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TECHNICAL REPORT 81-03

Quarterly Technical Report:

Video-Based Systems Research, Analysis, and Applications Opportunities

James F. Wittmeyer, III

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Computer Systems Management, Inc.

1300 WILSON BOULEVARD, SUITE 100 • ARLINGTON, VIRGINIA 22209

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QUARTERLY TECHNICAL REPORT:

VIDEO-BASED SYSTEMS RESEARCH, ANALYSIS, AND APPLICATIONS OPPORTUNITIES

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Video technology is growing rapidly providing new opportunities for DOD research, analysis, and applications especially in the areas of optical video discs, computer-based microfilm and microfiche, shared analysis or network systems, and video taping and playback. These technologies can be applied variously to intelligence, training, and information management problems in some very unique and cost-effective ways.

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SUMMARY

This Quarterly Technical Report covers the period from April 1, 1981 to June 30, 1981. The tasks/objectives and/or purposes of the overall project are connected with the design, development, demonstration, and transfer of advanced computer- and video-based command and control (C^2) systems; this report covers work in the video-based systems research, analysis, and applications areas. The technical problems addressed include the rapidly evolving video display (broadly conceived) world and how developments in the area can be exploited for Department of Defense (DOD) use for group problem-solving, telecommunications, training, and information management, among other areas. The general methods employed include a survey of video equipment and a matching of survey results to DOD functions. Technical results include a set of recommendations regarding how current and future video technology can be used productively in a variety of defense contexts. Future research will summarize and integrate all of the work performed during the two-year contract period.

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1.0 INTRODUCTION

The broad field of video technology will present countless unique opportunities to the Department of Defense (DOD) in the immediate and longer-term futures. Such will be the case because nearly all of the component technologies are accelerating at exponential rates, because the DOD has begun to develop a solid understanding of and appreciation for video technology, and because the cost of video technology is constantly falling.

This report looks at some of these opportunities. Specifically, presented below is a look at current and emerging video technology followed by a set of recommendations regarding how it can be used.

2.0 CURRENT AND EMERGING VIDEO TECHNOLOGY

2.1 Video Disc Systems

Perhaps the most dramatic and exciting development in recent years is the video disc storage system. (Appendix A presents information on the MCA "industrial" video disc player; Appendix B presents some reprints regarding how the various video disc systems compare.) Already video discs are in use in a variety of capacities. They are used for intelligence information storage and briefings, interactive training applications, and for the storage of video map data, among other problem-solving contexts. Beyond storage capacity, the chief advantages of the video disc storage system is that it permits the storage of video photographic images of all kinds and sound. It also provides for great storage economy. For example, Kenney, et. al. (1979) report that when compared with magnetic storage systems (the Philips) video disc systems are very efficient. "The media cost is estimated at $5X10^{-8}$ cent/bit and the hardware cost at $5X10^{-5}$ cent/bit. The volumetric storage efficiency of the optical disk is 100 times better than that of 6250 bits/inch magnetic tape" (Kenney, et. al., 1979: p. 36). Note the table below (Kenney, et. al., 1979: p. 38). Similarly, when one compares video disc recording/storage density and access time-versus-price with various magnetic media, the (Philips) discs again compare more than very

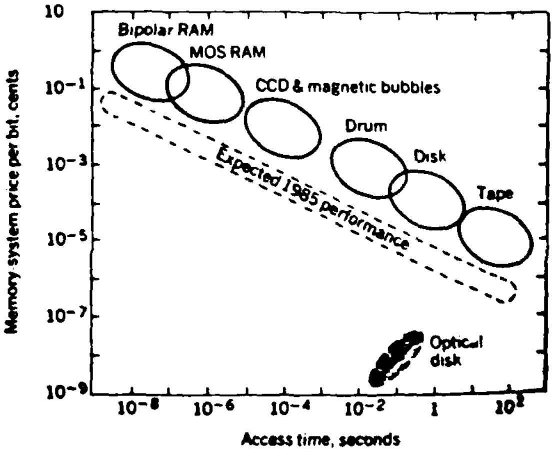
Characteristics of mass storage devices

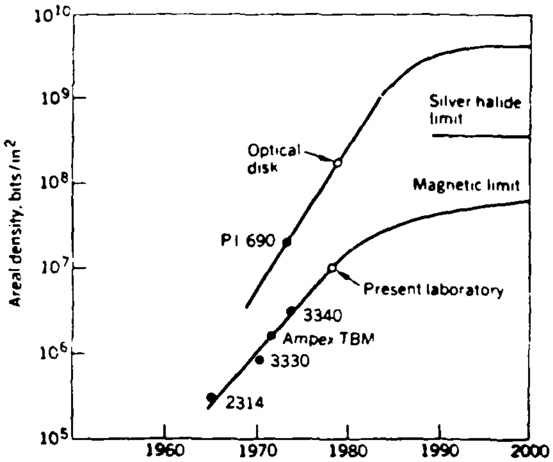
Device	User Capacity, Mbytes	Access Time, ms	Data Rate, Mbits/s	Hardware Cost, dollars	Media Cost, dollars	Media Cost/Bit, cents	Archival Life, years
Magnetic disk IBM 3340	70	35	7.0	20 000	2200 disk pack	$4\times10^{-}$[illegible]	2-3
6250 bits/in tape IBM 3420-8 (2000 Byte records)	91	45 000	3.3	28 440	16.50 2400 ft reel	$2.2\times10^{-}$[illegible]	1-2
Mass storage system IBM 3850	462 500	16 000	7	2 400 000	188 000 9400 cartridges $20 each	$5\times10^{-}$[illegible]	1-2
Philips optical disk	2500	100-500	5-10	10 000	10	$5\times10^{-}$[illegible]	>10
Philips juke box	25 000 000	3000	20-50	200 000	10 000 1000 disks at $10 each	$5\times10^{-}$[illegible]	>10
Philips optical disk pack	125 000	50-100	20-50	200 000	150	$1.5\times10^{-}$[illegible]	>10

Note. Performance and costs of magnetic equipment from "DATAPRO", optical disk figures are best estimates only

favorably, as suggested below (Kenney, et. al., 1979: p. 36).

Access time vs. price for various storage technologies puts the optical disk in a favorable position.

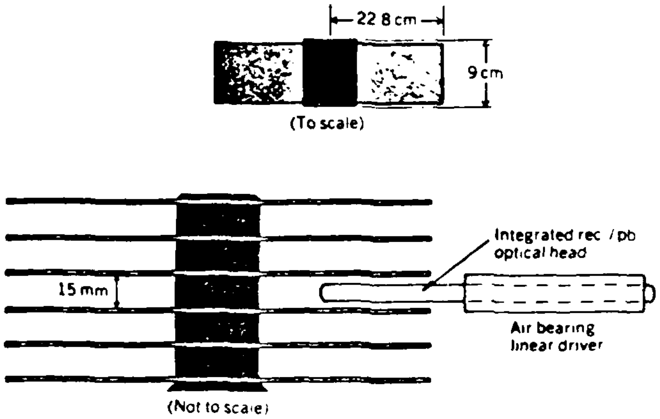


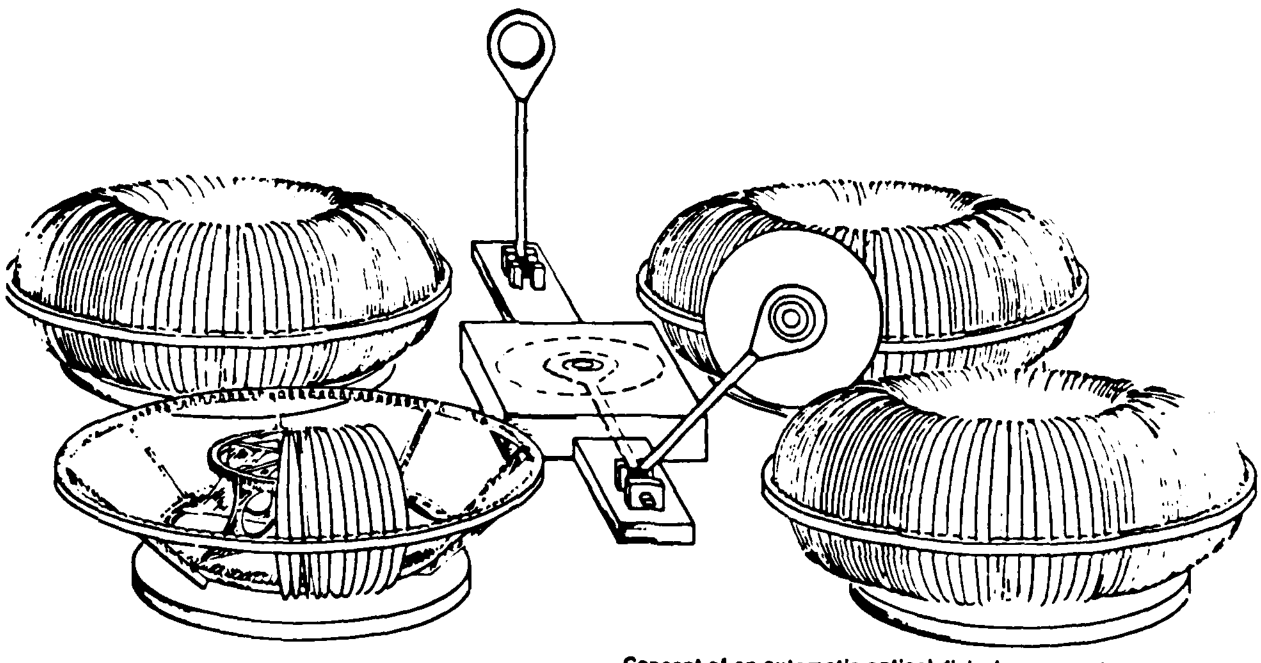


Areal recording density vs. time for various recording mediums, showing that the ultimate optical disk limit exceeds that for magnetic recording.

Of perhaps the greatest interest to video disc storage system users is the potential for enormous mass storage through the development of optical disc packs and automated, computer-controlled disc changer systems, both as suggested below by Kenney, et. al. (1979: p. 37).

Basic design of an optical disk pack with six double-sided disks gives storage capacity of one trillion bits.





Concept of an automatic optical disk changer system, with four lazy susans to handle the disks.

The authors suggest that a "juke box" disc system could access 1000 discs in three seconds, occupy 6 m^2 of floor space, and, when disc capacity increases to 10^{11} bits per disc side, provide access to $2X10^{14}$ bits, or 25 million Mbytes! Indeed, theoretically at least, there is no upward storage limit.

At the same time, there are several important disadvantages connected with the use of optical video discs. One concerns the non-erasing characteristic of discs which means that, unlike magnetic storage media, discs cannot be used over and over again. Secondly, disc production costs remain high relative to the creation of magnetic storage systems. Finally, small text resolution is sometimes poor (but this is due as much to limitations in video display as it is to optical disc storage/retrieval technology).

A problem of another sort is the incompatibility among discs and disc players which several manufacturers have chosen to create. Users will thus have to evaluate the advantages and disadvantages of each before making any investment commitments (see Appendix B for a look at how the various systems differ).

2.2 Micrographic Systems

Microfilm, microfiche, and other non-optical/non-magnetic storage media have only recently begun to attract serious user attention largely as a result of the integration of human-engineered computer-based control of large microfilm/fiche data bases (see Appendix C for the latest usage survey). They have also become popular because they are enormously inexpensive vis-a-vis magnetic tape or disk <u>and</u> a competent and responsible vendor and service community has finally emerged.

The equipment for the conversion to the use of micrographic systems is varied and reliable. Cameras available for film/fiche production include the following, as suggested by Sachs (1981: pp. 58-60):

- ALOS Micrographics Corp., Walden, N.Y., offers, among others, its Simplex Recorder, a 16mm rotary camera that can film up to 2500 documents an hour;
- Bell & Howell's ABR-100 recorder combines the high-quality photography of a planetary camera with the speed of automated operation. Its features include an automatic feeder, program cards to instruct the microprocessor, removable cartridge cassettes, and a microprocessor touch keyboard;
- The Canon Rotary Filmer 300DDS from Canon U.S.A., Lake Success, N.Y., is a free-standing console with three lightweight, interchangeable camera units of 24X, 40X, and 48X reduction ratios. Its standard features include exposure control, blip encoding, and endorser;
- Datacorp, Beaverton, Ore., offers its Datacorp 2000 Office Microfilmer, a compact, tabletop unit that produces dry, processed film strips at a 24-to-one reduction;

- Kodak's Recordak Reliant 750 rotary microfilmer processes more than 2,200 inches of document material a minute. The user is given a choice of several reduction ratios;

- Minolta, Ramsey, N.J., offers a 16mm planetary camera. The Micro Auto 16 features a cutter that produces jackets and microfiche;

- Terminal Data Corp's (Woodland Hills, Calif.) Documate II features an automatically-driven feed-table, a multiformat camera, operator-interchangeable lenses, an automatic page turner, and programmed fiche titling; and

- The SRC 1050 camera from 3M features dry-silver technology that permits rapid production and eliminates the need for liquid chemicals or plumbing. Either a single- or double-frame mode of exposure can be selected, and the two can be intermixed on a fiche. 3M's newest camera, the EF 5000 ducument camera, interfaces with a new page-search reader/printer, the EF 6000.

Computer-aided-retrieval (CAR) and computer-output-microfilm (COM) systems include the following (Sachs, 1981: p. 60):

- AM Bruning, Tustin, Calif., connects an on-line terminal directly to either Model 95 or Model 96 Automated Retrieval Terminal via the CAR interface. Users can employ on-line storage for data-base information and indexing to off-line microfiche data and micro-images of the original source documents;

- Bell & Howell COM Div. in Irvine, Calif., has three COM systems: the 3700, 3800, and 3900. The 3900 is a high speed, minicomputer-controlled system that converts data read from standard print format computer output tapes to 16mm or 35mm roll microfilm, or to 105mm microfiche. It operates independent of a source computer, and has several reduction ratio lenses. Bell & Howell's Excalibur data management system accomplishes retrieval of data, performing data capture and indexing at the same time. RK07 disk drives allow the system to be easily updated;

- Datacorp serves its customers as a COM software consultant, marketing its own COMTREVE software;

- DatagraphiX Inc., San Diego, offers several versions of its COM recorders. AutoCOM is a self-contained recorder/processor that converts output tapes to cut, dry microfiche in a single operation. The Mini-AutoCOM adds a 16-bit word minicomputer with a 32K word memory to the AutoCOM system;

- Kodak Komstar 100, 200, and 300 micro-image processors operate on-line with computer mainframes, and eliminate the need for liquid-chemical developing. The 100 and 150 IMT terminals are hooked up to a computer via an interface;

- Metropolitan Microforms Ltd. in New York markets its MCAR system, which satisfies the need for a one- or multiple-user information retrieval and input center;

- NCR Corp.'s (Dayton, Ohio) Q115 and Q118 COM recorder/processors are integrated, minicomputer-based systems that convert data on computer tapes into 105mm microfiche. The units can be optionally configured to function on-line to an IBM processor;

- The IQS (Intelligent Query System) software package is available from PRC (Planning Research Corp.), McLean, Va. This sophisticated information indexing package is especially suited for retrieval from very large quantities of documents stored on microfiche, roll film, and paper media; and

- 3M's Micrapoint retrieval system indexes documents and stores descriptors of the microfilmed items on magnetic diskettes. A search for one or more item may be initiated by keying in one or more of its descriptors. The system then directs the 3M Page Search Reader/Printer to retrieve and project the desired document images.

Film/fiche readers and readers/printers have page-search capabilities and are exceedingly small and portable including at least one which is hand-held and powered by an automobile cigarette lighter (manufactured by Micro Design, Inc. of Hartford, Wisconsin). Other manufacturers include (Sachs, 1981: p. 60; also see Appendix D):

- A.B. Dick;
- Xerox;
- Micron;
- Bell & Howell;
- Canon;
- Kodak; and
- NCR.

2.3 Shared Analysis Systems

In the last five years a great deal of progress has been made in the linking, or networking, of various kinds of information and analytical systems. There are actually only several networking modes, including local networking where individuals access shared information as individuals from geographically close and similar stations, local networking where groups jointly access information and solve problems, remote individual networking, and remote group networking. We know remote group networking as teleconferencing (which may or may not be video-supported).

2.3.1 Local Networking - Local computer networking (LCN) which almost always involves information sharing of one kind or another has enabled a great many offices to combine and enhance their efficiency. Via data transmission rates which range from 100K bps (thousand bits per second) to 100M bps (million bits per second), LCNs are today utilizing several alternative communications linking technologies including base-board coaxial cabling, broadband co-ax, fiberoptics, and even infared technology (see Seaman, 1981).

Currently there are a number of LCN systems which are capable of linking users efficiently within one mile or so, as listed below (Seaman, 1981: pp. 114, 116, 120, and 168):

- Network Resources Corp., a subsidiary of Sytek, Inc., offers a high-speed, broadband-based local networking system that reduces cpu overhead and achieves throughput on the bus of up to 1M bps. The new System 40 local networking system interconnects a wide variety of medium- and high-speed devices, with network nodes or adapters providing the necessary attachments to the bus. The resulting network can include host cpus, peripherals, mass-storage systems, high-speed work-stations, and so on;

- Network Systems Corp. offers Hyperchannel, which is a baseband coaxial cable local network system (TV-type) that transmits data at channel speeds up to 50M bps, ordinarily over 1,000 to 5,000-foot-long channels, depending on the particular system configuration. The Hyperchannel system uses a single multidrop coaxial cable to distribute data. Equipment attaches anywhere along the length of the cable and shares the trunk capacity on a demand basis for communications between any stations on the link;

- Nestar Systems, Inc. announced its local networking product Cluster/One Model A (A stands for Apple) in the second quarter of 1980. Cluster/One Model A enables up to 65 Apple II computers to be linked together in an LCN. The medium for the network is 16-wire ribbon cable. There is a connector at each node which attaches to a special communications card located in each Apple computer. Each Apple may operate as a stand-alone system, or it may connect to a shared resource such as a 33M-byte hard disk file server or printer;

- Northern Telecom, Inc., has developed a local networking system, called Omnilink, which enables users of the 405, 445, and 485 processors to link their units together with shared disk files, printers, and memory. The processors can be connected up to 5,000 feet of cable length apart by a baseband coaxial cable. Up to eight processors can be linked together in a single net. In addition, Omnilink installations can communicate with other Northern Telecom systems or with other vendors' mainframes via the large library of protocols, such as asynchronous, bisynch, 3270, and SDLC, maintained by the firm;

- Prime Computer, Inc., has developed and made available Primenet, a local network that offers, among other capabilities, the possibility of operating up to 15 Prime computer systems in a local ring network. Distance between any two nodes can be up to 750 feet.
  A Primenet is capable of communicating with any other manufacturer's system that uses the X.25 standard. Primenet currently supports Telenet and Tymnet in the United States, as well as a number of overseas systems. Prime computers using Primenet are able to interface with a number of mainframes from other manufacturers. Prime has made available several RJE (remote job entry) emulation packages (CDC, Honeywell, IBM, ICL, and Univac) and accommodates protocols used by IBM 3271/3277 displays. These packages permit users to shift many processing functions to smaller Prime systems;

- The initial product offering of Ungermann-Bass, Inc., founded in 1979, is Net/One, a vendor-independent local network that's targeted to the market for high-speed data communications within a single facility, such as a university campus. The first commercial installations were set up in July 1980.
  Net/One uses various types of coaxial cable, including CATV-type. A cable system without repeaters can extend 4,000 feet. In the near future, an additional 4,000 feet might be added with the help of a repeater now in the test phase of development. As many as 250 nodes can be attached to the basic 4,000-foot length.
  Net/One is almost entirely vendor-independent in terms of the hardware that can be connected to the net. Each node is programmable, either locally or remotely, and attaches to any cpu, terminal, or I/O device through a Network Interface Unit (NIU).

Terminals and other devices at the nodes can be software connected to each other through a "virtual circuit," or can operate in a "data-gram" mode wherein messages are transmitted on the net with source and destination addresses, and the addressed devices just acquire them. Datagram is a one-way broadcast transmission, while the virtual circuit is a two-way point-to-point transmission that includes message receipt verification and other handshaking functions. Data transmission rates on the network are up to 4M bps. By 1982, a 10M bps system will be available. Ungermann-Bass has its own version of an SNA-type protocol for use on the network;

- Ethernet was first developed at the Xerox Palo Alto Research Center (PARC) in California. The prototype system has been operating at Palo Alto since 1973. Other test locations include the White House and the House of Representatives, as well as several universities. The Xerox/DEC/Intel consortium now offers a modified version as a commercial product.
  An Ethernet network consists of a coaxial cable, made up of one or more segments, typically up to 1,500 feet in length, and a communications transceiver for each element of the office system. Each of these elements provides control for its own transceiver.
  An Ethernet network is used to connect system elements within a building or part of it. Other transceivers with associated processors could be used to connect different Ethernet networks to each other and to outside communications facilities for long-haul transmission. Each system element has a unique address. Information is transferred in packets, which include the data to be sent, the address of the unit that will receive, and the address of the unit sending. Each transceiver monitors the network before transmission to be usre it is

clear and during transmission to detect interference. If there is interference from a transmission by another element (contention), the packet is sent again later when the network is clear;

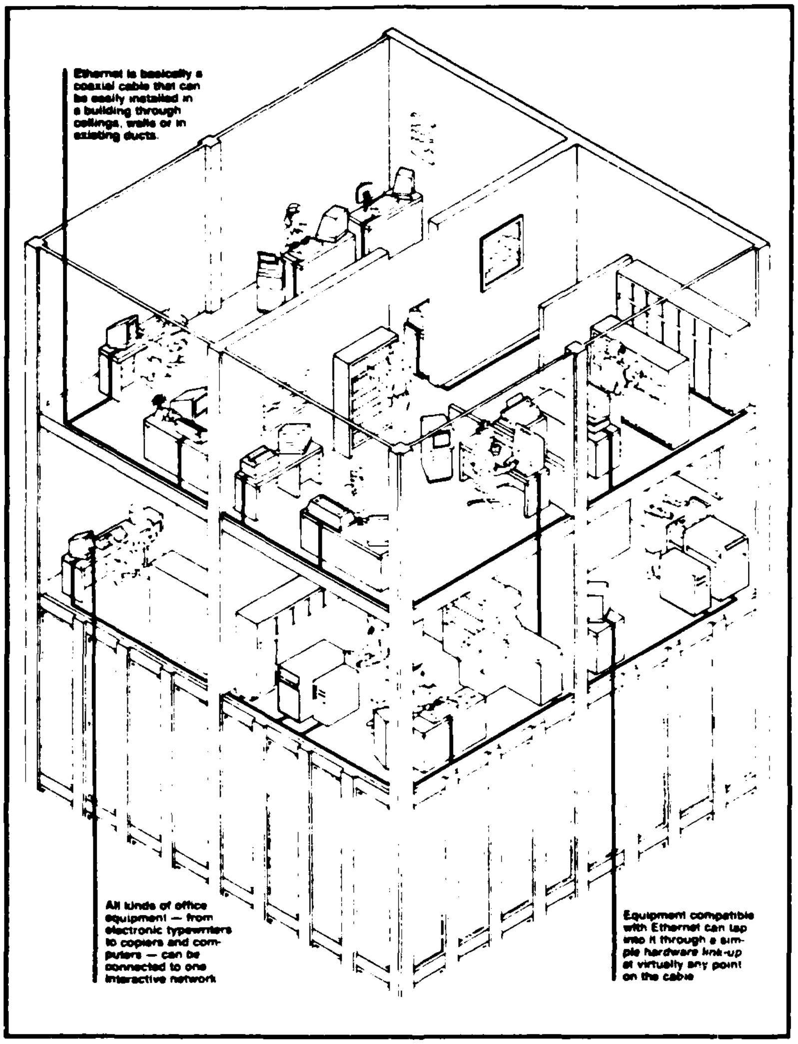
- The Z-Net system, an expandable LCN designed for multi-user business and specialized data interconnect, was introduced by Zilog, Inc., in May, 1980. Zilog, a maker of microprocessors, is one of several companies affiliated with Exxon Enterprises, Inc, (EEI) and part of Exxon Information Systems (EIS). In its plans for 1981-1982, Zilog anticipates announcing gateway technology that will permit remote Z-Nets to intercommunicate. Z-Net has applications ranging from electronic mail to office automation. It also provides an efficient tool for commercial small business environments with Cobol-oriented multi-user needs, such as inventory control and order entry. Z-Net is entirely passive. As many as 255 stations can be connected to up to about 6,000 feet of TV-type coaxial cable, using standard "tee" connectors. Data transmission along the cable is at rates of up to 800K bps;

- Wang has announced its Integrated Information Systems (IIS), declaring that these systems will be able to carry out both data and word processing. There are two lines of IIS, the first for the predominantly data-processing applications and the second for the predominantly word-processing applications. The former applications are handled by the VS line of computers, the latter by the OIS line of Office Information Systems. At the same time it announced IIS, Wang announced Mailway and Wise. Mailway is an internal electronic mail system that's compatible with OIS. Wise stands for Wang Inter-System Exchange, a network function that allows OIS systems within a building to be connected by a coaxial cable link. With Wise, up to 96 workstations are able to access each other, or any printer, disk storage unit, or other peripheral on the net. Devices can be located at cable lengths of up to one-half mile from each other, Wise handles data transfer rates of up to 4M bps; and

- In February 1981, A.B. Dick Co. introduced the Magna III Information Processing System, the latest in a line of text- and word-processing systems. The Magna III can be used as a stand-alone text processor or as the core of an expanded network of automated office system components that A.B. Dick Co. is developing. The heart of the Magna III is its "loop" concept, a high-speed synchronous protocol using a two-conductor cable that can be used to connect up to 255 stations. This means operators can share information--such as disk files--and can share other equipment such as specialized printers. Future additions to the Magna III line include new hardware and software packages such as advanced communications, mass-storage devices, intelligent copiers, matrix printers, and optical character readers (OCRs).

In order to visualize a local computer network, Seaman (1981: p. 112) presents a typical Ethernet configuration. It is presented below in an effort to illustrate how a local network can be developed.

The future of local networking is extremely bright. The incredibly high bandwidth which fiberoptic cables can provide is nearly available. Moreover, fiberoptic cables are immune "from electrical noise (from adjacent wires, high electromagnetic level environments, or lighting)" (Seaman, 1979: p. 108). They are also small, lightweight, secure, relatively



Many types of office equipment can be linked into a single integrated system via Ethernet. An Ethernet local area network cable (heavy line) connects system elements and lets users create, process, file, print, and distribute information electronically among various locations

error-free, and inexpensive.

Even infared communications are coming of age. Indeed, preliminary tests suggest that in single rooms and/or situations where clear lines of sight exist between communications points, wireless infared communications can be used effectively.

The same principles which underlie LCN technology facilitate teleconferencing and video teleconferencing for group problem-solving and meeting applications. For example, Matsushita has developed and applied a local video teleconferencing system and Decisions and Designs, Inc., under Defense Advanced Research Projects Agency support, has developed a local (office-wide) video teleconferencing system comprised of several teleconferencing stations (Hunter, 1980).

Finally, great interest is now being displayed in the interfaces to LCN and audio/video teleconferencing systems. Xerox, for example, has very recently introduced its Star system with spatial data management controls and France Telecom has developed a video telephone/display system which, like Xerox's Star system, can front-end LCNs.

2.3.2 Remote Networking - The packet-switch technology-based ARPANET is probably the best example of a shared remote network. But while it is a distributed system, it is limited to the transmission of alphanumeric and graphic digital data. Advanced video transmission is less well developed (or at least more expensive). For example, AT&T has only recently readied its Picturephone Meeting Service for commercial use (pending FCC approval). As Krass (1981: pp. 15-16) describes:

> "For the past few years AT&T has offered limited Picturephone teleconferences on an experimental basis (teleconferences are meetings held via closed-curcuit TV that allow two-way audio and video communications between participants at remote sites, thereby cutting down on expensive, time-consuming business travel). Should the FCC approve AT&T's application, the way would be paved for the company to develop a teleconferencing system that will link as many as 38 U.S. cities via land lines and satellites by 1983.
> AT&T has scheduled Picturephone service for New York and Washington, D.C., to begin in December 1981, following the filing of tariff applications (to determine rates for the service) with the FCC during the next few months. By 1982 the company plans to extend its service to Atlanta, Boston, Chicago, Dallas, Detroit, Philadelphia, Pittsburgh, and San Francisco. And by 1983 the service should reach an additional 30 cities, including Houston, Miami, and Seattle.
> Each Picturephone conference room will accommodate between two and ten people and will feature equipment that includes a conference table, a control panel, color TV cameras and monitors, a graphics display terminal, a hard-copy system, microphones, and videotape recording devices. With this and additional picture-processing equipment, AT&T says each room will be able to transmit and receive images of conference attendees, as well as visual aids such as slides and written documents. The hard-copy system, activated from a control panel, can produce paper copies of images displayed on the receiving monitors."

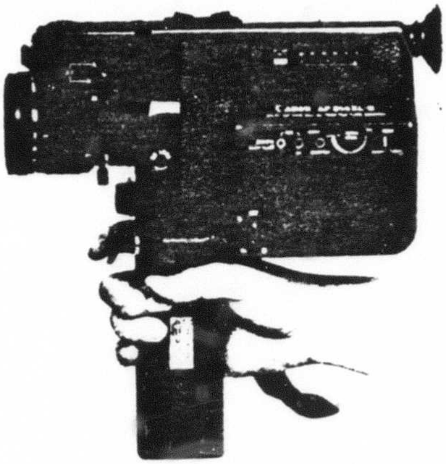
Most important to the cost-effectiveness of video teleconferencing is the recent FCC authorization for the launching of twenty satellites by eight corporations. True competition, and the reduced costs which it will foster, will result in the next ten years enabling more and more users to develop and apply video teleconferencing systems (see Edwards, 1981 and Briskman, 1981).

