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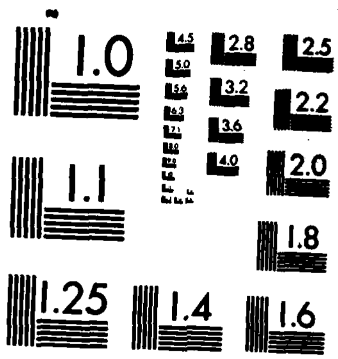
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NAVAL POSTGRADUATE SCHOOL

Monterey, California

THESIS

A SURVEY OF VIDEODISC TECHNOLOGY

by

Charles William Davis

December 1985

Thesis Advisor: W. M. Woods

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A Survey of Videodisc Technology

by

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requirements for the degree of

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ABSTRACT

In today's computer-based military environment the interactive videodisc offers a means to an efficient education and training system. It allows interactive instruction capable of responding to individual needs. Interactive videodisc also has potential as a mass storage and retrieval system accommodating complete catalogs of printed material. This thesis focuses on a number of studies completed on this new technology.

TABLE OF CONTENTS

I. INTRODUCTION

In today's computer based military environment there is a growing need for more efficient education and training systems. Two factors which have limited the growth of military education and training, are the scarcity of qualified instructors and the high costs of transporting and housing students. Past attempts to cut training costs included the development of self-instructional teaching systems including films, video tapes, slides and programmed texts. These systems were self-paced in an attempt to conform with each individual student's abilities.

The fusion of the microcomputer with the videodisc, has potential in military applications. This new technology appears to have potential to develop more efficient and economical training systems. Video is already widely recognized by management as an extremely powerful communication medium. Its power has been greatly enhanced by the interactive videodisc. It allows interactive instruction capable of responding to individual needs. Interactive videodisc systems have the capability to respond to student questions by explaining difficult material, giving additional examples, correcting mistakes, and by providing guidance. Aircraft maintenance can be enhanced by a videodisc system. Several jobs are done at the same time, with several people having different questions pertaining to their particular jobs. Each can refer to an interactive video manual kept on the hangar floor. Each person can use the system to assist him with his job. In interactive video, the computer program controls the video program, and the user, controls them both. Information can be retrieved from any place within the recording and shown at any point in the final program. The user can control both the speed and direction in which the video program runs.

This new technology has major potential, not only in training and education but also in applications involving information storage and retrieval. As a storage device, a single videodisc can accommodate a complete catalog and associated manuscripts, printed documents, microfilm, photographs and even films. Some discs can record both analogue and digital information. Low cost, high performance optical videodiscs let microcomputer users obtain the reliable high volume data access found in today's mainframe environment.

A number of studies have been completed dealing with this new technology. They include both technical and benefit analysis furnished by independent agencies. They have been sponsored by the military services. This thesis will focus on this literature and other selected articles about interactive video as learning systems in education and mass storage devices.

Educational applications for interactive video are increasing rapidly. These systems are being used by hospitals, businesses, schools, and large industrial firms. The purpose of this thesis will be to summarize some of the current literature in this field.

II. BACKGROUND

The videodisc has a long history. Its beginnings can be traced back as far as 1800 when Paul Gipkow received the first videodisc patent in Germany. During the same time period, Alexander Graham Bell produced an optically recorded 12 inch audio disc. He licensed it to Thomas Edison, who was in the process of producing the wax-cylinder audio player. Edison founded Westrix in order to develop the talking movies by matching the length of each film reel to a 12-inch audio disc, which was spun at 33 1/2 revolutions per minute (RPM). (Jarvis, 1984)

In the early 1920s England's John Logie Baird invented the mechanical scanning system. This television type of system used a 12-inch pressed waxed audiodisc containing a video test signal that was used daily for TV adjustments. The British Broadcasting Corporation (BBC) soon improved on the scanner with an electronic scanner television system. (Jarvis, 1984.

By the early 1940s the Germans were using a magnetic audio-recording technology in its radio stations. This was the forerunner of the audio and video tape. After World War II the Ampex Corporation began developing both videotape and audio recorders in the United States using this technology.

The videodisc we know today is a hybrid of the above technology. The 3M Corporation developed the first modern videodisc system in 1962. This system used a silver-halide media read optically with a light bulb.

The concept of computing was first developed in the 1830s by Charles Babbage with his huge mechanical calculator called the Difference Engine. This device was not successful in a practical sense because of the technology of the day. It was impossible to create parts with the fine tolerances needed. The device did prove that large numbers could be calculated automatically, with complex mathematical procedures. Babbage's design was remarkably similar to today's computers. (Jarvis, 1984)

It wasn't until the 1930s that electromechanical components, such as the telephone relay switches, became available for work to begin on the electromechanical calculator. Kanrod Zuse built a machine that operated not on the Arabic/decimal language of expressing numbers, but on a language called the binary code. In this language there are only two symbols, Ø and 1. By combining them in varying sequence it is possible to express any number or letter. Zuse's computer had thousands of telephone relay switches, each with a two switch position, open or closed (On or Off) switch. (Jarvis, 1984; Parsloe, 1984)

Alan Turing used this new language to build a machine that could be programmed to do one task and then be reprogrammed to do another in the early 1940s. Due to the second world war his contributions to the computer were just coming to light. During the 1930s the Germans developed a machine for coding military messages called Enigma. Enigma was a mechanical device of wheels and wires which randomized letters fed into it. The sender would set up a certain pattern on the machine, enter each letter of the message and note the random letters provided by the machine. Turing's computer (Colossus), using vacuum tubes instead of telephone relays, was used to break these random letter codes. After nine versions of Colossus were built and by wars end the British were able to unscramble German secret codes in a matter of a few minutes.

By the mid 1940s vacuum tube computers began to appear. Some filled entire rooms, weighing up to 30 tons, and broke down often from their own heat.

The transistor was developed in 1947 and computers were miniaturized, and then miniaturized again with the development of the Silicon Chip. This chip contained thousands of transistors linked together into a circuit, usually no larger than a quarter of an inch square. The Silicon Chip is capable of storing, switching and transforming pulses of electric ity and performing millions of operations a second. Today's microprocessor usually consists of upward of eighteen thousand individual transistor elements. Today's microcomputers consist of five separate units, linked together: the input device, arithmetic/logic circuit, control unit, memory, and a system for output.

Microcomputers are capable of branching but do not have nearly as much capability for video storage as the videodisc.

A dual sided, double density $5\frac{1}{4}$" microcomputer floppy disc holds about five million bits of information. This only gives it enough capacity to store about 12 images with similar quality to the videodisc. At a playback speed of 30 frames per second the entire floppy can store only 0.4 seconds of real time video. Videodiscs, on the other hand, are capable of storing up to an hour of real time video or some 108,000 still frame pictures each of which can be randomly accessed within a few seconds. The combination of technologies whereby the videodisc is used to store images and the microcomputer is used as an interactive and management tool, makes for a powerful teaching system.

General Motors was the first large scale user of the optical videodisc technology in the U.S. By 1979 GM had installed some 11,000 Pioneer educational/industrial players in their automobile dealerships. These first machines were used primarily as point of sale demonstrations for new car models. These were later used to teach salesmen about the many features of the cars. One audio track on these discs is in Spanish and the other in English. (Tayler, 1983)

Chrysler Corporation soon hopes to introduce an automotive navigational system which will allow motorists to find their location anywhere within the country. A laserdisc system is used to store over 13,000 road maps covering the United States in seven different sizes. Signals are received from NAVSTAR and processed by an in-car system that allows the vehicle to be displayed on a map to within 300 feet of its actual location.

The military has also shown a great interest in the interactive videodisc technology. They have been especially interested in the area of simulators. One such simulator is the Videodisc Interpersonal Skills Training and Assessment (VISTA). VISTA was installed at Fort Benning, Georgia, as part of the Infantry Officer Basic Course.

Perhaps the best known simulator application was the ASPEN disc produced by the Massachusetts Institute of Technology. This disc is a simulation of a ride through the streets, with the choices of turns at intersections and a capability for retrieving information about buildings and habitants while progressing. This application of videodisc usage is called surrogate travel. The military is interested in this application for orientation of troops prior to entry into foreign areas.

Videodisc usage in the public educational system began to take hold in 1983. There have been a number of projects that brought the videodisc into active classroom use. One of the largest of these is the WICAT Biology disc. The "Development of Living Things" disc allows students to perform simulated laboratory experiments without any of the usual laboratory equipment. The Nebraska Videodisc Group is currently producing a videodisc similar to WICATS dealing with chemistry and physics. (Heines, 1983)

With the availability of reliable optical videodisc players and high quality mastering and replications, many companies are now using videodiscs for education, training simulations, and archival storage applications. The University of Wisconsin reports that one out of every five elementary and secondary schools in the United States now has or is planning to acquire a videodisc player.

Other current large scale users of interactive videodiscs for education and training include:

* The State of Florida for welfare case worker training. New case workers receive all of their basic training from the system. Trainees are presented with a series of quizzes at the end of each unit of instruction.

* The Walt Disney EPCOT Amusement Park in Orlando, Florida uses a series of kioshs integrated into an interactive videodisc information center.

* Archival institutions from the Library of Congress to the Boston Museum of Fine Art where videodisc are used for archival storage of documents.

* IBM uses videodisc in over 180 branch offices where they are used both as a presentation tool and to provide reference material. IBM is also currently working on a videodisc project as a direct training tool for maintenance of their computers.

A. TYPES OF VIDEO SYSTEMS

Videodisc systems use either laser/optical or capacitance (stylus) technology. Each type has a different degree of interactivity.

The Laser/Optical disc is a highly advanced version of the punched card principle. This type of system comes in two types: CONSTANT ANGULAR VELOCITY (CAV) and CONSTANT

LINEAR VELOCITY (CLV). Only the CAV discs are interactive. The major difference between CAV and CLV systems lies in the number of video frames embedded in each track. In the CVA disc system each video frame is embedded in a separate 360 degree track. Each track consists of a row of micropits (each micropit is 0.6 micron wide and an average of 1.2 microns long) that is burned into the surface of the master disc by a laser beam rapidly firing in an on-off binary code.

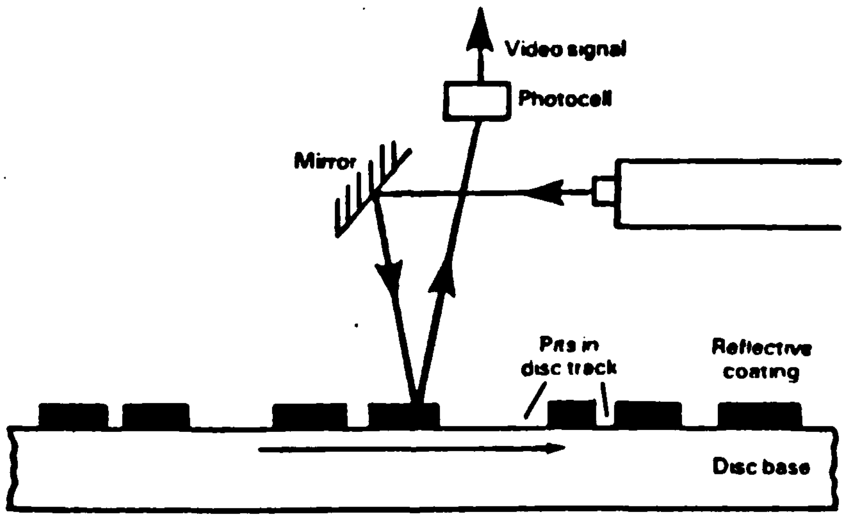


Figure 2.1 The Optical Videodisc System

Each track can store the 400,000 plus bits of digital information that are needed to create a single video image. Each disc can hold up to 54,000 still video images or 150 megabytes to 4 gigabytes of digital data. Because each frame begins at the same place on the track, the player can easily move from one track to another to give random access capability. The CLV disc system has more frames on the outer track than on the inner tracks. Because the frames do not begin along the same radius the machine can not identify any given frame. This makes random access and freeze frame impossible. This type of system has more frames per disc, so it is better suited for showing full length films rather than interactive instruction. (Currier, 1983; Jarvis, 1984; and Parsloe, 1984)

As the disc revolves on the turntable the laser is alternately reflected by the laminated plastic disc's polished aluminum skin or absorbed by the darker interior of the micropit. These rapid changes in the intensity of the reflected laser beam constitute the digitized video signal, which is then converted to the RF-modulated signal accepted by a standard television receiver. (Currier, 1983) With the use of lasers there is no physical contact between the pickup device and the disc surface. This is important because there is no wear what-so-ever as there is on the CEC systems. A laser system can display a single still frame without any wear on the disc, unlike a video tape where the video frame is damaged if played for a few minutes.

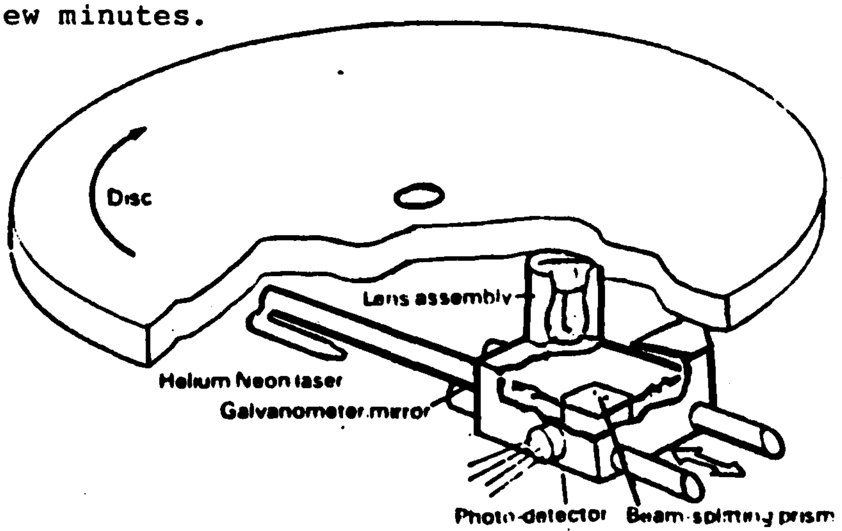


Figure 2.2 Laser Disc Assembly

Another feature of the video disc is that the signal carries two audio programs. Thus each lesson can be done in more than one language, such as Spanish on one track and English on the other as stated in the GM example above.

STYLUS VIDEO system comes in two types: Capacitance Electronic Disc (CED) and Very High Density Discs (VHD).

The Capacitance Electronic Disc (CED) system was actively marketed by RCA from 1981 to mid 1984. The CED video signal is embedded in tens of thousands of grooves 1/38 the width found on LP records. This disc is read by a diamond stylus that acts similar to a phonograph needle. The CED discs have longer playing times than do laser/optical and can store more images per disc. One of the major drawbacks of the CED disc is that with repeated play they become scratched and tend to skip. The CED is the least interactive of the three disc systems. (Currier, 1983)

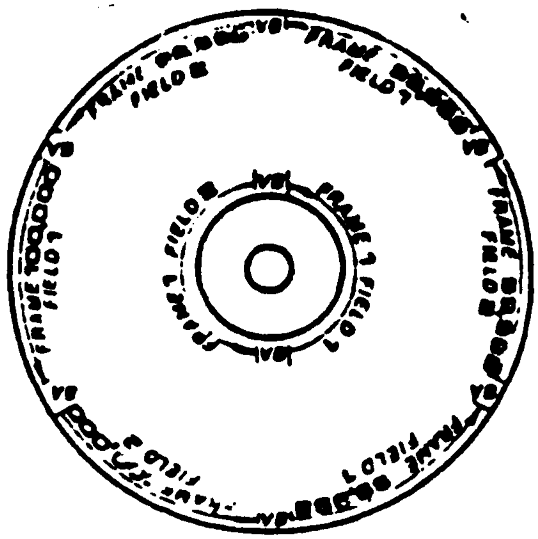
The CED disc contains not one but four video frames on each 360 degree track. For a single still frame to properly project there must be four identical video frames on the same track, so that the image does not flicker or jitter as the disc revolves. Consequently, still frame material cannot be played as freeze frames. In addition random access search times (worst case is 30 seconds) are much slower than in industrial CVA laser systems (5 seconds). (Currier, 1983)

VHD is very similar to the CED system, but instead of grooves the VHDs have micropits recorded spirally from the edge to the center of the disc. These pits consist of two kinds. The first type of pits holds the content information, such as video and audio single and the second type holds the data to control the stylus. Because the stylus moves freely over the disc as it spins at 900 RPM the system has greater interactivity and longer life than the CED system.

