DOCUMENT RESUME

ED 350 767 EC 301 574

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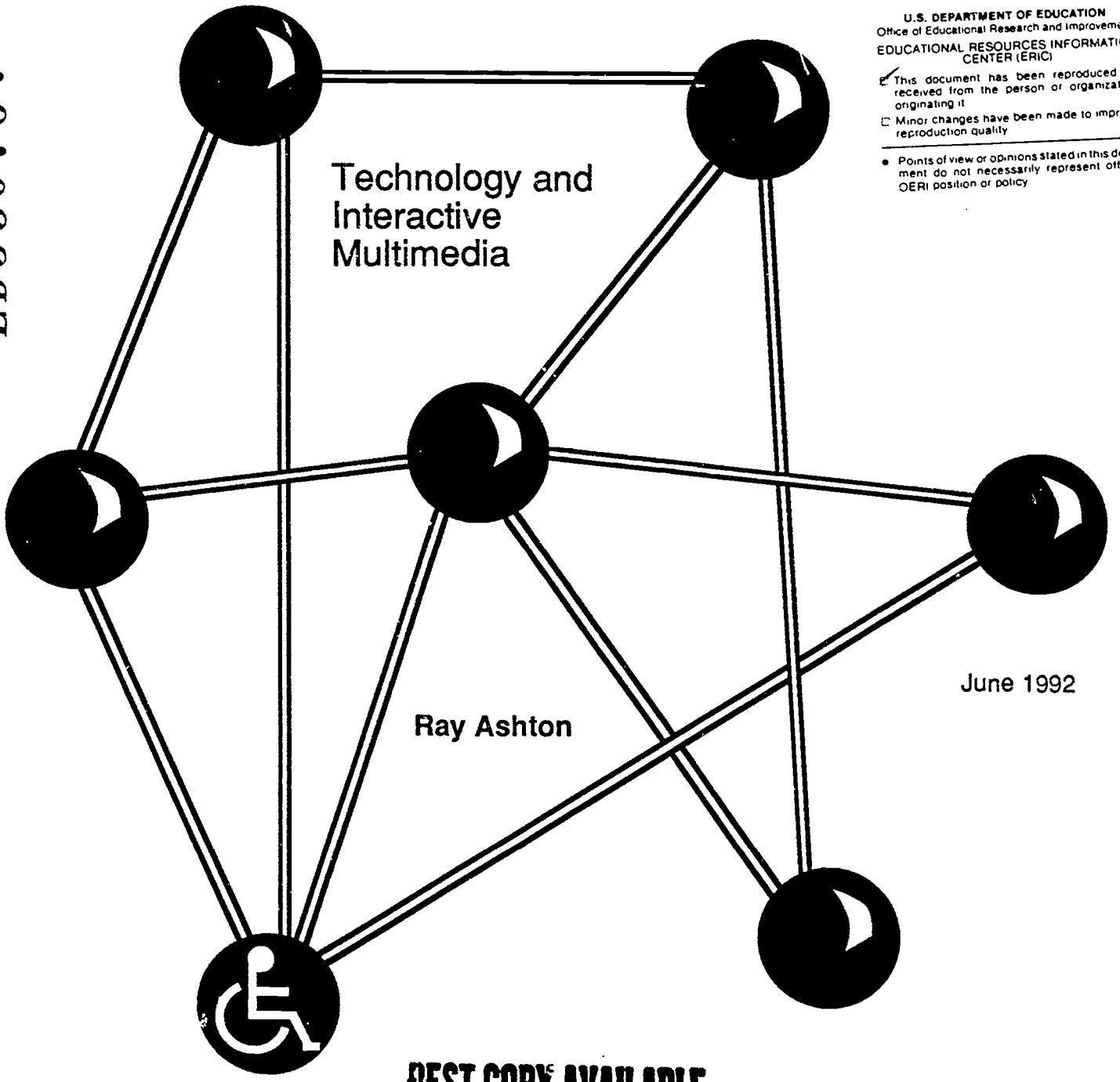
TITLE Technology and Interactive Multimedia. Identifying Emerging Issues and Trends in Technology for Special Education.
INSTITUTION COSMOS Corp., Washington, DC.
SPONS AGENCY Special Education Programs (ED/OSERS), Washington, DC.
PUB DATE Jun 92
CONTRACT HS90008001
NOTE 48p.; For related documents, see EC 301 540, EC 301 567-573.
PUB TYPE Information Analyses (070) -- Viewpoints (Opinion/Position Papers, Essays, etc.) (120)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Audiodisks; Computer Assisted Instruction; *Disabilities; *Educational Technology; *Electronic Equipment; Hypermedia; Interactive Video; *Microcomputers; *Optical Disks; Research and Development; Special Education; *Technological Advancement; Technology Transfer; Telecommunications; Television; Theory Practice Relationship; Trend Analysis; Videodisks

ABSTRACT

As part of a 3-year study to identify emerging issues and trends in technology for special education, this paper addresses the role of interactive multimedia, especially the digital, optical compact disc technologies, in providing instructional services to special education students. An overview identifies technological and economic trends, focusing on the convergence of the personal computer industry with the consumer electronic industry resulting in an exploding multimedia market. The current technology is then reviewed for the following areas: personal computers, digital audio tape, interactive videodisc, compact disc read only memory, digital video interactive, Commodore Dynamic Total Vision, compact disc interactive, magneto-optic systems, digital compact cassettes, compact disc recordable/erasable technology, blue (focusable) lasers, high definition television, virtual reality, and communications. Key trends identified for the year 2000 and beyond include improved data compression and storage technology as the underlying enabling technology, multifunction hardware platforms as the norm, cross platform compatibility, and increasing importance of product contents. Key issues for developers in the areas of cost, return on investment, transportability of applications, and marketing are identified. Finally, end user considerations and questions to drive a possible special education technology agenda are offered. An extensive resource section lists books, periodicals, other source materials, and sources of major studies (44 citations in all). A glossary offers definitions of technical terms. (DB)

Identifying Emerging Issues and Trends in Technology for Special Education



June 1992

Ray Ashton

Prepared by COSMOS Corporation for:
U.S. Department of Education
Office of Special Education Programs
under Contract No. HS90008001

PREFACE

COSMOS Corporation is conducting a study of the issues and trends affecting the role technology will have in the 21st century for individuals with disabilities. This three-year study is funded by the U.S. Department of Education, Office of Special Education Programs (OSEP), under Contract No. HS90008001.

COSMOS Corporation was founded in 1980, and is located in Washington, D.C. Since its inception, the firm has conducted a wide range of applied social science projects for public and private organizations and foundations. COSMOS's specialties include: conduct of case studies; identification and validation of exemplary practices; evaluation of education, job training, and human services programs; provision of technical assistance to state and community agencies; and strategic planning for public agencies and public firms.

Project participants include expert panels, project fellows, an advisory board, a consortia of practitioners, and project staff. These experts in the fields of technology and special education have come together to examine the issues and trends in these two fields, and how they impact the use of technology for special education in the 21st century. Three expert panels have started examining these issues: one with a focus on technology outside the field of education, one on special education instruction, and one on evolving service delivery systems in special education. Over the three year period their research will be synthesized and become the basis for predictions about the future.

This document is one of the papers commissioned in the first year. The purpose of the paper is to present information on one or more issues as part of the expert panel discussions. It is being shared with people inside and outside of the project to stimulate discussion on the impact of technology in the early 21st century. Readers are welcome to comment on these findings and contact COSMOS Corporation for further information.

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TECHNOLOGY AND INTERACTIVE MULTIMEDIA

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This paper will survey the current and potential future trends in technology and interactive multimedia. It is intended as an introductory statement on the new and emerging technologies that will serve as the building blocks for newer and yet uninvented technologies that will be available in the next two decades. It is not meant to be an exhaustive, in-depth explanation of these technologies and how they work technically. Rather, it is intended to provide a general introduction and framework, for the non-technologist, to define the boundaries for exploration in the next two years by the SPEDTECH technology project team. The scope of the paper has been confined to those technologies and systems that appear to have some potential value or utility in the educational environment within the next two decades.