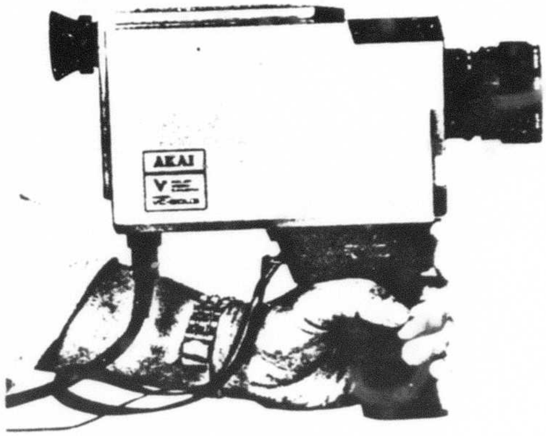
2.4 Video Recording and Playback

The movement in the design and development of video recorders is clearly toward the small and portable. The new Akai and Canon color camera systems, for example, are easily hand-held and their supporting VCR's are small enough to strap onto one's back (see Galluzzo, 1981: p. A10), all as shown below.

In addition, systems are becoming less power dependent (facilitating longer portable use) and much more automatic. In fact, several new cameras can hold a stationary or moving object in focus without manual adjustment.

Clearly, the trend is toward the development of even smaller, lighter, and more automatic systems.

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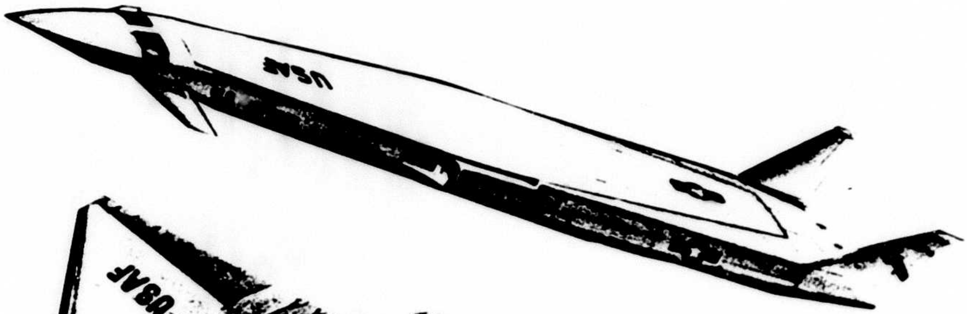
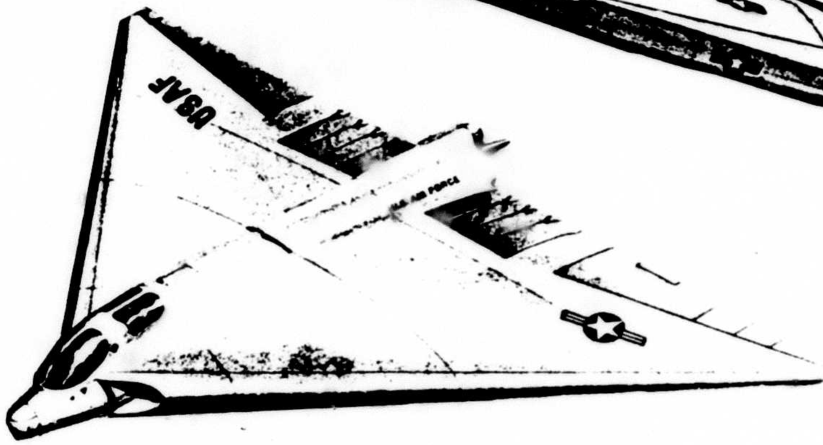
3.0 VIDEO APPLICATIONS OPPORTUNITIES

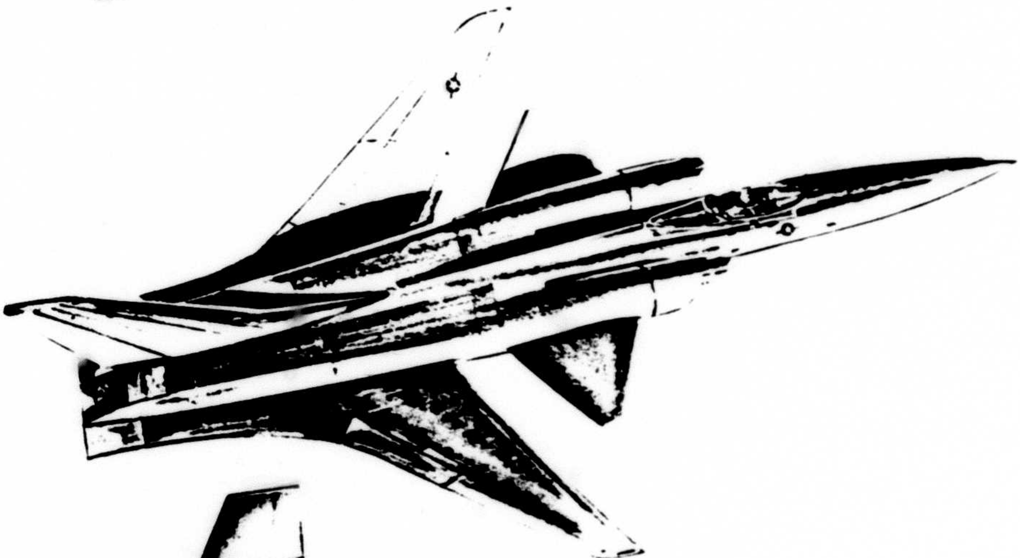
The above technologies will in the coming years lend themselves to countless DOD applications. While we have already begun to exploit the technologies for some limited research purposes we have yet to institutionalize any "production" systems. Presented below are thus a series of recommendations regarding how the technologies discussed in Section 2.0 can be applied to current and future DOD communications and information management problems.

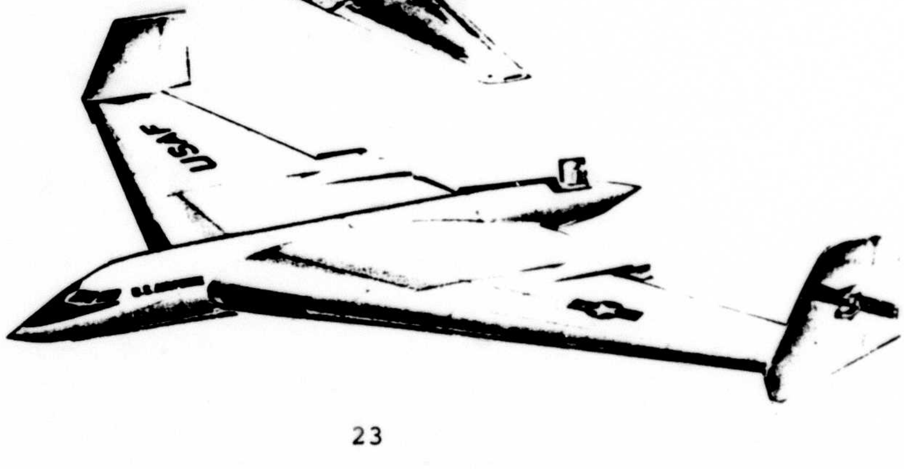
3.1 Video Disc Applications

Negroponte (1979) suggests a number of unique ways to conceive of video disc-based applications generally. They include the development of personalized, conversational, navagational, and synthesized movies, the use of unique user interfaces (such as touch sensitive displays, talking, and looking), and the development and use of new film techniques (such as variable consecutiveness, motion without movements, sound, still with sound over, and specialized overlays). While all of these ideas are useful and provocative, they are, from a DOD perspective, content-free. More marriages akin to the optical disc/military mapping/training variety must be encouraged. For example, optical video discs can be used to replay films of organizational behavior particularly during crisis management situations. The freeze frame, interactive nature of video disc use would be of enormous benefit during the conduct of previously impossible animated post-mortems. Similarly, personalized movies could be developed from user requirements typologies for training and re-training purposes. Conversational movies present another variation on the same theme, especially for more advanced trainees. Navigational movies could be used for order-of-battle planning and operations, security training, geographical orientation, and even animated simulation development. Synthesized movies, where the parts (data) are not arranged in any predetermined network structure, could be used for advanced weapons design where the barrel of one cannon could be placed upon the platform of another, and so forth and so on. Since possible data permutations and combinations are theoretically unlimited in synthesized movies, radically new designs could be assembled and tested. An example will highlight the process. In aircraft design but a few principles of aerodynamics govern the design and development process, but aerodynamic efficiency remains critical. Over the years many unusual designs have been generated and (experimentally) tested usually in scaled down wind tunnels with scale design models. But imagine an interactive mix-and-match design process supported by video disc-based images arranged and rearranged by a user. The apparently outrageous designs below (created in the conventional way) could easily have been synthesized from a video disc-based data base on aircraft design.









In many respects the concept of video disc-based synthetic design is analogous to the manual procedure implemented by police artists who "compose" faces of accused felons by mixing and matching noses, eyes, glasses, jaws, hair styles, and the like. Suggested here is the development of a video disc-based system which would accomplish the same end except that it should be endowed with default routines for completely unrealistic combinations and information about optimal design configurations in order to guide and accelerate user behavior on the system.

At the core of all such video disc applications is the notion of interactive motion or action. Programmed (computer-based) disc systems enable users to manipulate the video image in ways previously unimaginable to conventional film makers (see Appendix E). Accordingly, virtually any process/procedure/operation which can be explained, examined, and improved by filming can be enhanced via the use of flexible video disc playback systems. (Of course, the expense may not always be justified.)

Video disc systems offer another applications opportunity, however, in the form of enormous storage capabilities. As Kenney, et. al. (1979) have already suggested, "juke box" and multiple pack video disc configurations may revolutionize storage media systems development. DOD applications such as personnel recordkeeping, weapons systems capabilities statements, combat readiness/effectiveness records, alternative battle plans, contingency plans, and even space flight information might all be stored on optical discs available immediately and capable of storing all kinds of data and information. Indeed, where enormous records must be permanently stored and available virtually on-line the multiple disc configuration of the future may be very appropriate and cost-effective.

Finally, video disc-based "work stations" should be developed for special purpose defense applications. For example, Colony Productions offers several configurations (see Appendix F) which could be used to develop and transfer video disc-based technology.

3.2 Micrographics Applications

The application of microfilm and microfiche has lagged far behind their capabilities. In the intelligence field, for example, legal and procedural information about previous crisis management experiences could be easily converted to micrographics. In fact, the DARPA-developed Crisis Management Executive Aids might very well have been developed on fiche. Updating and cost problems would have been alleviated and some users would probably have preferred the computer-controlled fiche system to the system now in use. Similarly, research reports and records could be stored for quick analytical use on fiche and quick response distributed systems would benefit from large film/fiche stations. Treaties and other military and political agreements, which must be stored in exact forms, are also good fiche targets, as are designs, blueprints, proposals, and the like.

The keys, of course, are cost and speed. Film and/or fiche can be produced and duplicated almost immediately and inexpensively, unlike, for example, the production of optical and/or magnetic storage media. Reliability is also important since research suggests that CAR and COM systems are more reliable than magnetic storage systems.

Finally, the use of microfilm/microfiche can greatly accelerate the updating of training and other procedural and administrative manuals which would not only improve training but would also encourage training and education administrators to experiment more frequently with change.

3.3 Shared Analysis Systems Applications

There are a variety of ways in which shared local and remote networking and/or teleconferencing systems can be used in DOD. The major applications areas seem to fall in the intelligence and crisis management areas or in any area where group conferring, problem-solving, and/or decision-making is required.

3.3.1 Local Shared Systems Applications - Interestingly there are very few genuinely shared analytical work stations in operation in the intelligence community, save systems which enable analysts to send, receive, and save messages, cables, and reports, Even the Community On-line Information Network System (CIONS) is but a shade as capable as an LCN like Ethernet. Only old data bases are shared in any analytical sense and--most importantly--problems are still addressed primarily by individuals who may be only remotely aware of problem-solving colleagues. Proposed here, then, is the development of LCNs for group decision-making, forecasting, and evaluation, among other analytical activities. Since the networking technology is off-the-shelf and/or about to be developed new opportunities now exist for improved group problem-solving.

3.3.2 Remote Shared Systems Applications - Sometime in the not too distant future the way we all meet to solve personal and professional problems will be dramatically transformed. Instead of hopping on trains and planes and traveling thousands of miles to meet fact-to-face to discuss complicated problems, we will find ourselves sitting in front of television screens talking and working in much the dame way we now do in person. The procedure which will make this possible is, of course, the teleconference.

Today the teleconference is primarily audio involving telephone contact among the parties. Anyone can initiate a teleconference by simply calling a telephone operator who in turn calls all of the parties and connects them on the same line. Enhanced audio teleconferencing can include "electronic blackboards," devices which enable a party on one end of the teleconference to write on a blackboard and have it appear on a board on the other end.

But the problem with these kinds of teleconferencing is that you can not see the people who comprise the meeting. Consequently, you can not gesture, stare, or study the reactions the participants may have to what is said. In other words, audio teleconferencing does not replace face-to-face interaction but only offers a poor substitute. Audiovisual teleconferencing, on the other hand, which enables the participants to hear and see each other, offers totally new possibilities.

In recent years, audiovisual teleconferencing research has taken us to the point where we can successfully link two or more parties who can see and hear each other with relative ease. Some of these teleconferencing systems permit participants to see pictures of each other while others enable participants to converse in full motion.

Full motion audiovisual teleconferencing is now under development at Decisions and Designs, Incorporated (DDI).

With DARPA support, DDI is building a system which will enable individuals to meet electronically as though they were all face-to-face sitting around a conference table. Each participant sits in front of as many television screens as there are individuals in the teleconference. Above each of the screens are TV cameras which permit each of the participants to see all of the others. The screens are physically arranged in much the same way individuals might be seated around a conference table. Full motion video also includes overhead cameras at all of the teleconferencing stations which enable the participants to see simultaneously anything one wishes the group to see, such as charts, maps, notes, or pictures.

Each teleconferencing station has been "cabinetized"--that is, made to look like an unobtrusive piece of office furniture. Teleconferencers are thus made to feel comfortable and, hopefully, inclined to use the teleconferencing system with the ease and frequency that they now use the telephone.

The DDI system is now "local." Four teleconferencing stations, comprised of TV monitors, microphones, and cameras, have been connected within the same office building. DDI personnel are thus able to teleconference routinely and eliminate the time and trouble of walking half-way around the building to meet.

As with any good idea, however, there are problems. The most important is cost. While local, or closed circuit, audio-visual teleconferencing is relatively inexpensive, geographically remote teleconferencing is today extremely costly. Geographically dispersed full motion audiovisual teleconferencing stations can cost well over $100,000 a piece, and the necessary satellite communications costs can exceed $1M per year. However, by 1990 these costs will have been dramatically reduced. As more and more satellite circuits become available, as earth stations costs drop, and as the technology necessary for transmitting visual signals grows, we might very well telconference instead of travel.

Other problems are "social." Just as today many people are unwilling to sit in front of a simple computer terminal, there are likely to be those who will refuse to teleconference primarily because they will see it as an unnatural way to meet. Others may refuse to teleconference for privacy reasons, suspecting that, unlike during a meeting behind closed doors, too many colleagues or competitors may be listening in. Still others will see the teleconference as a threat to out-of-town treats.

Yet as travel costs continue to grow as a result of increased fuel and labor costs, the teleconference may eventually emerge as the cheapest way to "travel." And as the systems become easier and more fun to use, many of the social problems may disappear as well. In fact, by the 1990s almost all kinds of decisions and problems will be teleconferenced routinely. Bureaucrats will schedule teleconferences the way they now schedule trips. Problems which previously took days and even weeks to solve because of great distances will be solved in hours. Even in-house problems will be teleconferenced, freeing harried employees from traveling up and down the crowded floors of high rise office buildings, or around the Pentagon.

The greatest challenge, however, will not be to enable teleconferees to meet electronically in ways which duplicate face-to-face meetings; instead, the challenge is to build teleconferencing systems which improve upon face-to-face meetings (because face-to-face meetings are notoriously inefficient). In this way we can improve crisis management decision-making and other remote group problem-solving situations.

Finally, since industry is spending millions of dollars on the development of remote teleconferencing systems, DOD can concentrate efforts on the "social" aspects of electronic meeting behavior.

3.4 Video Recording/Playback Applications

The small, lightweight, and easy-to-use recording systems enable us to accelerate the production of optical video discs, film reports and demonstrations, and capture organizational and group behavior for post mortem analysis. Curiously such applications have not occurred with any frequency in DOD.

Of particular applied interest is the use of inexpensive videotape for training purposes. One application by Hallgren (1980) successfully interfaced a Sony SLO-320 videocassette recorder to an Apple II microcomputer (see Appendix G). Such applications have great implications for DOD training and education, briefings, and demonstrations.

4.0 CONCLUSION

All of the above video technologies and applications recommendations must be read within the context of an exploding technological revolution. Within a few short years all of the above may be obsolete and we may be conceiving of applications which today seem impossible. In other words, we must continually assess the video technology marketplace if we are to maximize its applied impact upon DOD.

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APPENDIX A

"The MCA Disco-Vision Industrial Player"

The MCA Disco-Vision Industrial Player

THE MCA DISCO-VISION INDUSTRIAL PLAYER

MCA DISCO-VISION has developed a new communications technology for the storage and retrieval of audio-visual as well as alphanumeric and computer information. The information is impressed upon a videodisc which resembles a grooveless long-playing phonograph record. The videodisc is played by means of a compact portable player and the image for information output is displayed on any standard TV receiver, monitor, or CRT (cathode-ray tube) device.

The MCA DISCO-VISION optical videodisc system uses a non-physical contact, low-power, helium-neon laser beam of coherent light to recover image-producing signals from the videodisc. Information from audio-visual and other sources can be mastered and then replicated for distribution and use on inexpensive videodiscs.

The MCA DISCO-VISION industrial player has been specially designed for instruction, training, audio-visual archive file retrieval and other communication uses by federal and military agencies, educational/scientific institutions and private industry. As a multi-purpose communications system the player and its optical videodisc will provide information in several different modes.

As an audio-visual source the player and videodisc provide full color or black and white high resolution motion picture and sound information with a capability of 30 uninterrupted minutes of playing time on one side of one disc.

As an information file retrieval source the player and videodisc can provide 54,000 separate, individual high resolution frames of full color image, alphanumeric, or computer information. As a mixed access source, the player and its optical videodisc can provide any combination of motion, aural, video and single frame information in any sequence.

The industrial optical videodisc player has been manufactured to accommodate the constant stresses and strains of everyday use. It is more rugged, more sophisticated, and more durable than the home consumer unit.

The transparent plastic videodisc surface protects the buried information layer from dust, thumbprints, scratches and other degrading debris. The videodisc can be handled, stored, and mailed easily and safely in almost any type of situation and environment without degradation. It is more rugged than the familiar micro-groove long-playing phonograph record.

A hand-held, digital readout controller for the player enables the user to pre-select rapidly and conveniently, as well as to automatically locate and freeze, any of the disc's 54,000 indexed frames which are individually numbered at the time the videodisc is mastered.

Because of the high-density information storage capacity of the optical videodisc and because information or frames at any point within the disc may be accessed almost instantaneously, the user thus has a new and powerful universal tool with which to store and retrieve vast volumes of every type of information quickly, easily and economically.

CHARACTERISTICS OF THE MCA OPTICAL VIDEODISC SYSTEM

- The videodisc is an inexpensive carrier of information. The disc itself is made of low-cost material, and lends itself to high speed and mass replication.

- The optical videodisc is 12 inches in diameter, with a center hole diameter of 1-3/8 inches. The rigid disc is .044" thick and weighs 3-1/3 ounces; the flexible disc is .010 inches thick and weighs 3/4 ounce.

- Each videodisc contains 54,000 frames or pages of information per disc side. A single disc carries more than 54 billion bits of information per side.

- Playing time is up to 30 minutes for a 12-inch disc. Two discrete audio channels are also available for stereophonic sound or selectable separate reproduction. The audio bandwidth is better than 15 KHZ.

- Program material appears on the disc in the form of a spiral running from the inner diameter of the disc outward, with a pitch of 66 micro inches or 1.66 microns per revolution. There are 15,000 tracks per radial inch.

- Since there is no contact between the pickup and the surface of the disc, no wear can occur which would degrade either the information carrier or the reading device.

- A videodisc will carry information now available on any film, videotape, film strip, microfilm, printed text, slide, transparency, audio-tape or phonograph record.

- Disc mastering from tape, film, live, or other information sources is accomplished in real time, using a laser to encode information onto the master disc. Addressing, special encoding and the inclusion of the two audio discrete channels is accomplished during the mastering process. The master is then used to form the replicated discs.

- The video format is standard NTSC, 525 lines, 30 frames per second. The videodisc rotates at 30 revolutions per second, or 1800 revolutions per minute, and provides one image during each 360° revolution.

- The playback system uses a one milliwatt laser readout. The coherent light beam is similar to those used in modern accounting and computer systems, and at supermarket checkout counters.

- The videodisc player can be attached easily to any conventional television receiver or monitor. The attachment to a receiver is accomplished in a few minutes through the antenna terminals and does not interfere in any way with regular over-the-air operation of the set. Unlike some other types of videoplayers, the DISCO-VISION player requires no modification of the TV receiver. The player itself has a built-in time-base corrector.

APPLICATIONS OF THE MCA DISCO-VISION INDUSTRIAL PLAYER

- In government and public agency activities, DISCO-VISION will fill two well-defined needs. The first, audio-visual applications will be for training purposes, in lieu of film and videotape. A variety of departments, such as Agriculture, HEW and Justice, can enjoy dramatic cost savings in the storage and distribution of their training materials on disc.

- A second use will be archival in nature for governmental and public departments or agencies which have an urgent need for high-density storage capacity. DISCO-VISION's enormous packing density exceeds that provided by conventional photographic film, magnetic tape and microfilm systems.

- Libraries will be able to offer their patrons a mass information retrieval service via the videodisc. This "electronic filing cabinet" concept will enable patrons to have quick and easy access to the centralized information and retrieval facility of any library. Not only will printed material be stored on the videodisc, but motion pictures, slide presentations, and even television programs now stored on film or tape can easily be transferred to the videodisc and made available to the library patron.

- Audio-visual material for instruction and training can be presented interactively on a standard TV receiver using the videodisc, which has the ability to store multiple answer material that can be selected at will. When used in conjunction with minimal data processing equipment, question-and-answer routines employing a "branching" and "sub-routine" capability could continuously feed back a program of appropriate audio-visual material predicated upon the students' response to initial presentations.

- Videodisc systems can be used as point-of-purchase sales tools in retail outlets, checkout counters and automobile salesrooms, replacing the more costly film and tape machines now in use at such locations.

- Videodisc players can also be utilized as training devices for salespeople, mechanics, technicians and others, for the storage and retrieval of maintenance manuals and information for automobile, airplane and other maintenance mechanics.

- An important DISCO-VISION application in the field of medicine is the potential for archival storage and retrieval of X-rays. Storing X-rays on videodiscs could reduce significantly the amount of space needed at present for this purpose. Once on the disc, stored X-rays can be accessed immediately for viewing on a CRT monitor.

- The disc could be used as an inexpensive, mailable, information storage medium for credit card verification. Each week videodiscs containing the numbers of all cancelled or stolen credit cards could be mailed to retail subscribers. The unacceptable or counterfeit card inserted into a reader terminal would flash a red light.

- Television programs currently distributed in the form of film prints or magnetic tapes could be distributed more easily and economically on videodiscs. The player's capability to lock onto any given point or frame within a videodisc program permits precise and easy cueing and insertion of commercials and other program material. In the same way, videodiscs can replace film or videotape for showings of in-flight movies, on ships, or on oil platform complexes at sea.

• Audio-only optical videodiscs which can play recorded music for 15 hours on one disc side can be used in commercial outlets as replacement for Muzak type services.

• The videodisc can fill instruction, training and information needs in emerging or lesser developed countries where no over-the-air TV exists or is available only on a limited basis.

The applications of the MCA DISCO-VISION system are far more numerous than the few examples provided above. The unique high-density storage and retrieval technology of the optical videodisc make it the core, the vital element in a rapidly developing video environment. Opportunities for its applications lie in all known print, graphic, audio-visual and file retrieval areas. It is the first all-purpose, universal still and motion, aural, visual and information storage and retrieval system ever devised.

INFORMATION STORAGE AND RANDOM ACCESS CAPABILITIES

• Each of the 54,000 frames on a single disc side can be immediately and randomly accessed by fast, radial traversing of the disc. The hand-held digital controller commands all of the player's random access functions --

fast-forward, reverse, freeze-frame, crawl frame, forward and reverse, slow-motion and single-frame step forward and reverse.

- To understand the enormous storage capacity of the optical videodisc, all of the pages of the Encyclopedia Britannica and all of its annual supplements could be transferred to a single videodisc, and there would still be room for additional material. Or, 400 million nine-digit numbers (such as Social Security numbers) could be stored on a single 12-inch disc with three-fold redundancy for accuracy.

- Through the use of the frame crawl control, each frame of the disc can be moved forward separately picture-by-picture, as a series of stills, in a desired time sequence similar to a regular slide projector, only much more rapidly. Each frame may optionally be individually identified by means of a digital display on the viewing screen.

- On a cost per frame basis, at 60 cents per disc manufacturing cost and 54,000 frames, the cost is .0011 of one cent per frame.

- A one-copy mastering technique is now in development. The user will be able to inexpensively master durable, single copy discs which can be played immediately without intervening processing or development. This single-copy disc will have the same durability and playback characteristics as the standard, volume-produced, consumer-type plastic videodisc.

- It is possible to code the videodisc for such automatic actions as access, start and stop.

- The industrial optical videodisc has significant potential in the area of micrographics. Both types of current microfilm systems are relatively cumbersome in use. They have an access time problem, while the optical videodisc does not. The videodisc can thus be regarded as the ultimate solution to microfilm system's limitations.

- Computer digital television peripheral products using optical videodisc technology are now under development. Since the optical videodisc has a much higher storage density than magnetic discs now used with computers, by melding the analog technology of the videodisc with the digital technology of the computer, the user will have available the best features of both systems.

The extremely high-density information storage capacity of the optical videodisc, and the player's freeze-frame, high-speed search-out, speed-up, slow-down and reverse capabilities, all combine to make DISCO-VISION a most valuable professional communication tool for the institutional, business, educational, governmental and industrial applications.

DISCO-VISION's high-density information storage capability also provides the most economic and convenient form of storing audio-visual information. The videodisc, with its 54,000 frame capacity and 54 billion bits of information per disc side, has the highest information storage density of any of the existing media.

It will allow the user to store and access any of the information contained in the 54,000 separate frames on a videodisc -- easily, rapidly and economically.

It is truly the technology of tomorrow, available now, today!

APPENDIX B

"Videodiscs: The Revolution in Information Storage"

"Video Discs"

"Video Disc Players: Laser Disc Vs CED"

"The Pioneer Model VP-1000 Videodisc Player"

Best
Available
Copy

technology update

Videodiscs: The Revolution in Information Storage

A customer in a busy General Motors showroom watches an on-screen demonstration with sound of the performance of the 1981 Chevrolet Citation, using a push-button panel to indicate which features of the car she'd like to know more about. The demonstration goes on, explaining those features in greater detail.

A family watches an uninterrupted version of the famous film Casablanca on the living room TV set, and then decides to replay the movie's stirring final sequence. Afterwards, they watch a historic Super Bowl football game, replaying a disputed call in slow motion.

A doctor watches a delicate cornea transplant operation on a demonstration screen at a leading hospital, listening to a voice-over of detailed surgical instructions. Later, a nurse watches the same demonstration, tuning in a different voice-over that gives instructions for a nurse assisting in surgery.

An aircraft technician learns to repair a complex piece of equipment through an interactive demonstration film that allows him to answer questions and choose from recommended solutions. Afterwards, he gets a score based on the number of correct answers he has entered using an attached keypad.

Scenarios like these are taking place daily in thousands of showrooms, homes, medical centers, factories, and offices across the country. Despite their diversity, they're all made possible by a highly publicized group of new technologies known collectively as videodisc. In simple terms, a videodisc system is like a visual record player—when attached to a TV set, it plays discs prerecorded with both images (black-and-white and color) and sound, and yields high-quality video and audio output. Virtually any kind of information—from movies to product demonstrations to business or technical data—can be recorded on a videodisc, which looks very much like a long-playing record with either a glossy black or silvery surface. Most videodisc systems allow users to manipulate the sequence of sound and images in some way, either by replaying, freezing the action (also known as freeze-frame capability), or slowing the speed of individual sequences, or through more sophisticated interaction.

A videodisc from DiscoVision's Optical Programming Associates division.

THE POTENTIAL

Beyond their obvious attraction as a home-entertainment medium, videodiscs are touted by disc-system producers, philosophers, and technical experts alike: manufacturers RCA Corp. and Pioneer Electronics advertise the "magic" of videodiscs; maverick thinker Buckminster Fuller says the technology can be a "lifesaver of humanity" for its medical and instructional applications; Professor Nicholas Negroponte of M.I.T.'s Architectural Machine Group calls videodiscs the most powerful information-storage medium yet devised. The key to their future usefulness lies in Negroponte's observation: a single videodisc may contain a full-length feature film or images of up to 54,000 of the world's greatest art treasures on its two sides—or an individual disc could contain the text and picture contents of the entire *Encyclopaedia Britannica* or an equivalent amount of business information.

However, the videodisc's immediate potential is hampered in that most systems have only playback, or "read only," capabilities. The combined video and audio recording, or "writing," process is prohibitively expensive for small quantities. It is currently performed only by research labs and the disc manufacturers, who can spread the cost of cutting each master disc by replicating it and selling the copies in large quantities.

This can be done for both entertainment discs and specially commissioned discs like the General Motors (GM) demonstration disc, which has already been distributed to more than 10,000 GM dealers. But videodisc experts like Negroponte and Jules Street, a consultant at Strategic Inc. (a San Jose, Calif., research firm, formerly Strategic Business Systems, Inc.), envision a not-too-distant future in which attractively priced industrial videodisc systems will enable businesses to record desired information on their own discs for internal or external use.

Both RCA and North American Philips Co. (a division of the Dutch company N.V. Philips) have demonstrated laboratory discs that can store as much information as 25 magnetic tape reels or floppy disks—the devices currently used to store computer data. This kind of information-storage capacity, when linked with a computer—not currently a component of most videodisc systems—could revolutionize the way businesses are run, from keeping records to training employees to selling products. For example, Street says that several large companies are experimenting with videodisc systems that could be used to record information like regional sales data and transfer it to the central office; this would be cheaper than phoning in to a central computer data base, which includes charges for telephone usage and on-line computer time. Other market observers predict that by virtue of their mass storage capacity, videodisc systems equipped with computers and special printers will figure prominently in the office of the future, performing many jobs now handled by such mundane business fixtures as photocopiers, facsimile machines, and filing cabinets.