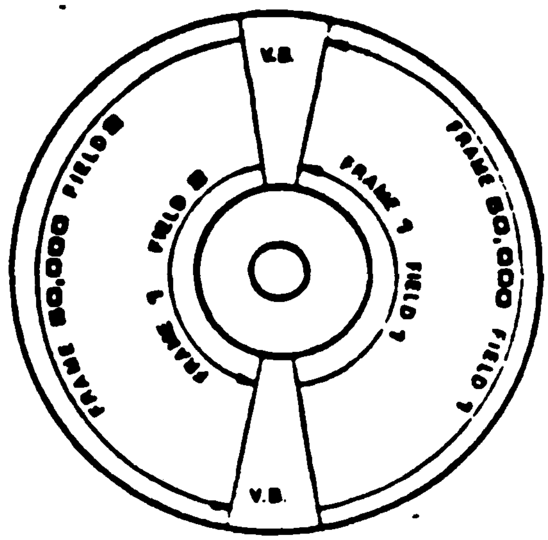
B. OPTICAL IS BETTER FOR RANDOM ACCESS

In the commercial market, because of the video game boom, optical disc are doing very well. "Dragon's Lair" by Cinematronics Corporation is one such game. More than 7,000 games were sold in the first month alone. According to several arcade owners a machine costing $4,000 in 1984 pays for itself in four or five weeks. Other games doing quite well are "Astron Belt" by Sega Enterprises and "Eon and the Time Tunnel" by Laser Disc Computer Games. (Lovece, 1985)

Pioneer video sold its entire plant capacity from February 1984 to June of the same year to arcade companies and plans to increase its output form 25,000 to 40,000 machines per month. Sony and Phillips Corporation have been expanding their laser video market, while RCA dropped it's CEDs. RCA's major problem seemed to have been in its machine's slow random access speed, up to 30 seconds for a full scan as opposed to the optical disc's time of less than five seconds.



Constant Linear Velocity
(CLV) Videodisc Format



Constant Angular Velocity
(CAV) Videodisc Format

Figure 2.3 Constant Linear Velocity vs. Constant Angular Velocity

All this activity has increased consumer interest in the next generation of videodisc players. Up to mid 1983 there was no ability to record on videodiscs.

Panasonic is marketing its optical memory disc recorder (OMDR),TQ-2022FC, which has the ability to record once. This machine is made for industrial use. It records and plays back movies without processing and accesses any frame on the disc in less than half a second. The TQ-2022FC is selling for between $35,000 to $200,000 (January 1984) and each blank disc costs several hundred dollars. The Japan Broadcasting Corporation has developed a disc that can be erased and re-recorded.

Another recordable disc system (not yet available) is manufactured by McDonnell Douglas and will consist of a player, recorder and duplicator. The system will use a photographic film medium. These systems will dramatically decrease the present cost to producing the master disc discussed later in this thesis. (Freiberger, 1984)

TABLE 1

VIDEODISC FORMATS AVAILABLE AS OF JUNE 1984

TYPE	Speed RPM	NTSC Images	Speed RPM	Capacity in Min.	Technology Pickup	Technology Disc
CED	450	27000	377	75	Capacitive	Grooved
LV	1800	45000	1500	30	Optical	Reflective
VHD	900	45000	750	60	Capacitive	Grooveless
OMDR	1800	-----	---	--	Optical	Recordable

Table 1 shows the Videodisc formats available in the current market. A list of current manufacturers and phone numbers can be found in Appendix A.

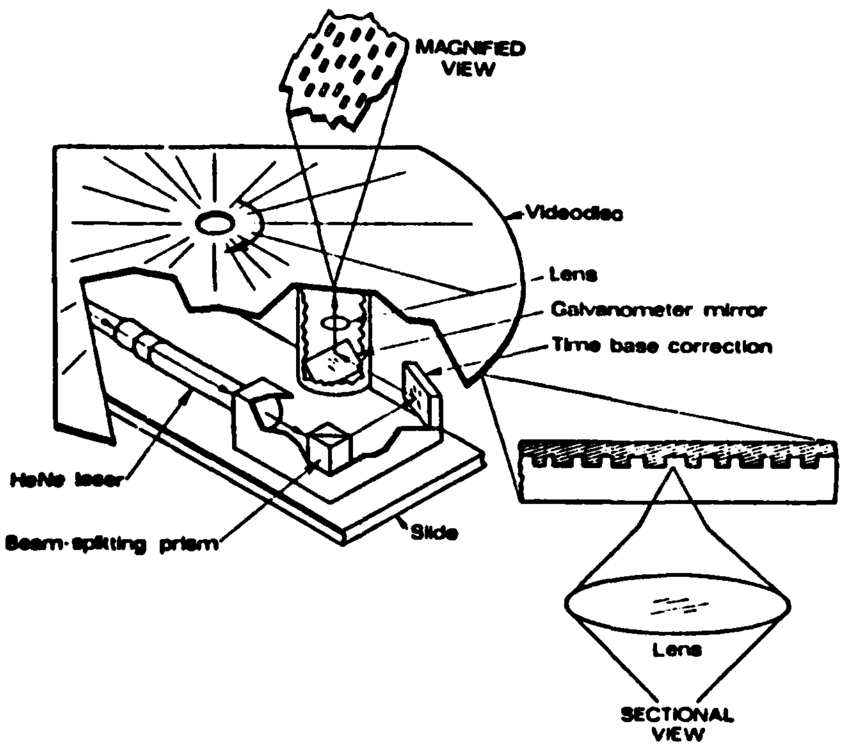


Figure 2.4 The Optical (Laser) Videodisc System

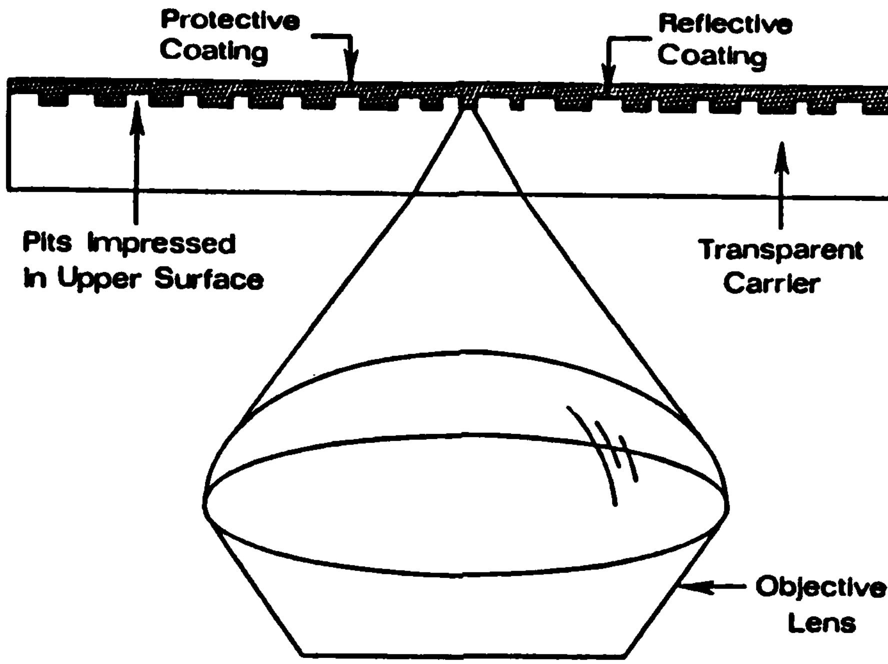


Figure 2.5 Optical Videodisc

C. INTERACTIVITY

The key advantage of interactive video is its ability to respond to the user. For example the student may select the sections of a lesson he wants to study or he may choose to go directly to the test at the end of the lesson. This is not the case in traditional instruction where material is presented in the same order to every student (Linear Programming, Figure 2.6). (Currier, 1983)

Watching videotapes or listening to lectures, the student usually plays the role of a passive observer. This is known to be a less effective method of learning than interactive participation that requires practice and provides feedback.

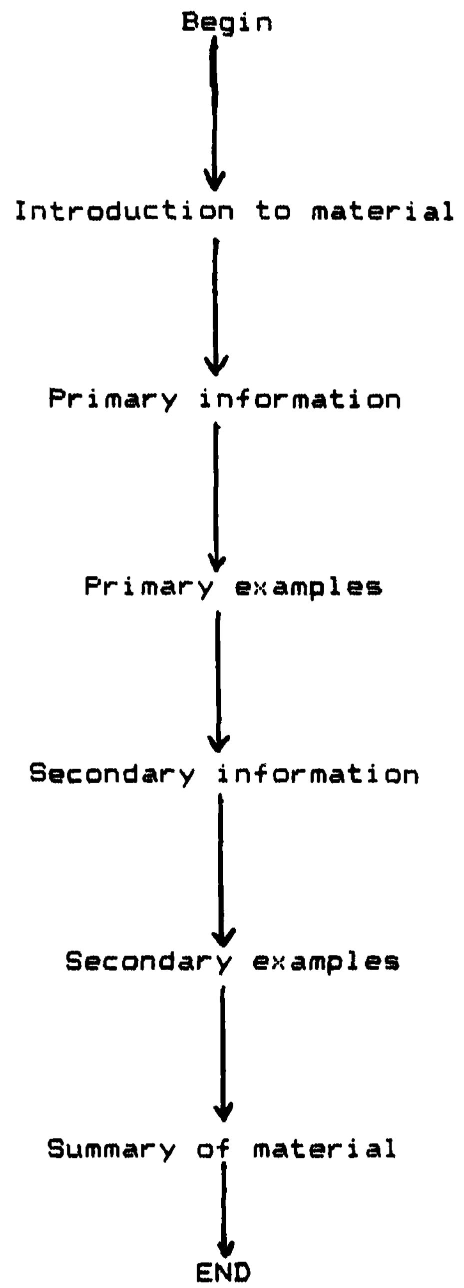
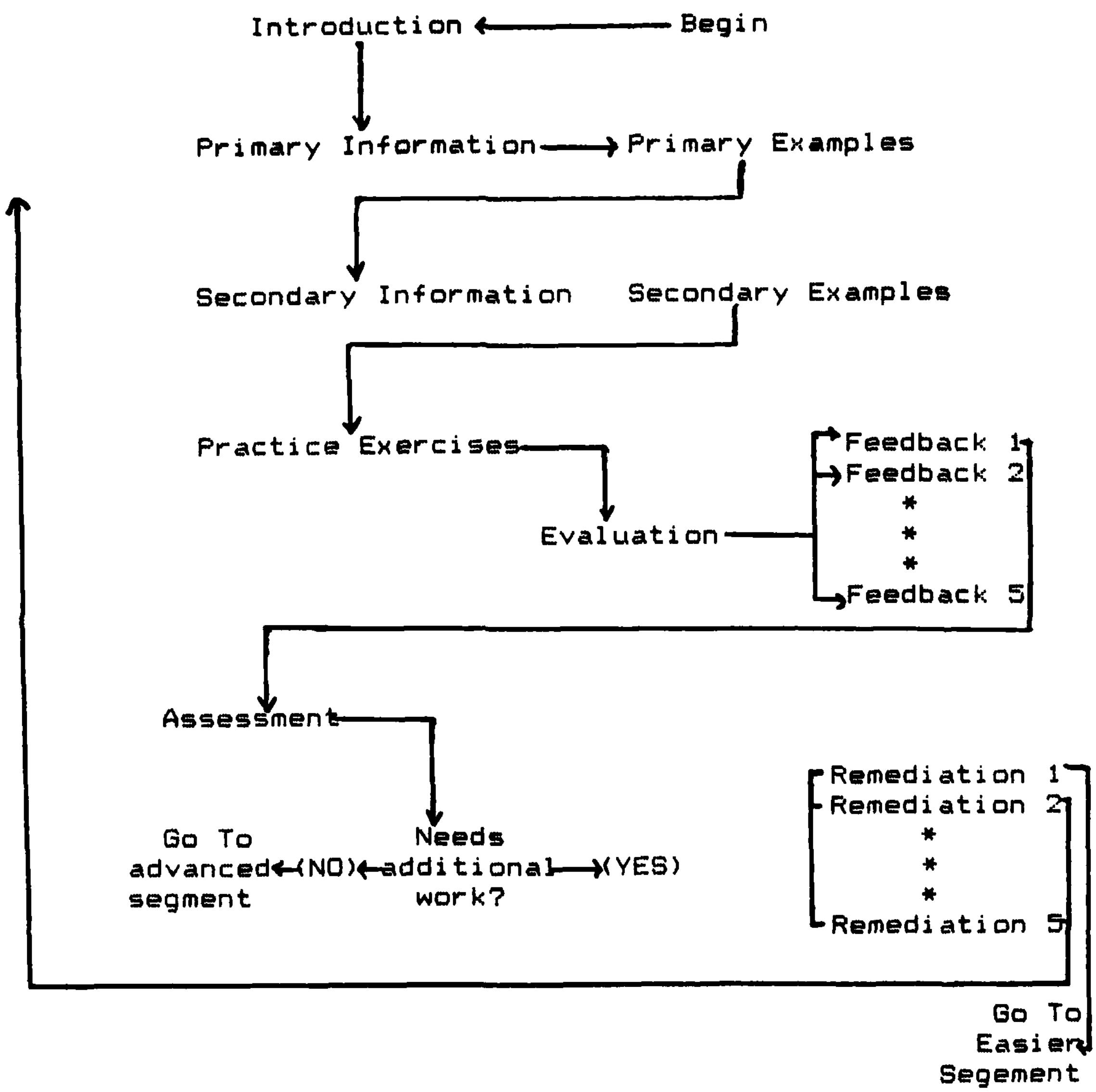


Figure 2.6 Linear Programming

In order to make the learning process interactive, designers have used a technique known as branching. Branching provides the student with alternative routes through the lesson (Figure 2.7). Each student is able to learn from his mistakes and can progress at his own pace and see the material he needs or wants to see.

The Nebraska Videodisc Group has defined the following four levels of interactivity, based on each systems capabilities, in which all videodisc systems fall: (Jarvis, 1984)

> LEVEL ZERO is made up of consumer players capable of straight, linear play only. The RCA CED system falls into this category as would most consumer players for home use.
>
> LEVEL ONE systems consist of a video player and a monitor. Home videodisc players with small internal microprocessors that are capable of direct, random access, automatic play to a designated point, automatic search (chapter stop) and variable rates of motions fall into this category. The player may be of the Laser/Optical type such as the pioneer laserdisc. There is little interactivity in these systems. The discs themselves may contain the embedded codes that allow the running program to stop at a defined place and wait for an input from the user or allow him to search for a particular "chapter" and begin play.
>
> LEVEL TWO systems consist of a monitor, educational/industrail videodisc player with either an internal or external controller. These players have a built in microprocessor to increase the interactivity of the system. These systems can run fairly sophisticated interactive programs and are capable of branching. The computer program is stored on one of the disc's audio tracks in one or more "program dumps" which are loaded into the player's random access memory as needed. This system does not contain full function microcomputers and RAM rarely exceeds 1K bytes.
>
> LEVEL THREE systems use a random access videodisc player controlled by a separate microcomputer and any number of other peripherals. This is the interactive technology of choice. These systems can handle highly sophisticated interactive programs, including simulations, movies, and



AN INTERACTIVE PROGRAM CONTAINS BRANCHING THAT ALLOWS THE STUDENT TO MAKE CHOICES.

Figure 2.7 Interactive Programming (Branching) maps. The program code is stored on a floppy disk that is read by the computer. The videodisc can be relatively simple, needing neither embedded codes nor program dumps. All the necessary intelligence is provided by the microcomputer, which searches for the specified frames and sequences and displays them in the order, and at the speed required. Computer generated graphics overlays can be added over the video images in level 3 systems.

Examples of levels one through three can be seen in Figure 2.8.

