use basic presentation programs such as Hypercard, Clarisworks©, PowerPoint™, or Aldus Persuasion™ to project simple or interactive slide shows from a microcomputer to a screen or through the video console used with two-way interactive video network
- Record video events with a camview or camcorder to use in lieu of field trips or interviews at places distance education adult learners are unable to attend
- Use Hypercard as an instructional authoring tool made easier with scripting tools such as HyperGasp™ and a depository of graphics found in such elementary sources as KidPICS
- Incorporate the mechanics of multisensory multimedia writing by using Hypercard with HyperStudio™ to create multimedia stacks with text, sound, graphics, and animation
- Combine Hypermedia with hypergrams, hypermaps, queriable illustrations, and hypercomics to enhance visual presentations
- Integrate QuickTime™ movies and/or slide shows and HyperStudio™ into ClarisWorks™ or Word Perfect™ to provide presentations with computer word processing programs
- Control laser disk players connected to computers with a program such as HyperStudio or LessonMaker™
- Create graphics and interactive pictures with QuickTime™ recording systems such as Video Spigot™ and Macintosh™ audio visual computers, scanners, Xap Shots™, and QuickTake 100™ digital cameras
- Use control panel icons and media control interface applications, connect sound to bitmap services, create or edit color palettes, and edit and play wave-form files

The main problem in creating a multimedia project is generally not a lack of technical knowledge, as there are many easy-to-use authoring systems. More likely, the difficulty is in establishing clear goals and procedures to produce what is needed for educational purposes (Lynch 1994).

Most aspects of computer-authoring systems take time and are work intensive. Authoring tools can provide extensive interactivity with full capability for editing video and animation for interactive multimedia presentations. The enhancements for these presentations or computerized interactions over distances can become quite involved when using electronic textbook tools with hypertext. This is because they are designed to annotate text with in-depth explanations, original documents, images, video, and sound. Media editing tools allow users to incorporate media from various sources into coherent presentations, including Musical Instrument Digital Interface (MIDI) programs for music editing ("Presenting Multimedia" 1994).

These medium-specific levels of interactivity start with linear-type presentations and step up to devices with which the user can make choices on how data are presented. A third or higher level involves multimedia systems that encompass external devices or computer peripherals that become part of the interaction involved with the instructional production. The fourth level is for the most part not readily available to most media users. These media in the experimental states or future stages of interaction involve speech recognition and virtual reality productions (Schwier and Misanchuk 1993).

Using a computer to produce text-only term papers or text-only overlay presentation products does not fully exploit the interactive-communicative power available in computers and distance education technologies.

Using a computer to produce text-only term papers or text-only overlay presentation products does not fully exploit the interactive-communicative power available in computers and distance education technologies. To make productive use of such technology, facilitators and learners should instead create graphic art, produce television programs, use desktop publishing to develop periodicals—a class newspaper, for example—with drawings and photographs, and prepare video term papers using multimedia resources (Van Horn 1994). This type of activity involves creating materials rather than following lesson plans

based upon reading textbooks and completing workbook assignments. It eliminates the "talking-head" lectures supported by chalkboard illustrations or overhead transparencies shown over a document camera. Multimedia productions emphasize developing visuals. Visuals can help in securing meanings that are not translatable in other terms.

The process of selecting or creating a visual representation involves abstraction—focusing on and selecting from a complex array of competing qualities that are useful for the achievement of some function or the accomplishment of a goal. Thus, in creating a drawing or selecting a video to represent what is to be learned, a person must decide which aspects are relevant and then invent or find symbols that can visually instill what is relevant so that the desired features are displayed. Such inventive symbolic representation of the visual qualities requires a high level of skill in abstraction (Eisner 1993). Schlosser and Anderson's (1994) summary emphasizes this aspect:

> The use of visuals, or graphics, can have a major impact on the success of a distance education course. However, to be effective, these visuals need to be tailored to the characteristics of the particular medium, and require considerable thought and preparation up front. (p. 28)

McFarland (1995) provides general parameters for reviewing, selecting, or developing visuals and text for educational multimedia packages. They pertain specifically to distinguishing a mediocre multimedia presentation from an excellent one that adheres to correct and consistent design of the interface:

- The material should relate to the knowledge of the user so it will link to prior knowledge (information mapping).
- Forethought should be given to determining whether words, illustrations, or icons are appropriate for each screen. A visually literate television society expects each visual to conform to context and content.
- Careful consideration should be given to determining whether attention value overrides learning value.
- In order to prevent learner frustration, the quantity of information on each screen should be limited. This will ensure

that the packaging of information does not overpower the intended message.