THREE INCOMPATIBLE TECHNOLOGIES

The electronics industry has spent more than a decade and over a billion dollars developing the technologies that have fueled this futuristic speculation. The result? Three divergent and incompatible technologies, each backed by at least one leading electronics firm. Videodiscs designed for one operating system cannot be played on either of the other systems, and each system has properties and capabilities purportedly best suited to different applications.

In a market many observers expect to outstrip the $6.5-billion-a-year color-TV industry, the leading and potential powers include a handful of American and foreign firms. But since 1978, when Magnavox Consumer Electronics Co. (a Knoxville, Tenn.-based affiliate of North American Philips Co.) released the first videodisc system in the United States, there have been so many production and retail distribution deals made in the burgeoning industry that when you walk into an electronics store, you can't tell the videodisc players without a scorecard.

Two types of videodisc technology are already available in the United States. Both Magnavox and Pioneer offer relatively sophisticated machines called laser optical systems, which use laser beams to read audio and video information encoded on grooveless discs. In contrast, RCA Corp. (the electronics giant based in New York) and its affiliates are pushing a system called the Capacitance Electronic Disc (CED), where in a phonographlike player uses a diamond-tipped stylus to pick up audio and video information encoded in microscopic grooves on the disc. The laser optical systems allow more sophisticated interactive playing features at a cost of several hundred dollars more than the simpler CED system. And Victor Company (JVC) of Japan will offer yet a third alternative in the United States later this year—a Video High Density/Audio High Density (VHD/AHD) or so-called grooveless capacitance system that also em-

Videodiscs in the Office of the Future

In addition to the marketing competition among vendors of consumer and industrial videodisc systems, a number of major computer manufacturers are working on videodisc systems for data storage in data processing and office automation systems—including virtually everything from word processors to mainframe computers. Xerox Corp., IBM, Control Data Corp., and Honeywell Inc. currently have such projects in their research and development labs, and Jules Street of Strategic Inc. predicts that fuel giants Exxon and Atlantic Richfield Co. (ARCO) could be among the earliest to release office automation systems with videodisc recording capability.

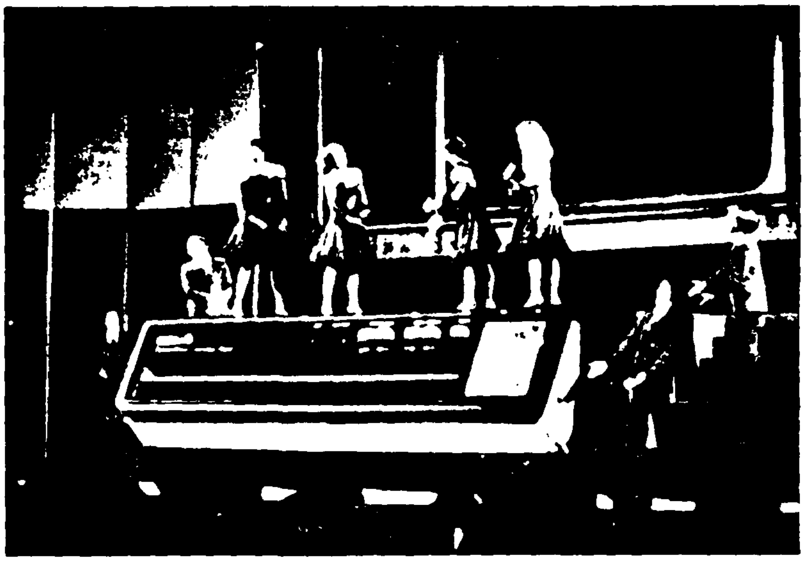
Despite the flurry of activity among U.S. firms, the first such system available in this country could come from Toshiba International Corp. of Japan. Toshiba's DF-2000 image recorder and laser file system was slated for release here in late 1981, but its introduction has been delayed for a year—purportedly because market research shows that microfiche is still a less expensive alternative for information storage. The DF-2000 has been in use since January 1981 by some Japanese banks, insurance firms, and other companies with massive paper files. The $60,000 system has a laser scanner, optical disc storage, and a copier—all connected to a display screen and keyboard. Similar in operation to a facsimile machine, the unit scans a page, converts it to digital data, and records it on a disc in less than 4 seconds. Later, the page can be retrieved and displayed within 4 seconds, or printed out in 14 seconds. The nonerasable discs cost $140 and can store data equivalant to 10,000 printed pages.

Will there be a videodisc system in your office in the near future? Most observers agree that disc manufacturers will have to achieve and maintain attractive price levels for sophisticated and highly reliable units before businesses will rally around videodisc-based systems, even for training and product-demonstration applications. The early consumer models were plagued by operating bugs and defective discs. The high costs and lengthy turnaround time for disc replication are also problems—although ARCO's Atlantic Richfield Development Corp. is testing an experimental disc called ARDEV, which can be replicated inexpensively using a device similar to a desktop copying machine.

In the meantime, many potential business users may bide their time until the videodisc systems with recording capacity become available at desirable prices. Most industry watchers agree that only then can videodiscs emerge as a viable medium for mass storage of images and data and for information retrieval.

—D.S.

SelectaVision VideoDisc: RCA's Biggest Gamble?



RCA's VideoDisc kickoff featured an entertainment number performed on a giant replica of a disc player.

"Foresight and nerve," recalls an RCA spokesman, were behind the communications giant's $130-million investment in color television, which the company was the first to introduce on the mass consumer market. RCA's investment in its SelectaVision VideoDisc players—17 years in development at a cost of more than $150 million, with a $20-million initial advertising budget—was also marked by those qualities. The product represents the company's biggest single budgetary outlay for a new consumer item, and this time the stakes are even higher than they were for color TV.

In a market where consumers are being seduced by a wide variety of options including cable TV and the popular videocassette systems (which are rapidly dropping in price and can record programs, unlike the disc players), competition for the consumer's home-entertainment dollar is keen. Moreover, rival firms like Magnavox and Pioneer Electronics are wooing consumers with laser optical-disc systems that offer more advanced features, and the Japanese Victor Co. will introduce a competitive system later this year.

Further, RCA's entry into the videodisc market comes at a time when the firm is in a considerable state of flux, characterized by chairman Edgar H. Griffiths's top-management-level firings last year and culminating in his own resignation, effective July 1, 1981 (when former Atlantic Richfield Co. president Thornton Bradshaw will take over). The company also saw first-quarter earnings slip, after an unusual increase in earnings in that period last year. The decline has been attributed to the unprecedentedly high videodisc introduction expenses plus high programming costs at the company's troubled NBC division.

To demonstrate its huge commitment to videodiscs and generate support among its dealer network, which will sell the product Griffiths calls "the most important consumer product since color TV," RCA introduced SelectaVision in February via a slick live broadcast, which cost $500,000 to produce and was beamed by satellite to color-TV monitors and projection screens for some 14,000 RCA dealers, distributors, and guests in 75 locations around the country. "We knew everything had to be done with enormous impact," says videodisc group vice president Jack Sauter. "The whole strategy behind our launch plan was to get the level of awareness up among both dealers and the public in the shortest possible amount of time." The unprecedented closed-circuit telecast featured presentations by Griffiths, executive vice presidents Roy Pollack and Herbert S. Schlosser, and Sauter. The event was hosted by Tom Brokaw of TV's "Today" show and included entertainment—previously taped song-and-dance numbers. Despite RCA's confidence in the reliability of its products and equipment, backup protection was heavy in case of technical failure, and videotapes of the program's dress rehearsal were on hand at each of the receiving locations as extra insurance.

Taking direct aim at the mass consumer market, RCA says it is banking on its CED (Capacitance Electronic Disc) system to become a "cornerstone" in its "continuing leadership" role in the electronic entertainment industry. The company could succeed in its strictly defined market, but many videodisc experts, including M.I.T.'s Nicholas Negroponte, say that such success would be detrimental to wide acceptance of the long-range potential of videodisc technology, since RCA could deflect interest from future systems that feature computer power and sophisticated interactive capabilities. Others predict that RCA's massive advertising campaign could boost competitors' sales. In addition, some observers note that RCA's chief market advantage right now is the SelectaVision player's $500 price tag. If the prices of the more sophisticated systems—which are currently several hundred dollars higher—drop, consumers as well as businesses may opt for them instead.

Meanwhile, RCA maintains there's plenty of money to be made from the consumer who simply wants to sit back and watch home entertainment on the videodisc system—the firm's advertisers call this "bringing the magic home." RCA market research indicates that about 7 percent of the 3 million American families who own color TVs would be interested in buying SelectaVision players during the product's first three years of production. In 1981 RCA expects to sell 200,000 players and more than 2 million discs under its own label, and the company expects to place SelectaVision in 30 to 50 percent of American homes by 1990. —*Jane Wollman* ploys a stylus for tracking and that JVC claims will combine the CED system's economy with the optical system's versatility. All three systems can be easily connected by cables to standard color-TV sets and use similar technologies to convert signals from the videodisc player into standard television signals—the differences are in the methods used to record information on the discs and to read it back.

THE OPTICAL SYSTEMS

Laser optical systems in two different configurations were developed independently by N.V. Philips in the Netherlands (which calls its system Visual Long Play or VLP) and the Los Angeles, Calif., entertainment conglomerate MCA Inc. (which uses the name DiscoVision). The two companies cooperated in the late 1970s to establish a "standard" optical system, which Philips's Magnavox affiliate sells under the name Magnavision. Last year IBM bought 50 percent of the DiscoVision operation from MCA, and both firms are partners in the recently formed Costa Mesa, Calif.-based DiscoVision Associates (DVA), which makes the optical discs. DVA also has an arrangement with the Japanese firm Pioneer Electronics to manufacture both players and discs under the LaserDisc label. Both Magnavision and LaserDisc units can play DiscoVision-made discs.

Laser optical discs have a smooth, silvery surface and are slightly thicker than a phonograph record, since they are made from 2 three-layer disc sides bonded together. Audio and video information is digitally encoded by a laser beam in microscopic pits arranged in circular tracks on the surface. There are 54,000 pitted tracks on each playing side, and each track contains enough information to form a single frame or television picture and its accompanying soundtrack—about one-thirtieth of a second of playing time, or a single revolution of the disc, for up to 30 minutes of programming per side. In addition, these discs can hold two different soundtracks for the same image—hence the capability to record the doctor's and the nurse's instructions for a surgical procedure or GM's English and Spanish accompaniment for its Chevrolet demo disc. Since there are no surface grooves —and no stylus grinding into them —optical discs are impervious to surface wear, and may be handled freely without the special care required by phonograph records or CED discs.

DiscoVision and LaserDisc systems read discs with a compact array of laser and optical components inside the player. A glass device called a raster grate diffracts (divides) the player's main laser beam into three smaller beams: the center beam is used to read the tracks on the disc, while the two adjacent beams perform the radial tracking function (normally done by a stylus) as the disc spins at 1,800 rpm on the player's turntable. Using a series of lenses and one- and two-way mirrors arranged at fixed angles, plus the reflective properties of the disc, the main beam reads or detects variations in reflected light corresponding to the pits in the disc. When the reflected light is passed through a prism, it bounces off another mirror and lands on photo diodes (electrical components containing semiconductor crystals), which generate FM signals like those used in radio broadcasting, except that they also contain the electrical signals needed to form video images. The FM signals are then fed to an electronic circuit, which translates them into video signals with two channels of audio.

At this point the signals are analogous to broadcast signals received by a television set—so they can be sent through a cable to the set's receiver, where TV components take over to produce the video and sound.

With the player's control panel, the user can locate any one of the 54,000 frames on a disc side and hold it rock steady on the screen for as long as desired. The optical player also allows clear forward or reverse playback in slow motion and fast motion at many speeds.

At the push of a button, each of the 54,000 frames is identified by its own on-screen number. If an inexpensive microprocessor component is added, the user can call up any frame by setting dials to the appropriate number. The microprocessor also facilitates an automatic indexing option with which the user can "program" a disc to hold a frame for a set interval before advancing, repeat certain segments, proceed at a different speed for a specified number of frames, or even skip around and play different segments of the disc in any specified order.

Besides the standard half-hour-per-side discs, the optical player can also play discs that DVA has developed especially for feature films and some industrial or instructional applications. These 1-hour-per-side discs are called Constant Linear Velocity (CLV) discs, and the extended playing time is offered at the sacrifice of features like freeze-frame, variable speed, and precise indexing, although program segments can be located using numbers on the screen that represent elapsed time.

Optical discs from DVA sell for $15 to $25 for feature films, and for

AARON REZNY

Videodisc programming includes a wide variety of entertainment material.

as little as $6 for short documentaries and how-to programs. Available at electronics stores, the Magnavox Magnavision player costs about $800 and the Pioneer LaserDisc system about $750.

DiscoVision Associates is also marketing a $2,250 system for business use, with more sophisticated interactive features such as the quizzing and scoring capabilities mentioned earlier. DVA produces the discs for use with the industrial system, with user costs of about $500 per side for producing the master videodisc and $5 to $10 per side for replication, depending on the features incorporated. An additional setup charge of $1,500 per side is waived if more than 5,000 copies of the disc are ordered. The DVA business system is already in use at a number of medical institutions as well as in some large companies, including GM, IBM, Hughes Aircraft Co., and even McDonald's Corp.

THE CED SYSTEM

RCA has staked millions on wide consumer acceptance of its low-cost SelectaVision CED system (see accompanying box, SelectaVision VideoDisc: RCA's Biggest Gamble?). The $500 system has more limited capabilities than laser optical players —RCA president Herbert Schlosser says the company has developed more sophisticated technology but currently rejects it in favor of the attractive price. The sole purpose of the system, says Schlosser, is to play back prerecorded entertainment material, and the current RCA VideoDisc catalog offers more than 150 titles, including recent and classic films licensed from nearly every major studio, concerts, TV specials, and instructional discs on subjects such as sports, cooking, and child care. The discs sell for $20 to $25 for most films, and less for shorter programs.

RCA makes its own players and discs, and has also signed TV manufacturer Zenith Corp. and the Japanese companies Toshiba Corp. and Sanyo Corp. to produce RCA players. The first SelectaVision players were introduced through RCA's retail distribution network in March 1981, and they will also be sold by several Japanese companies, by computer manufacturer Tandy Corp.'s Radio Shack retail outlets, and by major retailers including Sears, Roebuck and Co., J.C. Penney Co., Inc., and Montgomery Ward & Co. All players using RCA's CED technology can play only videodiscs made by RCA and its affiliates, which include CBS Inc. under an unusual noncompetitive arrangement—considering that RCA owns the NBC network.

The CED disc is thinner than the optical disc and looks more like a record album. Instead of there being two sides bonded together, both sides are stamped out from one lump of conductive plastic—actually a combination of carbon and polyvinyl chloride, from which records are also made. Since the surfaces of the discs are grooved, the discs cannot be handled without being damaged. To protect the surfaces, each disc has a rigid, plastic protective sleeve that can be removed only after a disc is properly inserted in a player. The surface is never exposed outside the unit.

SelectaVision VideoDiscs carry video and audio information in slots electronically etched into their grooves. If magnified, the walls of each V-shaped groove would look like plowed fields of ridges and dips. Each side of the disc can contain 27,000 grooves, or up to 1 hour of programming time, with each groove containing the audio and video data for four frames, or one-thirtieth of a second of playing time. CED discs spin at a speed of 450 rpm, as compared with the optical disc's speed of 1,800 rpm—hence the difference in number of frames played per revolution.

As the disc spins, the grooves guide the diamond-tipped stylus in a manner comparable to the operation of a phonograph. An electrode in the stylus picks up changes in electrical signals as represented by the capacitance, or variable width and spacing of the ridges and dips. The capacitance reading thus obtained at any instant is relayed to a detection circuit, which electronically processes it into separate FM signals for video and audio. Another electronic circuit processes the signal for reception by the attached TV set, through which the material is reproduced as TV picture and sound.

Numerals on the front of the player (like those on a digital clock) indicate which side of the disc is being played and show the elapsed playing time in calibrated minutes. Forward and reverse "visual search" buttons can be used to search for the exact location of a segment at about nine times normal playing speed. While users can manually stop the program to freeze a frame and repeat or vary the playing speed of certain segments, the CED system currently does not give users the means to rapidly locate and display a single frame (this capability, known as random access, gives optical systems a distinct advantage for business applications). Neither does the CED system provide the sophisticated interaction that makes optical systems desirable for training and instructional purposes.

THE VHD/AHD SYSTEM

The VHD/AHD videodisc system was developed by JVC with the blessings of its parent company, Matsushita Electric Corp. of Japan. JVC, Matsushita, the Fairfield, Conn.-based General Electric Co., and the British company Thorn-EMI have formed a consortium to coordinate VHD/AHD disc and player production with marketing. The system will be a latecomer on the videodisc scene, scheduled for sale in the United States toward the end of 1981. Priced at between $500 and $600, the players will be sold under the brand names of JVC, GE, and two Matsushita offspring—Panasonic Co. and Quasar. The first offerings, probably movie discs, will cost between $15 and $20.

VHD/AHD systems play grooveless discs with 1-hour playing capacity per side. The discs are smaller than CED and optical discs—about 10.2 inches compared with 12 inches. Sound and video information is contained in laser-encoded pits that resemble an optical disc's pits. The pits are arranged in spiral tracks, 54,000 per playing side.

The VHD/AHD player operates in a manner similar to that of the SelectaVision system. Since this pitted disc is subject to surface wear, it, too, must be protected by a plastic sleeve that is removed after insertion of the disc in the player. The electrode in a sapphire-tipped stylus tracks the electrical signals produced by spacing variations (capacitance) in the pits. Circuits in the player process these readings into video and audio signals for the TV receiver.

JVC's first offerings will feature dual soundtrack or stereo sound (which RCA expects to offer in the future) and forward and reverse playback with variable speed. Random-access indexing features and freeze-frame capability will be optional.

The VHD/AHD consortium claims its product will be virtually bug-free, since the player and the disc-mastering equipment will be assembled from standard parts that have already been test-proven.

With its combination of comparatively low price and advanced features, plus Matsushita's status as the world's largest consumer electronics company, the grooveless capacitance system could be a powerful contender for both consumer and commercial applications. But with the product's introduction only a few months away, the consortium has not announced agreements with any major entertainment or educational groups to provide programs for its discs —and some industry observers question how seriously the group plans to compete. ■ —Donna Stein

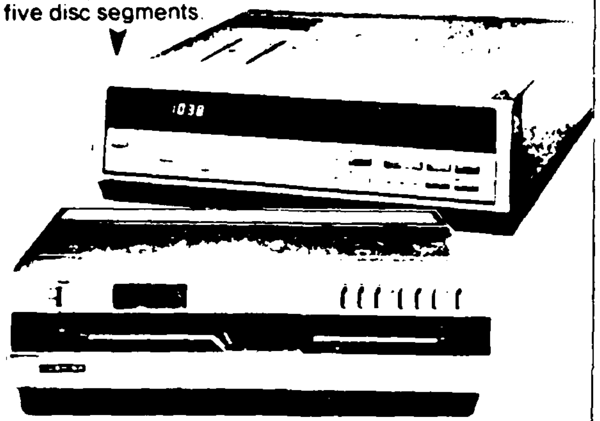
Special Report

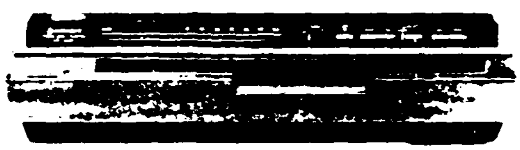
VideoFronts

VIDEO DISCS: Where the Action Is

The big news in video discs is that RCA is finally bringing its long-awaited SelectaVision CED player to the market [March 22], together with a large selection of program material culled from film and television libraries. A giant in the television industry, the company is aiming for the mass market [the "TV" rather than "videophile" households] through the same distribution network it uses for TV sales. Though a latecomer to the game relative to the optical format, RCA is entering it at a lower price and with more program titles. Presumably manufacturers committed to other systems will respond by releasing more titles and by *emphasizing the special-effects features* available only with the optical format.

Panasonic's video disc player uses JVC's VHD (Video High Density) system, which, like RCA's CED, employs a capacitance pickup stylus. The significant difference is that the 10.2-inch VHD disc is *grooveless;* tracking is controlled by servo signals engraved in the plastic disc. This makes such functions as freeze frame and random access somewhat easier to implement. There is an advantage for the manufacturer as well. The discs can be produced with essentially the same facilities now used to make phonograph records, at a slightly lower cost than that for current laser-optical systems. The Panasonic model can deliver stereo sound and comes with a wireless remote-control unit. Features include fast forward and reverse at 3 times normal speed, forward and reverse search at 180 times normal, slow motion at ¼ normal speed, and programmable random access of as many as five disc segments. ▼



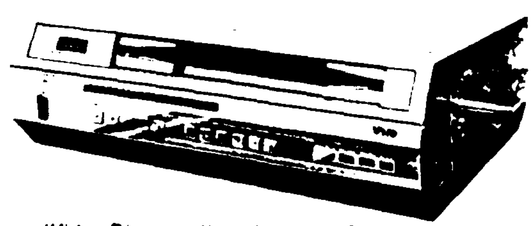


Toshiba says that ▲ its CED player will be available this fall. It will, of course, accept RCA discs. Functions include pause, 12 and 120 times normal speed in fast forward and reverse, and still frame. Price has not been set.

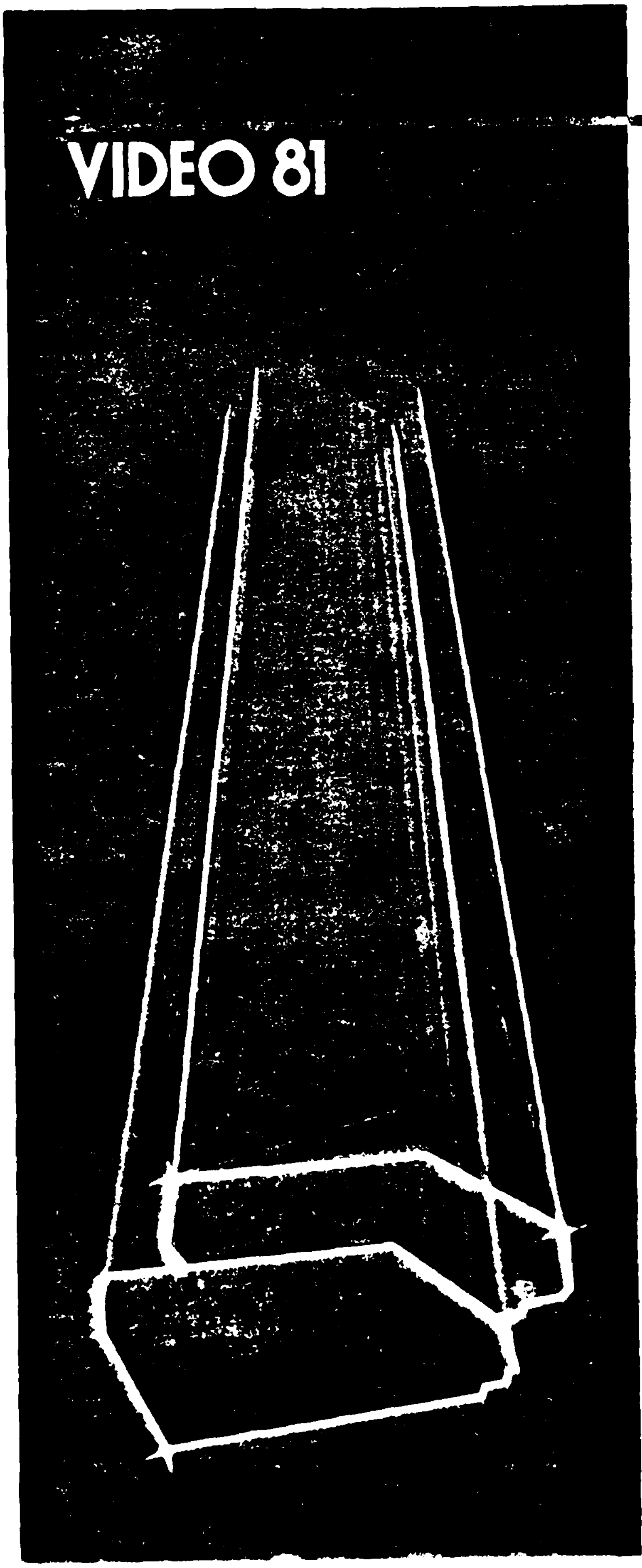
Scheduled for release late in the year, Sansui's VHD video disc player has stereo sound, fast-forward and reverse, search, and still-frame capability. It also incorporates a frame-numbering system with digital display on the TV screen. Sansui will also develop and market an AHD digital audio adapter for use with the player. ▼

The VIP-1000 CED ▲ video disc player ($500) from Hitachi has a wide array of features, including pause, fast forward and reverse at 10 or 60 times normal speed (both with picture), still frame, and optional wired remote control. The machine is equipped with audio, video, and RF outputs and probably will be convertible to stereo operation should RCA ever begin releasing stereo discs.

The first video disc ▲ system from Quasar will be available late this year. The VHD front-loading player provides stereo sound, fast forward and reverse, a search mode, freeze frame, slow motion, and programmable random access.



(Video Discs continued on page A10)



BY STAN PRENTISS

VIDEO

FOR OVER two years Magnavox has introduced its laser-optical system video disc (Magnavision) to market after market with little competition low yields in disc manufacturing and relatively apathetic consumer response But this summer and fall video disc players will stream from every vendor imaginable each hoping to excite consumer demand As with video cassette recorders this torrential flow will arise from just a few ultimate sources Fortunately as yet only three variations of the basic equipment exist although they are all mutually incompatible These originate with Philips-Magnavox RCA and Matsushita JVC the last using General Electric as one of two prime U S outlets

March s blast-off for the RCA SelectaVision which uses a capacitance electronic disc (CED) system with stylus pickup and spiral-grooved plastic records preceded the launch of the Matsushita JVC General Electric system video high density (VHD) player by just a few months The VHD system also uses a plastic disc and capacitive pickup but with a grooveless record that *does not physically contact the pickup* This permits a two-frame stop mode that the RCA system lacks

At this writing the competing forces line up like this RCA CED—RCA Zenith Sanyo Sears Hitachi J C Penny Sharp Radio Shack and Montgomery Ward Magnavox Philips optical laser—Magnavox Pioneer Sylvania Philco Fisher Gold Star and perhaps two others Matsushita VHD CED—JVC Panasonic General Electric Quasar Sansui and perhaps two others All told more than 20 sources will offer video disc products to the home entertainment market by next year

So far the leading competitors are Magnavox and Pioneer (laser-optical) vs RCA and Zenith (CED) Prices are currently $750 and $500 respectively How will the public react to a price differential of $499 95 for CED and VHD versus $749 for Magnavision? With discounts the prices won't be that far apart For those whose sharp eyes and even sharper ears demand respectively 4 MHz video bandpass and 20-kHz stereo reproduction the laser disc seems to be the system of choice Those who are less visually and aurally acute or who want to spend less could well choose between CED and VHD But available software titles (discs) and peripheral features such as the two frame stop mode frame and chapter indexing stereo etc also must be put into the equation Until VHD reaches the market however the disc contest will basically be Magnavox Pioneer vs RCA Zenith

CED Although the RCA and Zenith products have minor cosmetic differences what can be said of one will apply to the

DISC PLAYERS *Laser Disc vs. CED*

other, at least for the next year or so. The player measures 15½" D x 5¾" H x 17" W and weighs some 20 lb. Power consumption is 35 watts.

The cabinet has a removable top hatch for stylus/cartridge replacement. Operating controls are a function lever for OFF/PLAY/LOAD/UNLOAD, and pushbuttons for forward and reverse rapid access, visual search and pause. These are on the front panel along with LED readouts for elapsed playing time (in minutes and seconds) side 1 or side 2. A slot is provided for insertion of the 12-inch disc in its protective caddy.

With the function lever in LOAD, the disc entry door opens. When a disc is inserted, metal fingers remove it from its caddy and a lift plate positions it for the turntable. Thereafter, the caddy is manually removed and the function lever moved to its PLAY position. This action automatically lowers the stylus to the outside groove of the disc, and sound and picture commence after a delay of about eight seconds. During the ensuing one-hour-per-side program, the rapid-access forward and reverse buttons can be used to locate desired program segments.

For each second that one of these buttons is depressed, about two minutes of the program is displayed, so that an entire side can be scanned in less than 30 seconds. When RAPID ACCESS is used, the stylus is automatically lifted from the record and video is blanked, removing all noise effects from the screen. Meanwhile, the LED shows the elapsed time, within a minute, to any recorded position on the disc. The time signal is developed by an optical switch about the pickup arm drive.

The PAUSE mode also raises the stylus and suppresses video noise on the screen, while the LED readout flashes the letter "P" once per second. In VISUAL SEARCH, the platter is scanned in forward or reverse at about 16 times normal speed, with the picture remaining on the screen and the audio muted to avoid garbling. Pressing the VISUAL SEARCH FORWARD and REVERSE buttons simultaneously produces a soundless pseudostop mode, but the image is jerky since one groove is tracked and then the stylus jumps to a previous groove.

The recorded disc, made of poly-vinyl-chloride (PVC) resin, and loaded with tiny, uniformly sized carbon particles for adequate conductivity, has a thin coating of lubricant added to extend its life and that of the stylus. The vinyl caddy protects the disc against dust, liquids, scratches, or fingerprints. Grooves in the disc are about 2.5 micrometers wide with a maximum depth of 0.5 micrometer, matching some of the recorded signal wavelengths. Designed to be played in an ambient temperature of 60° to 90° F, the discs are said (by the manufacturer) to survive temperatures from −20° to +130° F.

Video and audio information is stored on a CED disc as frequency modulation (FM). Using FM eliminates the need to detect precise amplitude-modulation (AM) variations. Having dimensions several times longer than recorded wavelengths, the stylus maintains a fixed vertical position during playback. A thin metallized electrode on the trailing surface of the stylus forms one plate of a capacitor, the disc the other.

Variations in capacitance caused by modulation sensed by the stylus change the parameters of a resonant line through which a 915-MHz carrier from an ultrastable oscillator passes, thereby modulating the carrier. The carrier is then envelope-detected to recover a signal corresponding to the disc modulation. Video signals vary between 4.3 and 6.3 MHz, and one audio channel has a subcarrier frequency of 716 kHz, with maximum deviation of ±50 kHz. A second audio subcarrier to be added next year for stereo will be placed at 905 kHz. Thus both audio subcarriers, as well as the "buried color" subcarrier at 1.53 MHz lie within the 3-MHz (at −6 dB) system bandpass and do not interfere.