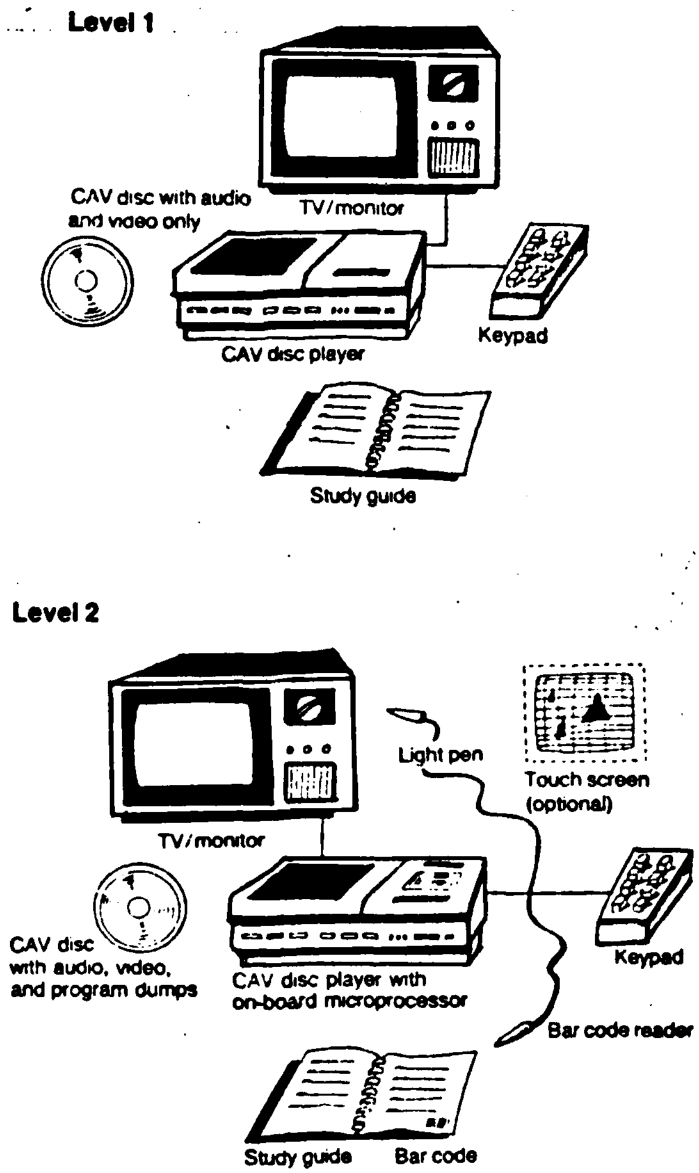


Figure 2.8 Three Types of Interactive Videodisc System Produce a Range of Interactivity from Simple to Sophisticated

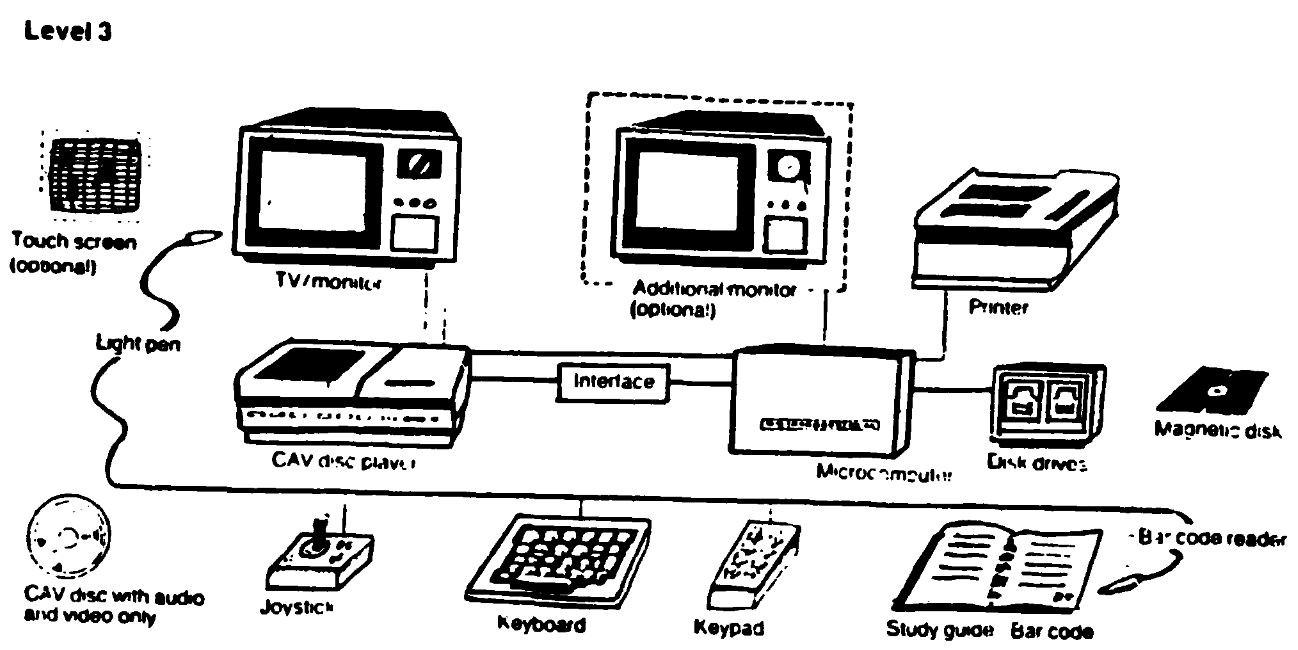


Figure 2.8 (cont'd)

D. COSTS

In general, videodisc system hardware is relatively inexpensive. The cost of systems that are currently on the market can be seen in Table 2.2. The major cost as in all computer systems are the software costs, i.e., the design, development and production of videodiscs, authoring, mastering videodisc instruction and maintaining an on-line intelligent videodisc system. The key to making such a system cost-efficient is selling enough copies to cover the fixed cost involved with it. No other interactive instructional system that provides motion, color, and audio is capable of operation at such low costs. The flexibility in scheduling and location plus the high quality of instruction and low cost may permit this technology to have a great impact on the military and educational environment in the near future.

E. THE FUTURE OF VIDEODISCS

There are several recent developments that will enhance and extend the capabilities of the videodisc systems in the future. Some of these include compressed audio, computer overlays, and direct read and write capabilities. The videodisc will likely become one of the important media of the eighties.

TABLE 2.2

VIDEODISCS CURRENTLY ON THE MARKET THAT INCLUDE A COMPUTER INTERFACE CAPABILITY AS OF JULY 1984

MODEL	PRICE	WORST ACCESS TIME	COMPUTER PORT TYPE
Hitachi			
8500	$1200	6 sec	RS-232C
9500	$1600	3 sec	RS-232C
Magnavox			
8010	$800	17 sec	CAT plug
Philips			
VP832	$1400	5 sec	RS-232C
Pioneer			
LD1100	$800	17 sec	CAT plug
LD 700	$800	12 sec	serial 8-pin DIN
LDV1000	$1200	3 sec	parallel 24-pin
LDV4000	$900	12 sec	serial 8-pin DIN
PR8210	$950	17 sec	CAT miniplug
LVD6000	$1600	3 sec	
Sony			
LDP1000A	$2500	3 sec	RS-232C
Lasermax	$600	12 sec	serial
SYLVANIA			
VP7200	$800	17 sec	CAT plug
Panasonic			
TQ2020	$18900	0.5 sec	RS-232C
TQ2021	$18900	0.5 sec	RS-232C
TQ2022	$24900	0.5 sec	RS-232C
TQ2023	$34900	0.5 sec	RS-232C
TQ2024	$2985	0.5 sec	RS-232C

III. VIDEODISC PRODUCTION

Designing and producing an interactive video disc is similar to writing, producing and directing a motion picture. Both media are layered with various steps of planning, production, and review; but each has its own unique considerations. For example, in videodisc production one must consider the use of computer software and the participation of the user. It consists of a combination of several different media that are combined to create an efficient learning tool.

To create a successful interactive videodisc one must keep in mind the end product. Several experts, such as designers, video producers and computer programmers are usually a part of the process. They provide expertise in their given areas. An example of this interaction in the design process is the need for good system software to take advantage of user interaction.

Several models have been developed to aid production staffs in the development of a good delivery system. The Army has developed a course in which they present a "how to" workshop for interactive videodisc authoring and production. This project was completed by the US Army Research Institute in Alexandria, Virginia. The workshop was developed from experience gained in projects that the Army and its contractors had completed in the past. One model is the

Interservices Procedures for Instructional System Development (IPISD). It is composed of five major phases. They are: (Wicat, 1979)

1. Analysis
2. Design
3. Development
4. Implementation
5. Control

The IPISD model provides the framework for monitoring progress and managing the overall development effort.

Each phase has specific activities that take place within its confines. Each activity flows into the next, as illustrated by the arrows presented in Figure 3.1. An example of the entire process can be seen in Figure 3.2. As can be seen, several of the steps overlap as the process is completed.

The workshop is based on six lessons or modules, from the workbook Interactive Videodisc Design And Production, in which the process of developing interactive videodisc can be completed.

A. MAJOR PHASES

It is assumed by the workbook that the person utilizing it is already familiar with the instructional development process. The six lessons presented are:

1. Project Planning
2. Authoring

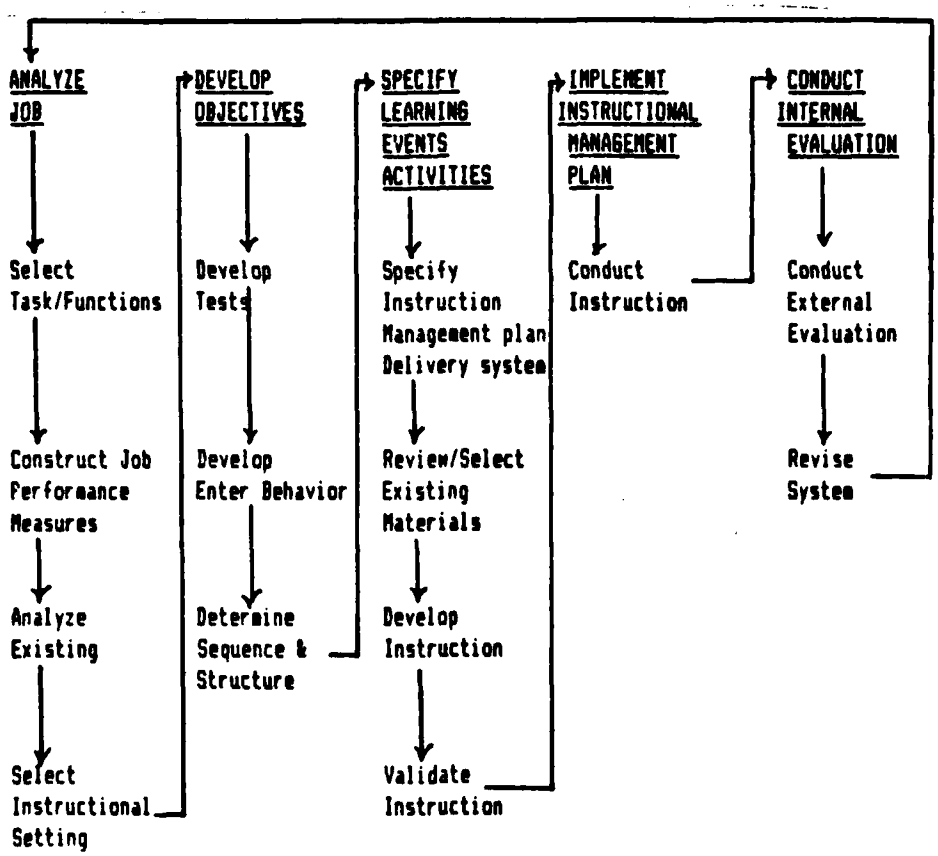


Figure 3.1 Specific Activities in the Major Phases

3. Pre-production

4. Production

5. Post-Production/Pre-Mastering

6. Mastering

The major tasks that are encountered in these stages are as follows. (U.S. Army Training Development Institute, 1981)

1. Project Planning

* Analysis and planning to determine strategies

* Selection of audio and visual materials

* Review of delivery system

The Project Planning stage provides a finalized set of materials and documents as raw material for the authoring

Production Sheet No.____

Lesson______Segment___SMPTE ( ) __ __ __ __ to __ __ __ __

Char. Gen. Cartridge ___ Page ___

Estimated Time (seconds) ________

GRAPHICS__________________________Art__Photo__Prop__No.__

VIDEO______Still__Motion ( ) __ __ __ __to __ __ __ __

CHARACTER GENERATOR____________External__Text__Animation__

STUDIO______________Highlight__Splite/Wipe__Quad__Window__

PROGRAM _________________Stop__Pause__Computer Generated__

Calc. Videodisc Frame No.___Actual Videodisc Frame No.___

AUDIO

1: ____

2: ____

Figure 3.2 Sample Production Sheet

stages. The members of the development team must consider the needs of the client and the targeted audience must be identified.

2. Authoring

* Design the course map
* Draft the storyboard
* Tryout of the lesson
* Reviewing the presentation

The major product in this stage is the storyboard. This is one of the most time consuming parts of the entire process. Videodiscs need more than the "conventional" storyboards. A production sheet is used. It carries not only the main message line but also the graphics, audio and information regarding computer branching directions, as well as answering processing instructions and specification for the computer generated display if any exist. An example of a production sheet is shown in diagram 3.2.

3. Pre-Production

* Prepare production list
* Complete specifications for all audio and visual materials will be finalized
* Select the talent
* Layout the disc geography

4. Production

* Actual Production of audio, video, and graphic materials
* Programming of special functions that are required in the lesson

At the conclusion of this stage all the source material must be completed.

5. <u>Post-Production/Pre-Mastering</u>

* Film transfers
* Edition master tapes
* Review and approve the master videotape
* Code the videotape

The final output of this stage is an edited and approved videotape and a master videodisc-coded master tape.

6. <u>Mastering</u>

* Actual mastering of the interactive videodisc

The master disc is a polished plate glass, .24 inches thick and seven inches in radius, coated with a thin metal film. The steps used in making the master disc are seen in Figure 3.3. Interactive videodisc mastering is not an exact

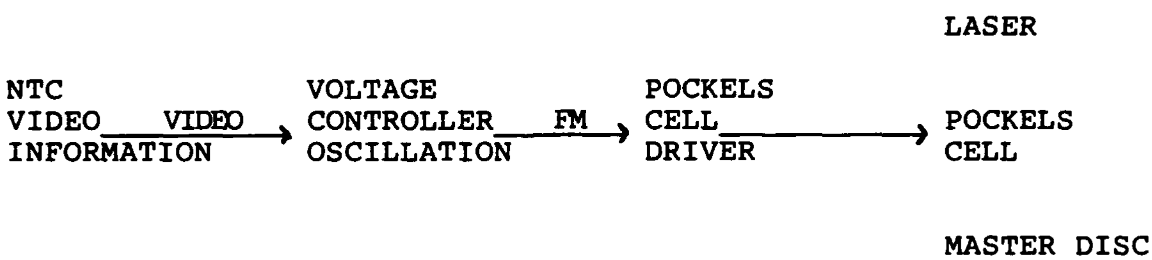


Figure 3.3 The Making of a Master Disc

science, thus it may take from six to twelve weeks for the initial mastering.

The master Disc is used to make a "STAMPER" disc from which replicas are made. Replicas are ususally made from an acrylic compound and are made by a process very similar to that used in the production of audio records. The plastic disc has a reflective aluminum film coated by a transparent plastic. The finish disc is only .04 inches thick and 12 inches in diameter. The cost for the material used is less than 15 cents per half hour disc.

While the cost of replicated copies is low, the cost of collecting and preparing information is the majority of the total cost. This high cost can be lowered somewhat by doing this type of work within the structure of the Department of Defense. Several locations would be well suited for this purpose such as the audio visual studio at Moffett Field in California which produces several films a year. (Witt and Galloway, 1982)

Another model for mastering videodiscs was developed along the same lines as the Army's, the Interactive Editing System (IES). This model was developed by The Video Production Group in the Office of Science and Technology at the University of Nebraska. This group developed an experimental flight-training program that used a realistic visual database to simulate flight. The system consisted of a videodisc player and TRS-80 Model III computer. It provided a text overlay that was used to plot the running distances between the airstrip and the aircraft and provided some additional instrumentation data. The Interactive Editing System was used to produce the instructional material used in the simulation program. The requirements for an IES include a read-write capability, rapid-frame access, broadcast quality, the ability to re-edit, simulation capabilities, and probability. A computer is used from the design process right up to the finished product.

The current IES system is based on a Bosh BCN-50, a one inch helical VTR, and is controlled by an 8080 microprocessor.

Figure 3.4 shows the production steps that were required to design, develop and produce the flight simulation videodisc. Each step will vary in length and complexity but many will overlap. The most critical stage is at the beginning of the process when the goals and objectives for the videodisc program are outlined. The interaction of the client is important throughout the process, as it is at the beginning to make for a successful endeavor. (Daynes, 1982)

Playback of the disc is shown in Figure 3.5. This process is basically the reverse of the recording process, Figure 3.3. The disc rotates at 30 RPM while the optical system is used to focus a low power helium neon laser beam on the disc.