The principal focus of the paper, in terms of depth of content, revolves around the digital, optical compact disc technologies (particularly Compact Disc Interactive) as the author firmly believes that the future of entertainment, information, training and education involves these technologies. Various market forecasts tend to support this belief. For example, various market forecast indicate that over five million optical disc drives will be installed by the year 1995, exclusive of the consumer electronics market. This suggests a market with a 40 percent per year growth rate in commercial and educational areas.

Overview

Paul Valery recently remarked that "the problem with today is that tomorrow is just not what it used to be." This could not be more true of the interactive world. We have recently witnessed incredible improvements in the microcomputer technology--the addition of high resolution graphics, substantially more memory, improvement in audio synthesis, increases in the speed of data manipulation, and the

proliferation of all sorts of peripheral devices to transform this medium into a fairly versatile and usable one. "Multimedia" has been added to the common lexicon of the discipline.

It has been just over ten years that the personal computer was launched in the United States. U.S. personal computer sales have increased from about $3.9 billion in 1981 to about $37 billion in 1991. World wide sales, in the same period, have gone from $8.5 to over $93 billion. In this period, the cost of a complete PC system has been more than halved; the storage capability cost per unit has declines over 50 percent; and the processing speed has virtually doubled every two years. The net result is that what was a "super" computer in the early 1980's is smaller, less expensive and much more pervasive in business, the schools and home environments. Much of what has been learned and implemented in the personal computer environment has been transferred and incorporated into consumer appliances.

How these developments will affect the future has been a matter of much conjecture among experts. However, it is safe to say that the future of computing and the future of consumer appliances is going to converge providing an all encompassing, digital, high speed, multimedia based system for delivering entertainment, information, education and training.

It is also safe to assume that given the impressive storage capacity of the optical disc, it will become the media of the future. Disc based technology is durable, cheap to replicate.

Furthermore, we will see continued miniaturization of the technologies with personal computers becoming smaller, telephones becoming less bulky, information and communications carried without modems both in a wired and wireless environment. In addition, we will see the advent of small computers equivalent to today's PC's in size, that will approximate the computing power of today's supercomputers. Costs of memory and microprocessors should drop with the concomitant changes that will occur in the chip design and manufacturing processes.

Television and computer technology will merge. New machines capable of processing information and displaying high quality full motion video and full bandwidth audio will be introduced. Future video games will be quite different with full motion video and an assortment of virtual reality techniques incorporated. Multimedia will make these games so different from today's games that we will not recognize the genre. Most of us with computers are familiar with the golf simulations available today. Tomorrow, the images will be photographic quality with you, the golfer, being able to, with a turn of the head, view the course from that specific angle. Hit a ball from the deep rough and you will see the grass fly.

The computer of the future will be faster, smaller, more portable and more user friendly. It is likely that the computer of the future will replace the telephone as we know it--moving close to Dick Tracy's "watch." You will be able, through your cellular computer, receive phone calls, not just messages, but calls with video of the caller.

"Software agents" will be pervasive, i.e. programs that learn your information needs and act on your behalf. The creation of knowledge and information is so accelerated that we do not have time to sift through all that is available continual process. But in the future we can let loose an "Agent" to do our searches for us. Students and professional researchers alike will do research this way.

The capacity and content of the new technology delivery systems will be complicated by the increasing attention paid to intellectual property rights. Enforcement of copying laws is growing. Piracy costs the software industry in excess of $8 billion per year ($2.4 domestic and $6 billion overseas in 1990).

The convergence of the personal computer industry with the consumer electronic industry will occur within the next decade, only to be enhanced with the arrival of improved definition television in the 1990's and with high definition television in the first decade of the new century. This fact was one of the driving forces that pulled together the two giants of the PC industry in the U.S., IBM and Apple. A major part of their strategic relationship is to create an multimedia

appliance, the nature of which will unfold in the next few months. However, insiders suggest that the outcomes of this new joint venture in the field of multimedia are five to six years in the future. Given the tremendous resources and marketing power of these two entities, careful attention should be paid to the proposed systems.

Industry pundits have forecasted a possible collision by the turn of the century between computer hardware giants and consumer electronic giants. The collision may, in reality, become more of a cooperative effort resulting in new types of products and a new industry of developers. The new technology will be small, portable, inexpensive, fast, backward compatible and future proof, based on widely subscribed to standards.

Technology will perhaps have its greatest effect on what has been termed "user friendliness," i.e. both the physical and software user interfaces. The new technologies will have remote and hardwired user devices that will ease of use of these appliances. The software "shells" that allow the user to communicate with the programs will become much more intuitive, literally making obsolete the command line interfaces that are so common in today's computers.

The "so-called" multimedia market is forecasted to explode over the next few years. In 1989, the multimedia market in the U.S. (only) was estimated to be approximately $440 million divided as follows:

- Education/Training - $0.13;
- Business Presentations - $0.26;
- Video Games - $0.03; and
- Other consumer - $0.02.

In 1994, that U.S. market is predicted to increase to a total of $16.6 billion divided as follows:

- Education/Training - $2.5;
- Business Presentations - $4.4;

- Video Games - $3.7;
- Information Retrieval - $3.4; and
- Other Consumer - $2.6.

The 1994 information retrieval sector includes access to office, portable office, and remote information and will involve data bases of various types; network publishing; and portable computer systems.

By 1994, the home entertainment center will be perceived as a multimedia computer system and it will expand to include local area network and multi-functional storage devices such as digital tape and optical discs. Its responsibilities include providing entertainment, managing the environment and ensuring security.

However with all these advancements, we have been unsuccessful in advancing the causes of real time interactivity. We have as yet not successfully combined real-time audio and video with computer code to interact simultaneously with the wishes of the end user.

We have seen a proliferation of "emerging" technologies, each bearing its own acronym, which have been proposed to solve this last real barrier to creating a usefully environment for "edutainment," information, education and training. Most of these "new" technologies derive from a former entity, whose functionality has been dramatically altered and/or improved. It is instructive for those not totally familiar with these developments to go through a catalog of these, seemingly acronymically-driven, technologies.

Personal Computer Technology

The next two decades will provide even faster change in the world of the Personal Computer as we have seen in the last decade. Computers of the future will be faster, smaller, more portable and more user friendly. It is likely that the computer of the future will replace the telephone as we know it - moving close to Dick Tracy's watch. You will be able through your cellular computer to receive phone calls, not just messages, but transmissions carrying video of the caller.

We can expect to witness the demise of the cathode ray tube display screen. In its place, we will see a flat, active matrix display panel that utilizes thousands of transistors for display of data. It will offer better resolution, portability, and ultimately lower cost. This technology will also finds its way into wall display panels for use both in the office and the home. No longer will we squint at computer screens. We will begin to stare at walls, on which the computer displays will be projected.

Processing speeds will increase at least geometrically. Parallel processors today can handle upwards of 1,073 database updates per second. This is achieved by both hardware and advanced software. By the year 2000, we will see a minimum of 10,000 database updates per second.

Computer storage will continue its evolution at a stunning rate. We currently talk in terms of megabytes. Within the next five years, we will speak in gigabytes (a billion bytes) and within the next decade, we will commonly speak of terabytes (about one million megabytes). Technically, it will become possible to store libraries on one piece of media for scanning and processing by a personal computer. In fact, it is possible today to purchase a "machine" (for over $1 million) that will store ten terabytes of data (equivalent to 300 Libraries of Congress). Practically, the costs and legal issues surrounding such endeavors will impede such practices for the foreseeable future. The cost of amassing, digitizing and transferring that much data to one media and the concurrent intellectual property rights acquisition would result in a sales price that easily would place it out of reach except for the wealthiest governments or corporations.

Keyboards Will Become Less Ubiquitous. Many will be replaced by voice-activated interface devices. Oral command of computers will come with the increasing quality of voice recognition systems. Portable and laptop computers will be capable of being driven by the human voice much as are dictaphones today.

Writing recognition, via a pen system, will also become readily available as physical user interfaces with computers. High level handwriting recognition programs will be available (some are today from Grid Systems Corp., for example).

While the technology of today only allows the interpretation of very carefully written alphanumerics, it is quite likely in the future that even the worst "doctor's" handwriting will be interpretable. This could have tremendous impact on homework and curricular writing skills programs.