- A visual must be carefully chosen so that the graphic and/or illustration contributes to or truly augments the learning process.

Although color supports communication, it must be used appropriately. Most multimedia manuals explain the simultaneous color effect, caution against overuse of color, and provide suggestions such as changing color when the topic changes. It is recommended that constant testing is done to ensure that illustrations and icons are culturally sensitive and build upon prior experiences of the learner. Likewise, redundancy should be avoided when using words to support visuals and vice versa. "The intent of the Human-Computer Interface is to keep the learner engaged by providing a clear and consistent interface and appropriate metaphors that support the learning process" (ibid., p. 69).

Options for Using an Overhead Optical Viewer

Keeping in mind the previous section's suggestions for multimedia use, this section illustrates ways to use a specific technology for distance education: the overhead optical viewer, also referred to as a document camera. Figure 3 shows that this viewer can be located on the instructor's console connected to the two-way interactive video network. It can be attached to a portable video conferencing system that can be rolled into different locations. This display unit illustrates much more than open-page documents. Properly equipped, it provides a variety of options for displaying multimedia presentations.

The unit shown in figure 3 has ports that are used to attach peripheral cables from computers, video cameras, or other electronic devices. This panel has switches to control what is displayed on the television monitors located in all the interactive video network studios. The switches on this panel control what distance education students will see on the television monitors in their receiving classroom. This includes switching from the camera panned on the instructor to the one showing the students

attending the course in the sending studio classroom. The latter is used when the sending-site students speak or hold conferences with other students on the network. The other panel switches are "on and off" switches controlling access to a variety of educational multimedia tools (Hakes et al. 1993).