The final step in the process provides the student pilot with visual display of the landing strip (through the propeller's arc) and a full range of instruments. After each landing, the system allows the student a view of the landing from various locations throughout the landing pattern and the field. (Daynes, 1982)

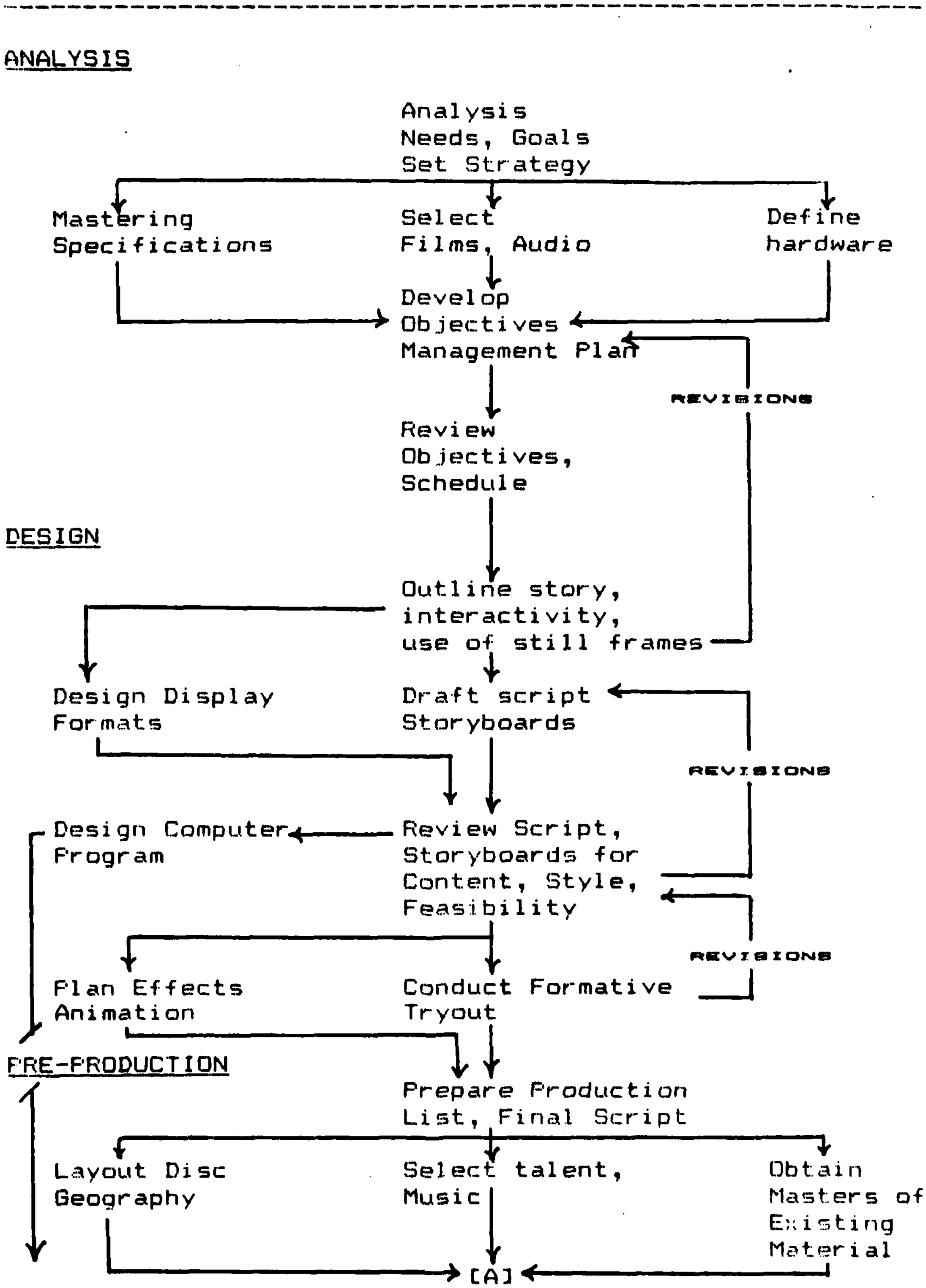


Figure 3.4 Videodisc Design and Production

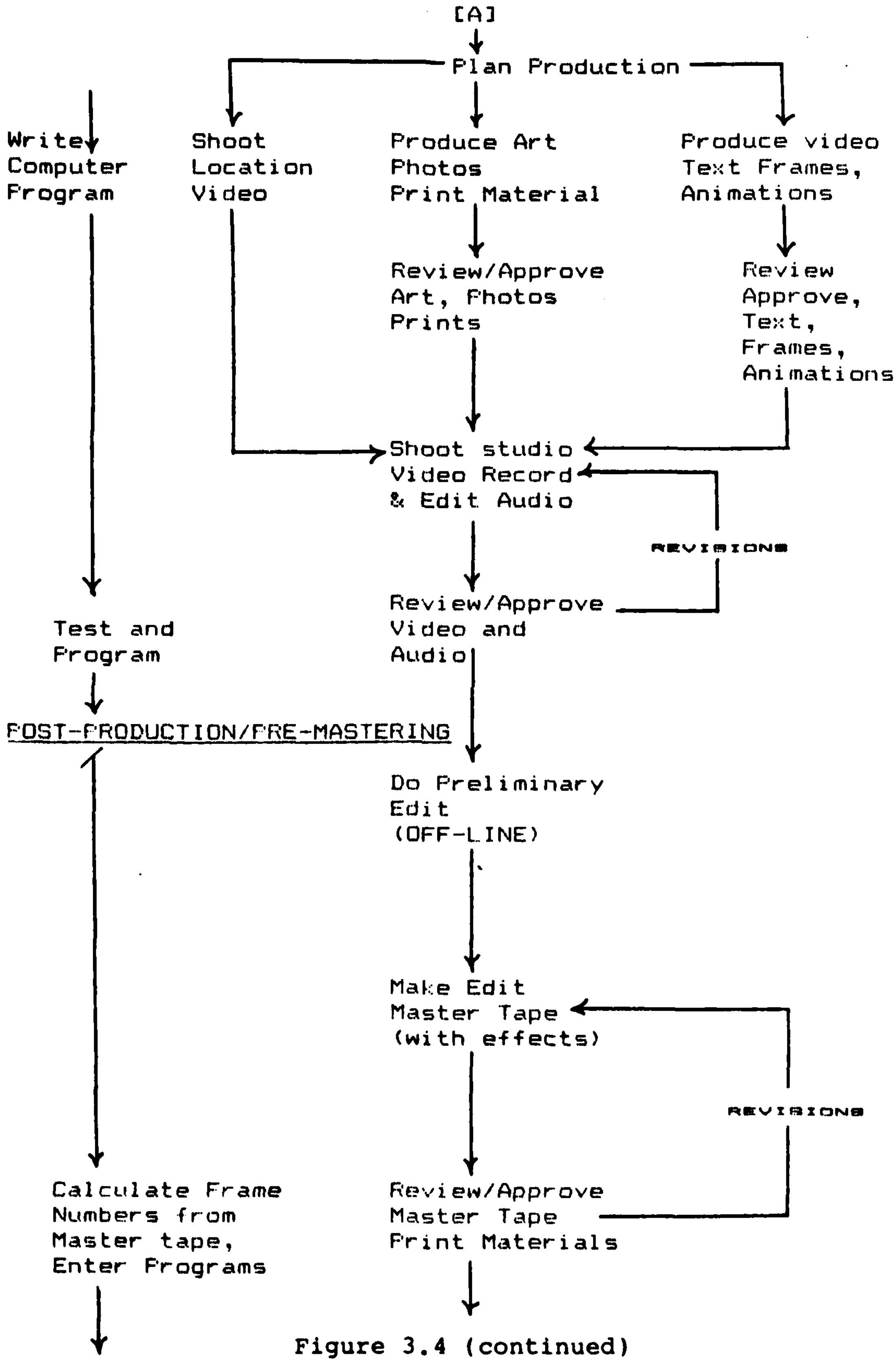


Figure 3.4 (continued)

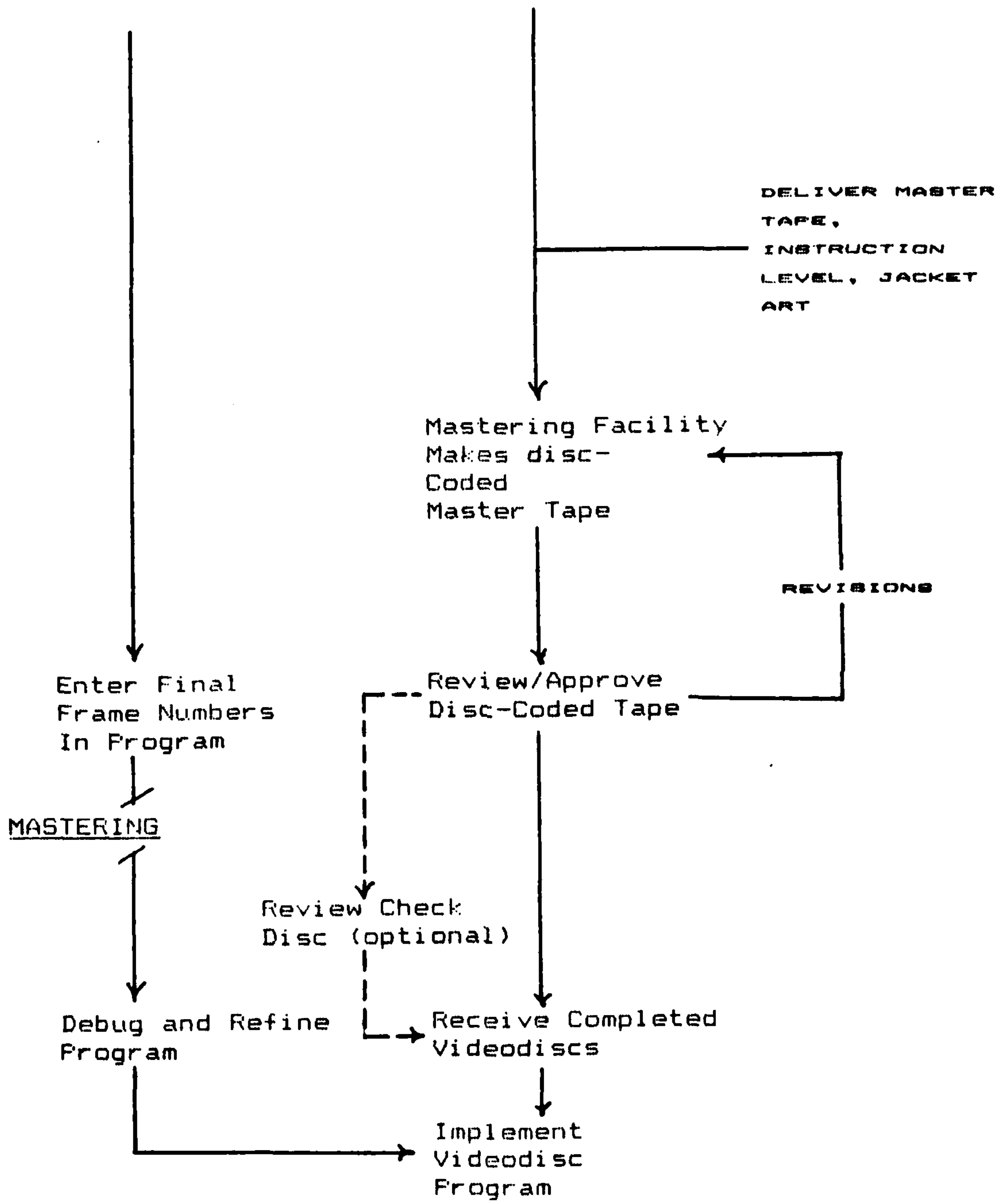


Figure 3.4 (continued)

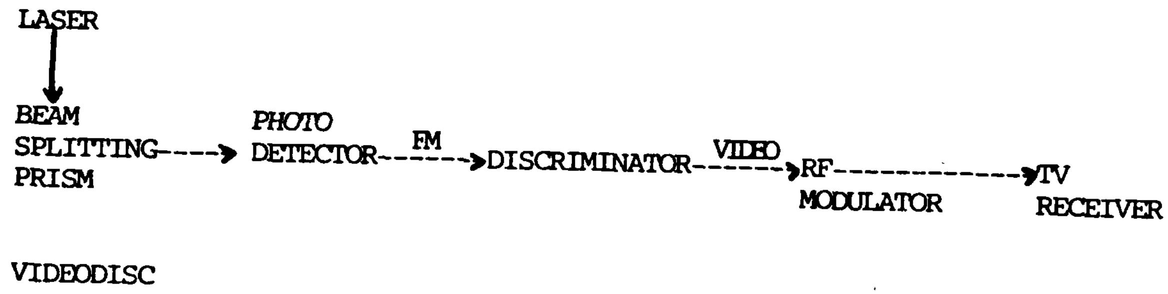


Figure 3.5 Playing the Videodisc

IV. MILITARY APPLICATIONS FOR VIDEODISCS

The videodisc appears to have numerous beneficial uses to the military. An example of this might be found in a Navy Patrol Squardon where the Tactical Coordinator (TACCO) usually must receive his tactical training through the use of multimillion dollar simulators or actual aircraft (P3 Orion) operation. Experience has its place, but the training process could be better. The use of programmed texts and manuals is not an efficient way of teaching these highly technical procedures. The videodisc with its visual sequences to supplement this training may provide better trained TACCOs by providing a vital link between the books and the aircraft.

The military generates a massive amount of paper work and requires massive document storage. An aircraft squadron in the Navy must take an enormous amount of documentation with it when it deploys. This includes everything from admin forms to maintenance manuals. The cost of moving these items from one location to another is significant. The optical storage disc could significantly reduce this problem. The example of the maintenance application used in Chapter I could cut hundred of pounds of manuals to almost nothing. With the capability of storing 40 billion bits of digital information per side, or up to 54,000 still frames of documentation (maps, books, photos, etc.) a single sided disc can hold an entire set of the Encyclopedia Britannica. The entire needs of a unit the size of a squadron could be filled by a single disc. Larger units the size of an aircraft carrier would need no more space than one cubic foot of discs, 300 one sided 12 inch diameter discs, the equivalent of 16 million frames of documentations.

The storage of documents on disc would save on space, funds, and manpower. When a given document is needed it could be displayed almost instantaneously and printed by a laser printer to give an original looking hardcopy.

The Military, especially the US Army has invested R&D funds in videodisc technology. The Army has adopted a training philosophy that requires "The United States Army Training and Doctrine Command (TRADOC) to supervise training provided at service schools via the medium of extension training packages sent to the units where soldiers spend most of their time." The job environment is where today's soldiers must do most of their training due to the limited time they have to spend away from operational units. Training and Doctrine Command (TRADOC) institutions teach only in those areas that require a large ratio of high quality instructors to students or that require high cost trainers and/or simulators. These training packages are based on critical job tasks, or are performance oriented, which allows the student to advance at his own pace. One such system is EIDS (Electronic Information Delivery System). (Mitre Corporation, 1977)

A. ELECTRONIC INFORMATION DELIVERY SYSTEM (EIDS)

EIDS is the specified system of the United States Army. It is a stand-alone system in which a computer manages the presentation of information by means of a videodisc player. The basic version consists of a microcomputer driven videodisc player and a standard television receiver. This system will be the primary delivery system for exportable training courses and materials in the Army, but it can also be used for a multitude of other purposes. (Army Signal Center, 1984)

Training information can be stored in various formats, e.g., motion sequences with or without audio, still frames with or without audio, line drawings or other illustrative materials with or without overlaid texts, etc. The microprocessor controls the functions of the videodisc player to present the material in the most effective manner.

1. EIDS Characteristics

The best source for defining the capabilities of EIDS is the description of what the Army wanted to buy from one of the three contractors building prototypes. The following are quoted from the Statement of Work of the EIDS contract for hardware selection (from the Statement of Work of the EIDS contract): (Army Signal Center, 1984)

> (1) System Operational Characteristics. The EIDS shall be designed, configured and developed as a stand-alone system using commercially available power. The functional purpose will be for delivery of technical, training management and instructional data to individuals and small groups. Design features shall allow for the following operating capability as a minimum:

(a) Register uses and generate records with various levels of access depending upon the status of the user.

(b) Process responses entered by a user from an alpha-numeric input device and position dependent input device such as mouse, joy stick, trackball, standard QWERTY keyboard or keypad.

(c) Calculate and preserve the score and other performance records for the test training cycle based on the student responses.

(d) Present feedback messages generated in response to user communication with the system.