Intercomputer communication, via modem, will change drastically. It will be possible to upload and down load information over the telephone without the use of the standard modem. Data transfer rates will dramatically increase.

Software will be all encompassing. One single, integrated, package will allow complete "office" procedure and support. This will become vital to teacher, administrator and business person. Also the very nature of software will change, allowing the user to literally create a new form program without writing any code, as we now know it. One analogy floating around the industry suggests that today no one in the software business is building individual doors, windows, faucets, sinks, etc., rather they are all building completed houses. The problem is those most of us do not want nor need a finished "house" of this sort. We would rather build to our own specifications. Object oriented programming will dominate the construction and presentation of programs for the foreseeable future.

Digital Audio Tape

Introduced in 1986, Digital Audio Tape (DAT) was to be the consumer answer to compact audio cassettes. DAT will hold two hours of digital music, similar to but not identical to, compact disc audio sound. The U.S. Congress has entertained a possible plan for significant import duties on DAT hardware due to the fact that copyrighted music can be recorded on this medium. In addition, the hardware manufacturers in 1989 signed the "Athens Agreement" which

required the manufacturers to install a device in each system that would limit the number of digital recordings made by that machine. This device would allow the owner to make only one digital copy of a particular recording, but would prevent them from making subsequent copies.

Some software producers have eyed this medium as a potential delivery system for interactive programming, particularly since the tape will hold approximately twelve hundred megabytes of digital information. In this delivery scenario, the major problem will be the addition of a microprocessor to handle decoding and display of information. A second major problem resides in the fact that magnetic tape is susceptible to stretching and deterioration over time. With digital information, any degradation of data is fatal to many applications.

To this point in time, the cost of the professional units with the power to be used in an interactive configuration have limited the potential market.

Interactive Videodisc

Interactive Videodisc (IVD) has been available for some years and most of us are quite familiar with what it is and how it works. Better known as the "laser videodisc," we have seen in the early 1980's hundreds of videodisc players utilized at Walt Disney's Epcot Center in Orlando, Florida. We saw General Motors and American Motors use of the videodisc in automotive showrooms to distribute new car information to potential buyers. We saw these same automobile companies using this technology to train and retrain employees from salespersons to mechanics.

Arcade games were quickly converted and developed for this system and widely distributed throughout the United States and abroad. Many such discs were developed for education. However, in better than eleven years, use of the videodisc in classrooms is small. Many investigations are underway nationwide to determine (once again) its

utility and success with students in the transfer of knowledge or thinking skills.

The laser disc is a 12 inch laser read optical disc that began life an a totally analog medium capable of holding 54000 frames of video along with an audio track.

Recent years have brought enhancements to IVD to continue to transform its capabilities into a more useful medium. Sound over still, a major problem in the past, has been solved. With recent developments in Pioneer equipment, the functionality of CLV (constant linear velocity) and CAV (constant angular velocity) have moved closer together. The development of many microcomputer-driven software programs have enhanced our abilities to deal with materials on the disc more effectively and more efficiently. Creation environments (often confused as "authoring systems" or "authoring tools") have been developed and of late have improved in usefulness.

However, except for Level One, IVD is not a complete system in and of itself. To take full advantage of its interactive potential, videodisc still requires a microcomputer for control, various kinds of non-standard firmware to execute its extended capabilities, and various kinds of non-standard software to effectively operate an application. To be at its most effective state, videodisc must be accompanied by a support system customized for a given application. Often a consumer who purchases the "customized" system will find that the next application he or she purchases will need additional firmware or software to operate the new application.

In 1987, a group of hardware manufacturers gathered together in an attempt to re-launch the IVD technology to the American consumer market by relabeling the technology as Compact Disc Video (CDV) with an emphasis on players that were multifunctional, capable of playing three and five inch compact audio discs, eight and twelve inch standard analog video discs, and eight and twelve inch analog video with digital audio discs.

However, it is unlikely that the analog videodisc, as we know it today, will survive the end of the century. Much of the creative work

that is just now being created on this medium will likely be moved into the digital delivery arena. This will allow wider distribution of these materials on a much less expensive and standardized hardware platform.

Compact Disc Read Only Memory

(CD-ROM)-Compact Disc Read Only Memory. CD-ROM is not a stand alone system. CD-ROM requires a microcomputer and the necessary boot software. It was originally designed as a text only, digital medium (capable of storing approximately 600 megabytes of digital information), but with the addition of firmware in the computer, audio and graphics can also be displayed. Until recently, CD-ROM was a standard only in that the manner in which materials were formatted on the disc was prescribed, thus making it operating system dependent. However, with the acceptance of the High Sierra Format Standard, CD-ROM discs, so formatted, are no longer operating system dependent.

CD-ROM finds its application basically in the commercial/ industrial environment. Due to the necessity of a stand-alone microcomputer, it has found almost no market in he consumer retail arena.

According to International Resource Development Inc., shipments of CD-ROM players and disc-based information and software was $127 million in 1988 and will rise to over $1 billion by the end of 1991.

In recent years, the CD-ROM specification has been dramatically altered and improved to allow more functionality and to provide for more cross-platform movement of the discs.

The first change was to add "XA," or Extended Architecture, to the specification. This allowed the additions of limited sound and graphics, thereby dramatically increasing the number and quality of applications that could be put on this disc.

The latest addition as been the "XA Bridge." This modification will ensure that the data sets included on the disc can be displayed and played back on a number of platforms including the new Nintendo

game system, Kodak Photo CD, and Compact Disc Interactive (CD-I), as well as VGA-based personal computers with CD-ROM drives.

At this writing a number of additional enhancements to the standard have been proposed by a variety of groups. Each of these efforts appear to take the form of attempting to increasing the versatility of the five inch compact disc format. Functionality and cross platform "hooks" are proposed to insure a broader use of the medium. Rest assured that these efforts will continue.

Digital Video Interactive

DVI is a chip set originally introduced by RCA's Sarnoff Laboratories in Princeton, N.J.. The technology was sold to General Electric and subsequently by GE to Intel, where ownership currently resides.

This chip set operates only in IBM PC's and "true" compatibles. In addition to the PC, the technology requires the special chip set (currently prices at about $1000), a CD-ROM drive and special software. This is an expensive configuration for most applications. In addition, the price and complexity of processing the video assets for this system have precluded any wide spread use of this technology in business and industry.

Commodore Dynamic Total Vision

(CDTV)-Commodore Dynamic Total Vision is a system based on an Amiga 500 (a three generation old computer) with a CD-ROM drive. It is Commodore's effort to compete with Compact Disc-Interactive in the consumer market. However, the system in underpowered (7.5 mh vs. 15 for CD-I). It does not allow for physical interleaving of materials on the disc. While, the base unit sells for $1000, Commodore has set this up as a peripherals business. To get a fully loaded system will cost well over $1400.

The two biggest drawbacks to this system are its lack of standards and its marketing organization. Commodore is going it alone attempting to create a de facto standard when the rest of the consumer electronics

world seems to be adopting Compact Disc-Interactive as the standard. In addition, Commodore's marketing efforts in the U.S. historically have been abysmal. Only 15 percent of their total sales occur in the U.S. Their single biggest market is West Germany. They simply do not have the marketing clout to complete against the rest of Europe and Japan Inc.

Compact Disc Interactive

In 1980, N.V. Philips and Sony Corporation jointly developed the compact disc digital audio system (generally called CD Audio). In late 1982 joint marketing of this medium began. CD Audio has become that fastest accepted new consumer electronics device in history. In the first four years, the installed based had climbed to 9.4 million units. By the end of 1989, there were over 60 million CD Audio players in use. At the time of launch in the U.S., the cost of this new music carrier was approximately $1500 at retail. By the end of 1990, cost to the consumer had dropped to roughly $150.00. Cumulative disc sales by the end of 1990 is estimated at 820 million units.