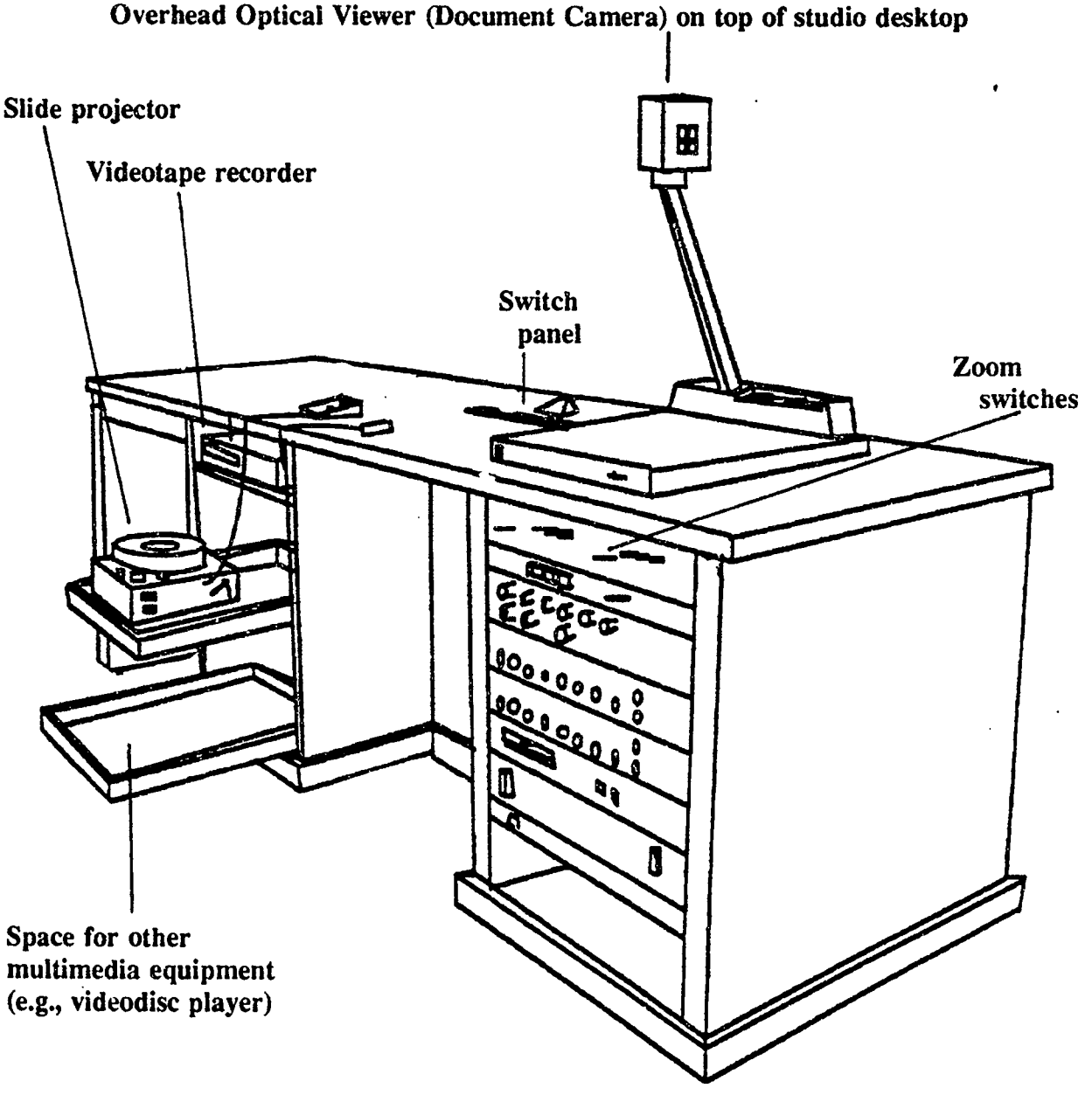

Figure 3. Interactive video (television) studio with a multimedia console

These studio panel tools include a videotape player, slide projector, computers, and the versatile overhead optical display unit. This latter tool is versatile because it has ports to connect other multimedia peripherals including those with video-audio-computer capability and/or connections used to display interactive images or informative text over the network television monitors. This versatile visual tool provides the interactive video instructor some leeway and choices based upon the intent or style preferred. A particular printed text with an image can be displayed on the network monitors by using one or more of the following multimedia options available on the studio panels:

- A sheet of paper containing the text with an image can be placed face up to the video camera that is facing the display panel of the overhead optical display unit. This is why it is called a document camera.
- A prerecorded video can illustrate this printed text with an image. The studio panel videotape player could be used, or a video camera equipped with video playback (camview) can be attached to the overhead optical display to show over the monitors.
- A computer presentation program can illustrate content about this printed text with an image by connecting the computer with video conversion capability to the overhead optical display. The presentation could be stored on either a CD, hard disk, or diskette file. The studio panel RGB[5] (digital-to-analog adapter) peripheral also could be used, depending upon the make and model of the computer available.
- A CD-ROM or a laser disk can be connected to the computer/RGB adapter for displaying instructional content over the network monitors.
- A computer presentation program or an advanced multiple-application word processor can display printed text with an image retrieved from a file stored on a host computer somewhere on the Internet.
- A computer can display this printed text with an image retrieved from a World Wide Web page stored on a host computer somewhere on the Internet.
- A comprehensive approach can involve some or all of these methods manually switched between the display panel, attached computer workstation, or the studio-installed peripherals.

[5] ***RGB:*** red, green, blue—the three primary colors used for computer video displays.

A typical distance education classroom has a console equipped with other multimedia appliances in addition to this versatile overhead optical display unit. The following illustrates ways instructors can provide learners with the same type of information using other available technologies:

- Use a video camera frame captured with a computer's application program, placed in a word processor document and sent over telephone lines to the distance education learners by the computer's fax option so copies can be duplicated for each distance education student.
- Use the studio-installed slide projector to display printed text with an image captured and pasted on a slide produced by a digital camera and a computer presentation program.
- Use computer word processing programs to capture graphic-animated images that can be illustrated as they are seen on the network monitors.
- Use the two-way interactive video network connections to transmit multimedia or any computer data, such as examinations, across the network for printing at each receiving site's computer workstation. The telecommunication network must have the capability of transmitting these data to each distance education classroom's computer workstation.

