DOCUMENT RESUME

ED 263 893 IR 011 879

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TITLE	Interactive Video in General and Special Education: A Development Manual.
INSTITUTION	International Council for Computers in Education, Eugene, Oreg.; Oregon Univ., Eugene. Rehabilitation Research and Training Center in Mental Retardation.
SPONS AGENCY	Office of Special Education and Rehabilitative Services (ED), Washington, DC.
REPORT NO	ISBN-0-924667-25-7
PUB DATE	85
GRANT	G008302264
NOTE	74p.
AVAILABLE FROM	International Council for Computers in Education, University of Oregon, 1787 Agate Street, Eugene, OR 97403-1923 (1-4 copies, $10.00 each; quantity discounts available).
PUB TYPE	Guides - Non-Classroom Use (055)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	*Computer Assisted Instruction; Computer Simulation; Computer Software; Drills (Practice); *Instructional Design; Instructional Development; *Microcomputers; *Production Techniques; Programed Tutoring; Secondary Education; Special Education; *Videodisc Recordings; *Video Equipment; Videotape Cassettes
IDENTIFIERS	Instructional Effectiveness; *Interactive Video; Story Boards

ABSTRACT

Designed to encourage and aid educators in developing interactive video software, this guide is an outgrowth of an interactive video research and demonstration project at the University of Oregon. Known as Project LIVE (Learning through Interactive Video Education), the objectives of the program were to: (1) develop interactive video courseware for secondary-aged handicapped learners, and (2) research the effectiveness of this instructional technology in relation to their learning performance. Section 1 of the manual provides an overview of interactive video and its various educational applications by explaining the hardware needed to operate such a system. Six instructional formats available to the instructional developer are then discussed: tutorial, simulation, drill and practice, educational games, guided presentations, and assessment. Designed for those who are interested in developing interactive video courseware, Section 2 presents 17 steps found to be important in the development process, and groups these steps into four broad development areas--instructional design, video production, computer production, and courseware finalization. A list of references completes the document. (JB)