One of the driving forces behind the success of CD-Audio was the fact that it was a de facto world standard. There were no beta v. VHS battles. The standard (commonly known as the "Red Book) prescribed precisely how data was laid down on the disc and prescribed carefully exactly what any player had to contain and how it performed prior to being labeled a "Compact Disc Digital Audio" device. This accomplished two things. One, there was absolutely no confusion of standards in the eyes of the consumer. Two, the producer was guaranteed that a disc produced anywhere in the world, when played on a "CD-DA" player purchased anywhere in the world would play equally well.

In 1985, Sony and Philips joined together to attempt to see how they might "extend" the CD Audio technology into a full blown consumer entertainment system. The result of their effort was Compact Disc Interactive. It too was destined to become a world standard. Sony and Philips were later joined by Matsushita as co-licensors of the technology. The technology was defined in a 1200 pages document,

commonly known as the "Green Book." It became the logical evolution of CD Audio and CD-I is, in fact, reverse compatible in that every CD-DA disc created will play on a CD-I player without modification either to the disc or player.

CD-I is a Complete Standard. The full functional specification for CD-I prescribes how data is configured on the disc itself, as well as the minimum or base case hardware configuration necessary to be labeled as "CD-I." This guarantees the buyer a real measure of compatibility. The CD-I specification is an applications driven specification for both the hardware and the disc. It is both machine and software dependent. The specification calls for a single medium that is real-time audio and video driven, but also has text, binary data and computer program capabilities. It is both a medium and base case hardware specification. It is both reverse compatible with CD-Digital Audio and as far as possible, future proof. It features set of compatibility rules that ensures that all discs can play on all players.

All CD-I Discs are Compatible With All CD-I Players. As will CD-Audio, the content of the discs does not recognize country or system of origin. Compatibility in this case, means that the developer does not have to incur the expense of remaster video for PAL, SECAM of NTSC. The disc compensates for the variation in signal. Compatibility, in the CD-I context, also means that CD-I players will play all existing CD-Digital Audio discs, thereby not outdating music owners collections of CD's. Further, any CD-ROM disc, encoded in the High Sierra format with XA (extended architecture modifications), will play on industrial CD-I players. The new 16 bit Nintendo games system will include an optical disc drive in 1992 and those discs will also be compatible with CD-I. 1992 will bring movies, full screen with CD Digital Audio quality sound to CD-I. Kodak's announced Photo CD which will enable consumers or professionals to put their photographic images on a compact disc and manipulate those images, is also compatible with CD-I.

In addition, much effort was made within the specification to insure some measure of future proofness. For example, provisions have

been made in the specification for the enhancement of the television signal and the television set, so that as the quality of the user's television picture increases, CD-I can deliver that improved image.

These characteristics are particularly important to program designers, as it lowers their investment and offers the opportunity of a higher return on investment without the normal conversion hassles.

Moreover, this means multi-functional machines. Applications become more transportable. The purchaser will only need make one major playback unit purchase decision. In all, software, or discs, from seven different standards or platforms will playback on every CD-I player.

Having been designed as a consumer appliance, CD-I will be much easier to use than most interactive media. Of course, part of the use pattern will be determined by the application itself, but the possibility of providing the user with a simple interface is included.

Having been designed as a consumer appliance means that the user interface is geared to the lowest common denominator, thereby precluding the entering of a complex code to boot or operate the disc. Moreover, the hardware is equipped with a variety of I/O (input/output) ports that will allow the industrial/commercial or educational marketplace to add it own particular physical interface mechanism. The implications for installation and for training in use are less than with other interactive systems.

The purchaser of a CD-I system will only have to have a color television set or a color monitor (it matters not which) to complete the installation. Projected 1991 launch costs are between $1200 and $1500 for an industrial player and approximately $1,000 for a consumer player with a projected precipitous decline in pricing due to chip development, and production amortization.

To the end user this means that the he/she can get a high level of real-time audio-video functionality in one box at a relatively affordable price (particularly in comparison to microcomputer based systems which the computer with the necessary boards often approximate $2500 or more in cost).

For those developers who bundle hardware and software, this costs means that they can offer their clients a lower cost bundled system, while at the same time raising their margins and possibly dramatically expanding their market possibilities due to the lower cost.

CD-I is Copy-Resistant. A frequent problem encountered by the software developer is that of unlawful or unrestrained copying. With CD-I and its complex algorithms and encoding schemes, copying, much less wholesale copying, becomes a thing of the past. The CD-I specification even allows a security device that masks part of the disc and allows playing of that portion only by specific individuals (with the appropriate code) and on specific machines.

The physical technology involved in CD-I is the same as is found in CD-Audio. CD-Audio has survived well riding in car dashboards suffering a 1980's urban malady, potholes. It has gone to the beach and survived through sand, sun and suntan oil.

This means that in industrial training it can easily be transported to the factory floor without fear of turntable dislocation or equipment malfunction. In schools this means that it can be easily transported from room to room without locking down the turntable or protecting disk drives.

As a standard, any disc created using the "Green book" would play on any player carrying the CD-I logo, regardless of purchase local or TV system. CD-I offers the flexible combination of audio, video, text, data, graphics and computer programs for interactive (or passive) operation on essentially self-contained players or appliances.

Thanks to the unprecedented ability to combine information of many different kinds, together with full accessibility of all the stored information at any required time, CD-I offers little short of a revolution in electronic publishing in the broadest sense of the word.

To the consumer, it offers a virtually universal entertainment system within the confines of one consumer appliance that attached to a standard television set (or computer monitor) as easily as any VCR player.

Not only will the consumer be able to listen to his entire collection of CD Audio discs, in 1992, he will be able to view his favorite movies the same platform, but this time with digital audio sound. In addition, the system will present the consumer with alternatives in a friendly and human manner which he can then use to "steer" his way to the desired information on the discs, using an exciting and entertaining procedure.

Imagine a CD-I dictionary providing not only the standardized text information found in any ordinary dictionary, but also much more. Like pictures of described objects if the user is interested in seeing them. Or sounds to indicate correct pronunciation of the words. With computerized facilities making it very easy to find additional information like synonyms, antonyms, word relationships and origins, correct spellings or suggested translations.

Lyrics and scores of recorded works could be included, together with virtually unlimited amounts of background information such as other featured artists, places where the works were performed or recorded, the labels for which the artist has recorded, important influences on his work...in fact the list of information that could be presented is limited only the imagination and skill of the producer.

Imagine playing golf on your favorite, but unavailable, golf course, using your own shot selection, club selection to accommodate differing weather conditions (generated at random). Imagine a cook book that not only lists ingredients, but provides a step by step manual of preparation and you choose the size of the party to be given. CD-I does the calculations for you and modifies the recipes and preparation procedures to accommodate your desires. While you food is cooking, enjoy a travelogue that provides real insight into why a given national cuisine developed in the manner it did.

This list of differing subject matters that could be put on these versatile discs is virtually unlimited and ranges from the purely educational to the purely recreational. The possibilities include any material which can benefit from CD-I's combination of versatile video

and audio content, plus instant random access to any other part of the contents--all on a standard television set.

By the turn of the century CD-I has been forecasted to reach a minimum of 20 million households in the United States and approximately 40 million households worldwide. In addition, the same 100 million discs will be sold by that time. Of course, such projections rely upon two factors:

- A sufficient variety of compelling added value software (discs); and
- A price point for hardware systems that will allow CD-I to be available in your nearest K-Mart.

Magneto-Optic Systems

Magneto-Optic Systems (MO). This technology is principally supported by Sony and currently intended for consumer product, specifically music. While the physical dimensions of the disc are flexible, Sony has chosen to introduce a future product using a 2 1/2 inch MO drive, called the "Mini Disc System." That disc will hold approximately 74 minutes of recorded music. It is expected to be available for purchase in the winter of 1992/1993.

This is a direct-over write disc (simultaneously erases and records) which uses both a laser diode and a magnetic head. The magnetic head makes it possible to design a very practical battery powered recorded and playback unit. It could become one of the contenders for the next generation of "walkmen."

This unit will carry the SCMS (Serial Copy Management System) that precludes no more than one digital copy of another digital media to be made with this system.

This system employs a non-compatible ATRAC (Adaptive Transform Acoustic Coding) scheme for the compression/decompression of audio. It should be noted that the resulting sound is inferior to the standard CD-Digital Audio disc.