These options have favorable features and drawbacks depending upon the objective, purpose, and utility of the data being presented. Instructors have been innovative with paper document presentations. They have the data in small print to be located on a corner of a sheet of paper. The document camera is focused to enlarge this print over the television monitors in order for the instructor to write lecture notes elsewhere on this document while the camera displays only the enlarged image of the data on the television monitors. This serves the same purpose as writing notes on the border of an overhead transparency in a regular classroom. Likewise, the presenter can point to the data with a pencil, circle content for special emphasis, or add script, much like using a chalkboard. Some instructors use a white slate with colored marking pencils to inscribe the text and image under the focus of the overhead optical viewer. Instructors who do this have the white slate marked to outline that portion the camera is able to capture at wide-angle focus.

Experiments with Multimedia over a Network

In many parts of the country, instructors are using two-way interactive television networks to experiment with computerized multimedia to enhance their presentations (Abraham, Smith, Johnson, and Strahl 1994). In this section, examples from North Dakota and other states illustrate the application of multimedia to instruction.

North Dakota Interactive Video Network

A variety of ways were used to experiment with multimedia technologies for instructional purposes over distance education media available on the North Dakota Interactive Video Network (Stammen 1995). The majority of the multimedia technologies used in these experiments were used with technologies located in the studio's instructional display panel (shown in figure 3). The experiments and practices were conducted by instructors who facilitated presentations through the use of video, audio, animated and/or print-based data over an interactive video network. The audience was adult learners located at identically equipped telecommunication classrooms located throughout the state of North Dakota (Stammen 1993).

Multiple-media presentations were used over the network to provide online visuals to enhance what was presented. The process allowed network time for learners to discuss, interact effectively, and encourage reflection about the demonstrations. This process complied with the teaching unit's goal to ensure direct and explicit instruction, cooperative learning, inquiry, and reflective learning. By using the system in this manner, this two-way interactive video network essentially extends, electronically, what can take place in a traditional classroom.

The advantage of having access to a distance education studio with multiple technological options enabled the instructor to present or illustrate data, hold group discussions, engage in cooperative learning exercises, and conduct simulations, experiments, or demonstrations that best meet the goals and objectives of the course. This includes connecting other distance education networks and/or computer-mediated communication networks, as well as capturing satellite broadcast programs.

A case study was documented during a computer data-management course conducted during the 1994 spring semester. Thirty-three adult learners, ranging in age from 28 to 56, participated in the course at 7 different two-way interactive video classrooms located throughout the state. The purpose of the course was to help the learners understand how to use the computer with distance education telecommunication networks (Stammen 1995).

The significant contribution of the experiment was enabling all aspects of multimedia data to be demonstrated over an interactive video network. The demonstration involved six national electronic computer networks. The audio and video connections provided standard television reception with a (T-1) telephone digital video network connected to a high school consortium's closed circuit fiber-optic network. Three classrooms were used at each network for a total of six locations throughout the state (Stammen 1994).

The interactive video network (sending) classroom was connected with ethernet wires to the university's computer center. This enabled Internet access to acquire video and audio clips stored at such places as the Ohio State University, Michigan State University, and the University of Minnesota. The adult learners could view these data at all television studio monitors located in both networks. The information about computer networking was being displayed on these network-studio monitors at the same it was being retrieved from the computer-mediated networks located at places in other states by using one or more of the following methods:

- A camera was focused on a computer monitor to show what was displayed.
- A computer workstation was connected by a cable to the optical overhead viewer.
- A personal computer, with a computer digital-to-analog video adapter, was connected to the RGB adapter installed within the studio panel equipment.

During the time the interactive video classes were not in session, the adult learners communicated by mail, fax, telephone, or e-mail. Learners located several hundred miles away were

able to have their questions answered and hold discussions in lieu of office visits. The facilitator used SENDIT for classroom and advisee correspondence. SENDIT is a statewide K-12 computer network that provides messaging services, library access, and gateways to other Internet resources (Dyrli 1993; Krumenaker 1995).

The full use of these technological options enabled the instructors to maintain high expectations about communicating, questioning, and instructing skills. A variety of tactics were needed to get every participant involved during each live or online session. Adult learners were required to use the media tools available in and out of the classroom.