After filtering, limiting, doubling, and conditioning, the FM signal passes to two demodulator stages, one for video, one for audio. Detected sound modulates the usual 4.5-MHz intercarrier for the r-f modulator stage. Video, simultaneously, passes through a nonlinear aperture correction circuit that inverts the modulation and adds it to the original signal to cancel any 716-kHz soundbeats in the video. Thereafter, video is detected and also compensated by a line dropout detector that replaces missing video with a portion of the previous horizontal line. The demodulated composite signal is then routed to a comb filter to separate chroma and luminance.

Chroma is next up-converted to the standard 3.58 MHz and recombined with luminance. Audio and video then modulate a video carrier for channel 3 or 4.

Control signals known as DAXI (digital auxiliary information) and "arm stretcher" are developed from digital and chroma information during vertical blanking intervals. DAXI is used to overcome a problem called "locked grooves" that occurs when static trash such as record dust will cause the system to replay a groove repeatedly. Since frame and field numbers are sequentially recorded along with the picture and sound information, a special microprocessor in the equipment refers to these numbers and verifies that each appears in proper order. Should a locked groove occur, the DAXI microprocessor generates a pulse that moves the stylus ahead two grooves correcting the condition.

Each field, we are told, contains 77 bits of digital auxiliary information. These in-

LABORATORY DATA

ZENITH CED

Parameter	Measurement
Video carrier	−50 dBm + 5.72 dBm*
Audio carrier	−63 dBm + 5.72 dBm*
Video S/N	40 dB
Audio S/N	26 dB
Video bandpass	<3 MHz (at −3 dB)
Audio bandpass	>30 kHz
Operating power consumption	35 W

MAGNAVOX LASER DISC

Parameter	Measurement
Video carrier	−51 dBm + 5.72 dBm*
Audio carrier	−67 dBm + 5.72 dBm*
Video S/N	39 dB
Audio S/N	24 dB
Video bandpass	>3.5 MHz (at −3 dB)
Audio bandpass	>30 kHz
Operating power consumption	75 W

*Positive 5.72 dBm added for impedance conversion from 50–75 ohms.
Test equipment used: Tektronix 7L12 spectrum analyzer, Telequipment D67A and Tektronix 465B oscilloscopes, and Sencore PR57 Powerite.

VIDEO 81

clude a start code, error detection codes, *26 bits as yet unused, and field and band* number codes. The number seen on the LED readout is derived from DAXI.

The arm stretcher is actually a time-base correction generated by comparing the frequency of chroma subcarrier developed in the video converter with a locally generated 3.579545-MHz reference. It compensates for disc eccentricity. When errors occur, a boom on the stylus moves it backward or forward to compensate. This prevents color variations and or horizontal tearing in the picture.

The dc arm motor is controlled by a fly-*leaf on the stylus, which rests between two* diodes connected out-of-phase and receiving a 260-kHz signal from a control oscillator. Their currents are synchronously detected to drive the dc motor as the difference signal requires.

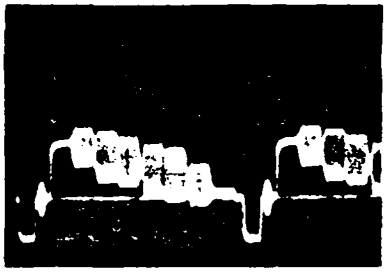
LASER DISC. The optical-laser disc player, introduced by N.V. Philips through its subsidiary, Magnavox, plays a grooveless disc that requires neither a caddy nor special handling. Audio and video information is encoded on the optical disc as a series of microscopic pits laid down in a spiral. The segment of the spiral scanned in one disc revolution is called a track and represents one video frame. Each 0.4-μm-wide track contains all the intelligence required for 8.1-MHz composite video and stereo sound. The discs have a surface of reflective aluminum and a transparent plastic outer casing. Minor scratches or dust on the casing do not impair reproduction.

Red laser light is used to read the program encoded on a disc. Laser light impinging on millions of disc pits reflected back through an optical system is directed onto a photodiode, where it is converted to an electrical signal.

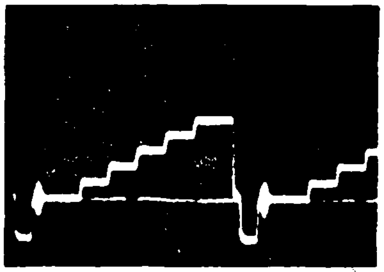
The two-speed turntable motor operates at a constant 1800 rpm on standard play or 600 to 1800 rpm on extended play. Separate CAV (constant angular velocity) and CLV (constant linear velocity) LEDs indicate which type of disc is being played. Freeze-frame capability is available, but only with CAV discs. A fast-forward mode allows one track to be jumped at the end of each field to produce a still picture as the same track is repeated. Using the search mode, hundreds of tracks are skipped to permit quick location of any desired portion of the program.

Audio signal transfer from player to TV receiver occurs after the 2.3-MHz left channel and 2.8-MHz right channel signals have been limited and detected, mixed, and applied to the output r-f modulator.

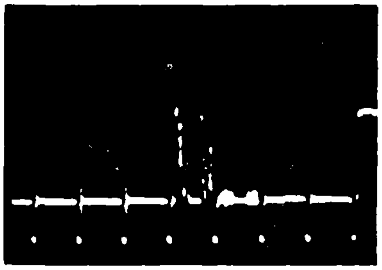
Included in the player are sync, color burst, and dropout protection. The last provides a means for countering dropouts caused by dust and scratches on the disc and appearing as gaps in the FM waveform. A seriously defective line of video is



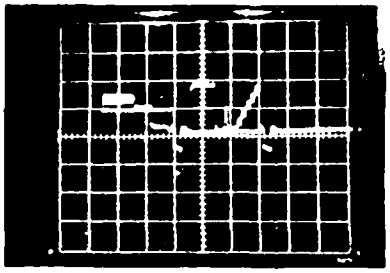
1A



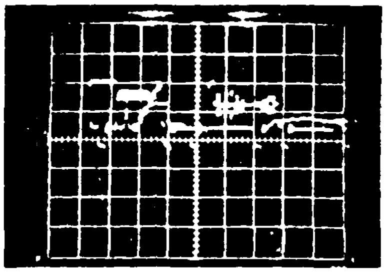
1B



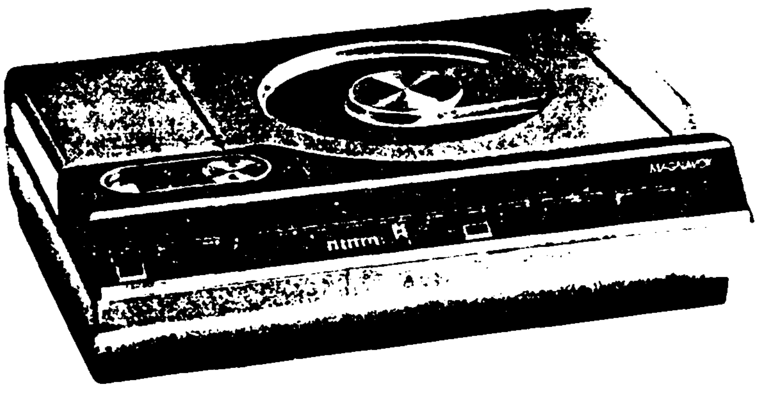
1C



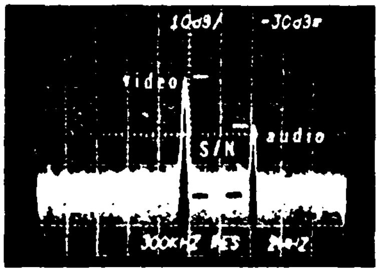
2A



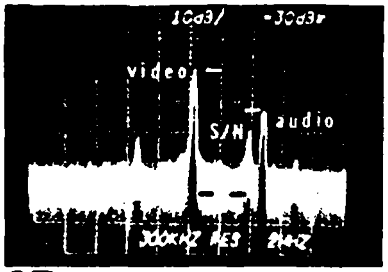
2B



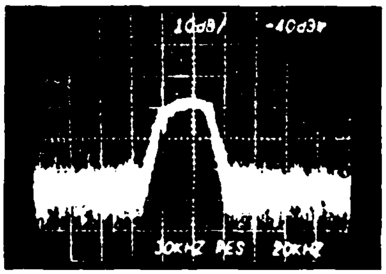
Magnavox Model VH8000 Laser Disc Player



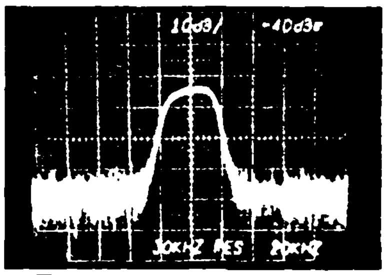
3A



3B



4A



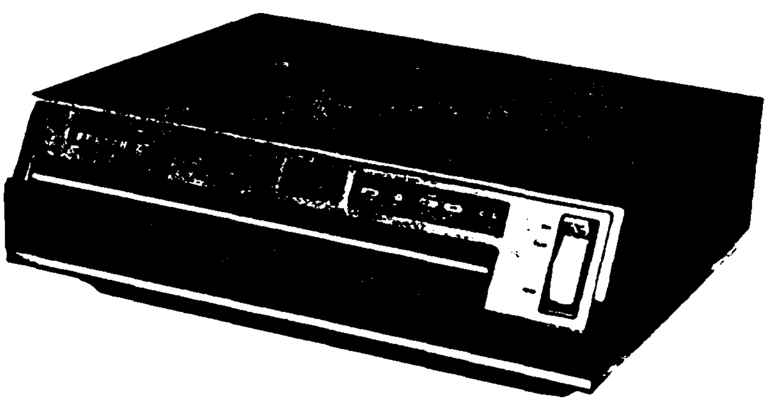
4B

Fig. 1A, B, and C (opposite top) were made on a Zenith player using a preprogrammed test disc and show NTSC color bars (A), gray-scale staircase (B), and DAX† information (C).

Figs. 2A. and B (left) show information obtained from VIRS and VITS on the Magnavox player.

Figs. 3A and B (at top) are spectrum analyzer displays of video and audio S/N for Magnavox (A) and Zenith (B).

Fig. 4A and B (above) are spectrum analyzer displays of audio carriers for Magnavox (A) and Zenith (B).



Zenith CED Video Disc Player

replaced by a previous line so that any signal interruption is virtually unnoticeable.

The r-f modulator processes audio and video by combining them on a regulation TV channel 3 or 4 carrier (user selectable). The resulting composite r-f signal is then fed to the TV receiver. (More detailed information on the Pioneer Model VP-1000 optical-disc player, which is the same operationally as the Magnavox player, can be found in the March 1981 issue of POPULAR ELECTRONICS.)

Differences between the Magnavox and Pioneer players are more mechanical than electrical. The Magnavox player has 20 replaceable modules, versus the board assemblies used in the Pioneer player, for easy servicing. Helium-neon lasers are the same, electronics are virtually identical, and the method of encoding 8.1-MHz video and 2.3- and 2.8-MHz audio carrier information into the microscopic pits on the disc is the same. Mechanically, some laser disc machines are slightly noisier than others, and an ear test is worthwhile before you purchase. Pioneer and Magnavox, through selected dealers, do their own service.

ELECTRONIC ANALYSIS. Our laboratory analysis yielded two sets of waveforms for the competing CED and laser disc systems. The CED tests (Fig 1) were made on a Zenith player using a preprogrammed test disc, since special signals to accommodate all player electronics are not yet available. For the laser disc system, however, both vertical interval test (VITS) and vertical interval (color) reference (VIRS) signals are available directly from regular 30-minute discs (Fig. 2).

The CED waveform in Fig. 1A reveals normal color bars and relative amplitudes, including the slight separation between green and magenta, which is to be expected. Burst has good formation, and there is little rounding of the horizontal sync pulse. Representing some five shades of gray scale out of a possible 10, the staircase is also very linear (Fig. 1B). Illustrated in Fig. 1C is the DAX† information and its pulses.

Magnavox information for VITS and VIRS (Fig. 2) is considerably more revealing, since these are the signals used to set up broadcasting-station luminance and chroma and to search for nonlinearities in the transmitting system. The first signal (Fig. 2A) includes both VITS and VIRS information from lines 18 and 19, respectively, of the vertical blanking interval. Following the chroma envelope on the left is the 50% IRE level, black reference at 7.5% IRE, and horizontal-sync pulse. Next comes an 18-microsecond window, barely discernible 2T and 12.5T sine-squared pulses for luminance and chroma amplitude and phase lag evaluation, and a six-level modulated staircase.

Some low-frequency tilt is discernible at the "toe" of the horizontal-sync pulse, and there is slight rounding of the window, denoting possible loss of high frequencies. The 1-to-3-MHz 2T pulse is at full amplitude, and the 12.5T chroma information reveals neither lag nor phase distortion. The modulated staircase appears normal, indicating no differential phase errors.

The waveform in Fig. 2B contains portions of intelligence from lines 17, 18, and 19 of the vertical blanking pulse, which allowed us to present multiburst on line 17 a little better, shown here to right of the center vertical graticule line. It shows up as a fairly strong 3.58-MHz burst just before the remainder of the waveform and barely a suggestion of 4.1 MHz thereafter. That the trace is seemingly down in the "mud" across the entire bandwidth is more of a problem with the TV receiver's synchronous detector than with the disc.

Spectrum-analyzer displays for the Magnavox (Fig. 3A) and Zenith (Fig. 3B) players are quite close in signal-to-noise ratios and video audio carrier levels, although the Zenith does beat the Magnavox by 2 dB in the audio S/N measurement. But carrier differences (video vs audio) are virtually nonexistent. Apparent spurs near the audio carrier in Fig. 3B are 3.58-MHz chroma subcarrier voltages that are not apparent in either the picture or the sound.

As for audio, the Magnavox spectrum-analyzer display (Fig. 4A), apparently containing some spurious modulation, exhibits 30-kHz signal bandpass in a 40-kHz window. The Zenith display (Fig. 4B) shows about the same bandpass, but without evident modulation.

COMMENTS. As opposed to more than two years in the field for Magnavox, RCA-Zenith's video disc player is brand new. However, being some 15 years under development, the CED system should come to the market with most of the bugs ironed out, and you can expect an extremely simple and fairly accurate operating player.

Two motors, a turntable, a microprocessor, and some associated electronics for the CED system, compared to optical system's tangential and radial mirrors, precision servo systems, complex disc-tracking, and an 1800-rpm turntable motor, accounts for much of the price differential between the two machines. However, the ability of the optical system to produce pictures of better quality and good stereo sound could render the price difference relatively insignificant. Then, too, later this fall, we understand that optical systems with fewer frills may become available to virtually wipe out all price differences.

As of this writing, video disc titles for both the laser-optical and CED players are quite varied. Among the offerings available are old and current movies, sporting events, tutorials, children's shows, etc. Prices for recent full-length movies for both systems are $24.95. In lesser offerings Magnavox, Pioneer, and DiscoVision will be selling single optical discs for as low as $5.95. RCA's best pricing schedule to date simply states that lower-priced discs should sell for $20 or less and account for at least 50% of available titles.

Popular Electronics Tests the Pioneer Model VP-1000 Videodisc Player

LaserDisc system connects directly to TV receiver and offers remote control with pause and freeze-frame

GATHER up 65 integrated circuits, 188 transistors, a 2-kilovolt helium/neon laser, precision lenses, and a two-speed turntable motor, put them all together in an attractive tan and walnut plastic package weighing 38.6 lb, and you have Pioneer's marvelous videodisc player. It uses a laser optical system licensed by N. V. Philips and is designed to play videodiscs of the MCA DiscoVision and now 3M labels.

Pioneer's system offers all the features available with the Philips/Magnavox player plus a full-feature remote-control system, pause and freeze-frame capabilities, and on-screen display of both chapter and frame numbers.

The player connects directly to the vhf antenna terminals of any TV receiver and optionally to the inputs of a stereo amplifier. Any disc can be played without interruption from beginning to end in a one-button operation, or any desired portion of a disc can be played simply by keying in its chapter (and/or frame) number. You can also fast scan or play back in slow motion in either direction. Sound reproduction can be in full stereo or in mono left or mono right. Finally, the two-speed player offers up to 30 minutes viewing time per disc side in standard play or up 60 minutes per side in continuous nonstop extended play.

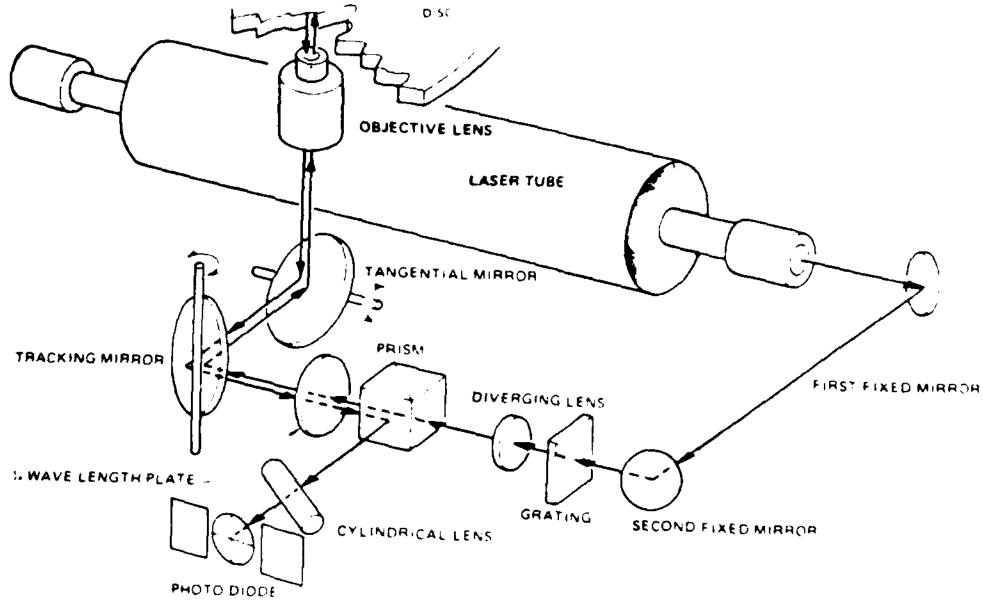


Fig 1. Diagram showing the path of the laser beam as it is reflected on to the disc and back again to photo diode

Housed in an attractive tan and walnut-grain plastic enclosure, the player measures 21⅝"W x 16"D x 5⅝"H and weighs 38.6 lb. Suggested retail price for the player is $749. The optional Model RU-1000 remote-control unit lists for $50.

General Description. Audio and video information are encoded on the disc as a series of microscopic indentations laid down in a spiral. The segment of the spiral scanned in one disc revolution is called a track and represents one video frame. Tracks are separated from one another by only 65 millionths of an inch (1.6 micrometers), but they contain all required intelligence for 8.1 MHz composite video, in addition to dual-channel (practically no crosstalk) sound. Each track is 0.4 micrometer wide. The discs have a surface of reflective material and a transparent outer casing. Minor scratches on the transparent layer do not degrade reproduction. Current prices for single recordings are $5.95, and those for multi-record albums range from $15.95 for older releases to $24.95 for more recent feature films.

When the player operates, red light emerges from the laser as a linear cone to the first and second fixed mirrors (Fig. 1). These change its directions and adjust the optical axis to the desired position on the grating. There, the beam's center is split into several parts, of which two are used to read tracking signals while the center, or zero-order, beam reads the FM and focus signals. The other residuals around the circumference are at lower energy levels and have no effect.

The three remaining beams now enter the diverging lens where they converge again on a focal point and continue as a pencil of rays into a prism that passes P-polarized, or parallel, light, but rejects S-polarized, or perpendicularly polarized, light. The ¼-wave plate following adds a 90° phase lag and changes the polarization to circular. Tracking and *tangential mirrors then take the beams* to the objective lens, where the pencil of rays is focused as an extremely fine spot on the signal (reflective) surface of the disc. A focus servomechanism keeps this spot constantly aligned with the disc's signal track.

Light impinging on millions of disc pits is reflected back through the objective lens, the path-altering tangential and tracking mirrors, and the ¼-wave-length plate. Once more there is a 90° phase lag, producing a total 180° phase alteration from the starting phase, and linearly P-polarized parallel light again emerges through the prism, with S-perpendicular light excluded. Light beams, thereafter, reach the cylindrical lens and the photo diode; and it is the photo diode that transforms the optical information into electrical signals.

The same signals also contain information from the FM focus and tracking beams (Fig. 2). When radial beams A and C are identical in value, they are on proper track and the zero-order beam is precisely on center. But when these two first-order beams are not equivalent, a difference output develops and is used by the tracking servo to correct the tracking mirror. The tangential mirror, whose changing angles derive from the video circuits, will correct any errors in disc revolutions, distortions, and concentricity. The laser and all optics are mounted on a motor-driven slide assembly that passes beneath the video disc as playback proceeds.

(Text continues on page 40)

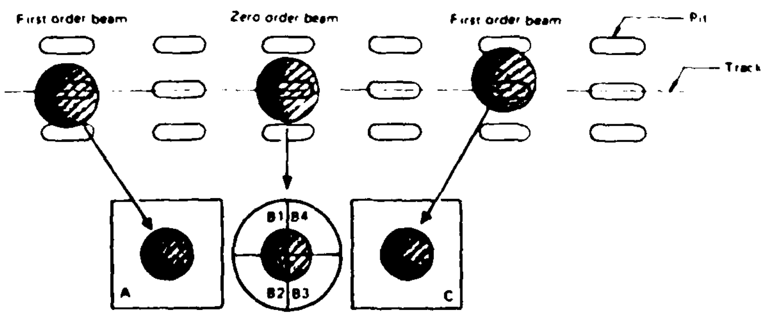


Fig 2. Optical information is converted into electrical signals for the audio, video, and tracking systems
(Figure 3 is on page 34)

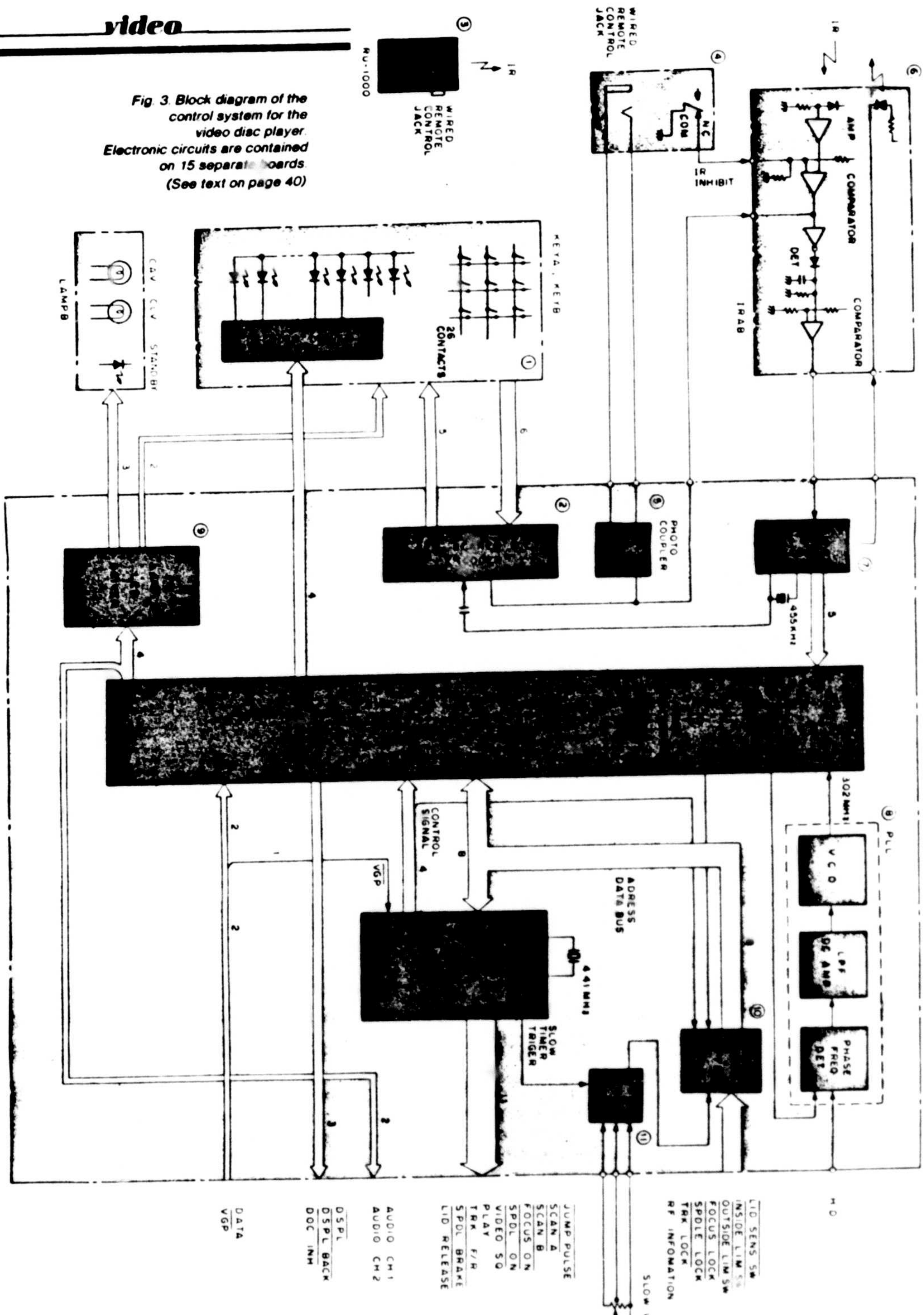


Fig. 3. Block diagram of the control system for the video disc player. Electronic circuits are contained on 15 separate boards. (See text on page 40)

(Continued from page 32)

The two-speed turntable motor operates at a constant 1800 rpm on standard play or 600 to 1800 rpm on extended play. Separate CAV (constant angular velocity) and CLV (constant linear velocity) LEDs indicate which type of disc is being played. Freeze-frame capability is possible only with CAV discs. In the fast-forward mode, one track is jumped at the end of each field, and a still picture results when the same track is repeated. In the search mode, hundreds of tracks are skipped.

Electronics for the VP-1000 are contained on what appear to be 15 separate divisions or boards having such identifications as VDEM, AUDB, SPDL, FTSB, LOGB, KEYA, etc., meaning video, audio, spindle and drives, focus tracking, logic for tracking, and key control, respectively. Schematics and wiring diagrams, along with adjustment instructions, are liberally contained in a 139-page service manual, which is both well-written and nicely illustrated. All mechanical sections are shown as exploded illustrations in reasonable 3D. There are also flowcharts for troubleshooting as well as a few logic diagrams.

The Control System (Fig. 3, p. 34) comprises KEYA, KEYB, IRAB, LAMP, and CONT boards, including a microcomputer arrangement that controls the playback modes and helps monitor operation of the entire video disc system. The RU-1000 remote control, with its wired remote control jack, can be used either through the IRAB sensor and amplifier as a completely wireless infrared remote control or plugged into the remote control jack and on to the photo coupler as a *wired* remote unit when noise is a problem. An IR inhibit grounds and defeats the IR remote function when the control is not used. Observe, however, that the photo coupler and key scanner/encoder will function with the SC COM plug at the rear of the receiver either in or out.

Upon command, the key scanner and encoder convert the signal into 10-bit serial pulse-code modulation (pcm), which is impressed on a 38-kHz carrier and transmitted back to IRAB and the input comparator. IRAB picks up these wired or wireless remote signals, detects and modifies their waveforms, then passes them to the key decoder. The 10-bit pcm code from IRAB is decoded into a 5-bit parallel binary code for the large data processor. A 455-kHz oscillator serves as clock.

On the other side of the data processor is a phase-locked loop with a 3.02-MHz clock that generates timing frequencies for character dots of the frame number display and uses an external horizontal drive (HD) signal to synchronize frame and chapter numbers on its slave TV screen with horizontal sync. Inputs to the data processor are from the input buffer, microprocessor and data VGP (external).

Through the input buffer, data enters the microprocessor from the lid sensor switch, inside/outside limit switch, and focus and spindle lock, along with r-f information. It also has a control bus

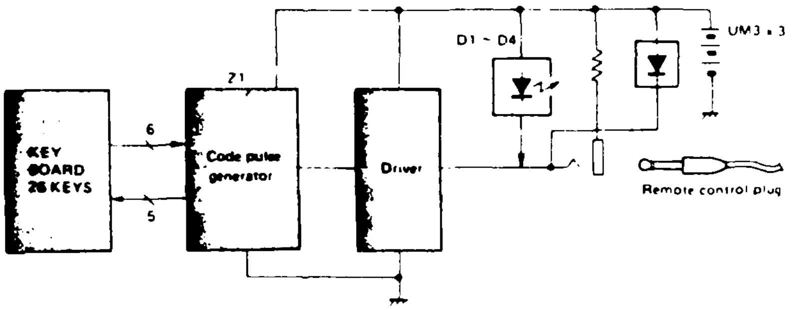


Fig. 4. Block diagram of the remote control unit. It can be wired direct or use infrared transmission.

from the slow mode VR timer and its shunt potentiometer. The microprocessor is an 8-bit unit with a two-kiloword master program stored in memory. The data processor also governs the decoder driver lamp and LED readouts as well and off/on signals for audio Ch. 1 and audio Ch. 2.

Signal transfer for player to TV receiver occurs after the 2.3-MHz channel 1 (left) and 2.8-MHz channel 2 (right) have been limited and detected, mixed and applied to the output radio frequency (r-f) modulator or pcm jack on the rear. Manual switching selects either stereo or Ch. 1 or Ch. 2 outputs. The video signal is separated from audio on the VDEM board by bandpass filtering and demodulation, then transferred to a rear VIDEO OUT jack on the player as well as the AM video modulator. Included are sync, color burst, and dropout protection. (The latter provides a means of covering up dropouts caused by dust and scratches on the disc, and appearing as gaps in the FM waveform. A seriously defective line of video is replaced by a previous line so that any signal interruption becomes virtually unnoticed.) The r-f modulator now processes audio and video by combining them on a regulation carrier (channels 3 or 4, in this instance), applying the result to the television receiver.