Digital Compact Cassette

Digital Compact Cassette (DCC). DCC was announced by N.V. Philips in early 1991 and has subsequently been licensed to a number of consumer electronics hardware manufacturers as well as a number of software and music companies.

Essentially DCC employs a standard magnetic audio cassette and is reverse compatible in that it will play all existing standard (analog) audio cassettes. What sets DCC apart is that it also both records and plays back digital sound recordings with a quality very similar to CD-Digital Audio discs. It employs to SCMS system to prevent multiple recordings.

CD Recordable/Erasable Technology (CD-R)

This technology is beginning to arrive at a price point that it will allow small industry, education and other developers to create "check" discs or replicate small quantities of CD-based digital, optically read, discs for local use or testing. Proposed international standards are being circulated among the major manufactures and software development houses. The arrival of this technology and its subsequent price reductions reinforces the notion that the digital optical disc is a reality.

Blue Lasers

The next major development that will impact dramatically the new technology market is the blue, or focusable, laser. These lasers currently exist in laboratories throughout the world, but are years away from commercialization. Current laser disc technologies utilize a red laser that moves across the surface of the disc, reading "pits." These pits contain binary information that is translated by a microprocessor.

Blue lasers are capable of being focussed by a microprocessor. This means that each "pit" on the disc can now hold up to five different levels of information. The effectively will expand the possible data content of each five inch disc to approximately 2.5

gigabytes. This has tremendous implications for mass storage of data on a relatively permanent media.

HDTV - High Definition Television

In the fall of 1992, the Federal Communications will begin hearings and attempt to reach a decision on which standard will become the norm for television broadcast within the continental United States. This decision will not mean that the standard selected by the FCC will immediately become a reality.

If the standard adopted means that the various broadcast and cablecast entities will have to make significant capital investment to create and disseminate programming for the new standard, implementation will be slow. In addition, since HDTV can potentially required a broader bandwidth for transmission, it is possible that the FCC could also be required to reassign bandwidths. In simple terms, this may mean that the current Channels 3 and 4 might have to be combined into one channel to carry sufficient data for the audio/video signal. Should this become a necessity, the political aspects of such a decision could further delay implementation.

Moreover, since the average American family only purchases replacement television sets every seven years, it will be well into the next century before HDTV in the United States becomes commonplace. In addition, this will mean a major financial investment on the part of businesses, institutions and schools should they opt to convert from existing television sets to HDTV.

There are currently several contenders for the standard. Although most of the proposed standards generally define HDTV as a video signal that has two times the current horizontal and vertical resolution, a wider screen aspect ratio, and CD-Digitial Audio quality sound, each one of the standards has a different implementation scheme.

Virtual Reality

While "virtual reality" is not, in pure terms, a technology, it nevertheless is quite important in the future of new technology

systems. Simply put, virtual or artificial reality systems enable the end user to become a participant in an abstract space in which neither the user or the physical hardware employed exist.

Virtual reality is quite "young" in technical terms. It is only beginning to be developed as a new "user interface" for technologies. Philosophers and developers are struggling with who best might use virtual reality systems. Will they best serve us to help break down barriers of race, culture, gender? Will they (or should they) offer only Western ways of assimilating knowledge? Will they offer supplements to our lives, our work and our education to the point that we begin to find refuge in this new cyberspace? What is their most utilitarian value?

At the least, virtual realities suggest a new beginning for technology interface design. And it is here that virtual reality will most likely have its biggest impact. It can transport the disadvantaged or physically disabled into "environments" heretofore unimagined. However, the danger is that sufficient research has not been completed to determine what problems arise in physical world simulation. How do humans process ideas? How do they visualize them, if at all, internally? What models best explain visualization? What is the most appropriate interface or metaphor to address a given idea or data set? What level of reality modeling is necessary? How can we visualize interconnectedness?

The answers to these and other questions are critical before any widespread use of virtual reality systems or interfaces occurs. However, it is certain that artificial reality is such a strong interface that it will be fully developed and with us for decades to come.

Communications

Current telephone lines, which provide us with both voice and data communications, are woefully underpowered to handle the ever increasing loads of voice, much less the increasing volumes of data that is being transmitted by business, government, and the service economy.

Fiber optic cables, capable of transmitted greater amounts of data at higher speeds, are gradually beginning to be installed. In addition, new methods of transmission are being developed and put on line.

It is unlikely that we will see the complete wiring of America in the foreseeable future as the bill for a complete fiber optic wiring of households in the U.S. has been estimated at $100 billion. However, we are gradually seeing confined area geographical networks being created within the private and public sectors to allow a dramatic increase in communication potential.

In 1991, a "frame relay" networking system was introduced that exploits the capability of the quality of fiber optic lines to transmit data (only) at ten times the standard speed of analog telephone lines.

In the mid 1990's we will see the introduction of Switched Multimegabit Data Services (SMDS) that will be provided by the various local phone companies to tie together specific areas and computer communication devices.

By the turn of the century, we should see longer distance and higher speed SMDS that will allow access to huge video libraries, provide PC access to large networks, allow for videophones in the home and office, and provide interactive multimedia (or even movies) on demand.

Trends for the Year 2000 and Beyond

The key trends of the next decade can be summarized as follows:

- Data compression and storage technology will provide the underlying power to any system that is successful. Compression will become the enabling technology. Object oriented programming and graphical user interfaces are providing the impetus as they both require significant memory and code to operate correctly and efficiently.

- Multifunction hardware platforms will become the norm. This is to say that for an appliance to be successful in the next decade

or two, it must be capable of handling or "playing back" more than one "standard" or media format. This will be more true in the consumer and information markets than in the industrial market. Given the continuing financial problems in the educational marketplace, it is safe to assume that multifunctionality may become a necessary precondition for purchase.

- Cross platform compatibility will be a key for software producers. This notion goes hand in hand with the multifunctional platform. For a product to approach ubiquity, it is become necessary for that product to play on multiple playback devices. As long as the content of the program is digital, it is a rather easy task to ensure, at least some, interplatform exchange compatibility. Various efforts are underway to attempt to define de facto interface standards, such as was done with CD-ROM via the "High Sierra Standard" to insure such compatibility, particularly in the personal computer field. In addition to standards, there are widespread efforts at developing operating system independent data sets.

When both interoperability and cross platform exchange is commonplace, the software developer's risks will be greatly reduced. This should accelerate the development and marketing of critical new products, particularly in the educational and industrial arenas.

- With improvements in technology, content will become the driving force. As functionality of platforms and software begin to offer almost limitless possibilities to the creative developer, the content, format and interface with the content become the forces which will create success.

- As we begin to see cross platform software development and delivery, copyright and piracy issues will become critical considerations. For example, if a teacher in a classroom decides to use portions of prerecorded video cassettes as part of a new multimedia lesson, presentation, who and how

are royalties paid? It is certain that in the near future, the twin issues of piracy and copyright will have to be addressed in a delicate balance with creativity and innovation.

Technology from the Development Point-of-View

In reviewing and analyzing a possible interactive system for adoption in a business or education environment, it is important to understand the issues involved for the developer (i.e. software provider). The professional user of a hardware platform must either depend on in-house development or external, often independent and unknown development houses for the software needed for training, information or education. If the institutional purchaser does not understand the mind of the potential product developer, erroneous purchase decisions will often be made. The key issues that a developer, either in-house or external, should consider are set forth below.

- What is the Cost of Development? Do I have to expend monies for additional hardware? Software? Can I use the traditional studio sources for production and post-production? What are the human costs involved? Can I do it alone or do I need a team? Can I add additional costs to the price of the application, or can I effectively amortize new development costs over several products?

- What is My Return on Investment? Most developers are not in the business for altruistic reasons. What delivery system then offers the highest ROI? To increase the price, one must increase the perceived value received. Which system allows for that?

- Transportability or Repurposing of Applications. Is the application sufficiently generic that it can be marketed and sold in a variety of institutions or channels? Can it be altered, or repurposed, for a broad market, potentially into consumer retail markets? If so, which delivery system best fits that scenario?

- If the application exists in another medium, what are the conversion costs to transfer that application to a delivery system with broader and larger potential?