For instance, learners made their presentations or illustrations with the same multimedia tools available to the instructor. Most chose to use the overhead optical display so their classmates could view their presentations on the television monitors. Several learners brought their own computers to present a report about their class project results. A series about networking computers that was downlinked from a satellite program was pre-recorded for use in this particular course. This helped to provide information from experts throughout the nation and served the same purpose as would a tour around the nation. In one instance, a section of these videos was used to illustrate how an expert displayed statistical data. This illustration helped set the stage for learning the objective for this subject. To supplement this lesson, the instructor used a camview camera to record how computers were networked in a nearby office. It was shown to the distance education classes while the instructor explained how local networking functions compared with those illustrated on video presentations previously downlinked during satellite presentations.

The instructor was able to illustrate how a microcomputer statistics program can outline graphical results by displaying a sheet of paper containing a computer printout of a scattergram. It was displayed on the monitors using the overhead optical display unit. An attached computer was also used to illustrate step-by-step instructions of the necessary procedures these learners needed to know about using that particular statistics program.

In addition, a presentation program, Microsoft's PowerPoint, provided colorful text and image illustrations in a linear sequence to summarize the procedures used to solve the statistical problem. This demonstration involved switching the panel controls to have the television monitors show what was on the document, what was on the computer monitor attached to the optical overhead viewer, and what was on the notebook computer showing the PowerPoint presentation.

A video clip was transferred by attaching the camera to the overhead optical display unit port to illustrate the process on the distance education classroom monitors. This sequence was developed by the instructor to present specific data to demonstrate each procedural step, which led to selecting graph options that produced the scattergram first shown on the paper printout. The computer that produced this video display was connected to another media outlet (the RGB peripheral) in order to show options or changes during the subsequent question-and-answer session that concluded the lesson.

During this particular two-way interactive video network lesson, another computer was also connected to this same overhead optical display unit to access a university computer center's mainframe, which then downloaded a scattergram onto the computer monitor. These various techniques helped fulfill the class objective in computer data management. The utility of these options serves several purposes. Time is at a premium when on the two-way interactive video network. These prearranged options help ensure that the needed computer applications will be accurately shown in operation when online during the prescribed time period. It is too easy to make mistakes while keying a computer demonstration during a lecture. By displaying the computer-created scattergram printout first, an instructor can quickly set the stage for learning by focusing on the results rather than attempting to access a computer file to show the same results. That can come later when the learners are familiar with the content and more patient with operator error during demonstrations.

The video clips that show the computer monitor going through the same paces to attain these results let the instructor concentrate on providing a narration of what the computer is accomplishing while the scattergram is being produced. The video

replay feature was helpful to answer the learners' questions or to emphasize a particular point. The ability to manipulate an attached computer or use the ethernet connection to access an online statistical program from a mainframe computer provided supplemental support to enhance learning.

The majority of these 33 adults located in distance education classrooms across the state had never before watched a computer perform a statistics program. The instructor-developed computer displays at the local studio helped to reinforce the learning objective as evidenced in the final class evaluations.

Other Examples of Multimedia Use

During the spring of 1994, New York University initiated a "teleprogram" network for 20 home-based students located as far away as Denver. They took four courses on modern business information systems. The network uses interactive electronic lectures, readings, laboratory projects, and video clips with software incorporating hypertext which allows students to jump from one application to another at the click of a mouse. This system gives the instructors opportunities to illustrate course material with graphics, animation, and full-motion video. The instructional process is made possible with software developed by Lotus Development Corporation called "Lotus Notes for Video." This product evolved from groupware allowing computer conferencing to create, edit, and share a variety of electronic materials in many ways. The students' computer-based video and group-communication servers are linked from their homes through an integrated-services digital network leased by the New York area's main telecommunications company, NYNEX (Jacobson 1995).

"At first, the program is not expected to engage all participants in simultaneous communication, as typically occurs in teleconferencing and some other forms of distance education. Rather, they are using Lotus software to communicate back and forth asynchronously, adding or modifying both textual and visual material whenever they need to." (p. A24) Plans were underway to incorporate live audio and video communications in the fall of 1995.