(e) Manage the time and order of presentation of instruction and assessment lessons.

(f) Provide optional capability to mix computer generated text and line graphics with video images generated from an optical storage device.

(g) Execute complex mathematical models that constitute the logic of two-dimensional job simulation programs.

(h) Playback textual and video material on command.

(i) Switch between video disc and computer video information.

(j) Microcomputer control of linear or branched program function.

(k) Playback video, direct or compressed audio and digital information in any combination.

(l) The video disc player shall be able to display from numbers as well as inform the CPU which frame is displayed via a bi-directional communication link, and shall be able to provide player status, including, but not limited to, the following: (a) lid open, (b) player initialize/ready, (c) audio 1, (d) audio 2, (e) frame display, (f) park.

(m) Have a storage medium which has handleability, i.e., the information carried by the medium is minimally affected by scratches, dust, dirt, and fingerprints.

(n) Provide secondary removable disk storage system as an optional modular capability, for the purpose of management and collection of data gathered for evaluation during the field tests. These devices shall be costed separately and will not be provided as part of the distribution cost model of the evaluation plan.

(o) Provide capability to operate the videodisc player, with the associated monitor, in its normal operational mode independent of computer control.

(2) Performance Specifications. The contractor shall provide integrating components and interconnecting cable in accordance with the following: The number of separate cables should be kept to a minimum. All cables required for operation of the EIDS will be capable of being stored within the case. Multiple-pin jacks and plugs, along with multiconductor cable shall be selected and so identified as to eliminate crossover during connection. A minimum of 20 feet of extension cable shall be provided to allow the monitor to be placed in a remote location.

(a) The EIDS shall have a maximum single side random access videodisc search time of five seconds as measured from initial command to performance output.

(b) The system shall incorporate protection against transient powerline fluctuations.

(c) Computer programs must be obtained from the videodisc.

(d) The system shall be capable of intermixing programs which contain both still frames, full motion sequences, still frame with compressed audio and digital information.

(e) The system shall be capable of randomly accessing to any single frame of a program series of frames using system software without the necessity of playing back everything that precedes the selected frame.

(f) The system shall be capable of displaying still frames on the display screen with a minimum of ten seconds of compressed audio per frame. (Up to ten normal videodisc tracks may be used for compressed audio for one still frame.)

(g) The system shall be capable of a "program stop" by use of pause switch, or by previously loaded computer program within the microprocessor.

(h) The EIDS shall contain two signal outputs, one capable of being applied at the antenna input of any standard NTSC television set without modification to the receiver and another providing direct video feed to a television monitor. As a minimum, one audio output should be provided.

(i) The systems, exclusive of the video monitor, shall be readily portable by one person when encased: target weight is 40 to 50 pounds total.

(j) The system shall be capable of operation on either 120 VAC, 60 Hertz or 200 VAC, 50 Hertz power.

(k) The system shall provide a minimum of one channel of audio amplification for reproduction of the audio channels provided by the video disc player in the normal play mode, and the compressed audio modes. As a minimum, the amplifier shall be provided with a volume control, two headphone jacks, speakers, and headphones. The headphone jack must be designed so that when the headphones are inserted no appreciable loading of the audio will occur.

(l) The EIDS shall provide a minimum of two channels of audio per video disc during full motion play mode. These audio channels must be independently selected from the EIDS.

(m) The EIDS will provide one RS-232C I/O port in addition to others required in the SOW. This port will be used for the optional connection of a communications modem as required.

2. <u>EIDS--The Modern Training Delivery System</u>

EIDS provides a computer interface, compressed audio, student interaction, random access branching, high density storage, freeze frame with sound over, motion, color, inexpensive replication and character generation. These capabilities will provide the modern force with a training delivery system that will generate extensive cost savings.

The system not only allows evaluation and feedback but also allows the use of simulation to replace hands-on training in actual equipment which may be very costly or not always available for training purposes, or both! The system will be used for both resident and non-resident training Army-wide. This will enable the Army to realize large savings in future end item equipment costs. (Army Signal Center, 1984)

The Army is especially interested in using videodiscs in simulations such as leadership training, 3-D battlefield displays and maintenance training simulations.

B. THREE-DIMENSIONAL BATTLEFIELD DISPLAY

The purpose of a 3-dimensional display is to provide enough information for accurate fire control solutions for fire teams. The system provides:

* A 3-D terrain view
* A screen size of 4' x 4' for the general view of members of the Tactical Operations Center (TOC) staff
* The display is under the control of an operator via a computer to access any picture in less than three seconds.

Diagram 4.1 shows the flow of information in a 3-D battlefield display system. The Army Topographic Development Laboratory follows a methodology similar to the one presented in Chapter III for developing and producing videodiscs to be used on these systems. Among problems encountered, the 3-D display of this system presented unique difficulty to develop a 3-D display. The first step was to obtain terrain photographs (orthophotos and their mates). The optical system used has a resolution capability of 200 lines or more per millimeter, more than the unaided human eye. Significant magnification is necessary if all of the information recorded by the photographic system is to be seen. This process causes a loss in some of the resolution when the film is converted to television images. Figure 4.2 shows how one APPS photo may be magnified for use with the unaided eye. (Decisions and Designs, Inc., 1984)

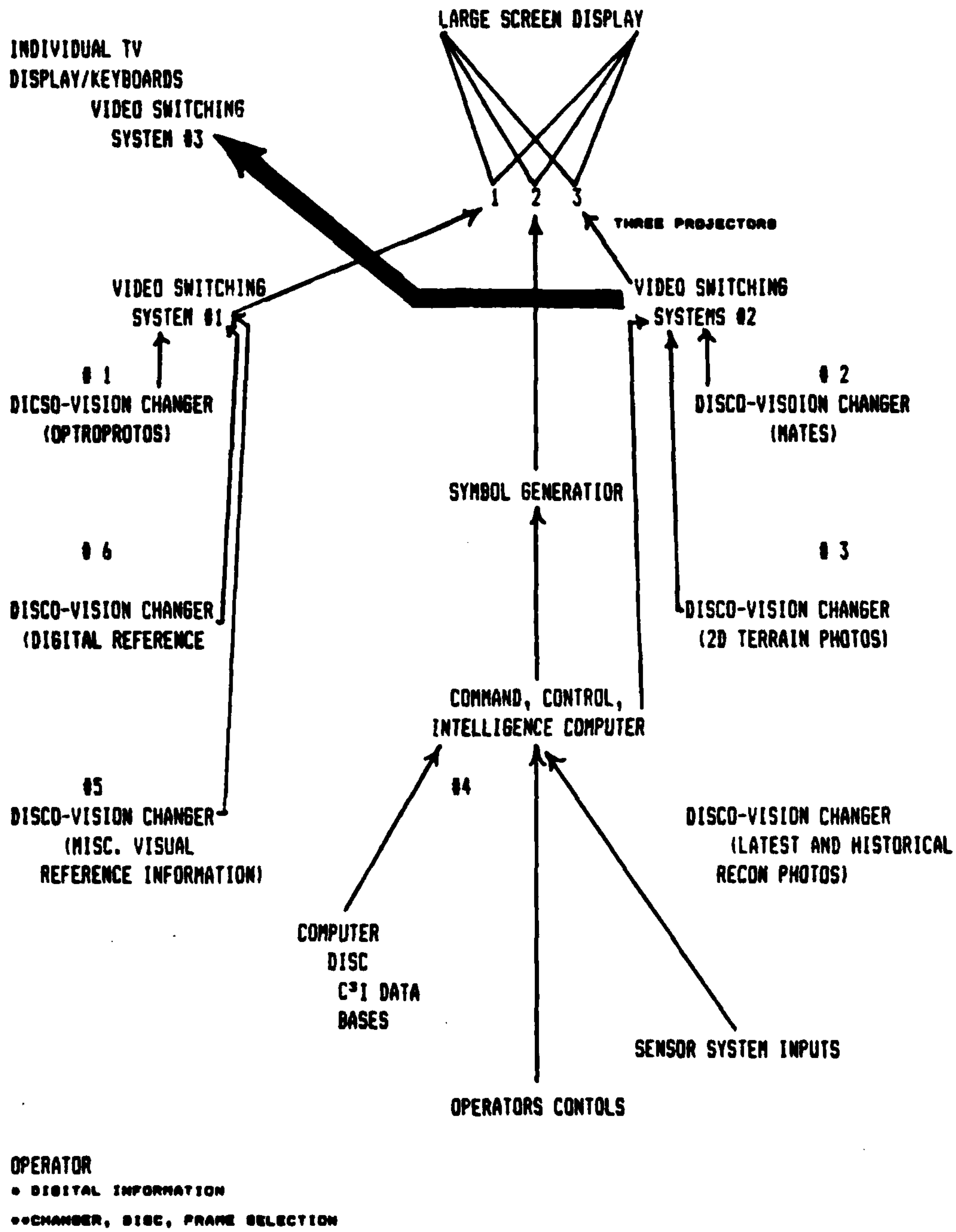


Figure 4.1 Diagram of the 3-D Battlefield Display System

This system was incorporated in the APPS (Automated Analytical Photogrammetric Positioning System). This system utilizes a point positioning data base in conjunction with reconnaissance imagery to determine precise locations for targeting or map making.

The APPS depends on having an area that has been metrically photographed. The accuracy of the photographs depend on a function of height above the ground at which it is taken. These photos are usually in a 150,00:1 or 100,000:1 scale. The smaller the map scale the greater the error factor.

The photos are recorded on videodiscs in stereo pairs. During the videodisc mastering process the stereo pairs are as closely registered as feasible. During playback, registration is refined using automatic optical image correlation techniques. In playback of the disc, the operator selects a scale and the approximate grid location of the target. The computer then finds and d plays the appropriate pair of APPS photos for viewing. After determining the target's location the user then moves the cursor to that location and selects a larger scale display. In effect this is a zoom feature that improves the accuracy of the targeting. Aircrews would also use such a system to plan missions on a vast number of targets.

Magnification of the APPS photos to 500:1 reduces error to about 4.2 feet versus the 41.7 feet at 50,000:1. As

Figure 4.3 shows, magnifying the photos increases the number discs needed by a factor of 100.

DESCRIPTION OF AREA	TOTAL AREA (SQ. MILES)	NO. OF DISC REQUIRED SINGLE FRAME 4x3 MI.	NO. OF DISC REQUIRED SINGLE FRAME 0.4x0.3 MI.
ASIA	16,988.000	26.2	2,621.6
AFRICA	11,506,000	17.8	1,775.6
N. AMERICA	9,390,000	14.5	1,449.1
S. AMERICA	6,795,000	10.5	1,048.6
EUROPE	3,745,000	5.8	577.9
AUSTRALIA	2,968,000	4.6	469.8
ANTARCTICA	5,500,000	8.5	848.8
WEST GERMANY	95,815	0.15	14.8
EAST GERMANY	40,646	0.06	6.3
TOTAL LAND MASS OF EARTH	57,530,000	88.8	8,878.1

NOTE 1 3-D requires double the number of discs.
NOTE 2 The entire earth at a single frame of 4x3 ft. 5280:1 would take up 3 cubic feet of storage space or 6 cubic feet for 3-D presentation.
NOTE 3 The entire earth at a single frame of 0.4x0.3 ft. 528:1 would take up 295 cubic feet of storage space or 590 cubic feet for 3-D presentation.

Figure 4.3 Geographic Videodisc

C. VIDEODISC SIMULATORS

Over the years various approaches have been utilized for instruction, ranging from textbooks to simulations. Assessment centers and role playing have been shown to be effective means for the assessment and teaching of interpersonal leadership skills. Both procedures require a large instructor core, including role players, evaluators, and administrators.

In order to reduce the high personnel costs videodisc programs could be used to supplement the current role playing and, hence, reduce the number of support personnel required. A major problem was the simulating of subordinates as they would probably respond in a given leadership situation. An audiovisual medium was needed that would allow rapid and accurate random access to a large number of video motion sequences depicting various outcomes. Videotape was one possibility, but access times were too long for realistic simulations. Videodisc technology opened the door for such simulation. (Mitre Corp., 1977; Tucker, 1984)

Research completed by Holmgren, Dyer, Hilligoss and Heller in later 1979 and 1980 has shown that a videodisc system could successfully train soldier skills even when only a fraction of the branching and other capabilities of the medium were used.

Another example of a training system is the Army tank simulator (developed by Perceptonics, Inc.), which uses the combined films of three cameras, concisely tuned for framing. The system joins the three video images, creating an extremely wide image similar to cinerama. The result is that an image, such as that of a tank can move across the entire screen giving a more realistic presentation. (Tucker, 1984)

Other recent projects have demonstrated the cost and training effectiveness of the computer assisted videodisc in the Army hardware maintenance domain (e.g., Young & Tosti, 1981). One such system, produced by the Cubic Defense Systems, trains Navy personnel to maintain a highly complexed radar system. The students are able to disassemble and repair the system by touching a control device or marker on the screen. For example, a red triangle on the screen unlocks, opens or gives access to that part of the equipment on which it is located. After the repairs are made the student is able to test the equipment using leads that can be connected to get computer generated readouts of electrical activity.

D. VIDEODISC INTERPERSONAL SKILLS TRAINING AND ASSESSMENT (VISTA)

The development of the VISTA leadership program included the selection of hardware, the identification of the most significant interpersonal problem areas for the target population (entry level infantry officers), designing the instruction in a way that would exploit the capabilities of the new technology, writing the scenarios, developing the computer software, and finally, the evaluation of all the products. The evaluation involved a series of experiments in which each different videodisc training scenario was experimentally compared to role playing and to a low-fidelity simulation of the leadership training scenario (programmed test).

The target audience that was selected to test and demonstrate the capability of videodisc for training and assessment of leadership skills was that of new infantry second lieutenants in the Infantry Officer Basic Course (IOBC) at Fort Benning, Georgia. The current method for training interpersonal leadership skills is role playing. This requires more than a dozen evaluators and the same number of soldiers playing roles to provide training for about 90 lieutenants in a three-hour period. In addition to the problem of high personnel costs, the effectiveness of role playing is greatly dependent on the acting skill of the role player and the ability of the observer to provide a meaningful critique. One of the possible advantages to the VISTA approach is the introduction of standardized training in an area where standardization has traditionally been difficult or impossible. (U.S. Army Research Institute for the Behavioral and Social Sciences, 1982)

1. VISTA Hardware

The selection of the hardware began with the design of an ideal system. This system was to consist of an industrial version, laser reflective optical, videodisc player; a color monitor; a microprocessor (and floppy disk drives) that had a NTSC compatible text generator, a real-time clock, a videodisc interface card; and finally, a touch-panel for the monitor.

Such a system would permit text from the computer or scenes from the videodisc player to be displayed on the monitor and would also permit a student to interact with the system by touching the monitor screen.

A real-time clock was included in the design to afford the capability to collect time-based measures of the student's performance.

VISTA HARDWARE

DEVICE	FUNCTION TO BE SERVED
Apple II Computer	Will contain the program which will control the videodisc player
DiscoVision Associates PR-7820 Optical format Videodisc Player	Will display motion sequences on command from the Apple II
Symtec Light Pen	Will permit the student to interact with the system by touching the light pen to specific positions on the face of the TV monitor.
Mountain Hardware Realtime Clock Card	Will allow the capability to collect time based measures or the student's performance.
Colony Products VAI-1 Videodisc Interface Board	Will permit the PR-7828 to be interfaced to the Apple II. Also permits the video signal to the monitor to be alternated between the signal from the videodisc player, and the text generator of the Apple II.

The use of a touch-panel eliminates the necessity of the student using a keyboard to interact with the system.

After the hardware was selected a review was made of the advantages and disadvantages of the various programming languages available for the Apple II.

The strategy used to develop VISTA was to generate an extensive list of potential interpersonal problem areas and subsequently to narrow the list down to the eight problem areas which were judged by subject matter experts to have the highest aggregate of difficulty, importance, and frequency.

In order to determine optimal leadership responses and justification for those choices, a number of sources were utilized:

a) The training material had to be consistent with existing Army leadership doctrine. The two relevant field manuals were carefully studied and heavily referenced.

b) Retired military personnel on the Litton staff and active officers and NCOs within the U.S. Army Infantry School Leadership Department were utilized as subject matter experts.

2. <u>Characteristics of VISTA Software</u>

When the program is executed, text is displayed that informs the student that the videodisc is being positioned. Next the student has the option of viewing the instructions on the use of the light pen or bypassing the instructions. If the student doesn't respond within ten seconds, then the light pen instructions are automatically given. (If a touch-panel is in use, the student substitutes touching the monitor screen with his finger for the light pen).