- Marketing and Distribution Channels. If I do not do my own marketing, what bundling possibilities await the product? Who has sufficient expertise with a given market and delivery system that the product can receive maximum and qualified exposure?

- Creativity. If I assume that the most creative, value-added product receives the highest price, which delivery system allows me to most creatively deliver my product?

- Installed Based and Commitment. If I chose a given system, what is the commitment by the hardware manufacturer/s? What kind of real installed base is there or can I count on in the near future?

The issues outlined above barely touch the surface, but suggest that product developers should unshackle themselves from their own particular hardware or system biases and look to their issues and the issues of the potential buyer to assist them in choosing the appropriate delivery system for a given product. To do otherwise may seriously limit their profit potential and the ultimate survival of their business.

The current plethora of technologies which can serve as product delivery systems complicate the developer's job. The number of acronyms that we are now faced with is apt to multiply, increasing the problem of choice even more. Tomorrow will indeed be different We must continue to be aware and understand the changing technologies to most appropriately position and profit from our product development activities.

So with this plethora of technologies and systems, the developer has to make the choice on which of the above to render his/her application. Too often the choice is made for the wrong reason. Obviously, the right reason is simply which technology of system best

delivers the application. Too often we use the excuse that the consumer wants this delivery system and we render our application on that system. However, what the consumer really wants is satisfaction of needs.

Ted Levitt, a marketing guru of the 1980's tells the story of the consumer going to a hardware store to buy a 1/2" drill bit. He is not concerned about whether the bit is carborundum steel, diamond-tipped, etc. The reason is simple: the consumer (or end-user) is, in reality, buying a 1/2" hole. The lesson is as true with applications that are delivered on new technologies.

End-User Concerns and Considerations

What are the end-user considerations when it comes to purchasing hardware platform and software applications? How do those considerations fit into the developer's perception of which delivery system is chosen? An end-user or purchaser should keep in mind during the decision making process the following issues.

- Cost of the Bundled (or Combined) Hardware and Software. Is the complete training or educational system cost effective? Does it demonstrate a cost savings over present technologies or methods? How long before the difference in costs are recovered with a new system?

- Multiple Uses of the System Relative to the Cost. If the technology chosen to deliver a given application is inexpensive, the end user is apt to ignore possible secondary uses of the hardware. However, if the hardware and software represent a major investment, the client is often apt to consider what other applications may operate on the same hardware without additional firmware or hardware purchases.

- Ease of Installation and Use. How much staff training time is necessary for efficient and effective use of the system in a training or educational environment? Can the system be

installed by on-site technicians, or even non-technical people?

- Robustness of the System. How fragile is the hardware? Is it often subject to minor repair? Where can those repairs be effected? Does the equipment have to be shipped to the North Pole for repair? Can it be done locally? How durable is the system when moved about a lot? Is it suitable for use on factory floor in OJT? Is the system proven in a number of environments? What is the mean time between failures of a given piece of the hardware?

- Is the Software Transportable to Existing Systems? Can the user add additional hardware systems at minimum cost to use the software is multiple locations? Is it possible for a trainer or educator to take the materials home to study and learn use of the application?

- Applications with Added-Value Over Other Similar Applications. Can the application (hardware and software) deliver more effective and useful demonstration in one system over the other? How can I get the most for the least? Or if I must pay more, what added value do I get for my money?

Possible SPEDTECH Technology Agenda

Below is listed a series of possible questions relating to the uses of technology in education for the future. They can serve as a framework for further panel work in the next two years and help to refine and define what technologies will be most helpful in Special Education and in education, in general, over the period of the next ten to twenty years. Too often, historically, the basic set of objectives have not been defined by the responsible education group. These questions will help lead to the formulation of the specific objectives. Piecemeal choices, without specific objectives, have been too expensive, duplicative and ineffective.

- What should technology be used for? Will it find its best use in instruction, bridging the home and school, administration, research, counseling, library services, and/or communications? What problems does technology best solve, or help solve? Should technology be used only to supplement and enrich traditional education?

- Who should technology serve? Is technology best used for students, distance learners, teachers, researchers, administrators, counselors, staff? How can the technophobia be overcome?

- What technologies should be used? Which technologies best suit the end users? Which technologies are best suited to fulfill needs? There are questions of adaptability, effectiveness, cost, relevance, potential which must be measured against the service to be rendered by the technology.

- What structures should be used to handle new technologies in the educational environment? Does new technology require a new group of coordinators? Should decision making surrounding the use of new technologies be centralized or decentralized? What should be the role, if any, of advisory groups?

- What new policies will have to be instituted to manage the new technologies? How will they impact teaching loads? Budgets? What of the twin issues of piracy and copyright? How will security of the new systems be handled? Who will provide technical support, and maintenance for both hardware and software.

- What training programs will be necessary? Who will be trained? How will they be trained? Should training be centralized or decentralized? Will the new technologies require a change in the traditional pedagogy? Who will set standards? Who will create and administer the training? Who will be responsible for follow-up and re-training?

- What involvement should (or will) faculty and administrators have? At what levels? Who

will decide which hardware and software will be purchased? Centralized or decentralized decision making?

- Who should (or will) set the priorities among the technologies, uses the technologies, users of the technologies. Who will set the priorities for purchases?

- What will be the costs in time, money and energy? Where will the resources come from? Will financial or human resources be diverted or will new resources be needed?

SELECTED SOURCES FOR INFORMATION ON TECHNOLOGY AND MULTIMEDIA

BOOKS:

The Art of Human-Computer Interface Design, Brenda Laurel (ed.), Addison-Wesley Publishing Company, New York, NY, 1990.

Good collection of research papers, case studies, surveys, tutorials, theoretical discussions and observations by working designers.

Artificial Reality II, Morton Krueger, Addison-Wesley Publishing Company, New York, NY, 1991.

Krueger is recognized by many as the "father" of artificial reality. This is an update of his original work done some ten years ago.

CD-ROM Information Products: The Evaluative Guide, C.J. Armstrong and J. A. Large (eds.) Gower Publishing Company, Old Post Road, Brookfield, VT 05036 ($84.95 per volume, two volumes).

A fairly thorough review of most products available on the market. All products are rated according to various criteria including considerations of the database, search software, installation procedures, documentation, retrieval speed, etc.

CD-ROM: The New Papyrus, S. Lambert and S. Ropiequet (eds.) Microsoft Press, Redmond, WA., 1986.

The "original" anthology on CD-ROM.

Computer Lib: Dream Machines, Ted Nelson, re-released by Microsoft Press, Redmond, WA, 1988.

See comments re Literary Machines.

Creating Interactive Multimedia: A Practical Guide, Carol Anderson and Mark Veljkov, Scott Foresman Macintosh Computer Books, Chicago, IL, 1990.

An easy to use text that stresses the creative, human approach to creating interactive multimedia.

Desktop Video: Market, Industry, Technology, and Outlook to 1995, Multimedia Computing Corporation, 1990.

Reference work on desktop video, present and future.

The Disconnection: How to Interface Computers and Video, Gerald A. Souter, Knowledge Industry Publications, White Plains, NY, 1988.

A sort of "how to" for point of purchase sales, employee training, classroom teaching and information storage.

Handbook of Interactive Video, Steve Floyd, Knowledge Industry Publications, White Plains, NY, 1983.

A bit dated look at the industry and a good how to guide for the creation and production of interactive video discs.

The Hypertext Hypermedia Handbook, Emily Berk and Joseph Devlin (eds.), McGraw-Hill Publishing Company, New York, NY, 1991.

This authoritative reference guide discusses design and implementation of on-line documentation and training materials.

High Definition Television: A Bibliography, William Saffady, Meckler Publishing, Inc., 11 Ferry Lane West, Westport, CT 06880, 1990.

Comprehensive listing of books, articles, government documents, reports and conference proceedings.

Interactive Multimedia: Visions of Multimedia for Developers, Educators, & Information Providers, Sueann Ambron and Kristina Hooper (eds.), Microsoft Press, Redmond, WA, 1988.

A collection of articles (some dated) that provide excellent insights into the issues surrounding multimedia.