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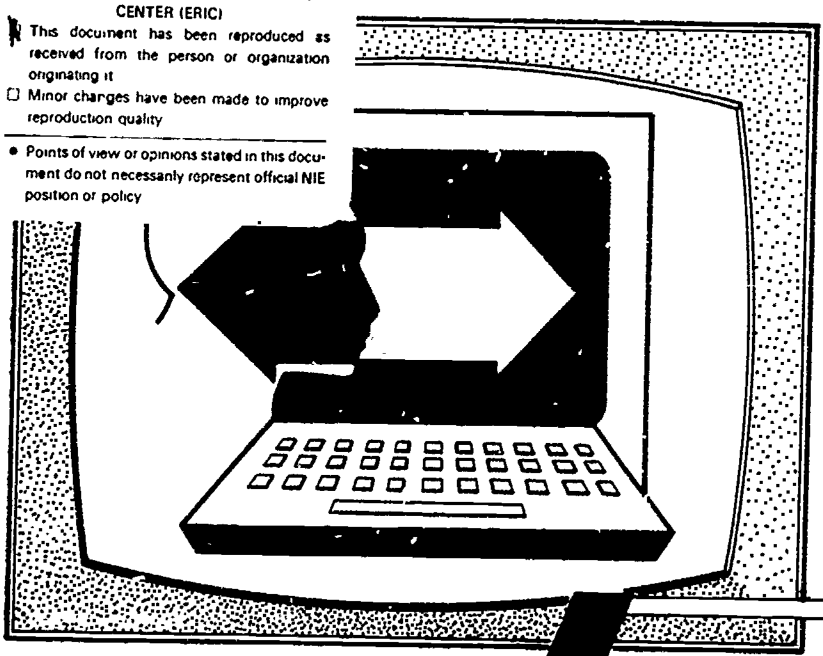
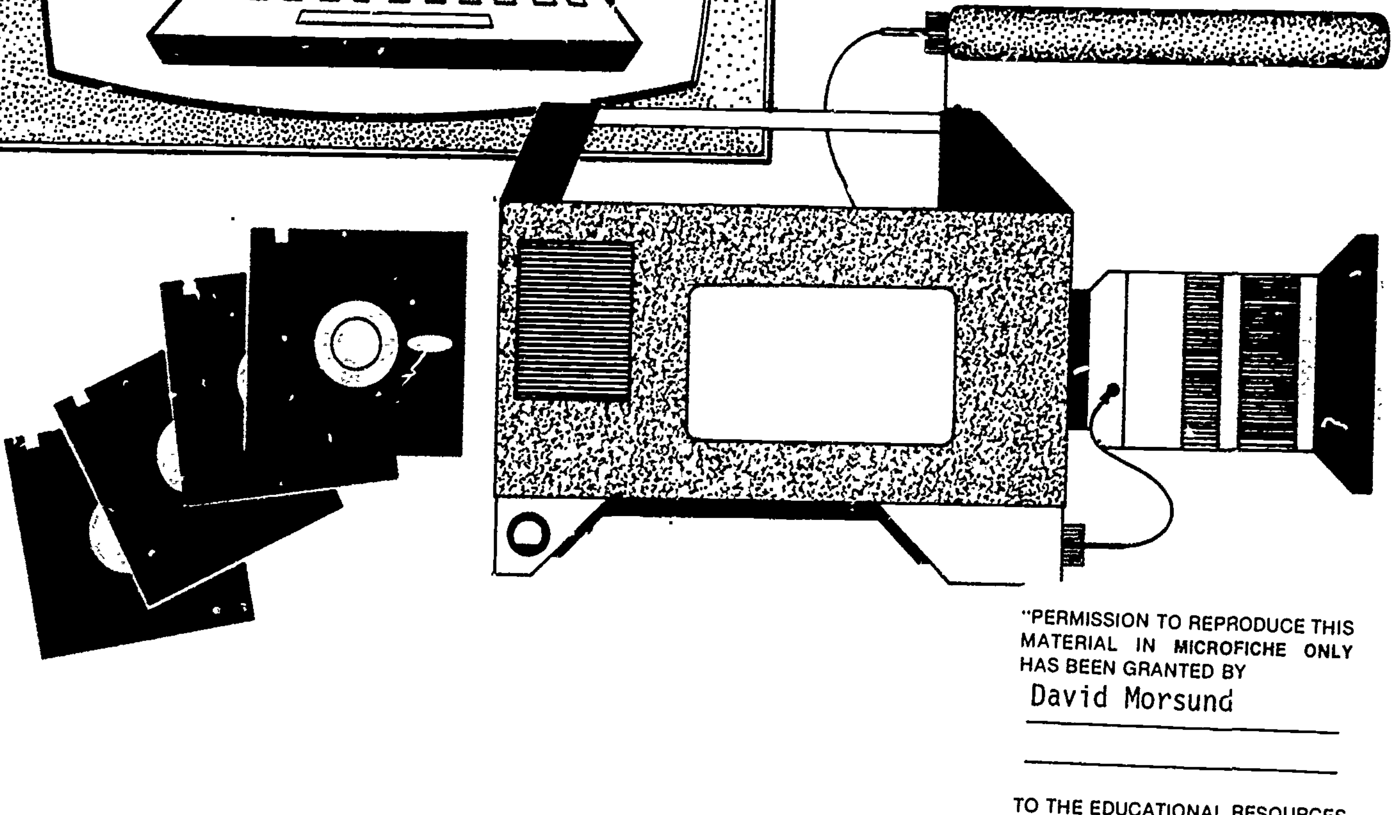


A Development Manual



ICCE Publications

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1787 Agate Street
Eugene, Oregon 97403-1923
(503) 686-4414, 686-4429

ISBN 0-924667-25-7

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Eugene, Oregon 97403

Published by
International Council for Computers in Education
First Printing June 1985
University of Oregon
Eugene, Oregon

ISBN 0-924667-25-7

This publication was supported in part by
Research Grant #G008302264 from the
U.S. Department of Education
Office of Special Education and Rehabilitative Services
Special Education Programs, Washington, D.C., 20202

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Introduction

Interactive video has been defined as:

> . . . a system of communication in which recorded video information is presented under computer control to active users, who not only see and hear the pictures, words and sounds, but also make choices affecting the pace and sequence of the presentation (Hoekema, 1983, p. 4).

In essence, it represents a new technology which is exciting many educators with its ability to effectively combine computer assisted instruction and educational video as two powerful learning media.

Simply speaking, the patience and speed of the computer are merged with the capability to provide learners visual information with respect to what is being taught. The implications this merging of computer assisted instruction and educational video has on the impact of learning is even more apparent when considering the benefits of each media (see Table 1).