The student then has the option to read an overview of how the lesson will progress. To look at the overview, the YES line is touched. To bypass the overview, the NO line is touched. When appropriate, this YES/NO convention is used throughout the program. Next, the student must enter his or her service number. This is done by touching the light pen to the appropriate sections of the screen to enter the digits of the service number and then to another line to enter the number.

The student then has the option of choosing the Pedagogical or Experiential mode. Once in the Pedagogical mode, the first event is either a display of pages of text or the initial motion sequence. If text is present, it is used to convey background information of the role to be assessed during the lesson. Next, a motion sequence may be displayed. This motion sequence is used to present the problem that the student is to deal with. Additional text may then be presented to give the student more background information pertaining to the scenario. Next the student is asked to construct a response regarding what he would do in this situation. The student is given up to five choices of what he could do in this particular situation. He is asked to choose the alternative that is closest to his constructed response or is the best of those given. After he makes his choice, he is shown that selection acted out, but not its consequences. When the choice is acted out, it is from the perspective of the person being counseled. That is, the student is looking at the junior officer. This was done for both role-modeling purposes and because it was thought that looking at the lieutenant conveyed less information than would be true if the student were shown the counselee's reactions. That is, the alternative is shown without indicating to the student whether it is the best of those listed.

The student is then given the option of keeping his selection or returning to the set of choices to make another choice. If he decides to keep his choice, he is again shown the response acted out this time along with its consequences. In this motion sequence, however, the perspective is that of the officer. Next the student is given feedback in the form of text as to whether or not this choice was the best of those listed. If it was not the best, the student is shown a display which permits him to request "HELP" from the computer, look at the consequences of the other choices, repeat the last correct response, or continue to the next junction point. The "HELP" option allows the student to move back to earlier junction points or to exit the program. The sequence of events listed above continues until the student has correctly progressed through the lesson. The student must make the appropriate choice before he is advanced to the next junction point thus the student not only sees the correct choice acted out, but is also given additional feedback in the form of text as to why that choice is considered to be the best of those given.

3. VISTA: The Experiential Mode

The Experiential mode of instruction differs from the pedagogical in that the second motion sequence, the opportunity to alter the selection made, and the textual feedback are eliminated during the lesson. This mode then simulates an interview more closely than does the pedagogical. Up to and including the set of answers being presented, the Pedagogical and Experiential mode, after a choice is made, the student is shown his choice acted out along with the consequences of that choice. The perspective during this motion sequence is that of the lieutenant. There is no provision for altering the selection and the only feedback is given in the counselee's reaction. This gives the Experiential mode the advantage of a more realistical flowing interaction, with the drawback of relying heavily on the acting ability of the subordinate to convey adequate feedbback about the quality of the choice made.

4. Grading and System Evaluation

The leadership Principles Test was graded by three independent judges for each of the six replications. The mean agreement across all combination of three judges taken two at a time for all replications was 82%. The mean scores for each of the three instructional mode conditions for all six replications are shown in Figure 4.5. The scores represent the mean number of acceptable leadership principles stated in the test for all three judges. The Mean for all three conditions across all six replications is shown in Figure 4.4. As indicated, the only individual replication showing a significant main effect due to mode of instruction was Replication 5 (Insubordination). Newman-Keuls Multiple Comparisons Tests indicated a satistically significant superiority of videodisc over both role playing and text in Replication 5.

An overall analysis of variance was conducted on raw scores (means for the three judges). The appropriate test was a two factor analysis of variance with the three modes of instruction forming the three levels of one factor (mode of instruction), and the six replications forming the six levels of the main effect due to mode of instruction was significant. A Newman-Keuls Multiple Comparisons Test indicated a statistically significant overall superiority of videodisc to both the role play and text conditions. Besides the significant effect due to mode of instruction, the analysis also indicated a significant main effect due to evaluation replication ($\underline{F}$ (5,295)=8.147,$\underline{P}$<.001), and Mode of instruction by evaluation replication effect was probably due to the different content areas covered in each of the replications. Similarly, the significant interaction probably indicates that optimum instructional mode depends on which content area is being taught. In order to remove variability in the data due to different topic content from replication to replication, all raw scores for each separate replication were

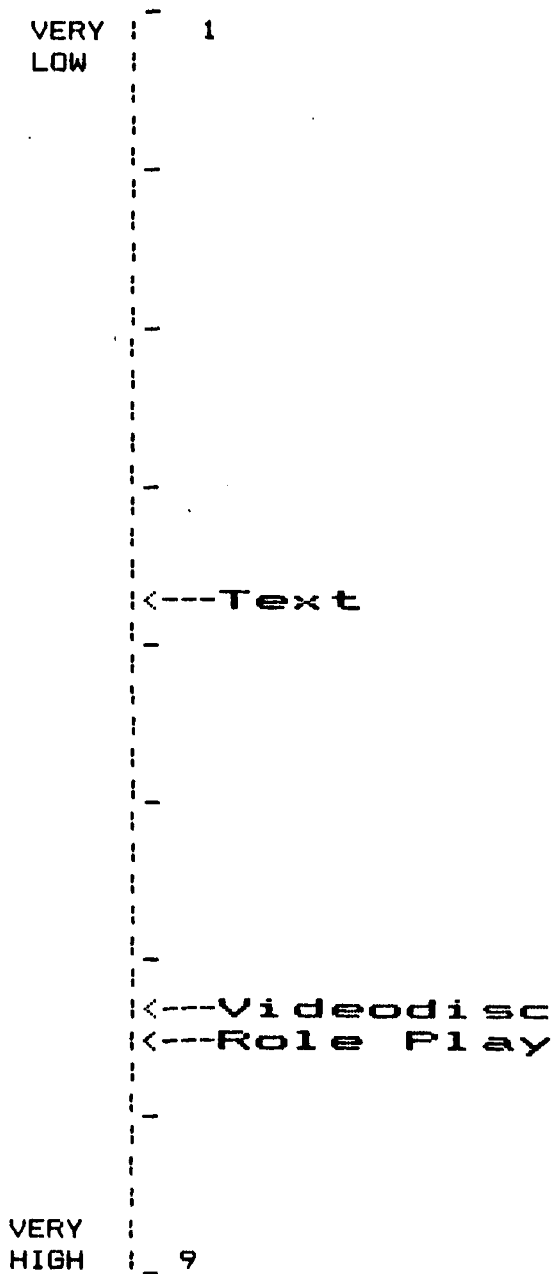
VISTA Replication	Main Effect	Role Play versus Videodisc Newman-Keuls	Role Play versus Text Newman-Keuls	Videodisc versus Text Newman-Keuls
#1 Verbal Abuse	$f(2,87)=2.24$ $p=.11$	-	-	-
#2 Taking Charge	$F(2,51)=3.09$ $p=.054$	$.05<p<.10$ (videodisc Role Play)	$p>.10$	$.05<p<.10$ (videodisc> Text)
#3 Meeting The NCOs and Platoon	$F(2,35)<1.0$	-	-	-
#4 Perfor-mance Counsel-ing	$F(2,41)=3.03$ $p=.059$	$p>.10$	$p<.05$ Role Play> text)	$.05<p<.10$ videodisc> text)
#5 Insubor-dination	$F(2,42)=3.85$ $p=.029$	$p<.05$ Videodisc> role play	$p>.10$	$p<.05$ videodisc> text
#6 Personal crisis	$F(2,38)<1.0$	-	-	-
Overall RAW SCORES	$F(2,294)=5.432$ $p=.005$	$p<.05$ Videodisc Role play	$p>.10$	$p<.05$ Videodisc> text
T Scores	$F(2,294)=4.633$ $p=.01$	$p<.05$ Videodisc Role Play	$p>.10$	$p<.05$ Videodisc> Text

Figure 4.4 Statistical Analysis of Leadership Principle Test for Evaluation 1-6 and Overall

transformed into T scores with a mean of 50 and a standard deviation of 10. Analysis of variance on the T scores indicated a significant effect due to Mode of instraction ($F(2,294)=4.633, P=.01$). As with the raw scores, a Newman-Keuls multiple comparisons test indicated a statistically significant superiority of the videodisc conditions relative to both the role play and text conditions. Also, as with the raw scores, there was no significant difference between the role play and text conditions. Of course, there was no effect due to Evaluation Replication because of the T Score transformations. The mode of instruction by evaluation replication interaction was removed with the T score transformations ($F(10,294)=1.638, P<.05$).

5. Subjective Preference Rating

In the Leadership Training Preference Test given at the end of the period of instruction, students were asked to rate each of the instructional modes on a scale of one to nine as to: (a) How much they would learn about dealing with people, (b) how useful the training was, (c) how it kept their attention, (d) how it motivated them, and (e) the quality of the content. The overall mean ratings averaged across all five subjective dimensions and all six evaluation are shown in Figure 4.5. Statistical analysis of the overall scores indicated that the preference of role play over videodisc was significant (Newman-Keuls, $p.<.05$). However none of the separate evaluations revealed a statistically



OVERALL MEAN RATINGS FOR FIVE QUESTIONS ON WHICH STUDENTS WERE ASKED TO RATE THE QUALITY OF THE THREE TRAINING PROCEDURES

Figure 4.5 VISTA: Overall Subjective Ratings significant preference for role ply over videodisc. Also, the preference of both role play and videodisc over the text condition was highly significant Newman-Keuls $\underline{P}$<.001>.

Similarly, all of the separate individual evaluations indicated a highly statistically significant preference for both role play and videodisc over text. When presented with a forced choise question as to which approach was the best in terms of learning about Army leadership, 58% chose role play, 37% chose videodisc, and 5% chose text. When presented with a forced question as to which approach best kept their interest, 54% chose role play, 44% chose videodisc, and 2% chose text. Overall, 90.5% of the students felt that the three approaches should be combined with the Counseling Laboratory consisting of 17.6% text, 36.8% videodisc, and 45.5% role playing. When asked whether they preferred the Pedagogical or Experiential mode of instruction, 70.2% indicated a preference for the Pedagogical mode (only the videodisc subjects were included in this analysis since they were the only students with exposure to both modes). This last comp;arison is probably unfair to the Experiential mode since students only received 15 minutes of exposure to the Experiential mode while receiving 35 minutes of exposure to the Pedagogical mode. Overall, 67.4% indicated that they thought the two instructional modes should be combined.

Students were also asked to rate various VISTA quality dimensions on a scale of one to nine. The four qualitative dimensions were rated relatively high. The median for writing was 6.86; the median for filming was 7.34; the median for acting was 6.60; and the median for feedback was 7.38. Finally, the students had relatively high agreement with the content of the training for both role play and videodisc (mean ratings were 7.29 and 7.24 respectively), but a significantly lower agreement with the text (mean rating was 5.92). The disparity between programmed text and videodisc was interesting (given theat the actual content was identical for the two), and probably reflected a general dislike for the programmed text.

6. Conclusion

The major purpose of the VISTA project was to determine if current computer-assisted videodisc technology could teach soft skills in the Army. The evaluation results suggest an affirmative answer. One important point needs to be made. In the final evaluation, the videodisc programs were matched against both a programmed test and role playing in order to make a relative comparison. The results do not necessarily imply that the VISTA products should replace role playing and written material for the following reasons.

First the results did indicate a general VISTA superiority overall, but inspection of the separate programs revealed a difference in the effectiveness of the videodisc programs on different topics. Second, the students indicated a preference for the role playing and felt that ideally, the three approaches should be combined. Third, the major dependent variable was the score on a cognitive acquisition of leadership principle test. It could be argued that a performance test such as role playing would have been more appropriate and may have indicated that role playing is the superior method. But, because of time limitation, it would be impossible to test every student using role playing. Also, the traditional problems of obtaining qualified raters, how to structure the ratings, and the general unreliability of such measures preclude role playing, as the dependent variable. Fourth, the VISTA products were never intended to replace role playing but rather to supplement it.

Because of the success of the VISTA project and other Army videodisc projects, it is recommended that more videodisc training/simulation efforts be considered. It is very important that careful front-end analyses be completed before trying to apply the new technology.

V. VIDEODISCS IN EDUCATION

A. GENERAL

Both communication and computer technologies have deep roots throughout education, although both have very poor beginnings.

Early video instructional material were little more than live lectures that were presented on TVs. The computer had an equally bad beginning. Software, not hardware, was the real problem in this case. Software developers were not sure where their market was. During the past five years the computer technology has made considerable progress with the introduction of Computer-Aided Instruction (CAI). Several projects, including a large-scale test in the Los Angeles public schools system via its education testing service, were responsible for this improvement. The introduction of PLATO and TICCIT allowed the student to interact with instructional material giving new life to the computer in educational applications. Because of these advances the videodisc may find a natural home. (Bejar, 1982; Heines, Levine, and Robinson, 1983)

The videodisc's educational potential lies in its successful integration into the total classroom environment.

It can only be as successful as the overall teaching program in which it is used. A fine line exists between the technologies which teachers perceive as helpful and technologies which are perceived as threatening. Tayler (1983) states, "Technological innovations likely to be attractive to teachers are those that help perform education tasks that are distasteful or boring or that enable them to solve learning problems that they have not been able to solve effectively or easily. They should be media devices, or systems that are tools to aid the teacher, not to displace him or reduce his dignity as a professional person." The videodisc falls into the teacher's aids category as it is not labeled "self-instructional or teacher proof".

The advantage of using videodiscs lies in its ability to respond as soon as the student responds and the personal instruction it can give each student. Teachers usually have groups of diversely talented individuals in their classes. As a result the subjects may be much to complicated for some and much to simple, for others. With videodiscs to supplement this instruction each student is able to proceed at his own pace. Another problem that videodiscs may address is that teachers sometimes have problems maintaining sequence of the material because of class length or interruptions. The videodisc can alleviate this problem by making it possible for the students to proceed at their own paces and to see the material in its proper sequence.

A lesson can be divided into several segments, each ending with an evaluation section. As the student demonstrates an understanding of the material of one lesson, he continues to the next. If he has difficulty he repeats the lesson or does a remedial lesson until it is completed. An example of this possible videodisc branching can be seen in Figure 5.1.

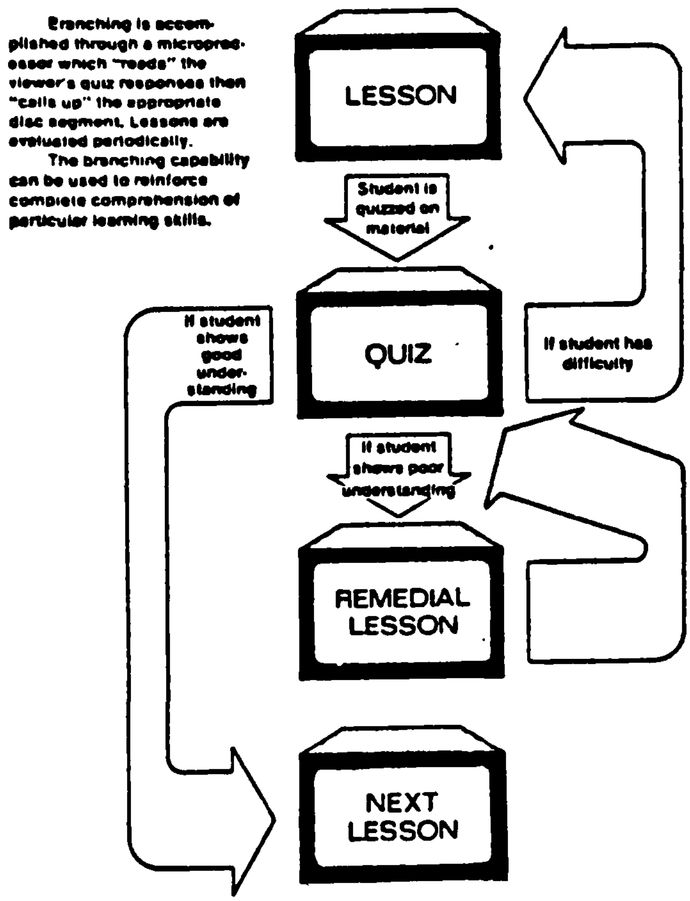


Figure 5.1 Videodisc Branching

A good indication of the educational potential for the interactive video can be seen in several projects conducted by Utah State University.