Interactive Optical Technologies in Education and Training: Markets and Trends, Sandra Kay Helsel, Meckler Publishing Company, Westport, Ct. 1990.

Describes current use of interactive optical technologies in these markets and "predicts" the future use of these technologies in these markets.

Interactive Television: The State of the Industry, Diane Gagnon, Arlen Communications, 1990.

Basic coverage of the consumer interactive television market.

Interactive Video, Richard Schwier, Educational Technologies Publications, Englewood Cliffs, NJ,1987.

Primer on the technology and step by step guidance on the creation and preparation of an interactive video disc.

Interactive Video Management and Production, Steven Imke, Educational Technology Publications, Engelwood Cliffs, NJ, 1991.

Provides guidelines for decision-makers on how production choices can affect the quality and cost of an interactive video presentation for training and personnel development.

Learning with Interactive Multimedia: Developing and Using Multimedia Tools in Education, Sueann Ambron and Kristina Hooper (eds.), Microsoft Press, Redmond, WA, 1990.

A collection of essays exploring educational innovation with multimedia.

Literary Machines, Ted Nelson. Available from Project Xanadu, 8480 Fredericksburg, #138, San Antonio, TX 78229)

One of the true visionaries in information delivery. Has been labelled a "raging maniac" by some, true visionary by others. Truly stimulating reading.

The Multimedia Producer's Legal Survival Guide, Stephen McIntosh,, Multimedia Publishing Corporation, 1990.

A must for anyone who create products which require the acquisition of rights from another individual or organization. Comes with either MAC or IMB PC diskettes containing copyright forms and sample agreements.

Opening Minds: The Evolution of Videodiscs and Interactive Learning, George Hayes, Future Systems Inc., Falls Church, VA, 1989.

A historical perspective on technology in public education and chronology of disc technology from the 1890's.

Virtual Reality: Theory, Practice and Promise, Sandra Helsel and Judith Paris Roth (eds.), Meckler Publishing, Inc. 1991.

A re-published collection of articles published in the 1990 issue of Multimedia Review exploring the complex and multifaceted nature of virtual reality, the creation of highly interactive, computer-based multimedia environments in which the user becomes a participant with the computer in the "virtually real" world.

PERIODICALS:

Advanced Imaging
445 Broad Hollow Road
Melville, NY 11747

Audio Visual Communications

50 West 23rd Street
New York, NY 10010

AV Video
Suite 314
25550 Hawthorne Boulevard
Torrance, CA 90505

CBT Directions
38 Chauncey Street
Boston, MA 02111-2369

CD Data Report
Helgerson Associates, Inc.
510 North Washington Street
Falls Church, VA 22046
($295 per year)

CD-ROM Professional
Subscription Department
11 Tannery Lane
Weston, CT 06883-9980
($86 per year)

Digital Vision
Suite 310
Blackfrairs Foundry
Blackfrairs Road
London SE1 8EN
England

European Multimedia Bulletin
European Multimedia Centre
24 Stephenson Way, London NW1 2HD
UK
Phone: 44-71-387-2233

Future Home Technology News
Phillips Publishing, Inc.,
7811 Montrose Road
Potomac, MD 20854
($395 per year)

HDTV Report
Phillips Publishing, Inc.
7811 Montrose Road,
Potomac, MD 20854
($397 per year)

HDTV World Review: The Journal for High Definition and Advanced Television Technology.
Meckler Publishing
11 Ferry Lane West
Wesport Ct 06880
($47 per year)

Information Industry Bulletin
Digital Information Group
51 Bank Street
Stamford, CT 06901
($295 per year)

InfoWorld
1060 Marsh Road
Menlo Park, CA 94025

Instructional Delivery Systems: The Magazine of Interactive Multimedia Computing
Communicative Technology Corporation
50 Culpeper Street
Warrenton, VA 22186

The International CD-ROM Report
Innotech
Unit 107
110 Silver Star Boulevard
Scarborough, ONT
M1V 5A2 CANADA

Journal of Educational Multimedia and Hypermedia
P. O. Box 2966
Charlottesville VA 22902
($40 per year)

Journal of Computer Game Design
Chris Crawford
5251 Sierra Road
San Jose, CA 95132
(must reading for anyone interested in gaming or simulation)

Journal of Interactive Instruction Development
Society for Applied Learning Technology
50 Culpeper Street
Warrenton, VA 22186

Media and Methods
1429 Walnut Street
Philadelphia, PA 19120

Microprocessor Report: The Guide to Microprocessor Hardware
874 Gravenstein Highway South
Suite 14
Sebastopol, CA 95472
($395 per year)

Multimedia and Videodisc Monitor (formerly The Videodisc Monitor)
Future Systems, Inc.
P.O. Box 26
Falls Church, VA 22040
($275 per year)

Multimedia Review: The Journal of Multimedia Computing
Meckler Corporation
11 Ferry Lane West
Westport, CT 06880
($97 per year)

Optical and Magnetic Report
Phillips Publishing, Inc.
7811 Montrose Road
Potomac, MD 20854
($397 per year)

Software Industry Bulletin
Digital Information Group
51 Bank Street
Stamford, CT 06901
($295 per year)

Technology & Learning
(Formerly Classroom Computer Learning)
Peter Li, Inc.
2451 River Rd
Dayton, OH
($24 per year)

T.H.E. Journal (Technological Horizons in Education)
Suite 112
150 El Camino Real
Tustin, CA 92680-3615

Videography
50 West 23rd Street
New York, NY 10010

Video Systems
P. O. Box 12901
Overland Park, KS 66212

Video Technology News
Phillips Publishing, Inc.
7811 Montrose Road
Potomac, MD 20854
($495 per year)

Vizions
Camden New Media
Third Floor
21 Elm Street
P. O. Box 1328
Camden ME 04834

OTHER SOURCE MATERIAL OF INTEREST:

NAUTILUS CD-ROM is a monthly CD-ROM information service published on CD-ROM. Contents include: software demonstrations, desktop publishing tools, graphics/photo resources, audio tracks and music, multimedia applications, games and entertainment, directories and databases. Available from NAUTILUS, 7001 Discovery Boulevard, Dublin, OH 43017-8066. ($9.95 per issue)

The CD-ROM Directory published yearly provides information on all available CD-ROM products and information on most of the companies involved in the design, production and distribution of CD-ROM products. This is also available in print form. UniDisc, 4401 Capitola Road, Capitola, CA 95010. (Disc $149; book $89)

Virtual Reality Conference Tapes covers the speeches and presentations made by noted authorities at the 1991 Virtual Reality Conference in San Francisco. Three VHS tapes are available for $225 each or $595 for the set. Published by Meckler Publishing of Westport, CT.

SOURCES OF MAJOR STUDIES

BIS Strategic Decisions
P.O. Box 5-0076
Woburn, MA 01815-0076

This group runs conferences and publishes major research in information technologies. Most reports run approximately $1,000 each.

Venture Development Inc.
Suite 206
1 Apple Road
Natick, MA 01760

Does major market studies and forecasts for new technologies.

Disk/Trend, Inc.
1925 Landings Drive
Mountain View, CA 94043

Publishes annual edition of sales and projects of optical and magnetic discs. Easy way to see history and follow development of new media markets.

Proceedings: Society for Applied Learning Technology, 50 Culpeper Street, Warrenton, VA 22186.

SALT holds various conferences each year on education and training. Printed proceedings for the last twelve years are available.

Multimedia: Achieving Competitive Advantage in the 1990's and Beyond:

Summit Strategies
PO Box 364
Prudential Center Station
Boston, MA, 02199

A two volume market report providing statistics insights into the prediction of the directions of multimedia for the future.

GLOSSARY

This brief glossary of terms for the multimedia area is an attempt to provide basic definitions for terms that are commonly encountered in the literature of interactive multimedia. It is, by no means, a complete dictionary of terms.

A/D Converters: Analog/Digital Converters. Devices which transform analog signals to digital signals for some kind of computer manipulation.

ADPCM: Adaptive Delta Pulse Code Modulation. A technique for the compression and storage of digital audio data.

Algorithm: A step by step process for accomplishing a task.