Remote control is (so far) the VP-1000's big exclusive feature. Its 26 keys deliver 30 different commands to the overall system using a 455-kHz ceramic vibrator matched to a similar oscillator on the key decoder. They duplicate virtually every command on the player itself except REJECT/OPEN and POWER on/off. There are search keys, chapter and frame displays, left/right audio buttons, chapter and frame, pause and play, in addition to still/step, slow, scan, and 3 X fast—the last four in either forward or reverse.

Serial pcm from the code pulse generator passes through a transistor driver (Fig. 4) on to the four LEDs. These consume approximately 1 ampere of peak current and, along with the 455 kHz oscillator, are not operational until some command key is pushed. Transmissions consist of 10-bit words. Each pulse string is generated by 10 clock pulses at the 38-kHz carrier frequency.

Advantages over the competition in this system include the remote control, two control buttons for frame and chapter digital locations rather than one, separate CAV (standard play) and CLV (extended play) lighted indicators, digital keys used in the search mode for frame and chapter location, the PCM jack on the back, and direct antenna and TV connections rather than a separate connector box. Unit operation seems also to be somewhat less mechanically and electronically noisy, although this can vary from sample to sample.

(Continued on page 42)

MODEL VP-1000 VIDEODISC PLAYER LABORATORY DATA

Parameter	Measurement
Video carrier:	−52.7 dBm
Audio carrier:	−61.7 dBm
S/N ratio for both carriers:	50 dB
Usable video bandpass:	≃4 MHz
Usable audio bandpass (−20 dB):	≃60 kHz
Power supply varied from 95 to 130 V ac with equipment operating satisfactorily.	
Operating power consumption:	71 W

Note: dBm 50 to 75 ohms conversion, decrease reading by 5.72 dB. Also dBm = dBV − 10 log Z + 30, where Z in this instance, = 75 ohms. Test equipment used: Tektronix 492 and 7L5 spectrum analyzers and Sencore PR57 Power-rite.

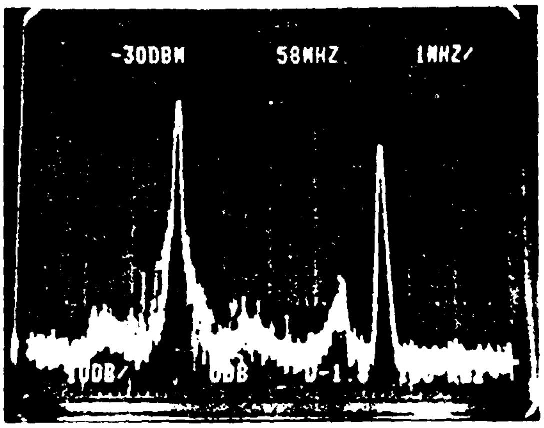


Fig. 5. Spectrum analysis shows output signal on channel 3 with video carrier on left and audio on right. The S/N of 50 dB is excellent.

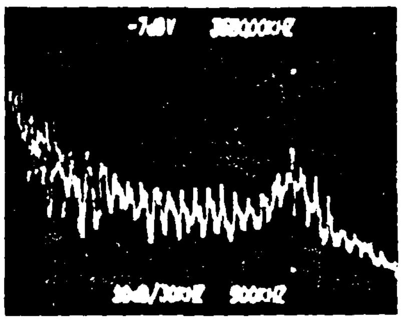


Fig. 6. Baseband video fills 5-MHz spectrum analyzer "window."

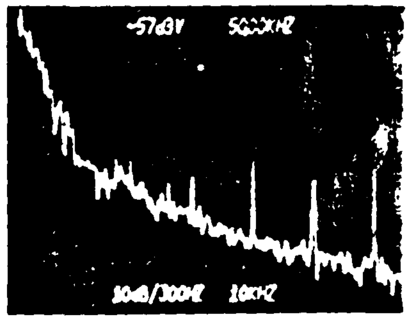


Fig. 7. Audio bandpass extends over 80 kHz with drop of 20 dB.

(Continued from page 40)

Evaluation. Lab tests usually involve oscilloscope and voltmeter readings. But here you have r-f carriers in addition to baseband video and audio outputs, and that requires spectrum analyzers. Furthermore, the usual 50-ohm impedance analyzer input must be matched to the 75-ohm output of the discplayer, and that results in an addition of 5.72 dB. Nonetheless, absolute levels are not nearly as important in this analysis as relative levels, so a rounded 6 dB difference in scale reading for Fig. 5 really won't matter much. For instance, the video carrier reading of −45 dBm becomes −51 dBm after correction for the 75-ohm termination.

But the important points are the position of this carrier with respect to the audio carrier and the S/N ratio. Here, the channel 3 video carrier rests at 61.25 MHz and the audio at 65.75 MHz, right where it should be. The audio carrier is slightly less than 10 dB below the video carrier, which is close to what we found on a broadcast signal.

Neglecting a few spikes about the video and audio carriers, the S/N ratio is about 50 dB, considerably in excess of the claimed 42 dB. The tallest voltage excursion next to the audio carrier is the 3.58-MHz color burst at −40 dB relative to video.

In the second spectrum analyzer photo (Fig. 6) baseband composite video from the player's output jack was evaluated. Beginning at zero reference on the left, the trace shows, once more, a slight rise around the 3.58 MHz color information, and then a gradual tail-off at 5 MHz. As you can see, the remainder of the waveform, taken during disc operation, is remarkably clean.

Good reports are also forthcoming about the audio output. Here, we're looking at a 100-kHz window, of which some 20 kHz is reference, but the remaining 80 kHz is surprisingly uniform with only a 20 dB drop. The spikes you see at 15-kHz intervals in Fig. 7 (and don't hear) are TV horizontal flyback pulses picked up by the lightly-shielded coaxial connector between player and analyzer. Audio connected to a stereo receiver sounded reasonable, as long as there was good quality stereo sound available for reproduction.

One thing you'll have to be careful about is software quality control. Good discs give positively superb results, but not all of them are good. You'll have to pick and choose carefully. In short, try before you buy!

If there's a negative remark to be made about the VP-1000 player, it's minor: the lid to the turntable section is a little stiff to open. Otherwise, this tastefully styled and nicely engineered product performed exceedingly well. From where we sit, the videodisc is for real and here to stay. —*Stan Prentiss*

CIRCLE NO. 102 ON FREE INFORMATION CARD

APPENDIX C

"Computers Move Into Micrographics"

1980 Usage Survey

Computers Move into Micrographics

The 11th annual usage survey conducted by INFOSYSTEMS confirms the growing influence of the DP and MIS departments in the design, control and approval of the use of micrographics, as well as the growing *relationship* with the computer.

by John M. Lusa
Editor

The growing influence of the data processing department and the increasing use of computers in the micrographics operation reported in last year's survey continue as the most significant data uncovered in the 11th annual Micrographics Usage Survey conducted by INFOSYSTEMS.

Many companies are planning to add computer-output-microfilm (COM) to their operations. This is a trend that has been in existence for some time and is again confirmed with the 1981 survey. What seems to be gaining real momentum is the use of computer-assisted retrieval of microforms. Some 11 percent of present micrographics users have or will soon have some form of computer-assisted retrieval. This is about the same as last year. Another 32 percent plan to use the process within the next five years.

Interestingly, computerization is coming into play in other areas. Word processors are now outputting to COM, according to 4.7 percent of those responding. In two years, this will grow to 12 percent. To a smaller degree, electronic mail users are outputting to COM, 2.0 percent. However, this will grow to 6.1 percent in two years.

One user wrote on his questionnaire, "we expect to expand the use of on-line fiche." Another will support his micrographics operation with "on-line inquiry." This comment was also typical: "Addition of some type of computer-assisted retrieval system." One user went so far as to say he would install "a stand-alone retrieval unit and a mainframe-controlled system," as well.

How Micrographics Needs Are Handled

	(Percentage)
All Handled By A Service Organization	34.7
All In-House	21.0
Most In-House	14.9
Equal Split Between In-House And By A Service Organization	14.9
Most At A Service Organization	14.6

Future Plans
Micrographics In-House Vs. Service Organization

	(Percentage)
Larger Share In-House	14.8
Larger Share From Service Organization	9.4
Little Or No Change	75.8

The tabulated results show that users of mainframe-controlled systems remained about constant at 40 percent. On the other hand, users of stand-alone retrieval units grew from 39.4 percent in 1980 to 48 percent this year.

The influence of the data processing department over

continued on page 36

COM Usage

	(Percentage)
Yes, In-House	10.9
Yes, Service Bureau	40.5
Plan To Within 2 Years	8.4
No	40.2

How Micrographics Is Used

	(Percentage)
Active or daily reference	75%
Semiactive reference	80%
Archival	82%

*Totals to more than 100.0 percent due to multiple responses

Who Recommends The Equipment?

	(Percentage)
DP Department	32.9
User Group	19.1
Office Services Staff	18.8
MIS	14.2
Records Manager	12.6
Other	11.7
Systems Group	9.5
Micrographics	8.9
Service Bureau	7.4
Purchasing Department	5.8
Consultant	2.8

*Totals to more than 100.0 percent due to multiple responses

Who Is In Charge?

	(Percentage)
DP Department	39.5
User Group	23.1
Office Services Staff	13.4
MIS	13.1
Records Manager	12.5
Other	11.9
Micrographics Department	7.1
Systems Group	5.6

*Totals to more than 100.0 percent due to multiple responses

Who Designs The System(s)?

	(Percentage)
DP Department	36.3
User Group	26.1
MIS	16.1
Office Services Staff	13.7
Systems Group	12.8
Vendor	12.5
Records Manager	10.4
Micrographics Department	8.6
Other	8.0
Engineering	4.8
Consultant	4.5
Service Bureau	3.3

*Totals to more than 100.0 percent due to multiple responses

Who Approves Expenditures?

	(Percentage)
Financial Management	35.0
President/VP/GM	32.6
DP Management	29.7
User Department	24.0
Other	7.7
Micrographics Department	4.2

*Totals to more than 100.0 percent due to multiple responses

Average Dollars Spent For Micrographics Per User Firm

Product	1976	1977	1978	1979	1980*	1981*
Film	$ 9,535	$ 7,140	$15,985	$19,541	$12,959	$16,918
Equipment	9,108	5,913	23,202	25,652	18,301	23,992
Supplies	4,735	1,479	6,644	10,749	8,503	9,428
Services	8,750	10,467	16,465	19,748	15,351	17,177
Avg. Total	$32,138	$24,999	$37,646	$46,436	$39,170	50,449
Salaries	**	**	**	**	$40,830	$49,966

*estimated **not available

micrographics continues to grow. In the 1981 survey, a new category—management information systems (MIS)—was added to three of the questions:

In answer to "Who recommends the equipment?" it was discovered that 32.9 percent of the time it is the DP department, while MIS was involved 14.2 percent of the time for a total of 47.1 percent, up from 1980 about two percent. The nearest competitor for involvement in this decision-making process is the user department with 19.1 percent. The office services staff was mentioned nearly as many times with 18.8 percent.

When asked "Who is in charge of micrographics?" DP and MIS were mentioned 39.5 percent and 13.4 percent of the time, respectively. User group mentions increased to 23.1 percent, while office services staff dropped to 13.4 percent of the vote. To both questions, the records manager was mentioned about the same, 12.6 percent and 12.8 percent. Since 1980, the stature of the records manager seemed to have dropped slightly.

To the question, "Who designs the system?" the combined total of DP and MIS was high—36.3 percent and 15.1 percent—for 51.4 percent. Again the user group category followed. This time with 21.1 percent of the mentions.

As in 1980 and before, users were asked what they spent on their micrographics operations. This year they were also asked to include salaries in their expenditures. This is the reason the charts show no entries prior to 1980

continued on page 38

Percentage Of Usage Of Micrographics By Industry

	Storage	Active Or Daily Reference	Semi-Active Reference
Construction, Mining And Agriculture	25.0	46.7	28.3
Manufacturing	44.6	33.9	21.5
Transportation	16.3	62.5	21.3
Utilities/ Communications	28.0	57.5	14.5
Retail/ Wholesale	27.8	42.7	29.5
Banking/ Financial	42.1	31.7	26.2
Insurance	32.7	34.5	32.8
Service Organizations	48.6	19.4	32.0
DP Service Organizations	40.4	41.7	17.9
Consultants	48.0	8.0	44.0
Educational	51.7	24.0	24.3
Government/Military	32.1	41.4	26.5
Total	40.3	34.3	25.4

Types Of Outside Micrographics Services Used

	(Percentage)*
Mag-Tape-To-Film Conversion (COM)	63.3
Filming Documents	39.9
Processing Film	31.0
Duplicating Film	30.2
Film-To-Paper Conversion	9.7
Storage	8.5
Mag-Tape-To-Paper Conversion	5.2

*Totals to more than 100.0 percent due to multiple responses

Use Of Computer-Assisted Retrieval (CAR) Systems

	(Percentage)
Presently Use	7.0
Plan To Use Within The Year	3.9
May Use In 2-5 Years	31.8
No Plan To Use	51.1
No Knowledge Of CAR	6.1

Type Of Computer-Assisted Retrieval (CAR) Used

	(Percentage)
Mainframe Controlled System	40.0
Stand-Alone Retrieval Unit	48.0
Others	12.0

The results of this question indicate that expenditures are down dramatically in 1980, but an estimate of 1981 expenditures shows a good increase but not quite up to 1979 in all categories. The 1980 results possibly are the result of the business slowdown or recession that occurred for most of the year. Interestingly, it appears inflation will take its biggest toll in the form of salaries. The users spent an average of $40,830 on this category in 1980, but expect to increase this expenditure to $49,966 in 1981.

The overall picture presented by the INFOSYSTEMS Micrographics Survey appears that usage is down. The editors of the magazine don't necessarily feel this is a trend. There is a good possibility that the results are the "luck of the draw," so to speak. Every nth name from the circulation list is selected for the survey by the research department. Possibly, for some reason, the makeup of the mailing list was different than it has been in past years. The editors would prefer to wait until another survey is made before making any significant trend predictions.

The 1981 survey was based on replies from 2,006 organizations for a return of 27 percent.

However, if the survey is taken at its face value, it indicates that missionary work is needed among nonusers. Of those using micrographics only (17.8 percent), some 39 percent said they would increase usage during the coming months. This is down from 47.4 percent last year. Of the nonusers, 26.9 percent indicated they would be evaluating the potential use within the year while another two percent actually planned to install a micrographics system. This type of response does indicate there is still a possibility of good growth for the micrographics industry.

The survey does indicate there is a movement to the use of outside micrographic service organizations. Some 34.7 percent now have all their micrographic processing done on the outside. Those responding to whether the processing is done "all in-house" represented 21 percent. The other splits were: most in-house, 14.9 percent; equal split between in-house and outside, 14.9 percent, and most outside, 14.6 percent. On the other hand, as to future plans, the tables were turned somewhat. Some 14.8 percent of the users expected to go in-house more, while only 9.4 expected a larger share to go outside and 75.8 percent saw little or no change. Those expecting to go outside is up slightly from 1980.

Respondents were asked to give comments on the relative merits of micrographics. Overwhelmingly the responses were favorable. They included comments such as "personally attempting to introduce COM;" "important new area."; "wave of the future;" "with implementation of COM in-house we see an accelerated rate of paper replacement with fiche because of cost, retrieval and space savings," and "cut storage space for computer printouts from a storage room, 15-ft. x 20-ft., to a single file cabinet." ❑

Usage Of Micrographics By Industry

Industry	Yes (Percentage)	No (Percentage)
Banking/Financial	**56.5**	**43.5**
Government/Military	**45.5**	**54.5**
Insurance	**40.5**	**59.5**
Utilities/Communications	**30.8**	**69.2**
Service Organizations	**22.7**	**77.3**
Educational	**17.8**	**82.2**
Manufacturing	**16.9**	**83.1**
Transportation	**11.4**	**88.6**
Retail/Wholesale	**11.2**	**88.8**
DP Service Organizations	**8.6**	**91.4**
Consultants	**6.7**	**93.3**
Construction, Mining And Agriculture	**5.6**	**94.4**
All Other	**40.0**	**60.0**

Growing Uses For Micrographics

	Today Percent Total	Two Years From Now Percent Total
Filming Correspondence	**26.5**	**7.5**
Microfacsimile	**12.3**	**4.2**
Computer-Assisted Graphics On Micro	**8.1**	**8.7**
Computer Input Micro. (CIM)	**5.9**	**2.5**
Word Processors Outputting To COM	**4.7**	**12.0**
Merging Text And Graphics On Micro	**3.9**	**6.1**
Electronic Mail Outputting To COM	**2.0**	**6.1**

Complete Report Available

Complete spiral-bound copies of the backup summary of the survey are available for $50. This shows a detailed breakdown by industry, for each of the 18 questions asked on the survey. Check or company purchase order must accompany all orders. Mail request to: INFOSYSTEMS Micrographics Survey, Research Department, Hitchcock Publishing Co., Hitchcock Building, Wheaton, IL 60187.

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Micrographic Salaries

Increases Across the Board

The salaries of full-time micrographic operational personnel in user companies showed modest increases in 1981 when compared to 1980 levels, according to the results of the fourth annual survey conducted by INFOSYSTEMS. The average increase for all nine categories in the survey was 5.8 percent.

The results were based on 334 responses from a mailing to 2,987 potential users. The respondents were asked to report salaries in effect on March 1, 1981.

The category showing the highest increase in the national average actual salary from 1980 to 1981 was the micrographic duplicating technician (43). The position showed a 10.6 percent increase from $178 per week to $197. The next highest was the micrographic production clerk (44) from $170 to $183 per week for an increase of 7.6 percent.

Of course, the operations manager (01) continued to be the highest paid, full-time position in the micrographics operations area. The national average for 1981 is $434 per week. The weekly figure quoted for 1980 was $423. The lowest paid, full-time position continues to be the micrographic production clerk (44) at $183. However, this is only $2 less than is the average for a camera operator (42).

It should be noted that all user companies do not utilize all the positions reported in the survey. They only reported those positions that are staffed full time.

For a copy of the complete job descriptions used in the salary survey, enter No. 10 on the Reader Information Card at the back of this issue.

Job Descriptions

Operations Manager, Micrographic Center (01). Plans, organizes and oversees all activities of the micrographic center through managing subordinates or by direct supervision.

Production or Laboratory Shift Supervisor (or leader), Micrographic Center (10). Responsible for the micrographic center's production operations on one shift.

COM Operator, Senior (30). Responsible for the complete operation of the COM equipment including job setup.

COM Operator, Junior (31). Operates the COM equipment under general supervision according to predetermined production schedules, quality standards, device capabilities and tape formatting requirements.

Micrographics Laboratory Technician (40). Fully experienced in basic wet process silver film technology.

Micrographics Processing Technician (41). Sets up, controls, adjusts and operates automated micrographic processors and duplicators, either one or both types.

Rotary/Planetary Camera Operator (42). Sets up, loads and operates a rotary or planetary camera for recording source documents on microfilm.

Micrographic Duplicating Technician (43). Operates one or more micrographic duplicators to produce roll-to-roll film, microfiche or aperture cards.

Micrographic Production Clerk (44). Receives, logs in, prepares and distributes documents to be microfilmed.

Weekly Salaries For All Micrographic Jobs: Nationwide

	Operations Manager, Micrographics Center	Prod'n/Lab Shift Supv. (or Leader)	COM Operator, Senior	COM Operator, Junior	Micrographic Laboratory Technician	Micrographic Processing Technician	Rotary/Planetary Camera Operator	Micrographic Duplicating Technician	Micrographic Production Clerk
National Statistics	(01)	(10)	(30)	(31)	(40)	(41)	(42)	(43)	(44)
Number Reported	79	85	115	96	69	45	165	23	39
Lowest Reported Actual Salary	252	186	150	148	159	131	120	154	118
25th Percentile* Actual Salary	321	219	192	167	173	181	150	169	145
National Average Actual Salary	434	296	265	241	234	219	185	197	183
Median* Actual Salary	429	285	260	227	231	210	165	196	185
Mode* Actual Salary	366	240	216	182	212	194	207	169	175
75th Percentile* Actual Salary	535	375	320	300	300	260	225	221	221
Highest Reported Actual Salary	750	615	514	445	375	375	346	281	346
Established Salary Range Average Low	331	271	248	228	206	197	170	168	165
Established Salary Range Average High	494	362	365	327	282	270	240	230	229

*25th Percentile – That point at which 25 percent of all other salaries are lower and 75 percent are higher

*Median – A figure having an equal number above and below

*Mode – The salary reported most often

*75th Percentile – That point at which 75 percent of all other salaries are lower and 25 percent are higher

APPENDIX D

Image Systems, Inc. Fiche Systems

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image systems

isi 5000
Computer Controlled Microfiche Retrieval System

Fast, random access

Ultra low cost data storage

Unlimited graphics capability

Plug compatible with most computers

isi 5000 FEATURES and SPECIFICATIONS

Image Systems, Inc. introduces its new isi 5000 computer-controlled automated fiche retrieval and display system. A "receive-only" computer peripheral, the isi 5000 is used with any interactive terminal to combine the economy of low cost microfiche storage and computer-fast retrieval of large amounts of alphanumeric and/or graphic data.

The isi 5000 contains up to 180,000 fiche pages of information, any of which may be computer-selected and displayed in 3 seconds on an 11" x 14" screen.

A fully-loaded isi 5000 can make over 1 billion characters available for on-line display to an operator. It would require 30 magnetic disc drives (40 megabytes each) to store an equivalent amount of alphanumeric information. Graphic capabilities are an added plus.

isi 5000's extensive capacity reduces the storage, transmission, and programming loads for many computer systems and makes minicomputers more effective for many applications.

REDUCES STORAGE REQUIREMENTS — isi 5000 takes large volumes of information out of expensive computer storage and puts it on low-cost microfiche.

REDUCES TRANSMISSION LOAD — Data can be distributed and stored on microfiche at each isi 5000 terminal. No more than eight characters are ever required to select any page of information, each containing up to 8,000 characters. This 1,000:1 reduction can save a time-share system from bogging down in its own transmission requirements.

REDUCES PROGRAM COMPLEXITIES — isi 5000 minimizes core and disk storage, and thus overlay and data shuffling requirements. By reducing transmission load, it also reduced queuing and data concentration requirements. In addition, isi 5000 reduces operator keystrokes and saves on translation, error checking and correction and print routines.

GRAPHIC CAPABILITY — isi 5000 can store either alphanumeric or graphic information or both. Information can be in the form of charts, maps, photographs . . . in black-and-white or in color.

FUNCTIONAL CHARACTERISTICS

isi 5000 can be connected either directly to the computer or remotely via a telephone line and dataset (modem). A "receive-only" terminal system, it is used in conjunction with an interactive computer terminal (teletype, CRT, etc.). isi 5000 uses exactly the same set of lines and datasets as the interactive terminal in the receive mode. A Computer Control/Manual switch allows isi 5000 to function alternatively as a stand alone microfiche storage and retrieval system. In this mode, power may be removed from the isi 5000 unit without affecting the operation of the terminal.

DATA LINE OPTIONS

IBM Correspondence Code	RS 232 C
ASCII Code	Current loop
EBCDIC	High speed low level

75 through 9600 Baud (field selectable)

MESSAGE FORMAT

isi 5000 accepts messages consisting of a two-character initiate field, a one-character field for selecting one of a number of isi 5000 units, and a five-character field that contains the selection information. The message format is

Z	X	O	FS_1	FS_2	FS_3	x/y 1	x/y 2
a		b	c			d	

a. Two-character initiate field
b. isi 5000 unit selection number (0 through 15)
c. Fiche selector field
d. Page selection field

ADDITIONAL OPTIONS

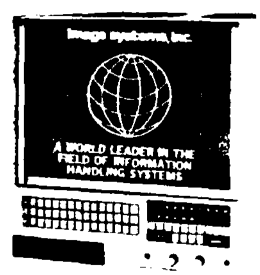
Printer — makes single or multiple electrostatic copies of any image on the screen in seconds.
Cartridge Carousel — offers unlimited data storage for the isi 5000 system.

SPECIFICATIONS:

Size	52 cm H x 46 cm W x 82 cm D (20.5" H x 18.25" W x 32.25" D)
Weight	51 kg (112 pounds)
Power	115 VAC, 60 Hz or 220 VAC, 50 Hz (Other power requirements available)
Screen Display Size:	28 cm H x 33.5 cm W (11" H x 14" W)
Controls and Indicators	Power (on/off) Power Focus Vertical and Horizontal Image Adjustment Computer Control/Manual Selection Switch
Additional Features	Selectable odd/even parity Selectable parity inhibit Automatic detection of transmission errors Selectable word length, 7-8 bits

isi 5000 Models

REDUCTION FORMAT	KEYBOARD SLOPE	KEYBOARD FLUSH
20 x (5 x 12)		X
24 x (7 x 14)		X
24 x (7 x 9)		X
27 x (8 x 10)		X
30 x (10 x 10)		X
42 x (12 x 16)	X	X
42 x (12 x 20)	X	X
48 x (13 x 18)	X	



(Flush keyboard)

Sold and serviced through a comprehensive worldwide dealer network.

image systems

For further details, call or write:
Image Systems, Inc., P.O. Box 2488, 11244 Playa Court, Culver City, CA 90230
Telephone: (213) 390-3378 Cable: IMAGELACAL TWX: (910) 343-6465

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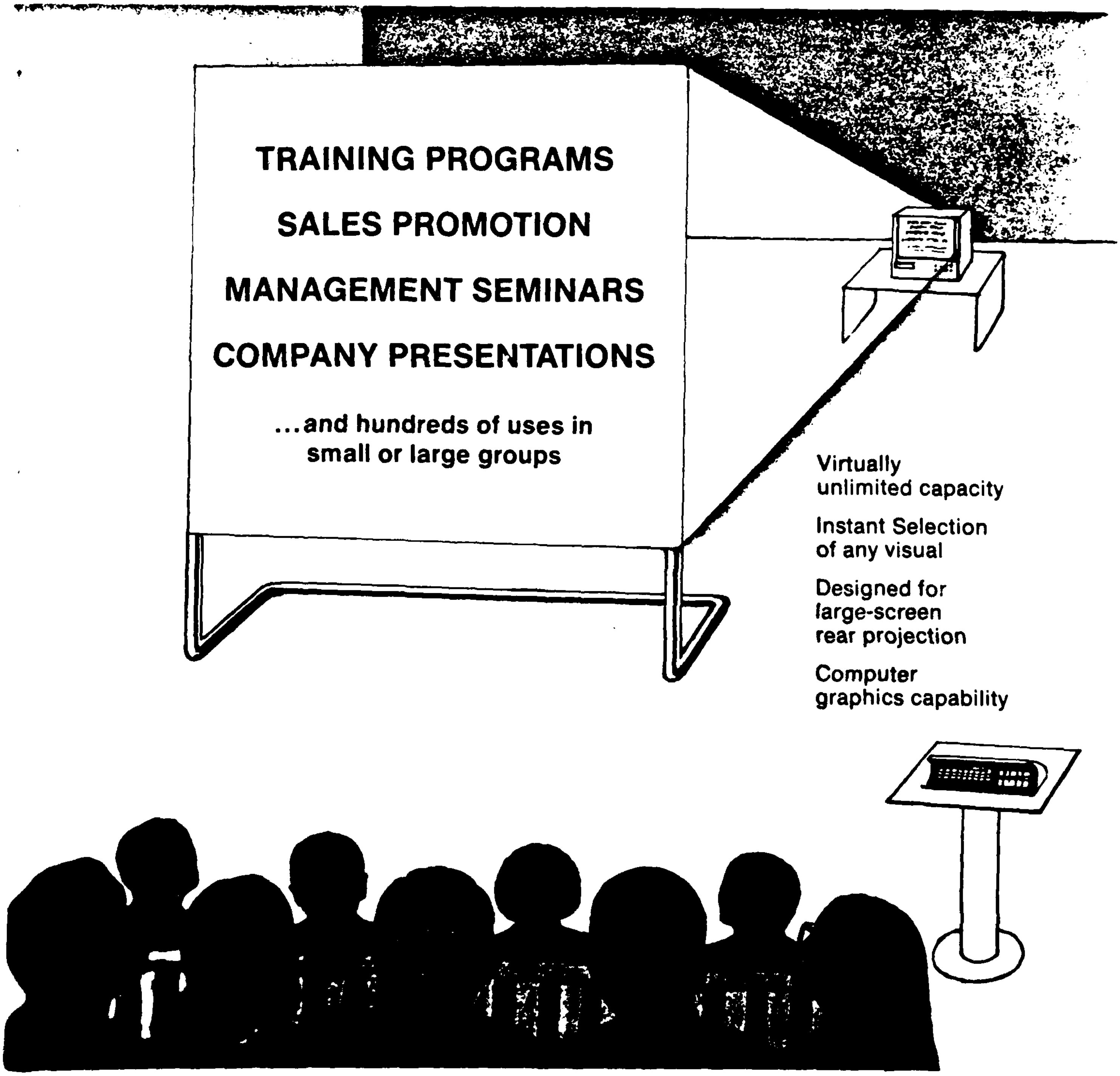
isi 8000
Automated, Large Capacity Visual Presentation System



Virtually unlimited capacity

Instant Selection of any visual

Designed for large-screen rear projection

Computer graphics capability

isi 8000 Automated, Large Capacity Visual Presentation System

IT'S NEW— isi 8000 is a new concept for the group visual presentation field. It combines a very large capacity for visual materials with automated, fast retrieval and projection of any specific visual. isi 8000 is based on Image Systems' extensive experience in developing microfiche retrieval systems and optical systems design.

LARGE, LARGE CAPACITY— isi 8000 uses microfiche for storing up to 180,000 frames of alphanumeric and graphic information. This unusual capacity allows the user to store many long presentations in the system and yet have very fast random access to any part of any presentation.

EASY TO USE— A remote keyboard allows the operator to select any frame and display it on a rear projection screen in 3 seconds. The keyboard has a full set of controls for fiche frame selection and focus, and has a self-contained prompting light for darkened rooms. It can be located up to 25' from the projector.

AND VERSATILE— isi 8000 can be configured to accommodate microfiche prepared at varying reductions from 24X to 48X. Fiche can be COM generated or photographed from original documents or artwork. Any graphic material from alphanumerics to photographs may be used.

isi 8000 OPTIONS

Model 8830 Cartridge Carousel—offers unlimited data storage for the isi 8000 system. A modified carousel is designed for easy insertion of special cartridges that hold up to 52 microfiche each. Up to three cartridges may be used simultaneously. Total capacity of the cartridge carousel is 624 microfiche.