One such project, The Video Innovation Project (VIP) used commercially available components of a training seminar on the use of a lettering scriber, to produce a videodisc to teach the use of the instrument. Mastering the lettering scriber for precise technical lettering is extremely difficult for the first time user. Students were given printed guides containing a numerical index of all the information in the videodisc program and then allowed to proceed at their own pace. (Heins, Levine, and Robinson, 1983)

The result was that the students learned at a faster rate and were able to master the lettering scriber. By using the freeze-frame and slow motion features the students were able to duplicate the gliding motion necessary for maximum scriber clarity. The random access capability of the disc increased the efficient use of the students' time and added to their sense of satisfaction.

Utah State University is also involved in a project for the exceptional child. This project has as its goal the identification and remedy of specific problems experienced by the learning disabled. The system employed gives the children tasks, such that the solution involves touching the screen. A representative lesson is called "Matching Colors, Shapes and Size". A large object, i.e., square, circle or triangle is displayed on the screen while a narrator, a puppet, asks the child to locate the center of the object by touching the screen. If the child has numerous errors, the computer will return to the beginning or to another similar lesson elsewhere on the disc. As soon as the child shows an adequate understanding of the material the computer jumps ahead to keep the child's interest. There is no reason to complete all of every lesson if it appears that the child has mastered the material because he is likely to become bored. The pressures of immediately understanding and getting the right answer in front of the teacher and the class are eliminated. (Bergheim and McGeever, 1984)

B. UNIVERSITY OF IOWA ART HISTORY PROJECT

Another application that the videodisc is well suited for is in art history. Late in 1979, the University of Iowa developed a project in which a data base of visual material, a slide library, was transferred to videodisc in order to evaluate the advantages and disadvantages of such a system over the more traditional methods. One thousand black and white glossy photographs of woodcuts and engravings were transferred to 16mm film by the university motion picture units and made into a videodisc by Thomson-CSF of Paris, France. (Sustik, 1981)

The hardware consisted of a Hewlett-Packard 2000 time-sharing computer, a Thomson-CSF TTV-3620 educational/industrial videodisc player, and an Apple II computer which served as a communications link, over phone lines, between the videodisc player and the HP. Two video monitors were used, one for the image and the other for associated texts.

Two computer programs were developed to operate the system and to retrieve the pictures from the disk using a list of criteria for choosing the picture. The user is able to select the picture by frame number, a unique catalog number consisting of volume, page, and item according to the Bartsch's LePeintre Graveur (Bartsch collection of works in the British museum's Department of Prints and Drawings). Verbal specifications could be used also to retrieve the picture such as artist, date, medium, state (if the print was completed in stages) or theme such as "The Life of Christ". A combination of any of these would limit the number of pictures that would be chosen and displayed. The use of verbal specifications made it easier for first time users or people not familiar with the coding system to enter the system. When more than one picture was to be viewed the next picture was accessed by hitting the return key. The index was displayed as follows:

```
     You may select the slides by the following categories:

                  1.  Videodisc Frame No.
                        Bartsch No:
                        2.  Vo. No.
                        3.  Page No.
                        4.  Item No.
                  5.  Artist
                  6.  Medium
                  7.  State
                  8.  Date
                  9.  Theme
                 10.  Soundex search on title

                  Clear  Search  Help  End

                 Your command? __
```

Figure 5.2 Screen Display of Categories of Images

The system was designed for displaying pictures in the lecture room and for research.

The evaluation was only done from December 1 through 11, 1980 and was installed in the slide library of the art school. The location was inappropriate for full evaluation by the students and the time span was very short for this type of project, which is probably why only sixteen people completed the survey, the main evaluation tool. Of the sixteen, three were staff, nine were graduate students and one was an undergraduate student.

The major strengths of the system seemed to be in the overall access speed compared to using the slide drawers found in the slide library and in the large amount of information that can be accessed in one place. The weaknesses that were identified by the survey were poor image quality, the inability to compare two images simultaneously, the inability to interrupt the search, limited range of material on the system, the inability to "ZOOM" in on details. Another problem that arose was in the time-sharing system. At times of peak load the system was slowed down considerably.

This project was completed three years ago and many of the weaknesses can be eliminated. The use of the time sharing computer is no longer needed because of the introduction of interfaces with microcomputers such as the Apple, Commodore, IBM, and Atari. The poor quality of the display has been improved with higher resolution TVs and new techniques in photography, An example of the improvement in quality can be seen in "National Gallery of Art Disc". The disc not only covers the art collection of the museum but it also covers the history of the museum. The first side of the disc contains a comprehensive history of the museum from the original conception to the realization of its East Wing. The second side contains 1,645 works of art, including paintings, drawings, prints, and sculptures in still frame representations. Descriptive text accompanies each frame. Also included is a 55 minute linear program giving a tour of the entire institute. The entire disc is narrated by the director of the gallery.

Each piece of art was taken to a studio and photographed separately. Each transparency was then scrutinized closely. This process took two years to complete.

To maintain photo reproductions of the highest quality a special transfer method was used. The use of a Rank Cintel Flying Spot Scanner with a X,Y zoom gave a detailed, full view of the 35mm slides. The ESS system allowed for storage of still frames for accurate imaged representations. Each image was color corrected by the use of a Dubner color connection system. (Sustik, 1981)

Some 2,000 discs were sold, mostly to universities and colleges, at a cost of $95 each. Considering the still frames only, the cost is only about $ .06 per work of art. To buy high quality slides (as used in art schools) of 1,645 selected artworks would cost over $1500.00 to reproduce. More and more schools are recognizing the benefits of discs and the cost saved in having them as opposed to slides that deteriorate and need replacing at very high costs.

A nationwide study conducted by the American Institute for Research (AIR) for the Department of Education was completed in early 1983. The project furnished 45 schools with videodiscs, authoring systems, and the technical assistance needed to set up an operational system. The major problem that was encountered was the shortage of educational discs. Most of the discs available were linear in nature and teachers found it difficult to find information on them. Most of the schools participating have since discontinued their interactive program, but a few have kept up with the technology. A few of these are: (Currier, 1983; Bergheim and McGeever, 1984; Reinhold, 1984)

St. Paul Lutheran School, Melrose Park, IL--They use their system primarily for math and music classes.

Osseo Area Schools, Osseo, MN--This school system has developed its own discs to aid in teaching elementary students punctuation, language arts, dictionary use, and animal classification.

California School for the Deaf, Riverside, CA--This school produced two 27 minute discs that teach language and reading skills to students aged 5 to 21. These discs contain only visual material and no audio.

P.K. Laboratory School, University of Florida, Gainesville, FL--Two interactive videodisc workshops for teachers or computer consultants were produced to acquaint them with the technology and help them work with school districts in developing interactive activities.

A market research was completed in May of 1983 by the SRI Research Center, located at Lincoln, Nebraska, with five objectives in mind: (SRI Research Center, 1983)

1. To assess the availability of present and future use of video disc players in the school system.

2. To determine the instructional level at which these systems are being or would be used if available.

3. To determine what the perceived strengths and weaknesses of videodisc instruction systems are.

4. To identify the availability and sources of instructional information.

6. To see what decision process was made in the purchases of videodisc systems.

A random sample of 330 directors of audio visual services for school systems was used from two separate but overlapping populations. The first population of 146 was taken from a nationwide sample and the second population of 184 was taken from the states of California, Florida, Illinois, New York, and Texas. The second sample of specific states was used to concentrate efforts in states that are known to be active in instructional technology. Each person was interviewed by phone and asked a series of 14 questions.

Individuals from kindergarten to 12th grade came from a sample of schools with a $45 per student expenditure budget for instructional material. The collegiate systems were chosen from the membership list of Association for Educational Communication and Technology. After the selections were made each was divided into type of school system and geographical area. The types of system, and the percent of respondents from each where (n=_) indicates the number of schools interviewed in each area.

1. Kindergarten through 12th Grade (n=164) 50%
2. Kindergarten through 4th Grade (n=) 4%
3. Junior High (7th-9th Grades) (n=) 2%
4. Senior High (10th-12th Grades) (n=) 14%
5. Community College (n=30) 9%
6. 4 Year College (n=58) 18%
7. Kindergarten through 8th Grade. 3%
8. Others 2%

The Geographical areas and percentages in each were:

NORTHEAST (n=74) 22%
Connecticut, Massachusetts,
New Jersey, New York, Pennsylvania, Rhode Island,
Vermont, and New Hampshire.

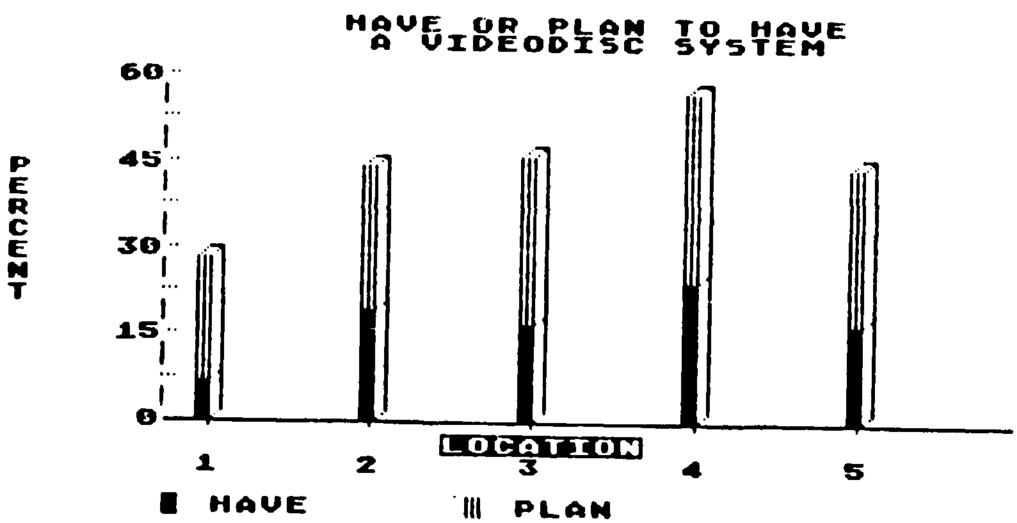
SOUTH CENTRAL (n=100) 30%
Alabama, Arkansas,
Delaware,
Florida, Georgia, Kentucky, Louisiana, Maryland,
Mississippi, North Carolina, Oklahoma,
South Carolina, Tennessee, Texas, Virginia,
West Virginia, and Washington, DC

NORTH CENTRAL (n=69) 21%
Illinois, Indiana, Iowa,
Kansas, Michigan, Minnesota, Mississippi, Missouri,
Nebraska, North Dakota, Ohio, South Dakota, and
Wisconsin.

WEST (n=58) 26%
Arizona, California, Colorado,
Idaho, Montana, New Mexico, Oregon, Utah,
Washington, Wyoming, and Nevada.

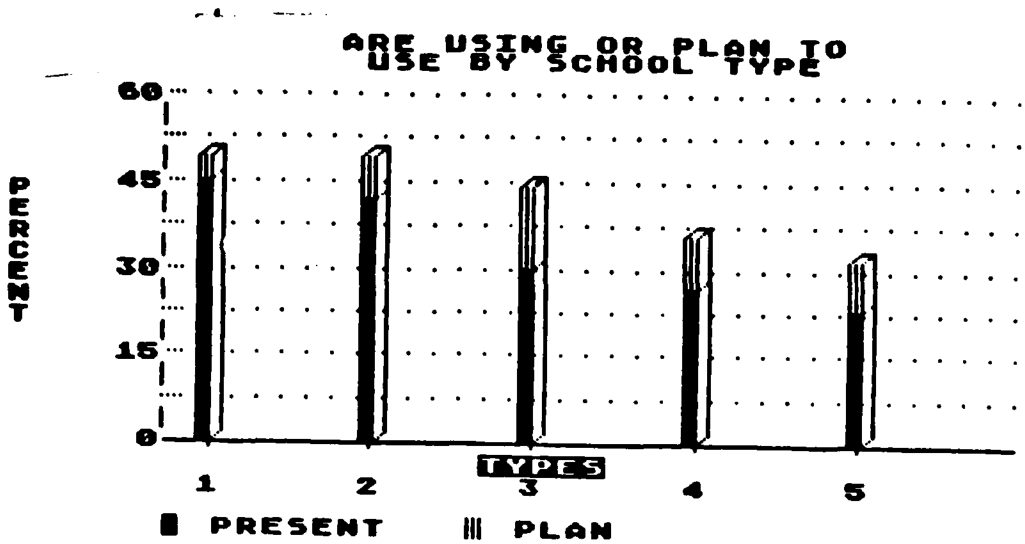
The given sample size of 330 at a 95% confidence level, the maximum expected error range is $\pm$5.4%. In other words, if 100 random samples were picked from a population, 95 times out of 100 the result would not vary more than $\pm$5.4% points from the results of the entire population.

One of six, (17%) of the schools interviewed had a videodisc player. Other surveys have indicated that the Northeast, especially the Boston area, has invested heavily in videodisc technology, but this survey indicates that the Northeast is the least likely to have them in its schools. Four year colleges are more likely to have videodisc players than any other type of schools. Figures 5.3 and 5.4 show the breakdown by location and by type of institutions that presently have or plan to have a videodisc system.



1. NORTHWEST
2. SOUTH CENTRAL
3. NORTH CENTRAL
4. WEST
5. TOTAL

Figure 5.3



1. SR. HIGH
2. JR. HIGH
3. ELEMENTARY
4. COMMUNITY COLLEGES
5. FOUR YEAR COLLEGES

Figure 5.4

One in four (27%) of all respondents said that they planned to buy a videodisc system in the future. Two in three (66%) said that they would not buy a system. The reason given was overwhelmingly the fact that the school had a different system, while only about a quarter said that the systems were too expensive. Again schools in the Northeast are likely to purchase a videodisc system while the Western region is the most likely to. Colleges, both community (the most likely to) and four year institutions were the most likely to buy videodisc systems in the future. Of real interest is that there is no real difference between the nation wide sample and the specific state sample regarding their intention to purchase videodisc systems. Of the schools stating they were going to purchase a system, 53% would do so within the next three years.

Of the schools that presently have videodisc players, about 20% have them connected to a computer. Almost half of those who do not, plan to connect them to a computer in the very near future.

Senior highs and junior highs use their videodisc systems the most for instructional purposes (Figure 5.5), elementary schools have indicated they plan to increase their use of their systems (Figure 5.6).

Level	Percent
Senior High	45%
Junior High	42%
Elementary	30%
Community Colleges	27%
4-Year Colleges	23%

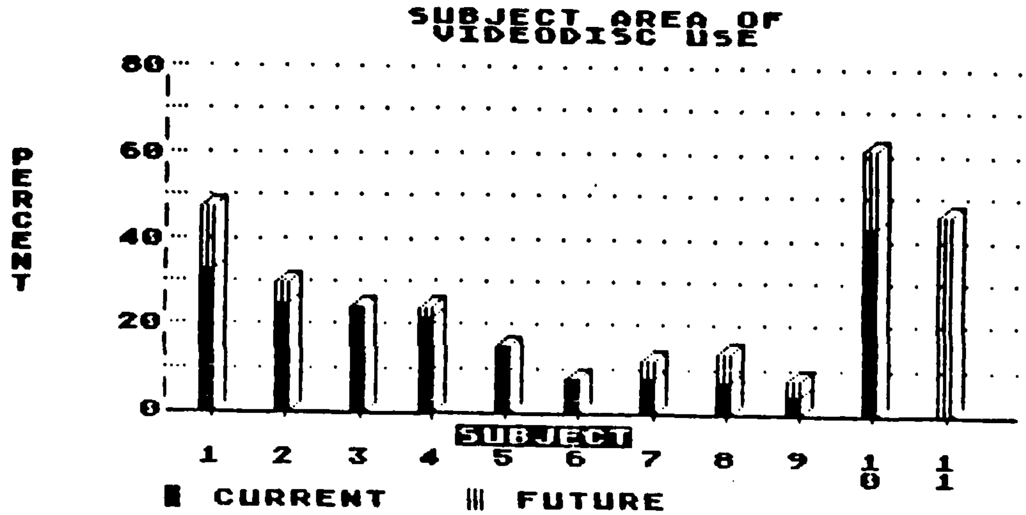
Figure 5.5 Current Level of Instruction

Level	Percent
Elementary	14%
Community Colleges	9%
4-Year Colleges	9%
Junior High	7%
Senior High	4%
None	41%
Don't Know	16%

Figure 5.6 Plan Additional Levels of Instruction

Two out of five said that they had no plans of additional levels of uses for their videodisc system. Slightly over half indicated that the videodisc player was used at least as much as they had anticipated.

The survey asked three questions dealing with the subject areas in which the videodisc player was currently being used. As can be seen in Figure 5.7, General Science, Social Sciences, English, and Mathematics were at the head of the list. The future use of videodisc systems seems to lie in the general science area also. None of the other areas were even close.