(AI)-Artificial Intelligence: The analysis, representation and/or application of information by mean that appear to mimic primitive levels of human intelligence.

Analog: A continuous, unsampled representation of an electronic signal, such as broadcast television or a VCR tape. As opposed to "digital" which contains numeric representations of data. Digital signals do not degrade as do analog signals. Analog signals are "original" and unsampled; digital signals are sampled, binary representations of the original signal.

Applications Software: Software which contains the programs for a specific application, rather than general purpose software such as a programming language.

ASCII: An international standard for the representation of alphanumeric figures in binary form.

Authoring Tools: High level computer programs and routines that help facilitate the creation and preparation of interactive programs most often by reducing the number of required instructions.

Authoring Systems: The necessary equipment to encode the basic audio, video and graphic data, via authoring tools, so that it can be stored directly on magnetic or optical media.

Bit: A single binary digit.

Byte: A group of eight bits.

(CAD)-Computer Aided Design: In engineering or architecture, frequently the designer employs the computer to do the complex mathematical calculation and rendering necessary to complete a design.

(CAM)-Computer Aided Manufacture: This term most often refers to the use of computer controlled robotics devices used in a manufacturing environment.

(CCITT)-Consultative Committee on International Telephone and Telegraphy: An international standards setting group for video conferencing technology. This group has been responsible for setting forth the Px64 standard which took effect in June of 1991.

(CD-DA)-Compact Disc Digital Audio: The accepted world standard (referred to as the "Red Book") for the storage and playback of digital audio. This disc carries an optical recording of a PCM stereo audio signal, with associated control and display data, which is read by a laser pick-up in the CD Player.

(CD-I)-Compact Disc Interactive: A multimedia system for simultaneous, and interactive presentation of audio, video, text and data. This standard, known as the "Green Book" standard, is co-licensed to hardware manufacturers and software developers by its creators, NV Philips, Sony, and Matsushita. It is a de facto world standard.

(CD-ROM)-Compact Disc Read Only Memory: A disc-based product capable of holding about 650 megabytes of digital data. It is a de facto world standard (often referred to as the "Yellow Book") co-developed by NV Philips and SONY.

(CD-ROM XA)-Compact Disc Read Only Memory Extended Architecture: A hybrid standard created to partially bridge the gap between CD-ROM and CD-I. It utilizes certain CD-I audio resolutions and graphics resolutions.

CD-ROM XA Bridge: A proposed new standard that would assure compatibility between CD-ROM discs for personal computers and CD-I discs. It is the format for the recently announced new Nintendo CD-based games system to be released in 1992.

Compact Disc: A system for recording high density digital data on an optically sensitive disc, and reading it with a laser beam. It was originally conceived as a medium for high fidelity music reproduction. It is now applied as a text/data medium for electronic publishing (CD-ROM) and a multiple-function medium for interactive programming (CD-I).

Compression/Decompression: The process of compressing the size of a data signal by eliminating irrelevant components of the data to allow for real time transmission and manipulation of data types. This allows

for representation of data to be made when a full data stream would exceed the bandwidth of the delivery system.

(CDV)-Compact Disc Video: Essentially this is what we have known as "laser discs" with one significant addition. Traditional laser discs were encoded with analog video and audio. CDV has traditional analog video encoding with digital audio encoding.

(DAT)-Digital Audio Tape: A proposed standard to the recording of high quality digital audio sound on magnetic tape.

(DCT)-Discrete Cosine Transform: An algorithm for the compression and storage of digital motion video data.

(DVI)-Digital Video Interactive: A form of digital video encoding developed by the Sarnoff Labs in Princeton, N.J. (now owned by Intel) which requires the use of specific boards to provide a programmable architecture for video compression and decompression.

Interactive Media: Media on which information is held in such a way that, by means of an application program, it is delivered in the course of a dialogue with the user. The application program may also be held on the same media.

(ISDN)-Integrated Services Digital Networks: A methodology for high speed transmission of digital data via fiber optic cables. ISDN could easily form the hardwired support for two way interactive television.

(JPEG)-Joint Picture Encoding Group: This group functions as a standards definition group for still image compression. Its recommendations are forwarded to ISO (International Standards Organization). If ISO confirms the standards, they become de facto world standards. Such a draft standard for still images has been passed on to ISO.

(LAN)-Local Area Network: A means by which data is transferred internally within a building or within a confined geographical data via wire.

Mastering: The final step, prior to replication, of a disc product which creates of "master" disc from the source materials. Subsequent discs are "cut" from that master.

(MIDI)-Musical Instruments Digital Interface: An international standard/specification that defines how various electronic musical devices communicate with one another.

(MPEG)-Motion Picture Experts Group: This group functions as a standards definition group for digital motion picture compression and associated audio. Its recommendations are forwarded to ISO (International Standards Organization). If ISO confirms the standards,

they become de facto world standards. Such a standard based on the discrete cosine transform has received preliminary approval from ISO.

Natural Language Recognition: This refers to the ability of a computer to recognize and respond to commands given it by voice.

Network: Electronic linkage between communications devices such as data terminals, work stations, etc.

Object-Oriented Language: A programming language that allows the software engineer to use a higher level of code to speed and create more sophisticated programs rather than being confined to the use of low level or basic machine level code.

(OCR)-Optical Character Scanner: A combination of hardware and software that is able to scan printed documents and "read" them into binary digital code that is stored and manipulated in a computer.

(RAM)-Random Access Memory: A cache of memory on board a computer that provides the location and environment for the computer to do its real time computing.

Real-Time: This is a computer state wherein data is processed at the same rate that it is taken into the computer or is used by the computer, i.e. for display, etc.

(RGB)-Red, Green, Blue: A standard for the projection of video images onto a computer monitor. This is currently considered the highest video resolution commonly available.

(ROM)-Read Only Memory: A memory component of a computer system on which the user cannot store information. This portion of memory is "preprogrammed by the manufacturer of chip maker to contain unchangeable data necessary for operations,

RS-232: One of the standard interface protocols which allow the computer and peripheral devices to communicate with one anther.

RE-422: A higher level, faster version of the RS-232.

Sampling: The representation of an analog waveform created by measuring its value at discrete points.

Sampling Rate: The frequency with which data samples are generated.

(SCSI)-Small Computer Systems Interface: A protocol by which peripherals are attached to and communicate with personal computers.

(SMPTE)-Society of Motion Picture and Television Engineers: The professional standards organization that determines standards and protocols for film and television.

Standards: In the electronic computing and hardware areas, these are uniform sets of protocols which define how devices communicate internally, with each other, display data, etc. They are normally an effort to create a set of data that can be used by dissimilar and non-compatible technologies.

Systems Integration: This is the process of integrating diverse pieces of hardware and software into an integrated whole.

Tools: This is a computing term that refers to various software utilities and applications that a computer software engineer utilizes to create or manipulate programming.

Videodisc: This is a laser-read optical disc that contains analog video and either analog or digital audio data which is played back on a standard television set. Videodiscs are capable of containing 30 minutes of motion video per side or up to 54,000 still frames.

Virtual Reality: This term is applied to computer-generated realities we can "enter" by virtue of bodily peripherals, such as data gloves, which represent these realities as if we were really within them.

(WORM)-Write Once Read Many: A disc-based, laser-read optical medium for write once (i.e. non-erasable) data storage. The binary representation of the data is etched on the disc via a laser beam.

PAPERS AVAILABLE FROM COSMOS

The papers commissioned by the project are available upon request include:

"Technology and Interactive Multimedia" by Ray Ashton;

"VLSI Technology: Impact and Promise" by Magdy Bayoumi;

"Conceptual Framework: Special Education Technology" by Richard Howell;

"Demographic Characteristics of the United States Population: Current Data and Future Trends" by Beth Mineo;

"School Reform and Its Implications for Technology Use in the Future" by John Woodward;

"Textbooks, Technology, and the Public School Curricula" by John Woodward;

"Workforce 2000 and the Mildly Handicapped" by John Woodward;

"Virtual Reality and Its Potential Use in Special Education" by John Woodward; and

"Annotated Bibliography: Training, Education Policy, Systems Change, and Instruction" by Lewis Polsgrove.

Copies of these reports are available upon request.