An example in the rural United States involves adults and high school students taking a Russian course using a similar system created with NextStep©. This experimental project supported by Eisenhower funds from the U.S. Department of Education was used at North Dakota Department of Public Instruction's Division of Independent Study. This project, piloted during the 1994-1995 school year at five small, rural high schools in northwestern North Dakota, combines all multimedia features. The students correspond with e-mail using the statewide SENDIT K-12 network (Hingst 1994). This effort evolved from an online course in research and writing that was piloted at the same schools in 1992-1993. The group started this partnership in 1988 with a Macintosh Authorware project that produced a computerized, multimedia-based Spanish course. It is now available to adults nationwide who have access to a Macintosh computer; however, most subscribers prefer the print-based version of the course.

Access issues make it difficult to replicate experiments involving multimedia uses over distance education media. Computer-mediated communications are rapidly becoming available for these purposes due to the widespread accessibility to the Internet at colleges and universities and aggressive advertising of commercial online services. Partnerships developed to establish two-way interactive video services between colleges, universities, and school districts were formed to address access and equity issues. Now that they are in place throughout the nation, attention is being given to using multimedia to enhance learning over these networks. It is important to focus on what students are learning over these technologies (Gibson 1992).

The literature indicates that active use of multimedia technologies over networks is only in the beginning stages. Two texts that provide comprehensive explanations are ***Education on the Internet*** (Ellsworth 1994) and ***How Multimedia Works*** (Holsinger 1994). The first title is an "encyclopedia" of computer-mediated telecommunication opportunities in education. The second contains colorful visuals explaining detailed technological relationships with interactive television technologies and multimedia.

Implications for Educators

The literature reviewed in this paper implies that the number and range of programs used to develop multimedia products are extensive and vary according to the capacity of the interactive telecommunication network and/or the computer operating system. The extent of use also depends upon the degree of skill and knowledge of the facilitator, intensity of the work involved, amount of time available to accomplish the task, and funds that can be appropriated to the endeavor.

Caution is emphasized about using distance education for learning for a variety of reasons, but primarily because it can be hard work, time intensive, and technologically complicated. In addition, multimedia should not be construed as a way to replace person-to-person interaction whenever possible, but rather to reach distant learners who might not otherwise be reached without the use of these telecommunication technologies. Within this context, the literature implies that it is important to establish a system in which the multimedia technology used to accomplish distance learning objectives—

Multimedia should not be construed as a way to replace person-to-person interaction whenever possible, but rather to reach distant learners who might not otherwise be reached without the use of these telecommunication technologies.

- Adheres to learning principles that are the foundation of adult, career, and vocational education, such as:
  - — to acquire and sustain attention;
  - — to ensure that the project has relevance to their immediate needs;
  - — to instill a sense of confidence and desire to stay involved; and
  - — to promote satisfaction through participation.
- Is updated and kept current with new technological developments.
- Can be used to manage and improve the instructional and assessment design processes by creating records of student progress.

The literature also implies that it is important to understand the capacity of the endeavor to be undertaken in addition to knowing about the technology that is used to deliver the distance learning. This is because it is often necessary to tailor, customize, and manipulate the content when designing multimedia distance learning opportunities for adult, career, or vocational education. The following generic guidelines have been abstracted to emphasize what instructors need to know:

1. Learn how to make simple and basic illustrations. Then learn to develop complex presentations whenever motivated by an idea to better explain and educate.

2. Learn the fundamentals and varied multimedia options that are currently available for use in distance education classroom environments. This includes mastering the following—

   - who will benefit from the multimedia presentation;
   - what to use these technologies for in educational settings;
   - where to obtain support and assistance whenever in need;
   - when to use them for various adult, career, and vocational education settings and postsecondary and workplace environments;
   - why certain teaching-learning models, instructional strategies, learning styles, and adjustments to aspects of the intelligence dimensions would be integrated; and
   - how to integrate these technologies in curriculum through teamwork and cooperative learning.

3. Learn how to develop and produce microcomputer applications or integrated programs that project interactive displays on a distant computer monitor screen and on a television monitor—

   - to present information in a classroom setting (presentation)
   - to create and/or develop hypermedia programs (assimilation)
   - to use authoring tools/applications for independent learning situations

- to produce student/teacher projects, moving from these first three models to a "real work" model that encompasses: (1) problem definition, (2) resource identification, (3) solution development, and (4) peer involvement and reporting.

4. Learn how to use computer peripherals such as devices for still-picture camera capturing, CD-ROMS, optical disks, or video-clip application programs.