Model 8860—provides a special locking mechanism for the loading door of the retrieval unit. Only authorized personnel are able to add or remove microfiche from the file.

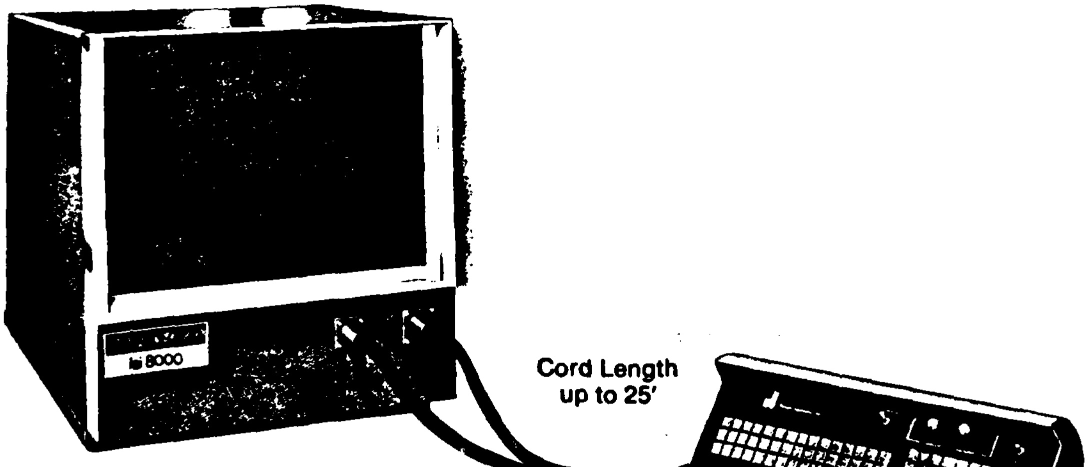
Sold and serviced through a comprehensive worldwide dealer network

isi 8000 SPECIFICATIONS

Format At 3 Times Magnification	Reduction	Projector to Screen Distance	Available Image Size at Screen Width	Height
ANSI Type 1 (NMA) (7 x 14)	24X	50.5"	37.0"	37.0"
ANSI Ttype 2 (COSATI) (5 x 12)	20X	47.3"	30.8"	36.0"
42X	42X	44.9"	44.6"	37.0"
48X	48X	54.4"	44.6"	36.0"
Format At 2 Times Magnification				
ANSI Type 1 (NMA) (7 x 14)	24X	26.9"	24.7"	24.7"
ANSI Type 2 (COSATI) (5 x 12)	20X	24.9"	20.6"	24.0"
42X	42X	22.9"	29.7"	24.7"
48X	48X	29.2"	29.7"	24.0"

isi 8000 PROJECTION UNIT:

Size:	48 cm H x 45 cm W x 63.5 cm D (19" H x 18" W x 25" D)
Weight:	43.5 kg (96 pounds)
Power:	115 VAC, 60 Hz or 220 VAC, 50 HZ
Control Indicators:	Power (on/off)
	Power Focus
	Vertical and Horizontal Image Adjustment



For further details, call or write:
Image Systems, Inc. P.O. Box 2488, 11244 Playa Court, Culver City, CA 90230
Telephone: (213) 390-3378 Cable: IMAGELACAL, TWX: (910) 343-6465

Form No 8000/11-77 Printed in U.S.A.

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isi 4000 MENTOR
Automatic Microfiche Storage and Retrieval System

isi 4000 MENTOR Features and Specifications

MENTOR is a data storage and retrieval system that holds over 180,000 pages of information and displays any page in 3 seconds or less. Up to 780 low-cost microfiche are stored at random inside the system, giving you filing economy through reduced space and reduced filing costs. With MENTOR, you have fast filing and fast finding of all your information.

FAST FILING—MENTOR provides complete random storage: you never have to maintain a filing sequence. Image Systems unique microfiche "edge" enables MENTOR to "know" electronically where every page of information is. No more wasted time putting information into a sequence... no more wasted time looking up misfiled data. Absolute file integrity is assured... the microfiche never leave the system.

FAST FINDING—direct access to any page of information in 3 seconds or less. No more lengthy file searches for that important information you need right away. A mere five digit code entered on the keyboard selects and displays any page of information. The first 3 digits locate the desired microfiche ... the last 2 digits locate the specific page of the microfiche.

MICROFICHE ECONOMY—reduces the cost of data storage, date handling, and data distribution. Over 200 pages of information are contained on a single 4" by 6" microfiche, which has a storage density 1200 times that of paper and 40 times that of magnetic tape. Data conversion to 48X microfiche is easily accomplished either by on-site filming of paper documents or by computer output to microfiche ... or through an Image Systems Service Center.

MENTOR's special 11" x 14" glare resistant screen gives you a clear, sharp, easy-to-read display of text, pictures, maps, drawings, charts ... in black-and-white or in color. MENTOR's fully visible tilted keyboard is designed for operator ease, convenience, and efficiency.

MENTOR—saves you time, space, work, and mistakes ... all of which add up to saving you money.

MENTOR OPTIONS:

Model 4826 Printer—produces 11" wide by 8½" high electrostatic copies directly from the display on the screen.

Model 4830 Cartridge—offers unlimited storage of microfiche beyond the basic carousel capacity. A modified carousel is designed for easy insertion of special cartridges that hold up to 52 microfiche each. Up to 3 cartridges may be used simultaneously.

Sold and serviced through a comprehensive worldwide dealer network

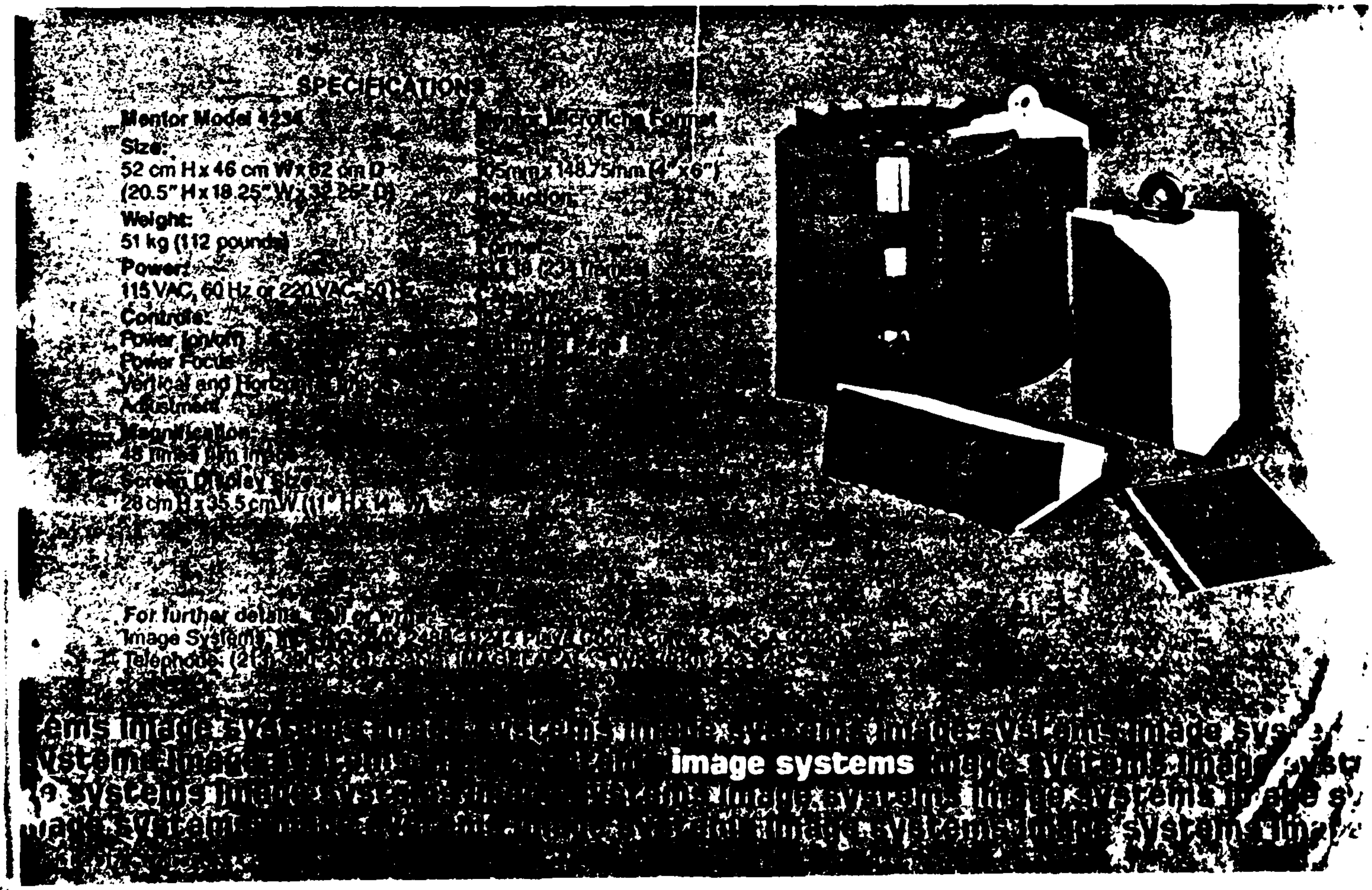

Image systems

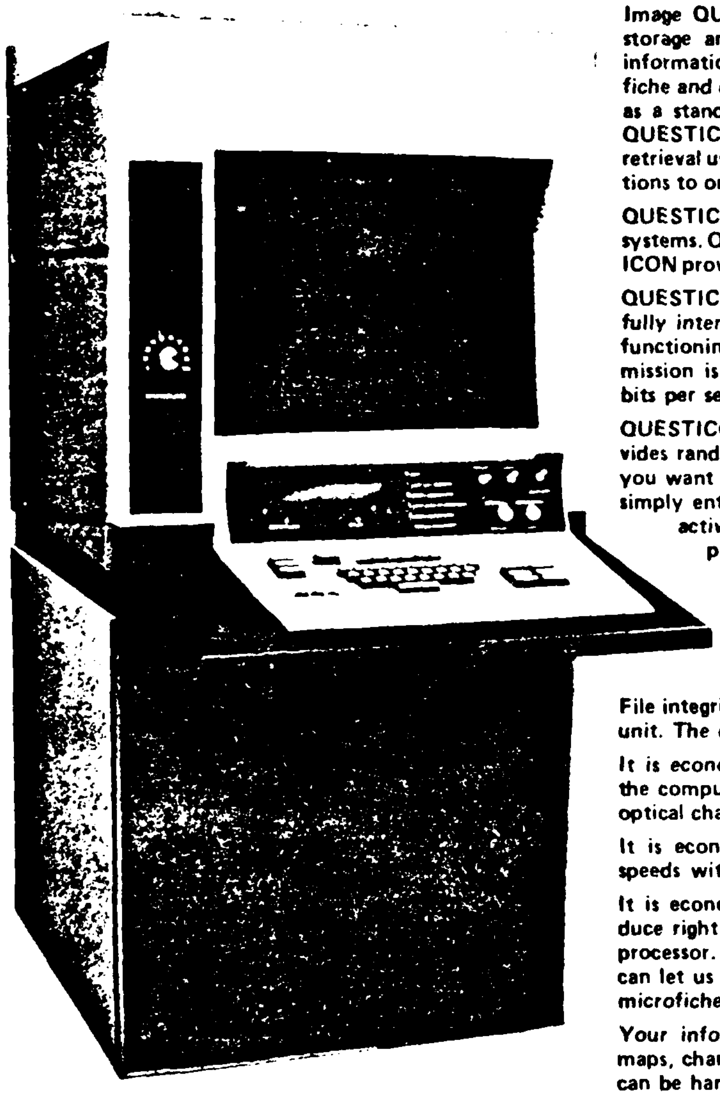

Image QUESTICON is a low cost, fully interactive micrographic storage and retrieval system. It holds up to 213,000 pages of information (or 2.5 billion characters) on as many as 780 microfiche and displays any page in three seconds or less. It can operate as a stand alone unit, but is primarily designed to interface to a QUESTICON (or any other) computer. Up to 256 QUESTICON retrieval units can be interfaced by direct cable or telecommunications to one QUESTICON computer.

QUESTICON eliminates the four major drawbacks of similar systems. QUESTICON is interactive, QUESTICON is fast, QUESTICON provides total file integrity and QUESTICON is economical.

QUESTICON contains all circuitry to enable it to operate as a fully interactive computer terminal (except modem) — as well as functioning as a microfiche storage and retrieval system. Transmission is asynchronous at selectable speeds from 300 to 9,600 bits per second.

QUESTICON is fast because we've designed a system that provides random access to the filed information. You locate the data you want without sequencing through the whole storage file. You simply enter a search argument and QUESTICON operates interactively with the QUESTICON computer or your own computer. It will perform logical search routines, select and display any page you want within 3 seconds or less. If you want the next page in the file, it is displayed in a fraction of a second. A 32 character dynamic display is included for operator instructions and/or computer messages.

File integrity ....All of the microfiche are contained within the unit. The data is never misfiled or lost.

It is economical...Source data conversion costs are a fraction of the computer input media conversion costs such as, keypunching, optical character reading and programming.

It is economical...It provides access to large files at computer speeds without a computer.

It is economical...It uses standard microfiche that you can produce right in your own facilities with an easy to use camera and processor. Or, if you do not want to do your own processing, you can let us do it for you. Our lab is equipped to handle 6 million microfiche per year.

Your information can be in the form of words, photographs, maps, charts or drawings; in color or black and white. The source can be hard copy or computer output to microfiche (COM). With the QUESTICON, regardless of the type of data, the information is still only 3 seconds away. The speed, low cost and flexibility of the QUESTICON system makes it ideal for use any place you need rapid access to static, dynamic or cyclic updated files.

QUESTICON contains the standard RS 232C interface which permits QUESTICON to interface to any computer. This reduces the transmission load in many timeshare applications. Relatively static data can be distributed and stored on microfiche at each QUESTICON terminal. No more than eight characters are ever required to select any one of 213,000 pages of information, each containing up to 11,610 characters (or graphics). This 1000:1 reduction in transmission requirements can save a timeshare system from bogging down in its own transmission requirements.

QUESTICON reduces computer program complexities by minimizing, 1) core and disk storage and thus overlay and data movement requirements, 2) transmission load and thus queuing and data concentration requirements, 3) operator key stroke and English language input, and thus translation, error checking and correction and print routines.

QUESTICON is user oriented for ease of operation. It is easy to learn and simple to operate. The computer and QUESTICON both guide the user. A "HELP" key is available, to be used as necessary, during the search routine. The electronic keyboard can be designed to suit your particular needs. Common keys include alphabetic, numeric, page forward, page backward, reset, print this page, print this document.

OPTIONS

Model 3820 Printer — makes available an electrostatic copy of any display on the screen in eleven seconds. Added copies of the same display are at 6 second intervals. Copy is pre-cut input in 8-1/2 x 11 or 11 x 14.

Model 3830 Cartridge QUESTICON offers unlimited data storage for the Image QUESTICON system. Modification to the QUESTICON carousel for Cartridge QUESTICON is designed for easy insertion of the cartridge into the carousel, as needed, without any sacrifice in final retrieval time of three seconds. Three sections of the carousel are modified for the loading of a cartridge that holds up to 50 microfiche.

General Specifications

Reduction Ratio	42x and 48x
Storage capacity	149,760/187,200/212,940 pages (780 microfiche)
Number of images/microfiche	192/240/273
Access time	3 seconds or less
Document size	up to 11" x 14"
Microfiche size	4" x 6" inches
Screen display size	approximately 11" x 14"
Overall size including printer	59.75" high x 26" wide x 46.75 deep
Weight	543 pounds
Power	115 volt
Communications Specs	300 to 9,600 Bits per second (Selectable) asynchronous ASC11 Code
Cartridge for Cartridge Carousel	50 microfiche/cartridge

Printer Features

Electrostatic copy
Automatic Multi-copy capability
Pre-cut paper of 8-1/2" x 11" or 11" x 14"
Liquid toner supply
Adjustable contrast control

Controls and Indicators

Power On/Off
Vertical-Horizontal Image Adjustment
Power Focus
Six indicator neons under computer control
Six indicator push buttons under computer control
Typewriter Type Keyboard for communicating with computer

For additional information, please contact:
Image Systems, Inc., 11244 Playa Court, Culver City, California 90230, Telephone (213) 390-3378

FAST, RANDOM ACCESS – isi 2000 is a system that provides completely automated access to large files of information. With Image Systems' patented binary microfiche clip you store information at random and locate the data you want without sequencing through the entire file. Just press 5 buttons or less, and the page you want is displayed in 3 seconds. If you want the next page in the file, it's available in a fraction of a second.

COST EFFECTIVE – isi 2000 provides access to large files at computer speeds without a computer. It uses standard microfiche that you can produce right in your own facilities with support equipment also supplied by Image Systems including fiche cutters, clip attachers and easy-to-use cameras.

Your information can be in the form of numbers, words, photographs, maps, charts or drawings – in color or black-and-white. The source can be paper documents or computer readable data bases (magnetic tape, disk, punched cards). With Image Systems' isi 2000, regardless of the type of data, the information you want is still only 3 seconds away. The speed, low cost, and flexibility of the isi 2000 system makes it ideal whenever you need rapid access to static, dynamic or cyclic updated files.

FILE INTEGRITY – A unique internal carousel stores up to 780 microfiche within the retrieval unit. Information never leaves the file.

DATA RETRIEVAL – takes only five pushbuttons on the keyboard. Use three buttons from the left keyboard to select a microfiche. Then use two buttons from the right keyboard to select the specific frame on that microfiche. A longlife, high intensity lamp projects a brilliant life-like image of the selected page. The entire selection cycle takes three seconds or less.

FORMATS

Model	Description	Reduction	Format	Storage Capacity (pages)	Max. Page Size (inches)
2060	ANSI Type 2 (COSATI)	20X	5 x 12	46,800	9.25 x 11.50
2080	COM 80	27X	8 x 10	62,400	13.2 x 10.66
2098	ANSI Type 1 (NMA)	24X	7 x 14	76,440	9.17 x 11.50
2100	Decimal	30X	10 x 10	78,000	16 24 x 10 03
2192	42X	42X	12 x 16	149,760	14.25 x 11.00
2240	42X	42X	12 x 20	187,200	11.0 x 10.50

OPTIONS

Model 2820 Printer – makes single or multiple electrostatic copies of any image on the screen in 13 seconds. Additional copies of the same display are at 6 second intervals. Copy is pre-cut, 8½" x 11" or 11" x 14".

Model 2830 Cartridge Carousel – offers unlimited data storage for the isi 2000 system. A modified carousel is designed for easy insertion of special cartridges that hold up to 52 microfiche each. Up to three cartridges may be used simultaneously. Total capacity of the cartridge carousel is 624 microfiche.

Model 2850 Remote Keyboard – permits control of the isi 2000 unit from a separate keyboard connected by a cable (25 feet maximum length). Maximum flexibility in situating the retrieval unit is possible.

Model 2860 Security Kit – provides a special locking mechanism for the loading door of the retrieval unit. Only authorized personnel are able to add or remove microfiche from the file.

isi 2000 SPECIFICATIONS

isi 2000 Retrieval Unit:

Size:	48 cm H x 45 cm W x 63.5 cm D (19" H x 18" W x 25" D)
Weight:	43.5 kg (96 pounds)
Power:	115 VAC, 60 Hz or 220 VAC, 50 Hz (Other power requirements available)
Screen Display Size:	28 cm H x 35.5 cm W (11" H x 14" W)
Controls and Indicators:	Power (on/off)
	Power Focus
	Vertical and Horizontal Image Adjustment

isi 2000 with Printer:

Size:	77.5 cm H x 66 cm W x 79 cm D (30.5" H x 26" W x 31" D)
Weight:	154.7 kg (341 pounds)
Controls and Indicators:	Power (on/off)
	Multi-copy selector (1-23 copies)
	Exposure Control
	Print (start cycle)
	Power On Indicator
	Ready Indicator
	Toner Supply Indicator
	Paper Supply Indicator
Paper Supply:	Pre-cut sheets, 8½" x 11" or 11" x 14"

Sold and serviced through a comprehensive worldwide dealer network.

image systems

For further details, call or write:
Image Systems, Inc., P.O. Box 2488, 11244 Playa Court, Culver City, CA 90230
Telephone: (213) 390-3378 Cable: IMAGELACAL, TWX: (910) 343-6465

image systems
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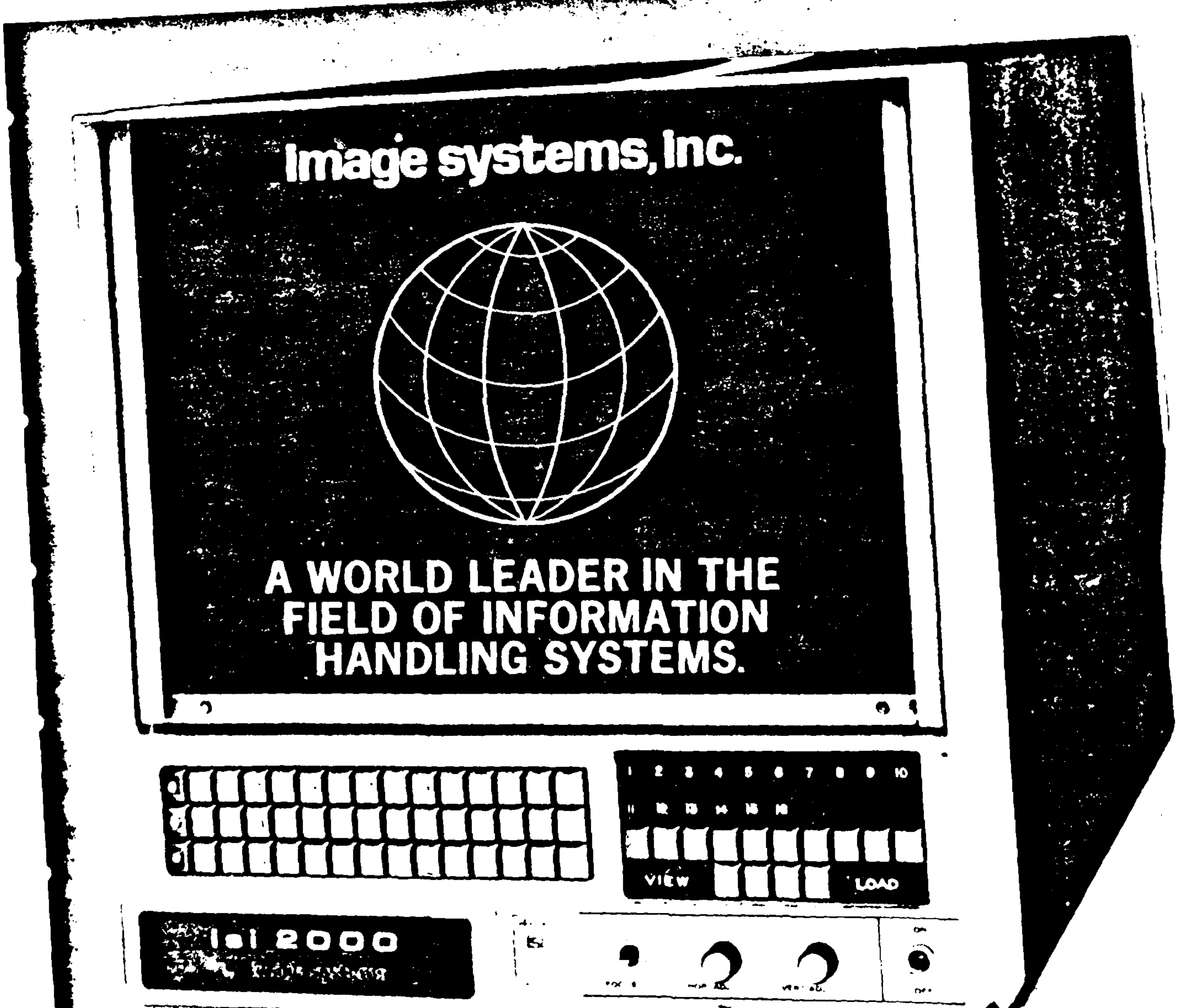
isi 2000

Automated Retrieval and Display System



Fast, Random Access
Cost Effective
Total File Integrity

The isi Printer System:

- Makes available an electrostatic copy of any one of up to 187,200 displays in seconds.
- "Closes the loop" in an automatic microfiche retrieval system. Any original source document or computer listing which is on microfiche in the unit can be retrieved upon demand as a paper duplicate of the original source document.
- The paper media for those documents in a self contained storage file where a "walk away" copy is required.
- The answer for providing a paper copy back-up for the customers' "lost" document, or follow-up.
- The managers' tool for obtaining paper copy from massive storage files on microfiche.

OPERATING FEATURES:

- Electrostatic Copy
- Pre-cut Paper 8½" x 11"
- Easy Loading of Paper Package of 200 Sheets
- Easy Access to Paper Supply
- Liquid Toner Supply
- External Toner Refill (access)
- Adjustable Time Exposure Control
- Copy delivered in 8 Seconds Minimum to 12 Seconds Maximum

TWO MODELS AVAILABLE:

X825 Front delivery
Full size viewing and printing for letter size document (8½"W x 11"H format)

X826 Side delivery
¾ size (75%) viewing and printing for computer output documents (11"W x 8½"H format)

Sold and serviced through a comprehensive worldwide dealer network.

SPECIFICATIONS:

Size:
64.8cm x 72.4cm x 84.5cm
(25½" Wide x 28½" Deep x 33¼" High)

Weight:
121 Kg. (267 lbs.)

Power:
117 VAC, 60 Hz or
220 VAC, 50 Hz

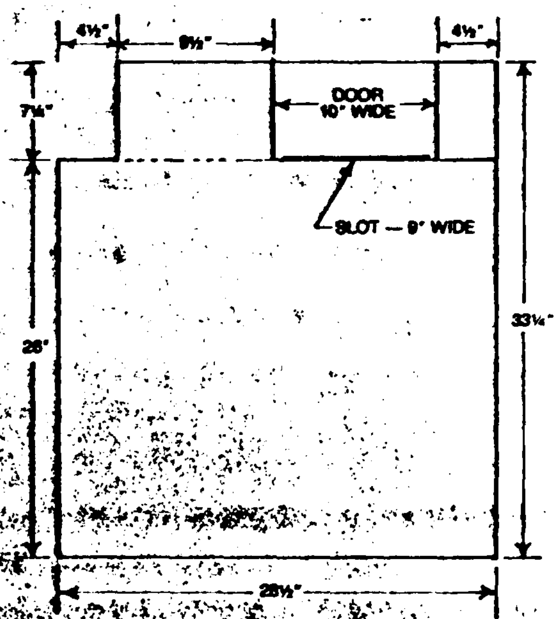
Controls & Indicators: (Retrieval Unit)
Power — On/Off (Master)
Vertical Adjust (Image)
Horizontal Adjust (Image)
Power Focus

Controls & Indicators: (Printer Unit)
Exposure Control/Densities and Contrasts
Print - Print Cycle
Paper Out Indicator
Toner Low Indicator

Paper Supply:
Pre-cut 8½" x 11" in 200 sheet insertable packages

Toner Supply:
Plastic bottles, premixed toner and replenisher

SIDE DELIVERY MODEL



For further details, call or write:
Image Systems, Inc., P.O. Box 2488, 11244 Playa Court, Culver City, CA 90230
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Form No. 4157B. Printed in U.S.A.

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isi PRINTER
for
Series 2000, 4000 and 5000

Virtually Unlimited Storage Capacity
Automatic Microfiche Retrieval
Electrostatic Copy Produced in Seconds

APPENDIX E

"Interactive Action"

HANDS-ON REPORT

Interactive Action

Hands-on appraisal of the first optical video disc with programming you can manipulate.

by Myron Berger

In a very real sense, the era of the video disc was ushered in recently with the arrival of the interactive disc. Until now, the only programs available for the U.S. Pioneer and Magnavox optical laser players have been films of various subjects pressed onto disc. Now Magnavox and Pioneer have joined with MCA to form Optical Programming Associates, and its initial release is *How to Watch Pro Football*. This interactive disc is the first made expressly to take advantage of all the capabilities of this unique new medium.

"Interactive" is a term that slipped into public usage several years ago, when Warner Communications installed the Qube two-way cable television system in Columbus, Ohio. Using a hand-held keyboard controller, Qube subscribers are able to engage in a two-way electronic dialogue with many of the programs they watch. In the case of the interactive optical video disc, viewers use the transport controls on the player to manipulate the program and customize its presentation of information.

The stated aim of the pro football disc is to help viewers understand and enjoy the game more than they do now—essentially an educational mission with a strong measure of appreciation thrown in. The presentation presumes that you have at least a passing familiarity with the subject and, preferably, an interest in it that may border on passion. It is most definitely not for beginners. Although my own interest in football falls considerably short of passion, I found it entertaining and the potentials of interaction—which this disc only hints at—to be exciting.

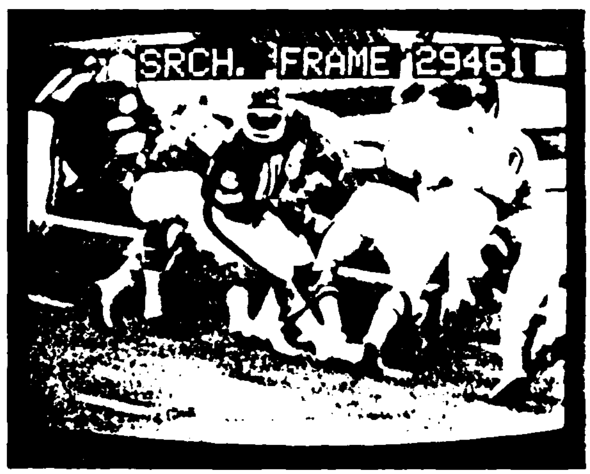
This program goes about its mission in a fairly straightforward manner. A number of professional coaches each present a lesson on a different aspect of the game. Dallas Cowboys coach Tom Landry, for example, discusses passing strategy in one section, and Miami coach Don Shula offers his thoughts on goal-line defense in another.

The lectures (and that is, after all, what they are) include heavy doses of explaining football jargon—a language only slightly more comprehensible than Middle High German. Both strategy and terminology are almost invariably demonstrated in footage from pro games.

Since the optical disc player is eminently controllable, the viewer can use the freeze-frame, SLO-MO, scan, and frame-step features or search out a particular frame or chapter. Most of these functions, incidentally, are not available on the CED player developed by RCA and will likely be offered only as options on the VHD players due out late this year from JVC, Panasonic, Quasar, and General Electric.