Unfortunately, the fields of general and special education currently lack courseware designed to take advantage of this promising technology. As such, a major intent of this manuscript is to encourage and aid educators in developing interactive video courseware.

This effort is an outgrowth of an interactive video research and demonstration project at the University of Oregon known as Project LIVE, which is an acronym for Learning through Interactive Video Education. The objectives of this program are to: (1) develop interactive video courseware for secondary-aged handicapped learners, and (2) research the effectiveness of this instructional technology upon their learning performance.

Table 1

The Benefits of Interactive Video

Computer Assisted Instruction
• Individualized instruction
• Immediate feedback
• Active learner participation
• Repeated trials
Educational Video
• Real-life settings shown
• Real-life situations portrayed
• Appropriate models presented
• No reading required

Throughout the remainder of this manuscript, we will be using a variety of courseware development illustrations drawn from our experiences with Project LIVE. It is important to note, however, that the design principles and production procedures included are sufficiently "generic" so as to aid in the development of educational interactive video courseware, regardless of the intended audience or the focus of the educational content. As such, what is presented in the two major sections is equally applicable to the development of either general or special education interactive video courseware.

The purpose of Section 1 is to provide the reader an overview of what interactive video is and the many different ways it can be applied in education. First, the hardware components necessary to create an interactive video system will be presented. This general introduction to the mechanical aspects will provide the less familiar reader with a basic understanding of how interactive video operates. Second, six instructional formats available to the interactive video developer are identified and discussed. These educational applications include: (1) tutorial, (2) simulation, (3) drill and practice, (4) educational games, (5) guided presentations, and (6) assessment.

The second section is designed for those who are interested in developing interactive video courseware, and herein lies the major intent of the manual. That section contains information on each of the 17 steps we have found to be important in the development process. They are presented within four broad development areas: (1) instructional design, (2) video production, (3) computer production, and (4) courseware finalization.

Section 1

Overview of Interactive Video

The purpose of this section is to both introduce the reader to the different hardware system configurations of interactive video, and to explore potential software applications in the fields of general and special education. It is intended to provide those with less experience in interactive video the basic knowledge necessary to fully consider where and how this relatively new and untapped technology might be used. It should further help to clarify development issues which are discussed in more detail in section 2.

Hardware Systems

The heart of any interactive video system is the video player itself: a videodisc player (VDP) or videotape recorder (VTR). We will take a look at both machines and their relative advantages with respect to this instructional technology. First, however, we will examine the different levels of interactivity commonly used to categorize interactive video hardware systems.

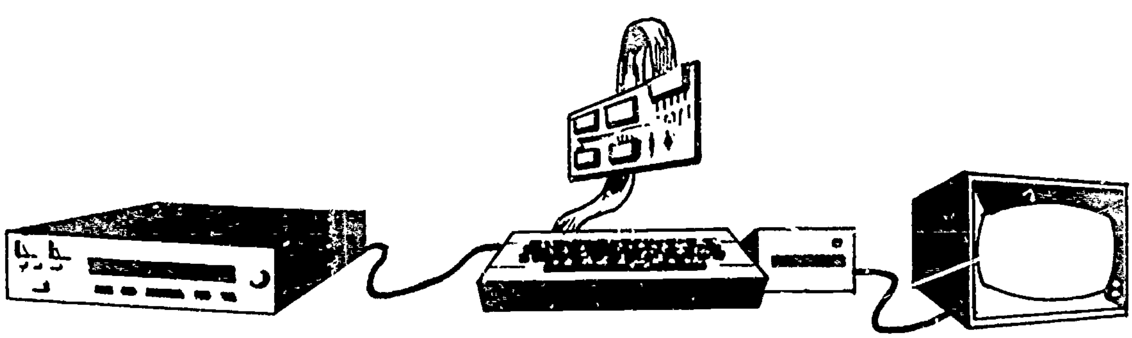
Levels of Interactivity

Three levels of interactivity have gained universal acceptance within interactive video to describe the amount of controlling interplay possible between the student and the system. Levels one and two apply to specific implementations of a videodisc player for interactive video, while Level three can use either a videodisc player or a videotape recorder. Level three provides the most power and flexibility.

Level One. Level one refers to the use of a basic videodisc player with no special computer processor associated with it. The machine can be manu controlled through its remote control device to quickly jump to any re frame or chapter location on the disc. Chapters are a number of ined locations on the disc which mark the beginning of logical units isual material. No computer programming is incorporated with a level one system.