5. Learn how to access online multimedia presentations over the Internet through computer-mediated communication client servers such as Telnet[5], FTP, Gopher[5], WAIS[5], World Wide Web (Netscape), and accessing local area hosts containing CD-ROM or other multimedia/hypermedia-based files.

6. Learn how to use a combination of tools in an instrumented classroom containing television monitors or in two-way interactive-television classroom teaching stations. These combinations include video cameras, video recorders, filmstrip projectors, still-picture camera capturing, microcomputer connections to digital-to-analog (PC to Monitor) RGB conversion, telephone modems, fax connections, polling technology, studio ethernet connections to the Internet resources, and overhead optical display units (documentation cameras) which in turn provide multiple connections for these educational tools.

[5] ***Telnet:*** **an Internet protocol enabling users at one site to log into and use the computer system at another site.**

[5] ***Gopher:*** **menu-based software that provides flexible access to network resources such as databases.**

[5] ***WAIS (Wide Area Information Servers):*** **software that allows for a consistent approach to searching and information retrieval across various databases.**

Lynch (1994) provides the following guidelines regarding steps to keep in mind while developing either a simple or complex multimedia project:

- Explore all possibilities by reading, visiting, and attending conferences
- Identify suitable problems to solve and consider if the production is necessary
- Identify potential collaborators, resources, and support
- Target the audience and where projects might be used after development
- Set clear, realistic goals and keep objectives and messages clear
- Avoid superfluous embellishments and unnecessary clutter or noise

- Plan for the distribution possibilities of the product and study copyright issues
- Test, redesign, and evaluate student experiences as early and often as possible

The key to understanding what works with telecommunication technologies is that data displayed on a computer monitor can also be shown on a distance education television monitor. The capacity is dependent upon the bandwidth. The more bandwidth available between technologies, the quicker robust, high quality, interactive data can be transferred between these technologies.

Computerized multimedia provides incredible communication powers for educators interested in presenting interactive data to help explain and educate over distance education technologies. Nationwide, computer connections over telephone lines have expanded to the extent that the news media commonly provide electronic mail addresses for public access of hypermedia pages over the Internet or commercial online services. New distance education technologies allow educators to create virtual windows into which they can see, hear, and communicate with learners anywhere depending upon their telecommunication network's infrastructure and/or economic limitations. The changes occurring in the television, telecommunication, and computer industries have created many ways in which educators can draw upon multimedia for distance learning. Rapid changes, unique techniques, merging technologies, and different standards make developing good educational presentations time intensive and challenging. The type and form of the distance education technology affect the degree of instructional interactivity and the capacity of the telecommunication technologies. This is demonstrated by what is occurring throughout the nation with live, two-way, interactive television networks, how multimedia is retrieved over the Internet or online services, and what is possible in education with videoconferencing using both of these media as options to meet a desired educational need or objective. Interactive multimedia learning will likely increase in the future, especially for training (Charp 1995). Top quality multimedia in a collaborative environment is best suited for working adults (Jacobson 1995).

Expertise is needed in many areas because many of these technologies are not simply plug-and-play presentations. Once the

skill and knowledge are acquired to use these technological tools properly, an educator then needs time to create effective multimedia presentations. Effective, in this context, means providing distant learners with multimedia images or illustrations that help them learn better than they would without the aid of these distance education technologies. This implies creating an image that can adequately portray what has been difficult to explain with words or one-dimensional, chalkboard-type drawings. To create such illustrations, the instructor has to imagine how best to explain and teach with imagery rather than with words, overhead transparencies, chalkboard, or inanimate graphics. This involves imagination. Imagine creating colorful images that could move and make sounds to create a learning moment over an interactive, two-way telecommunication network. If a high school biology teacher uses the World Wide Web to have students dissect frogs, imagine what can be developed by educators to serve the educational needs of learners in agriculture, animal science, or marine biology.

The following illustrations show how multimedia can enhance distance learning in adult, career, and vocational education:

- A career educator spent 50 hours creating a multimedia authoring program to recruit prospective students with assistance from a multimedia specialist located at a university multimedia laboratory. The interactive hypermedia presentation graphically illustrates descriptions of faculty, institution, requirements, and potential job opportunities.
- A vocational teacher educator spent less time using a computer presentation program with multimedia capabilities to insert document files than was formerly spent making overhead transparencies. This instructor has yet to add animation, sound, or video to these frames; however, colorful pictures and graphics were gradually added to portray what is to be learned.
- An architect attended an evening workshop to learn about how to use a document camera to illustrate conceptual plans and bubble diagrams, then used the video camera to walk through facilities in order to present it to the students over the interactive television network.
- An adult educator developed visual presentations to show accounting and financial problems over interactive television

monitors. Whenever applicable, correct answers would appear from different sides of the monitor screen to help emphasize the accounting format or cycle while the explanations were provided for each correct response.