Scene from first video disc with viewer-manipulated program.

Designed for laser-optical players, the disc's primary purpose is to educate viewers about pro football. A second disc—for children—is due soon and requires greater viewer participation.



Among the many viewer-operated controls is SEARCH FRAME, which lets you locate a particular frame almost instantly. A total of 54,000 individual frames are contained on the disc.

Another exclusive feature of the optical players—discrete two-channel audio—is used in three chapters on this disc to convey different information. In two cases, the viewer is quizzed on the material he has just watched. By silencing Channel 2, he sees a play and hears the question. He then backtracks to the beginning of the question, silences Channel 1, and activates Channel 2, which contains the answer.

In the third example of two-channel audio, Kansas City coach Marv Levy presents his thoughts on offensive moves at the goal line on Channel 1 while coach Shula discusses goal-line defense on the other channel. The visual material in both cases, obviously, is identical. This application of the feature is interactive in the sense that the disc asks what you would like to hear, and you respond by pushing a button and get what you selected.

Another interactive function afforded by the optical disc drive controls is the presentation of an NFL play book. The 361 pages of the volume (containing terminology and standard formations and plays) are reproduced at the rate of one page per disc frame. If the machine is in the play mode, all 361 pages will flash by in a matter of 15 seconds. If you care to read the material, you use the STILL/STEP-FRAME button to advance one page at a time at your own pace.

What is essentially the first video disc game, entitled Freeze When, is contained in Chapter 6, Side 2. You punch up the frame number display on your screen, watch footage of a play, and hit the STILL/STEP-FRAME button as soon as you can tell whether the quarterback will pass or run. By deducting the number of the frame when the play started from the number of the frame when you reached your decision, you arrive at your score.

The video disc has been programmed to activate the transport functions of the player so that freeze frame occurs automatically at the conclusion of each play and the score rating chart is displayed. By hitting the STILL/STEP-FRAME button, you move to the next frame for instructions for the next play. Move one more frame to note the number, hit PLAY, and you're off.

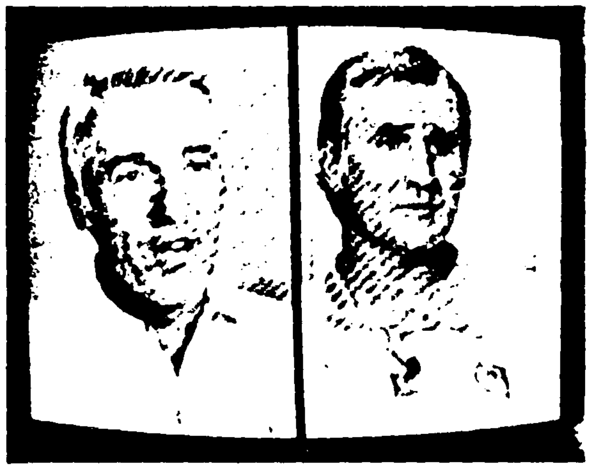
All the interactive features on my disc worked perfectly, although the play book sequence is only marginally useful since most of the print is too small to read (regardless of screen size). Still, the diagrams are quite clear, and they make up perhaps 75% of the material in the book.

Image quality throughout the disc is good, though not spectacular. Optical video disc manufacturers claim an image at least as good as the best broadcast picture, and color saturation, contrast, and clarity are indeed comparable. But the disc is marred by a high noise level. Another minor problem is the fact that all the material was originally shot on film stock rather than video tape. The result is a graininess that is occasionally disturbing, though never disruptive.

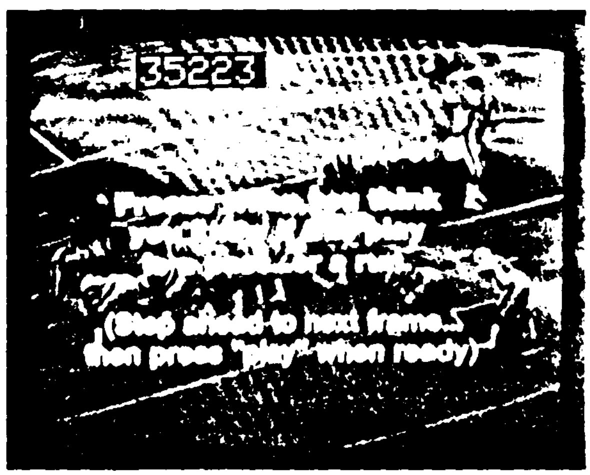
While my enthusiasm for the subject was distinctly limited, I felt almost as if I were in the presence of a historically important device. Assuming that video discs will prove to be as significant a medium of communication, information, and entertainment as its proponents suggest, this first interactive disc is, in fact, a milestone.

The second such disc from OPA, due out soon, is a children's program that is said to be far more interactive than the football release. If this is only the beginning, I can't wait to see what follows!

Questions and answers are on separate audio channels. With Channel 2 off and 1 on, you hear a question. Backtrack to the beginning, switch audio channels, and get the answer.



Offensive goal-line strategy is discussed by Kansas City coach Marv Levy (left) on one audio channel, while Miami coach Don Shula fills you in on goal-line defense on the other channel.



A video disc game called Freeze When tests how quickly you can guess if the quarterback will pass or run. Scoring is based on the number of elapsed frames from the beginning of the play.

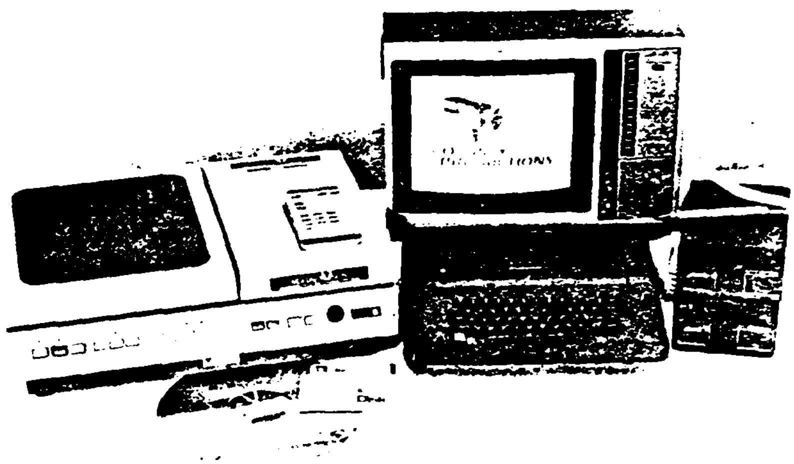
APPENDIX F

Colony Productions

Intelligent Videodisc Configurations

The promise of the "Intelligent" Videodisc is now a Reality.

It has been a long wait. For years educators and trainers have written and speculated about the instructional power of an "intelligent" videodisc system. We have envisioned amazing applications and unlimited capabilities. But the implementation has always been "just around the corner."



Coloney Productions is pleased to announce that a fully integrated, reliable, cost-effective, "intelligent" videodisc/microcomputer system is finally here, in living color.

The Coloney system combines some of the finest components available. The videodisc provides all the advantages of television, slide/sound, and multi-track audio along with an immense storage capacity and a rapid, random search capability. The computer offers color graphics, legible alphanumerics, branching to any portion of the lesson, student control of lesson pace and content, and automatic management of student performance. The light pen permits tactile involvement and reduces reliance on a complex keyboard.

Together, these components meld into one successful delivery system, on one screen. It is surprisingly inexpensive and simple to use. And it has *already* been successfully demonstrated to leaders in government, military and industry across the country. People are buying and using it. It is here, now.

Coloney Productions screened a wide variety of potential components before choosing these as the best and most practical. Coloney was the first to bring them together. Only now is an inexpensive, "off-the-shelf" package with these capabilities available. Here is a glimpse of each component.

Please turn for details

The Coloney "Intelligent" System

The Videodisc Player

DiscoVision Associates (DVA) provides the videodisc player for this system. The PR7820 is an optical-type reflective disc player with an on-board programmable microprocesser. The player allows slow motion, freeze frame and other options and can access any one of 50,000 video frames in less than five seconds. Because the system uses a low-voltage laser to play back information, there is no physical contact with the disc and no wear to degrade picture quality. The discs are highly durable and the player is easy to operate.

The Microcomputer

The computer in this system is produced especially for Bell and Howell by Apple Computers. It offers such standard features as floating point BASIC in ROM, high and low resolution color graphics, up to 48K bytes RAM, game paddles, and a typewriter style ASC II keyboard. The B&H micro is also flexible enough to grow with you. Eight expansion slots allow addition of the two disc drives that are standard with our system, as well as printers, modems, and other *peripherals.*

The Interface

The hub of this new system is the new VAI-1 package (Videodisc,Apple II Interface) which is exclusively manufactured and marketed by Coloney Productions. Originally developed by Utah State University, the VAI-1 card is housed inside the microcomputer and accesses *all videodisc functions* available through the DVA player's remote port. In addition, it allows the video to switch between videodisc and computer generated images through a simple software command. The package, complete with cables, software and manual, is easily installed and highly reliable.

Authoring and Software

Bell and Howell provides two innovative authoring approaches for use with this system. The GENIS package, which comes with the package, allows nonprogrammers to design and execute lessons complete with text, questions, feedback, hints and easy access to the videodisc. The package tracks student input and tabulates correct and incorrect answers and the number of response attempts. Any instructor may design, edit and execute meaningful lessons with GENIS. A second authoring option, a professional package with extensive scope and capability will soon be announced by B&H.

In addition, this system can use a wide variety of other data and financial management software, games, and simulations available for the Apple II. This multiple use capability makes the system even more cost-effective in *most environments.*

The Light Pen

The Symtec professional light pen adds considerable flexibility to this system. With this tool, the student can interact directly with the information on the television screen -- typing skills and reliance on the keyboard are not required. Constructed of stainless steel, the pen is rugged and simple to use. It adjusts to any standard TV monitor and may be synchronized to a remote video source. Software and documentation come in both BASIC and machine code.

Applications

The Coloney Productions "intelligent" system lends itself to a wide array of appplications. Linear film, video and slide-sound presentations may be mastered onto videodisc and viewed through this system. It is most useful, however, in situations where it is desirable for the student to become directly involved in the instruction. Basic skills -- literacy, math, and the sciences (nuclear fusion without the danger) -- may be taught dynamically and effectively. The "psycho" or cognitive portion of psychomotor skills (e.g. sports, mechanical activities, sign language, etc.), can be presented and practiced. Simulation of complex, multi-variable training problems (flight training, fission reactor maintenance, radar operation, etc.) can be developed simply and effectively. The Coloney group has even designed a generic 2-D/3-D simulator that provides all the capability of the "intelligent" system *and* actual hands-on activities.

Cost-Effective

Coloney personnel have developed a learning- and cost-effectiveness model that provides *detailed information* about 28 different instructional delivery systems (including lecture, text, film, videodisc, full simulation, etc.) and their effectiveness with various tasks, students and situations. This practical "bottom-line" information indicates when this system is and is not the best choice. Many organizations are finding that for some applications, especially where the system is used for multiple tasks, the Coloney system (priced under $6,000) is clearly the most cost-effective approach available.

Let Us Help

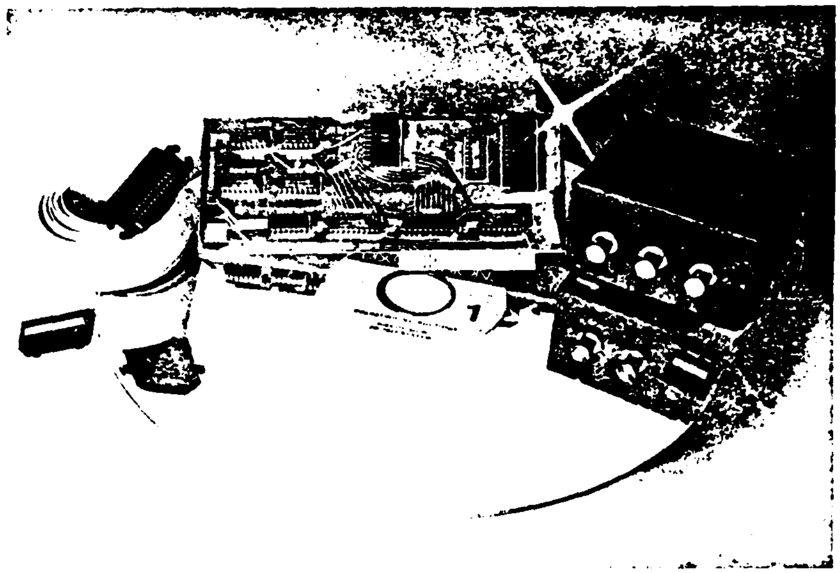
We offer you our experience and expertise. We can assess your individual needs and show you how and when this approach is best applied. Coloney Productions provides instructional systems design and development capabilities from needs assessment to the finished, evaluated product. Our media production capabilities include videotape, slide-sound, graphics, original music production, creative and technical writing, software design and videodisc consultation. Please call or write with your questions or ideas. The wait is over. Let us help you now.

COLONEY PRODUCTIONS

1248 Blounstown Hwy., Tallahassee, Fl. 32304 (904)575-0691

Announcing the new Videodisc/Apple Interface.

Coloney Productions is pleased to announce the VAI-1, an interface package that connects the DVA PR7820 industrial videodisc player to the Bell and Howell Microcomputer (or Apple II Plus).



Background

In 1978, the Utah State University Videodisc Innovations Project began development of an interface card that would allow the Apple II to "talk" to a videodisc player. Under the direction of Professor Robert Wooley, prototype versions of the card and accompanying software were produced and successfully demonstrated during 1979 and early 1980. Through these months of research and development, the card was updated and improved to offer maximum reliability and performance options.

Now, a commercial edition of the USU card is being manufactured and marketed by Coloney Productions, a Florida-based firm. It was Coloney Productions that first integrated the DiscoVison Associates' model PR7820 industrial videodisc player with the new Bell and Howell Microcomputer and software packages. Since May, 1980, the Coloney group has successfully demonstrated this interactive system (equipped with light pen and "English" language course authoring), to military, industry and government leaders across the country. Backed by its parent company, a large engineering design and manufacturing firm, Coloney Productions is now producing the new VAI-1 package, an improved version of the Utah State prototype.

Please turn for details

The VAI-1

Description

The VAI-1 is a single circuit card that fits into the micro's peripheral buss. It is a simple task to install the card which fits neatly inside the Bell and Howell Microcomputer housing. The card is sold with a complete support package that provides all the hardware and software required to connect the micro and the DVA PR7820 videodisc player, and to access all the control functions available via the PR7820 remote control port. The VAI-1 also allows the user to switch the monitor display from computer output to videodisc output by a software command.

Specifically, the package contains the following:

1. A single computer card that is inserted into slot three of the microcomputer buss;

2. A six-foot control cable that connects the interface card to the remote port on the DVA PR7820 videodisc player;

3. Cables to connect video signals from the videodisc player to the interface card and from the interface card to the user's monitor (connectors are BNC);

4. An operating manual with instructions for installation and use of the interface card, including sub-program listings for controlling the videodisc via Applesoft and PASCAL.

User's notes included with the manual will also provide simple sub-programs to aid the user in developing instructional programs that control the videodisc functions using a Symtec light pen (pen purchased separately).

Delivery and Warranty

Limited quantities of the VAI-1 will be available by September, 1980. Larger quantities will be available soon thereafter. A limited warranty will accompany each package to include the repair and/or replacement of defective units or components up to 90 days after delivery. Prototype boards have proven to be highly reliable under varied and stressful conditions.

A Major Breakthrough

With the new VAI-1, you will have access to the most powerful instructional delivery tools ever offered: the microcomputer and the videodisc. Now they work in complete harmony, and the advantages of both technologies are combined in one highly effective system. We invite you to join the increasing number of individuals and organizations that wish to harness the promise of the "intelligent" videodisc.

For more information and pricing, please call (904)575-0691 or write Coloney Productions, 1248 Blountstown Highway, Tallahassee, Florida 32304. We will be happy to provide further information and to answer your questions.

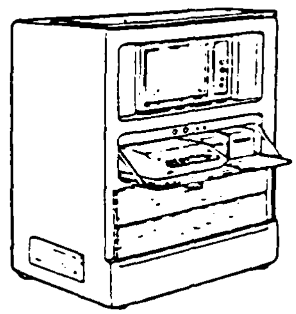
1248 Blountstown Hwy., Tallahassee, Fl. 32304 (904)575-0691

COLONEY PRODUCTIONS

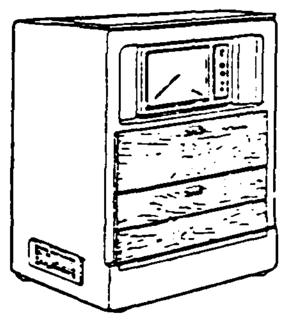
The Coloney "Intelligent" System
Learning Carrel

The tremendous capabilities of the Coloney Learning System have found a home—a student station that can be easily rolled into the classroom or learning center, plugged into a single wall socket, and turned on with the push of a button. Coloney Productions is pleased to introduce its custom learning carrel. This rugged yet handsome fiberglass unit places each component—computer, TV monitor and videodisc player—in strategic and accessible locations. Just over 50" tall, the carrel is just the right size for students of all ages. Castors equipped with a lock-down feature provide both mobility in transit and permanance while in operation. Locking doors on front and back offer easy access to all components, as well as security, and the door to the computer area also provides ample desk space for the student.
The system is carefully designed to maximize air circulation and to endure considerable abuse. Operable in three separate modes, the carrel and system are flexible enough to meet the demands of divergent target populations.

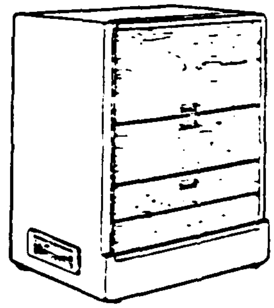
High technology need not be intimidating or burdensome. The carrel is in full production. Let the Coloney System bring the most exciting training and educactional technology to you, today.



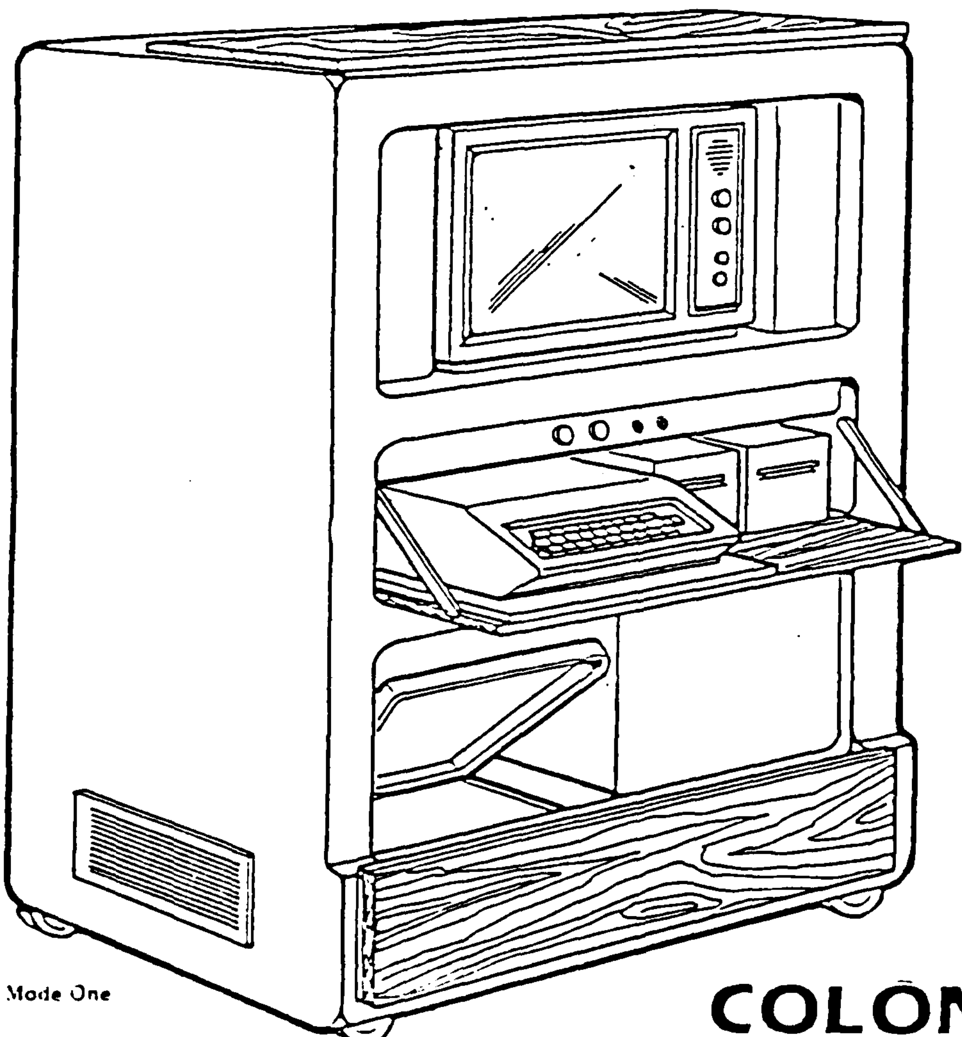
Mode Two



Mode Three



Secure



Mode One

COLONEY PRODUCTIONS

1248 Blountstown Hwy. Tallahassee, FL 32304 (904)575-0691

APPENDIX G

"Interactive Control of a Videocassette Recorder with a Personal Computer"

Interactive Control of a Videocassette Recorder with a Personal Computer

Dr Richard C Hallgren
Dept of Biomechanics
Michigan State University
East Lansing MI 48823

The use of computers in education is not a new concept. Many colleges have effective time-sharing systems for use by both students and faculty. However, the recent widespread acceptance of small personal computers has opened up many opportunities for increased use of computers in education. One such use is for computer-aided instruction (CAI).

This article describes the method used to interface a Sony Betamax videocassette recorder, Model SLO-320, to two popular computers, the Radio Shack TRS-80 and the Apple II computer, so that a low-cost, lecture-supplemented, computer-aided instructional system is achieved. The system was originally designed for medical students, but it has a wide range of applications.

Medical colleges make considerable use of videotaped lectures. These allow a student to review material presented at a lecture which the individual was not able to attend, or to review material in preparation for examinations. Often the student does not need to review an entire lecture, but needs to be concerned only with specific segments.

About the Author
Richard C Hallgren is an assistant professor in the Department of Biomechanics at Michigan State. He works on applications of microprocessor-based systems to scientific research. This project was supported by Independent School District #196, Rosemount, Minnesota.

> If a computer could be used to control the presentation of videotaped material to a student, perhaps learning could be more efficient.

The Sony SLO-320 videocassette recorder has the capability of selectively searching for and playing specific segments of a videotape through the use of an RM-300 Auto Search control. The operator can enter a number representing a specific location on the tape. The recorder will move the tape to that location and begin playing. This search process uses a timing signal which is placed onto the tape during the recording process. The autosearch function allows students to review or examine material without having to sit through a whole lecture.

As part of any learning experience, it is important that the student know whether he or she has retained facts and understood concepts. This question is usually answered at examination time, often to the dismay of the student. If a computer could be used to control the presentation of videotaped material to a student, perhaps learning could be more efficient.

For example, if a student wants to review the symptoms of the disease hypercalcemia, the computer can not only control the presentation of the material, but after the material has been reviewed, the computer can *ask* the students *questions* related to the material. If the student retains the material and answers the questions correctly, new material can be covered.

However, if the student cannot answer the questions correctly, the videotape is rewound, and the material on the tape is presented again. By doing this, the student gains confidence that he or she is really learning the material.

It is a relatively straightforward

Betamax Connector Pin	Signal	Source/ Destination	BASIC Command	Machine-Language Command
CN1-20	$\overline{\text{BEGINNING OF TAPE}}$	from Betamax	PEEK(– 16137)	LDA $C0F7
CN1-7	$\overline{\text{CASSETTE IN}}$	from Betamax	PEEK(– 16133)	LDA $C0FB
CN1-11	$\overline{\text{REWIND}}$	to Betamax	POKE – 16142,3	LDA #03 STA $C0F2
CN1-8	$\overline{\text{STOP}}$	to Betamax	POKE – 16142,0	LDA #00 STA $C0F2
CN1-13	$\overline{\text{PLAY}}$	to Betamax	POKE – 16142,1	LDA #01 STA $C0F2
CN1-12	$\overline{\text{FAST FORWARD}}$	to Betamax	POKE – 16142,2	LDA #02 STA $C0F2
CN1-15	$\overline{\text{COUNT}}$	from Betamax	PEEK(– 16141)	LDA $C0F3

Table 1: *Videocassette recorder functions controlled through the Apple II interface of figure 1. The recorder being controlled is the Sony Betamax SL0-320 videocassette recorder; this is done through the pins that connect the recorder to the RM-300 Auto Search control unit. The software commands necessary to activate these functions are given in both BASIC and 6502 machine-language forms.*

task to interface either the Apple II or the TRS-80 to the Betamax SL0-320 recorder. This article will describe both the hardware and software necessary to interface the Apple II computer to the Betamax, followed by the necessary changes to translate this to the TRS-80.

Interface Implementation—Apple II

The Apple II, with its eight peripheral-board connectors, makes the job of designing and implementing interface cards relatively simple. Since these connectors are on the main computer board, any interface cards will be inside the computer, using the computer's power supply.

Figure 1 shows the Betamax to Apple II interface in schematic diagram form. The left side of the schematic shows connections made to the Betamax through the connector normally used for the RM-300 Auto Search control. The right side of the diagram shows the connections made to the Apple II through the interface connector.

It is a relatively straightforward task to interface either the Apple II or the TRS-80 to the Betamax recorder.

Connector pin CN1-20 from the Betamax goes low when the videotape has been completely rewound. Connection CN1-7 from the Betamax goes low when the videotape has been loaded into the player. These two signals are sampled at the beginning of the program to assure that the videocassette starts from a predetermined point. Connection CN1-15 from the Betamax carries the timing signal that has been formatted onto the videotape. This signal is divided by a factor of 60 by IC1 and IC2.

IC3 is an 8-channel data selector which is used to selectively connect signals from CN1-20, CN1-7, or the divided timing signal, to data-bus line seven (D7) in the Apple II. D7 was chosen because its state can be easily

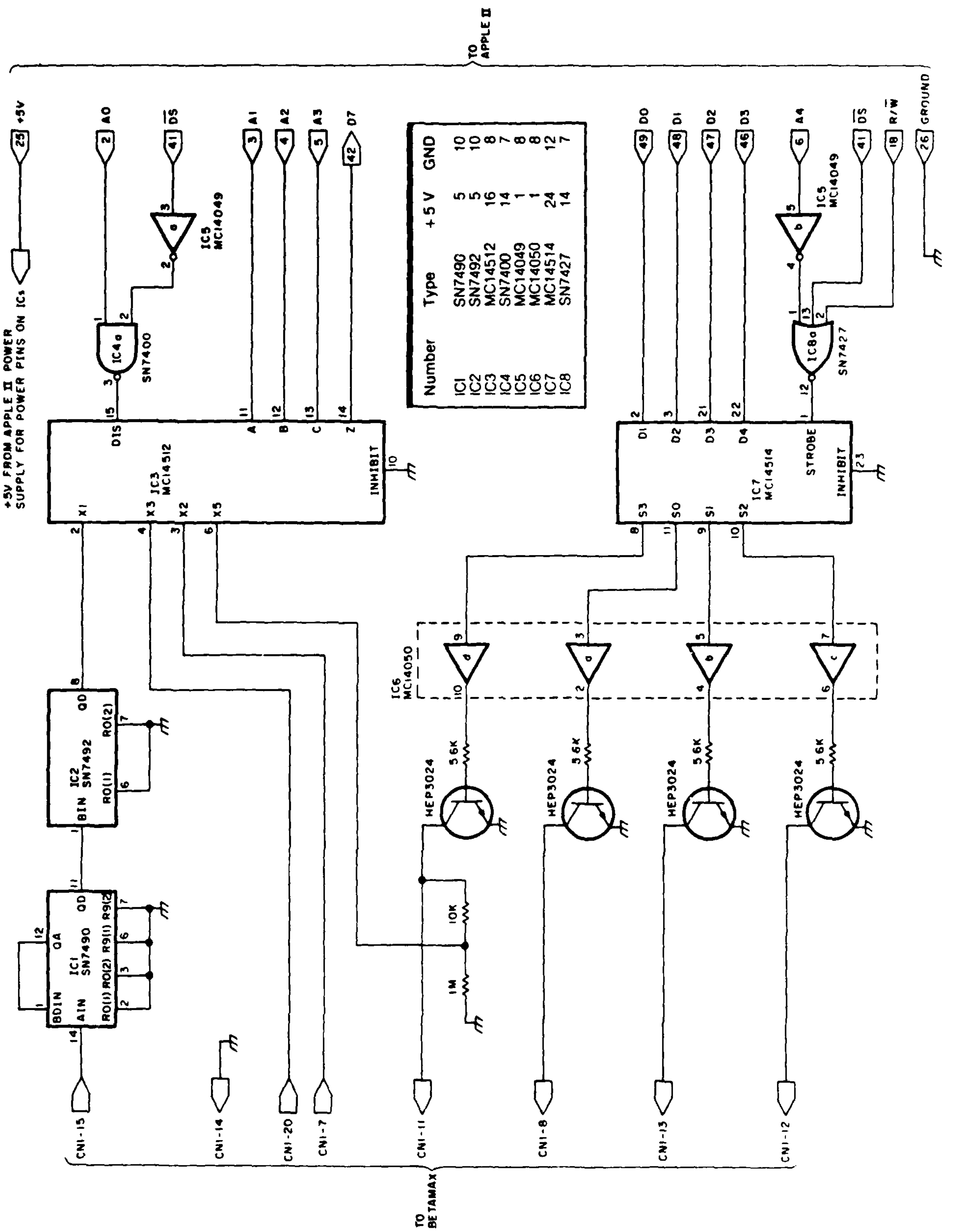


Figure 1: *Schematic diagram of the videotape control interface used to connect the Apple II computer to the Sony Betamax SLO-320 videocassette recorder. Connection to the Betamax unit is made through the RM-300 Auto Search control connector. Connection to the Apple II is made through one of the input/output card slots on the main computer circuit board. Connections to the videocassette machine are shown on the left side of the diagram; connections to the computer are shown on the right side. The* $\overline{DS}$ *line of the Apple II is a device-select line that is active when in a low logic state.*

tested by rotating it left from the accumulator into the carry bit.