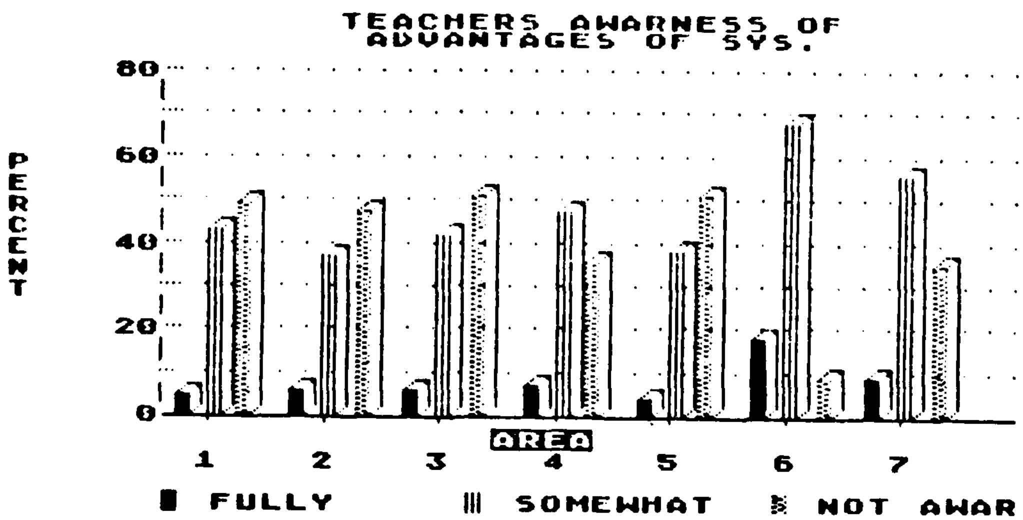


1. GENERAL SCIENCE
2. SOCIAL SCIENCE
3. ENGLISH
4. MATHEMATICS
5. FINE ARTS/MUSIC
6. PHYSICS
7. BIOLOGY
8. LANGUAGE
9. COMPUTERS
10. OTHERS
11. DON'T KNOW

Figure 5.7 Subject Area of Videodisc Use

When asked which areas had an inadequate supply of instructional programming available 41% indicated that they didn't know, but of the 167 who did answer 56% said that all areas needed work.

Teachers were asked if they were aware of the advantages of videodisc systems compared to other methods of instruction. The awareness was high among schools that currently have videodisc systems. The West and the specific states which were included by themselves had the strongest perception of teacher awareness. Figure 5.7 and 5.8 indicate that the split was very close between those somewhat aware and those whose teachers were not at all aware.



1. NORTHEAST
2. SOUTH CENTRAL
3. NORTH CENTRAL
4. WEST
5. NATIONWIDE
6. SCHOOLS WITH VIDEODISC PLAYERS
7. SCHOOLS WITH PLAN TO PURCHASE VIDEODISC PLAYERS

Figure 5.8 Teachers Awareness of Advantages of Systems

Although meetings and conferences play a major role in getting the information about videodiscs to the educational community, direct mail and brochures are used the most. Even publications were not as effective as direct mail. Of those who did read a publication regularly Instructional Innovator was the forerunner followed by Electronic Learning.

The technology is there and is slowly being accepted into the education systems around the country. School systems are moving towards videodisc systems and are taking advantage of its interactive capabilities.

C. WICAT BIOLOGY DISC

One of the best known educational projects is emphasized in WICAT's "Development of Living Things" videodisc. This biology disc was used in introductory biology courses at Brigham Young University and Brookhaven Community College. Figure 5.9 shows the table of contents for the biology disc. There are four major units of instruction: an introduction, an unit on the cellular and molecular basis of development, an unit on the genetic basis for protein synthesis, and an unit on genetic control of development. (WICAT, 1979)

The introduction consists of explanations of the features of the videodisc system and how to use it. Using special (tactics) keys the student is able to jump at any time to the next higher menu, select out the rules, motion sequences or micrographs from any lesson or unit and look at them separately. He also has the option of going directly into the practice problems at the end of the lessons.

CREDITS	SIDE A
UNIT 0 Introduction	00001
0.1 Motion Menu Introduction	00009
0.2 How to use this Intelligent Videodisc SYstem	23786
0.2c Learning with this Videodisc and your Role as a Learner	25497
UNIT 1 The Cellular and Molecular Basis of Development.	27205
1.1 The Basic Model of Development	27207
1.2 Cell Sturcture and Function	35177
1.3 The Central Role of Proteins	43505
(a) How Cells Differ	43514
(b) The Nature of Protein molecules	43560
(c) Structural Organization of Proteins	43601
(d) Enzymes and Isozymes	45146
Lab: Electropheresis	45187
Vocabulary Games	45449
Glossary	45505
Micrograph File	45887
Scientific Notation	46012
	SIDE B
UNIT 2 The Genetic Basis for Protein Synthesis	00001
2.1 Genetic Structures	00005
2.2 Protein Synthesis: Phase I, Transcription	02711
2.3 Protein Synthesis: Phase II, Translation	03927
2.4 More About RNA and Protein Synthesis	06285
Experimental Techniques and Evidence	
(a) Experimental Techniques and Interpreting results	06292
(b) Lab Guides	06493
(c) Experimental Evidence Relating to the Synthesis and Function of RNA	06573
UNIT 3 Genetic Control of Differentiation and Development	06722
3.1 Two Models for Genetic Control	06727
3.2 Cleavage: The Egg in control	10887
3.3 Gastrulation: Cells Move and begin to Interact	16813
3.4 The Mystery of Organogenesis	23921
3.5 The Development Process	24955

Figure 5.9 Biology Disc Table of Contents

In addition to the lessons in a learner controlled rule-example-practice format various laboratory exercises and lab guides were placed throughout the disc. Three different vocabulary games were also incorporated, allowing the students to become familiar with biology terminology introduced on the disc.

The following was the class makeup prior to the videodisc learning experience:

Selected Roles	% Choosing
Practical Learner	46.4
Informed Lay Person	27.8
Future Specialist	20.6
Biological Scientist	2.1

The project was divided into three phases:

PHASE I - Use a manual videodisc in biology instruction.

PHASE II - Control of the manual videodisc by microprocessor.

PHASE III - Evaluation of a videodisc designed for the intelligent videodisc concept.

Students were split up at the different institutions with some using videodisc instruction while others learned by the traditional approach. The results were divided into five areas:

1. Analysis of learning and study time.
2. The student achievement analysis.
3. Student and teacher reactions to videodisc learning.
4. Learning strategies using videodisc instruction.

5. Changes in knowledge, interest, confidence, and attention.

TIME ANALYSIS

	Presentation times	Outside study
PHASE III DALLAS GROUP		
Classroom Instruction	150 min.	232 min.
Videodisc Instruction	120 min.	160 min.
Total Learning Times	382 min.	261 min.

There was a 32% savings in total time for the videodisc group.

	Presentation times	Outside study
BYU GROUP		
Classroom Instruction	150 min.	265 min.
Videodisc Instruction	138 min.	101 min.
Total Learning Times	415 min.	234 min.

Here we see a 62% savings for outside study in the videodisc group with a 41% total time savings.

In the student Achievement Analysis the videodisc student retention scores were consistently greater than that of the classroom retention scores.

Student and teacher reactions to videodisc learning were as follows:

Things liked about videodisc systems.

a. The ability to learn at one's own pace.
b. The ability to review material easily.
c. The interactive practices, answer and feedback frames.
d. Motion sequences and visual illustrations.
e. Videodiscs are interesting and attention holding.
f. Videodisc save time in learning.

Things disliked about videdodisc learning.

a. Menus were displayed too often.
b. Hardware problems.
c. The noise of the computer and it was much too slow.
d. The videodisc screen was sometimes jittery.
e. More instruction is needed in the use of the keyboard.
f. Wanted to use headphones to reduce distractions.

When asked to rank the different methods of instruction the student preferred the videodisc.

The rankings were as follows:

1 Videodisc

2 Small Group Discussion

3 Individual Study

4 Computers

5 Films

6 Laboratories

7 Classroom Lecture

The preferred place to study while using a videodisc was in the Learning Center, followed by home and the library. The classroom was last.

As an educational tool the videodisc has proven itself not only feasible but also preferred in some situations to traditional methods. Students using videodiscs spend less time studying and achieve significantly higher test scores than those not using them.

VI. CONCLUSIONS

Effective utilization of existing videodisc systems has been demonstrated throughout industry, education, military, and the business world. The key advantage of these systems is their ability to respond to the user as well as giving him greater freedom. It is possible to improve existing capabilities through the continued cooperation between all parties involved. By combining the motion pictures, computer, and the book, the videodisc has become a powerful learning tool. Richard L. Currier called this new medium, "The ultimate educational tool."

Intelligent videodisc systems are now available from several sources and are very cost effective for many applications, especially for use in the military. Cost will continue to be the major driving force in the selection of videodisc systems.

Simulators represent the greatest saving over actual equipment. They were once the private domain of fighter pilots, but with advances in videodisc technology other applications are moving into the limelight such as ones for tanks, ships, and gunnery training. These tend to be more efficient than actual equipment because they:

* Provide feedback to the user.
* Provide for the simulation of a greater number of malfunctions.

* Tend to have fewer breakdowns when used by students.
* Tend to be more forgiving than actual equipment.

Another type of videodisc system that is becoming popular in the military community is the "Maintenance Simulator". There is little data available in this field. Most of the data collected thus far deals with course end performance. Research needs to be conducted on the job performance to measure to measure retention of the course material. "The purpose of school training is to qualify students to perform well on jobs in the field and not, per se, to complete a course at some school". (Gibbons, 1981)

Educations applications for interactive videos have multiplied in the past years. Some very interesting projects are taking place throughout the country. They all have the same thing in common. They show that the videodisc is an excellent tool and when used correctly it can enhance both classroom learning and individual self-study.

APPENDIX A

A LIST OF MANUFACTURERS AND PHONE NUMBERS OF VARIOUS VIDEODISC AND HARDWARE COMPANIES

PLATTER PRESSERS

Laser Video	(714) 630-6700	Anaheim, CA
Pioneer	(201) 573-1122	New York, NY
Sony	(201) 930-6432	Park Ridge, NJ
Technidisc	(313) 352-5353	Troy, MI
3M	(612) 733-3906	St. Paul, MN

PLAYERS

Hitachi	(312) 981-8989	Chicago, IL
Panasonic	(201) 348-7000	Secaucus, NJ
Philips	(212) 697-3600	New York, NY
Pioneer	(201) 573-1122	Montvale, NJ
Sony	(201) 930-6432	Park Ridge, NJ
VHD	(714) 660-9294	Irvine, CA

VIDEODISC RECORDERS

Dover Insruments	(617) 366-1456	Westborough, MA
Optical Disc Corp.	(714) 522-2370	Cerritos, CA
Panasonic	(201) 348-7000	Secaucus, NJ

HARDWARE AND SYSTEMS

Bell & Howell	(312) 328-5175	Chicago, IL
Compuvision	(212) 532-9113	Santa Cruz, CA
Digital Controls	(404) 441-3332	Norcross, GA
DEC	(617) 276-4111	Bedford, MA
Digital Techniques	(617) 273-3495	Burlington, MA
Hazeltine	(703) 827-2300	McLean, VA
IEV	(801) 531-0757	Salt Lake, City, UT
Micro Ed	(800) 642-7633	Eden Prairie, MN

Appendix A (continued)

NCR	(305) 323-9250	Lake Mary, FL
New Media Graphics	(617) 272-8844	Burlington, MA
Sony	(201) 930-6432	Park Ridge, NJ
Terak	(602) 998-4800	Scottsdale, AZ
Video Vision	(201) 377-0302	Madison, NJ

APPENDIX B

LISTING OF SELECTED VIDEODISC TITLES

AT&T, "A Demonstration Videodisc", Videodisc (July, 1980).

CBS, "A Walk Through the Universe", Videodisc (1983).

Computers in Education Program of the Alberta Vocational Center, "Deaf Awareness; Let Your Fingers Do the Talking", Videodisc, (1984).

Chrysler Corporation Automotive Electronics, "Chrysler Laser Atlas Satellite System", Videodisc system (1984).

Ford Motor Company, "Electronic Ignition System", Videodisc (October, 1979).

Grolier Electronic Publishing, "The Body Disc:, Videodisc, (1984).

IBM, "IBM Office SystemS", Videodisc, (June 1982).

ICS/INTEXT, "Trobuleshooting Microprocessors", Videodisc (1984).

Interactive Media Corporation, "Philip Pearlstein Draws the Artist's Model", Videodisc (September, 1984).

Interactive Technologies, "The National Science Test", Videodisc (1984). Touch screen Exhibition at the Boston Museum of Science.

ITT Programming Education Center, "Telephony", Videodisc (1983).

McGraw-Hill, Inc., "The Development of Living Things", Videodisc, (May, 1978).

National Gallery of Art & Videodisc Publishing, Inc., (VPI), "National Gallery of Art", Videodisc (1984).

Optical Programming Associates, "How to Watch Football", Videodisc (1984), "The First National Kidisc", Videodisc (1983).

RDI, "Dragon's Lair", Videodisc (1984). "Space Ace", Videodisc, (1984). "Thayer's Quest", Videodisc (1985). Played on the HALCYON Interactive Video System.

SmithKline & French Pharmaceuticals, "Diagnostic Challenges" Videodisc (June, 1980).

University of Nebraska, "Villa Allegre", five-disc set (1984), "Music Is", five-disc set "Infinity Factory", Ten-disc set, (1984).

U.S. Army Research Institute (ARI), "Call for Fire", Videodisc (June, 1980).

Video Inc., "ByVideo Disc 4", Videodisc (1984).

Video Vision, "Space Archive", Videodisc (1983-1985).

VPI/Vidmax, "MysterDisc", Videodisc (1984); "Robot Rebellion", Videodisc, (1984); "Laser Shuffle", Videodisc, (1984).

APPENDIX C

COST FACTORS OF VIDEODISC INSTRUCTION

1. REPRODUCTION COSTS: Reproduction of discs in quantity is typically less expensive than other visual media. 1982 costs:

* Two sided (one hour) disc - $19.00 (includes mastering)
* One hour videotape/cassette - $36.00
* One hour, 16mm film - $200.00

2. SOFTWARE MAINTENANCE AND REPLACEMENT COSTS: Videotape wears out. One hundred plays are about the maximum before picture quality deteriorates to an unacceptable level. Videodisc do not deteriorate with normal use.

Film maintenance is an ongoing, fixed expense. Each time a film is used it must be inspected--from end to end--for damage, dirt, and breaks requiring splicing.

3. AVAILABLE EQUIPMENT: Equipment and facilities now available for videotape production can be used without modification, for videodisc origination.

If you are already using TV for training, you have already amortized a third of your training equipment costs--TV monitors.

4. FACILITIES UTILIZATION: Users find videodisc players easier to use and more responsive than videotape players or film projectors. How much of the footage in a film or videotape library sits unused because people are intimidated by the projection/playback equipment?

5. SAVINGS: In addition to expected increases in training effectiveness efficiency as evidenced by tests of information delivery systems, the following are examples of general applications, and the type of savings that can accrue:

APPLICATIONS	SAVINGS
Part task simulation for equipment, operation, maintenance, and repair.	1. Reduce end item equipment requirements.
	2. Reduce training equipment maintenance costs and parts demand.
Various/surrogate field exercises.	1. Facilities cost effective use of fuels, ammunition, and ranges.
	2. Make more efficient use of field exercise time by vicarious pre-exercise training.
	3. Provide "field" training regardless of weather, geographic location, or equipment availability.
Soft skill training for gaining interpersonal skill development, language training.	1. Increase efficiency and standardization in instructor dominant training modes such as role playing, case study, interrogation training and counseling training.
	2. Standarization in interpersonal training programs.
	3. Provide vicarious experience in this.

AD-A164 992 A SURVEY OF VIDEODISC TECHNOLOGY(U) NAVAL POSTGRADUATE SCHOOL MONTEREY CA C W DAVIS DEC 85 2/2

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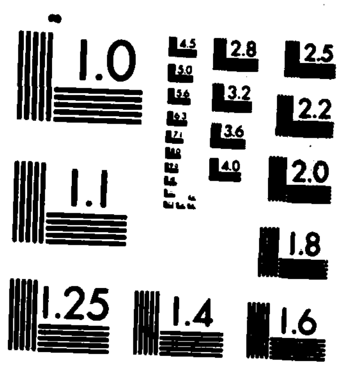

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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