- As adults return to higher education in increasing numbers, colleges and universities throughout the nation are placing hypermedia explanations on World Wide Web pages for prospective students to view on the Internet. Placing these pages on the Web is not difficult or time intensive if the resources are readily available.
- A high school vocational teacher developed a series of multimedia presentations to coincide with each lesson. Students were able to access these productions on computer diskettes to use as study guides or for taking examinations. The teacher acquired visuals, graphics, and pictures as a member of a commercial shareware club and a public domain exchange group.

The technological medium should be secondary to the purpose of making learning happen through the educational process between those separated by distance.

Imagine sitting in front of a video camera placed on the top of a computer workstation. The system contains software such as network video with session directory, visual audio tool, and a whiteboard to draw, illustrate, or type messages. Consider how this could be used over the Internet for teaching a course to people at other locations. What could best be used to teach and explain? Verbal explanation? Graphical drawings? A movie? A picture? A spreadsheet chart? An animated illustration that could move or make sounds? A storyboard containing whatever imagery is necessary to accomplish the lesson to be learned?

The answers are left to the imagination of those who will be creating the multimedia objects these new technologies provide to fit the educational needs. The more multimedia imagery resembles professional quality, the more instructionally viable multimedia will be for a population accustomed to explicit, high quality, instructionally effective commercial television presentations. In any event, the technological medium should be secondary to the purpose of making learning happen through the educational process between those separated by distance. This implies that if high quality verbal discussion is enhancing thinking and making learning happen, then the state-of-the-art multimedia might not improve the interaction. The effectiveness of multimedia for distance education is dependent upon the educational art and skill of the instructor or facilitator.

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Glossary

Asynchronous: asynchronous transmission occurs when bytes of information are sent with unequal time intervals between them, allowing characters to be sent one at a time. In distance education, asynchronous may also refer to communication between individuals who are not online at the same time.

Authoring program: software used to create computer-based instruction.

Bandwidth: the amount of information that a cable or electronic circuit can transmit or carry at one time.

Compressed video: video that is reduced to lower the amount of space needed to store and transmit it.

Computer conferencing: linking of computers via telecommunications networks to a common space for discussion, exchange, and other activity.

Ethernet: a popular local area network technology developed by Xerox that interconnects multiple computer workstations.

Fileserver: a device that stores and distributes files to each computer on a local area network.

FTP (File Transfer Protocol): process that allows a user linked to one network host to access and transfer files from another host.

Gopher: menu-based software that provides flexible access to network resources such as databases.

Instructional Television Fixed Service: a set of microwave frequencies that have been designated for use by educational facilities; allows television transmission over about 20 miles.

Integrated Services Digital Network: a digitized telecommunications network allowing transmission of video, voice, and data over the same channel.

Netscape: one of several hypermedia browsers that enables users to access and integrate a variety of material via the World Wide Web.

Object-oriented programming: a computer system, operating system, or programming language that supports the use of objects.

Protocol: Procedures that control the transmission and receipt of data across a network.

Repeater: device that receives an electrical signal, boosts it in order to increase the possible transmission distance, and retransmits it.

RGB: red, green, blue—the three primary colors used for computer video displays.

Switched 56: Transmission network operating at 56 kilobits per second (Kbps) that allows dial-up videoconferencing.

Synchronous: synchronous transmission occurs when bytes of information are separated by equal time intervals in sequence. In distance education, synchronous may also refer to communication between individuals who are online at the same time.

Telnet: an Internet protocol enabling users at one site to log into and use the computer system at another site.

UNIX: one of the most popular computer operating systems that allows multiple users and multitasking.

WAIS (Wide Area Information Servers): software that allows for a consistent approach to searching and information retrieval across various databases.

World Wide Web: a hypertext-based system for finding and accessing Internet resources.

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