Apple has conveniently provided an internal decoding scheme that forces a DS (Device Select, active low) line to go low whenever certain address locations are accessed. The Betamax interface card was designed to reside in input/output (I/O) card slot 7. This means that the DS line (pin 41) will go low whenever hexadecimal memory locations C0F0 thru C0FF are addressed. Table 1 shows the Betamax connections and functions that will be accessed for a given BASIC statement or a given machine-language command.

The Betamax can be commanded to move the tape in any of the play, rewind, fast forward, or stop modes by dropping the appropriate line from connector CN1 to ground logic state. IC7 is a 4 to 16 line decoder latch which is used to selectively turn on one of the four transistors that control the function of the videocassette recorder.

Software Control of the Video Recorder—Apple II

The software portion of the project was handled in two parts:

- A machine-language routine was written to count the pulses coming from the timing track on the videotape and to determine when the desired destination location along the videotape is reached.
- A routine written in Applesoft floating-point BASIC loads the videotape destination location and controls the video recorder. In addition, all of the routines used to quiz the students were written in Applesoft BASIC, but are not shown in this article.

Figures 2 and 3 show the flowcharts for the machine-language routines. Listings 1 and 2 show the actual program code in assembler format with comments. The programs are quite similar. The *increment* routine in listing 1 is used when the videotape is being moved forward (play or fast-forward modes) and the *decrement* routine in listing 2 is used when the videotape is being moved in reverse (rewind).

Upon entering the appropriate subroutine from the BASIC program, the processor status and the accumulator are pushed onto the stack. The line carrying the pulses from the timing track on the videotape is then sampled until it has been determined that the tape has moved a distance equal to 1 pulse width. A present-location register consisting of two 8-bit words is then incremented or decremented depending on whether the tape is being moved forward or reverse.

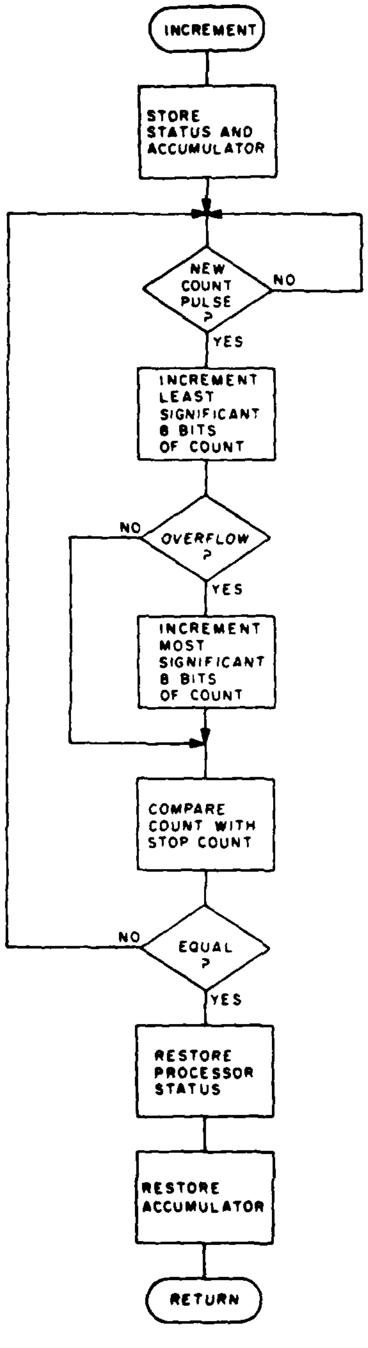


Figure 2: *Flowchart of the increment machine-language subroutine that monitors forward motion of the videotape. See listing 1 for the 6502 code; see listing 4 for the Z80 code.*

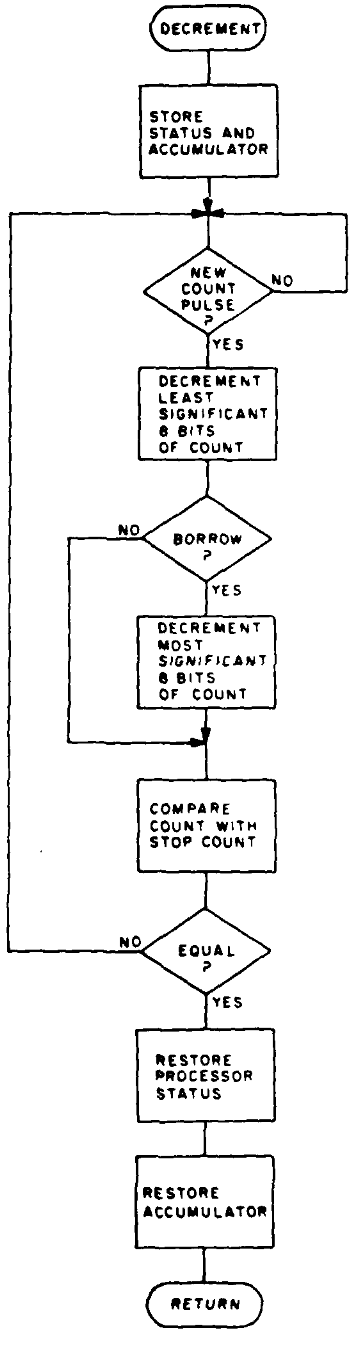


Figure 3: *Flowchart of the decrement machine-language subroutine that monitors reverse motion of the videotape. See listing 2 for the 6502 code; see listing 5 for the Z80 code.*

Listing 1: *Assembly-language subroutine for the 6502 processor. This routine, used in the Apple II, monitors the forward motion of the videotape by counting timing pulses derived from the videotape and sent over connector pin CN1-15 of the RM-300 Auto Search control connector.*

Hexadecimal Address	Hexadecimal Code			Instruction Mnemonic	Operand	Commentary
0310	08			PHP		Save processor status
0311	48			PHA		Save accumulator
0312	AD	F3	C0	LDA	$C0F3	Sample count line
0315	2A			ROL		Rotate bit 7 into carry
0316	B0	FA		BCS	$0312	Branch if carry set
0318	AD	F3	C0	LDA	$C0F3	Sample count line
031B	2A			ROL		Rotate bit 7 into carry
031C	90	FA		BCC	$0318	Branch if carry clear
031E	EE	03	03	INC	$0303	Increment least significant 8 bits
0321	D0	03		BNE	$0326	Branch if no overflow
0323	EE	04	03	INC	$0304	Increment most significant 8 bits
0326	AD	03	03	LDA	$0303	Load least significant 8 bits
0329	CD	05	03	CMP	$0305	Compare with least significant stop count
032C	D0	E4		BNE	$0312	Branch if not equal
032E	AD	04	03	LDA	$0304	Load most significant 8 bits
0331	CD	06	03	CMP	$0306	Compare with most significant stop count
0334	D0	DC		BNE	$0312	Branch if not equal
0336	68			PLA		Restore accumulator
0337	28			PLP		Restore processor status
0338	60			RTS		Return from subroutine

Listing 2: *Assembly-language subroutine for the 6502 processor. This routine is called from the Applesoft BASIC program to monitor the reverse motion of the videotape by counting timing pulses derived from the tape.*

Hexadecimal Address	Hexadecimal Code			Instruction Mnemonic	Operand	Commentary
0360	08			PHP		Save processor status
0361	48			PHA		Save accumulator
0362	AD	F3	C0	LDA	$C0F3	Sample count line
0365	2A			ROL		Rotate bit 7 into carry
0366	B0	FA		BCS	$0362	Branch if carry set
0368	AD	F3	C0	LDA	$C0F3	Sample count line
036B	2A			ROL		Rotate bit 7 into carry
036C	90	FA		BCC	$0368	Branch if carry clear
036E	38			SEC		Set carry
036F	AD	03	03	LDA	$0303	Load least significant 8 bits
0372	E9	01		SBC	#$01	Decrement least significant 8 bits
0374	8D	03	03	STA	$0303	Save
0377	AD	04	03	LDA	$0304	Load most significant 8 bits
037A	E9	00		SBC	#$00	Decrement if borrow
037C	8D	04	03	STA	$0304	Save
037F	AD	03	03	LDA	$0303	Load least significant 8 bits
0382	CD	05	03	CMP	$0305	Compare with least significant stop count
0385	D0	DB		BNE	$0362	Branch if not equal
0387	AD	04	03	LDA	$0304	Load most significant 8 bits
038A	CD	06	03	CMP	$0306	Compare with most significant stop count
038D	D0	D3		BNE	$0362	Branch if not equal
038F	68			PLA		Restore accumulator
0390	28			PLP		Restore processor status
0391	60			RTS		Return from subroutine

The contents of this present-location register are then compared to the contents of a register containing the two 8-bit words representing the destination. If the two registers are equal, the tape has reached its destination, and the computer returns control to the BASIC routine. If the two registers are not equal, the routine loops back to wait for the next timing pulse.

Figure 4 shows the flowchart of the BASIC program, and listing 3 shows the BASIC program code with comments. (Only the tape-control routines are given here.) During execution the program first sets the physical location of the videotape to 0. If the cassette has not been loaded into the machine, a message is printed on the video display and the program waits until the cassette has been loaded. The program then checks to see if the tape has been rewound to the beginning; if not, it rewinds the tape. The tape is now at its beginning and the count register has been set to 0.

Next, the number representing the destination location of the desired program material is loaded into the destination register, and the present physical location is compared with the desired location. If the present

Listing 3: *Tape control routines from the Applesoft floating-point BASIC computer-aided instruction program. The routines that ask questions of students have been omitted from this listing. This program calls the machine-language subroutines of listings 1 and 2 (for the Apple), listings 4 and 5 (for the TRS-80).*

```
50    REM START
52    POKE 771,0: POKE 772,0: REM INITIALIZE COUNT REGISTER
54    X = PEEK ( - 16133): REM SAMPLE LINE CN1-7 FROM BETAMAX
56    IF X < 127 THEN GOTO 70: REM IF CASSETTE LOADED THEN GOTO 70
58    VTAB 10: REM SET VERTICAL TAB TO 10
60    PRINT "!!!!!!!!!LOAD TAPE!!!!!!!!!!"
62    GOTO 54
70    X =PEEK ( - 16137): REM SAMPLE LINE CN1-20 FROM BETAMAX
72    IF X < 127 THEN GOTO 80: REM IF TAPE REWOUND THEN GOTO 80
74    POKE - 16142,3: REM REWIND TAPE
76    GOTO 70: REM RETURN TO C IF TAPE REWOUND
80    SR=92:SP=114: REM LOAD DESTINATION COUNT
90    GOSUB 10000: REM JUMP TO CONTROLLER ROUTINE
99    END

10000 REM CONTROLLER ROUTINE
10002 R1 = 0:R2 = 0:P1 = 0:P2 = 0
10010 X = PEEK (771) + 256 * PEEK (772): REM GET ACTUAL LOCATION
10020 R1 = SR: REM DETERMINE DESTINATION COUNT
10021 R1 = R1 - 256
10022 IF R1 = 0 THEN GOTO 10030
10023 IF R1 > 0 THEN GOTO 10032
10024 IF R1 < 0 THEN GOTO 10035
10030 R2 = R2 + 1: GOTO 10090
10032 R2 = R2 + 1: GOTO 10021
10035 R1 = R1 + 256
10050 P1 = SP: REM DETERMINE NEW DESTINATION COUNT
10051 P1 = P1 - 256
10052 IF P1 = 0 THEN GOTO 10080
10053 IF P1 > 0 THEN GOTO 10082
10054 IF P1 < 0 THEN GOTO 10085
10080 P2 = P2 + 1: GOTO 10090
10082 P2 = P2 + 1: GOTO 10051
10085 P1 = P1 + 256
10090 IF X < SR THEN GOTO 10100: REM DETERMINE RELATIONSHIP OF ACTUAL COUNT TO DESTINATION COUNT
10091       REM
10092 IF X > SR THEN GOTO 10200: REM COUNT
10094 IF X = SR THEN GOTO 10300
10100 REM FAST FORWARD
10110 POKE 773,R1: POKE 774,R2
10112 POKE - 16142,2: CALL 784
10114 POKE - 16142,0
10116 GOTO 10300
10200 REM REWIND
10202 R3 = 0:R4 = 0
10210 R3 = SR + 2
10211 R3 = R3 - 256
10212 IF R3 = 0 THEN GOTO 10220
10213 IF R3 > 0 THEN GOTO 10230
10214 IF R3 < 0 THEN GOTO 10240
10220 R4 = R4 + 1: GOTO 10250
10230 R4 = R4 + 1: GOTO 10211
10240 R3 = R3 + 256
10250 POKE 773,R3: POKE 774,R4
10252 POKE -16142,3: CALL 864
10254 POKE -16142,0
10256 POKE 771,R1: POKE 772,R2
10300 REM PLAY
10310 POKE 773,P1: POKE 774,P2
10320 POKE -16142,1: CALL 784
10400 REM STOP
10410 POKE -16142,0: POKE -16142,10:RETURN
99999 END
```

physical location value is less than that of the desired location, the videocassette recorder is commanded to move the tape in fast-forward mode. The BASIC program calls the machine-language subroutine which monitors the forward motion. When the destination is reached, the machine language returns to the BASIC program.

If the present physical tape location is greater than the desired location, the Betamax is commanded to rewind, and the program jumps to the machine-language subroutine which decrements the count, monitoring the reverse motion. When the destination is reached, the machine-language routine returns to the BASIC program. If the present physical location

Text continued on page 132

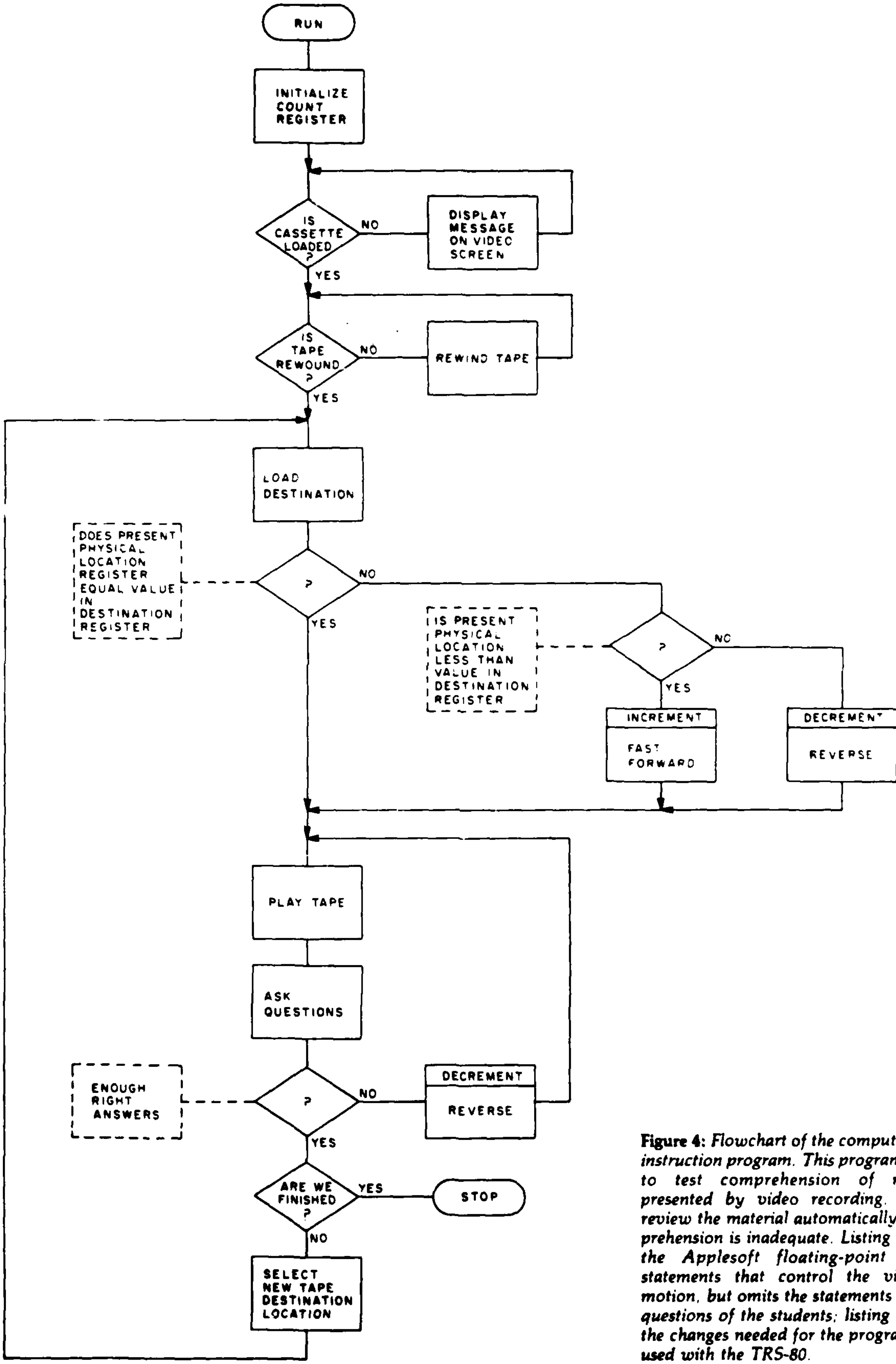


Figure 4: *Flowchart of the computer-aided instruction program. This program is used to test comprehension of material presented by video recording, and to review the material automatically if comprehension is inadequate. Listing 3 shows the Applesoft floating-point BASIC statements that control the videotape motion, but omits the statements that ask questions of the students; listing 6 shows the changes needed for the program to be used with the TRS-80.*

Betamax Pin	Signal	Source/ Destination	BASIC Command	Machine-Language Command
CN1-20	BEGINNING OF TAPE	from Betamax	PEEK(−9)	LDA $8007
CN1-7	CASSETTE IN	from Betamax	PEEK(−11)	LDA $8005
CN1-11	REWIND	to Betamax	POKE −1, 3	LDA #03 STA $8001
CN1-8	STOP	to Betamax	POKE −1, 0	LDA #00 STA $8001
CN1-13	PLAY	to Betamax	POKE −1, 1	LDA #01 STA $8001
CN1-12	FAST FORWARD	to Betamax	POKE −1, 2	LDA #02 STA $8001
CN1-15	COUNT	from Betamax	PEEK(−13)	LDA $8003

Table 2: *Videocassette recorder functions controlled through the TRS-80 interface of figure 5. The software commands necessary to activate these functions are given in both BASIC and Z80 machine-language forms.*

Listing 4: *Assembly-language subroutine for the Z80 processor. This routine, written for the TRS-80, monitors the forward motion of the videotape by counting timing pulses derived from the videotape and sent over connector pin CN1-15 of the RM-300 Auto Search control connector.*

Hexadecimal Address	Hexadecimal Code			Label	Instruction Mnemonic	Operand	Commentary
7B00	F5				PUSH	PSW	Save accumulator and processor status
7B01	3A	03	80	RESTR	LDA	$8003	Sample count line
7B04	17				RAL		Rotate bit 7 into carry
7B05	DA	01	7B		JC	RESTR	Jump if carry set
7B08	3A	02	80	AGAIN	LDA	$8003	Sample count line
7B0B	17				RAL		Rotate bit 7 into carry
7B0C	D2	08	7B		JNC	AGAIN	Jump if carry not set
7B0F	21	03	7F		LXI	H,$7F03	Load H,L registers
7B12	34				INR	M	Increment least significant 8 bits
7B13	C2	1A	7B		JNZ	AHEAD	Jump if no overflow
7B16	21	04	7F		LXI	H,$7F04	Load H,L registers
7B19	34				INR	M	Increment most significant 8 bits
7B1A	21	05	7F	AHEAD	LXI	H,$7F05	Load H,L registers
7B1D	3A	03	7F		LDA	$7F03	Load least significant 8 bits
7B20	BE				CMP	M	Compare
7B21	C2	01	7B		JNZ	RESTR	Jump if not equal
7B24	21	06	7F		LXI	H,$7F06	Load H,L registers
7B27	3A	04	7F		LDA	$7F04	Load most significant 8 bits
7B2A	BE				CMP	M	Compare
7B2B	C2	01	7B		JNZ	RESTR	Jump if not equal
7B2E	F1				POP	PSW	Restore accumulator and processor status
7B2F	C9				RET		Return

Number	Type	+5 V	GND
IC1	SN7490	5	10
IC2	SN7492	5	10
IC3	MC14512	16	8
IC4	SN7400	14	7
IC5	MC14049	1	8
IC6	MC14050	1	8
IC7	MC14514	24	12
IC8	SN7427	14	7

Text continued from page 126.
is the desired location, there is no need to move the tape and the BASIC program continues.

After the present physical tape location is made equal to the desired location, the Betamax is instructed to play, and a new value representing a new destination at the end of the instructional segment is loaded into the destination register. After the desired length of tape has been played, the tape is stopped and the program jumps to the subroutines which quiz the students on the material.

Interface Implementation — TRS-80

The concept of controlling a videocassette player with a personal computer is equally applicable to other systems such as the Radio Shack TRS-80. The TRS-80 has a number of subtle niceties such as low cost and distributed service centers which make it very popular with educators; and the existence of an external bus connector makes the design of specialized interface circuitry relatively easy. The TRS-80/Betamax combination can provide all of the educational benefits that have been discussed in the Apple/Betamax section; in addition, the TRS-80 has a bold 32-character format that makes reading text on the video monitor very easy.

Figure 5 shows the TRS-80/Betamax interface schematic. Lines CN1-20 and CN1-7 from the Betamax are sampled at the beginning of the program to ensure that the cassette has been inserted into the player and that the tape has been rewound. Once

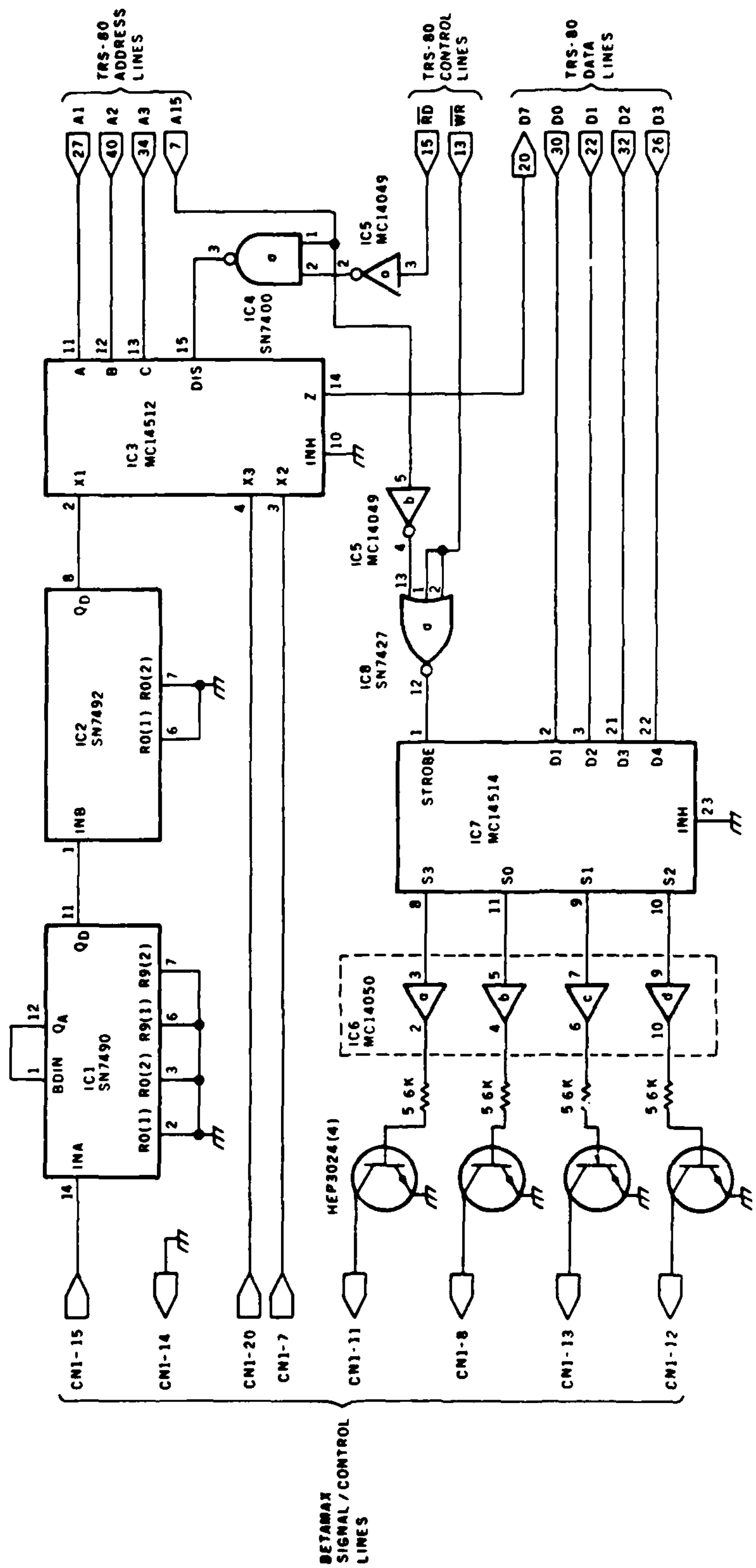


Figure 5: *Schematic diagram of the videotape control interface used to connect the TRS-80 to the Sony Betamax SLO-320 videocassette recorder. Connection to the Betamax unit is made through the RM-300 Auto Search control connector. Connection to the TRS-80 is made through the external bus connector on the rear left-hand side of the TRS-80.*

Listing 5: *Assembly-language subroutine for the Z80 processor. This routine is called from the Level II BASIC program to monitor the reverse motion of the videotape by counting timing pulses derived from the tape.*

Hexadecimal Address	Hexadecimal Code			Label	Instruction Mnemonic	Operand	Commentary
7B60	F5				PUSH	PSW	Save accumulator and processor status
7B61	3A	02	80	REST:	LDA	$8003	Sample count line
7B64	17				RAL		Rotate bit 7 into carry
7B65	DA	61	7B		JC	REST	Jump if carry set
7B68	3A	02	80	AGANE:	LDA	$8003	Sample count line
7B6B	17				RAL		Rotate bit 7 into carry
7B6C	D2	68	7B		JNC	AGANE	Jump if carry not set
7B6F	37				STC		Set carry
7B70	3A	03	7F		LDA	$7F03	Load least significant 8 bits
7B73	DE	01			SBI	01	Subtract one
7B75	32	03	7F		STA	$7F03	Store result
7B78	3A	04	7F		LDA	$7F04	Load most significant 8 bits
7B7B	DE	01			SBI	00	Subtract one if borrow occurred in previous SBI
7B7D	32	04	7F		STA	$7F04	Store result
7B80	21	05	7F		LXI	H,$7F05	Load H,L registers
7B83	3A	03	7F		LDA	$7F03	Load least significant 8 bits
7B86	BE				CMP	M	Compare
7B87	C2	61	7B		JNZ	REST	Jump if not equal
7B8A	21	06	7F		LXI	H,$7F06	Load H,L registers
7B8D	3A	04	7F		LDA	$7F04	Load most significant 8 bits
7B90	BE				CMP	M	Compare
7B91	C2	61	7B		JNZ	REST	Jump if not equal
7B94	F1				POP	PSW	Restore accumulator and processor status
7B95	C9				RET		Return

the cassette has been inserted, the tape will be automatically rewound if necessary.

Line CN1-15 from the Betamax carries the timing signal formatted onto the videotape. The signal is divided by a factor of 60 by IC1 and IC2. IC3 is an 8-channel data selector used to selectively connect line CN1-20, CN1-7, or the divided timing signal to data line seven (D7) in the TRS-80. D7 was chosen because its state can be easily tested by rotating it left into the carry bit.

Address line A15 from the TRS-80 is not normally used because of memory size restrictions. It was therefore pressed into service to provide a signal line for addressing the interface board. IC7 is a 4-to-16 line decoder latch that is used to selectively turn on one of the four transistors, causing the Betamax to either play, rewind, fast forward, or stop. Table 2 shows the Betamax pin connections and the function that will be accessed for a given BASIC statement or a given machine-language command.

Listing 6: *Modifications of listing 3 needed to create a tape control Level II BASIC computer-aided instruction program for the TRS-80. The lines in this listing should replace their counterparts in listing 3 to create a program that will run on the TRS-80 and its associated interface board.*

```
52      POKE 32515,0: POKE 32516,0: REM INIT COUNT REGISTER
54      X=PEEK(-11): REM INITIALIZE COUNT REGISTER
70      X=PEEK(-9): REM SAMPLE LINE CN1-20 FROM BETAMAX
74      POKE (-1,3): REM REWIND TAPE
76      GOTO 70: REM RETURN TO SEE IF TAPE REWOUND
99      END

10010   X=PEEK(32515)+256*PEEK(32516): REM GET ACTUAL LOCATION
10110   POKE 32517,R1: POKE 32518,R2: POKE -1,2
10112   POKE 16526,0: POKE 16527,123: X=USR(0)
10114   POKE -1,0
10250   POKE 32517,R3: POKE 32518,R4: -1,3
10252   POKE 16526,96: POKE 16527,123: X=USR(0)
10254   POKE -1,0
10256   POKE 32515,R1: POKE 32516,R2
10310   POKE 32517,P1: POKE 32518,P2: POKE -1,1
10320   POKE 16526,0: POKE 16527,123: X=USR(0)
10410   POKE -1,0: POKE -1,14: RETURN
```

The software used by the TRS-80 is virtually identical in design to that of the Apple. Figures 2 and 3 are still valid as flowcharts for the routines that position the videotape during forward and backward tape movement, respectively. The implementation of these routines in Z80 machine code (designed specifically for the TRS-80) are in listings 4 and 5, respectively.

The BASIC driver program, given in figure 4 (flowchart) and listing 3, is valid as written for the TRS-80, with the exception of lines containing the PEEKs and POKEs specific to the TRS-80 interface (see table 2). The BASIC program for the TRS-80 is obtained by substituting the lines given in listing 6 for their counterparts in listing 3.

User Reaction

Initial response to the system has been enthusiastic. Since immediate feedback is an important part of an educational experience, it is expected that the system will enhance retention and understanding. At present, lectures and program materials for medical students are being generated for use in the College of Osteopathic Medicine. Upon completion of the material, experiments will be conducted to see if the system does enhance learning capabilities.■