Level Two. A level two system is a videodisc player with a built-in microprocessor which can hold and execute small computer programs. Several programs can be written onto a level two videodisc at the time it is mastered. These programs can later be run automatically without need of a separate computer. The programs are small and limited in their capabilities, however.

Level Three. Level three interactive video systems, which are the focus of this manual, are comprised of four hardware components as shown in the figure below. They are: 1) a microcomputer, 2) a videodisc player or a videotape recorder, 3) a computer-video interface card, and 4) a video monitor. These four components when properly connected allow the user to run interactive video software which consists of a computer program and associated video on ei her disc or tape.



The central piece of equipment in a level three system is the interface card. It is essential because it is what allows the computer to operate the video recorder and the TV monitor. In most typical interactive video systems, the interface card is designed to be plugged into one of the expansion slots inside the microcomputer. Its machine level programs are then accessible to the computer for handling information flow between the video player, computer and video monitor.

Some interface cards now available reside outside the computer, and interface with the computer through an RS-232C serial port. The advantage to this approach is that the card will work with any microcomputer with a serial card. Otherwise, an internal interface card must be purchased for each specific computer, such as the Apple II or IBM PC.

There are many manufacturers of interface cards, and one should shop around for one that delivers the features and reliability needed at a competitive price. Most cards on the market at this time work either with a certain number of specific videotape recorders or one or more videodisc players. Thus, if you want to use both disc and tape, you must look specifically for a card that will support that or purchase two cards.

Both level two and level three computer programs can be used for instructional purposes much as computer assisted instruction (CAI) programs. They can allow for student inputs just as in CAI, but unlike a CAI program they have the further capability to control the playing of various video segments depending upon those student inputs. Thus, different visual and auditory feedback can be provided to a student depending upon responses to questions (e.g. correct or incorrect). Level three systems can also easily be programmed to routinely output student results to both a computer diskette and to a printer for permanent records.

Videodisc

Videodiscs used in today's interactive video systems employ an optical laser technology. The disc itself looks similar to a long play audio record, but is silver in color and much more durable. A laser beam in the VDP is focused to read the video and audio information stored in millions of tiny micropits on the disc. No physical contact is made with the surface of the disc during the read process, and thus no wear occurs to the disc. This technology also provides a very high quality reproduction of video and audio by current visual media standards.

A videodisc can hold 54,000 still frame pictures on each of its two sides. This is also equal to 30 minutes of motion video (30 frames per second X 60 seconds X 30 minutes = 54,000 frames). Further, the disc can be used to store any combination of still pictures and video. Thus, a single side of a disc could hold pictures of all the articles in an entire museum, and still have room for several minutes of interspersed narration.

The source of these visual materials can come from a wide variety of media such as film, videotape, and 35mm slides. Existing materials in these formats can be combined into a single instructional program. A wealth of educational materials exist on film and can be accessed by developers for inclusion on their disc productions through arrangement with the distributors of those materials.

The videodisc player can access any frame on the disc directly from any other frame. Thus, while search speeds vary from model to model, they are quite fast. The time required to search from end of a disc to the other ranges from a minimum of 1-2 seconds on more expensive industrial models to approximately 15 seconds on cheaper consumer models. Of course, average searches will be far shorter, and therefore, quicker. Currently, the costs of videodisc players range from $400 to several thousand dollars, with a typical player used in interactive video costing less than $1,000.

Most VDPs come with a remote control device which allows control of special features from across a room. Thus, pictures can be frozen, a given frame or pred ined point (chapter) can be accessed, or the speed and direction (forward or reverse) can be changed. The videodisc chapters are analogous to those of a book, and allow the user to easily move to the beginning of logical units of material within the disc.

Videodiscs are created through a pressing process in one of several plants in the country according to very specific instructions about the layout of materials provided by the developer. Currently, the minimum setup costs for such a production are $2,500 for one 30 minute side of a disc. Cost for each disc pressed is then determined by the total number ordered, beginning at $18 per disc for orders of less than one hundred. These figures do fluctuate some and will no doubt change over time, but they are provided here to give the reader an idea of what kind of costs to expect.

Due to these costs, it is very important that all materials and instructions be accurate when pressing a disc. The expense of repressing a disc to remove errors is borne totally by the developer. Videodisc pressers do provide a service to protect developers against such a problem, however. For approximately $800, one copy of the disc will be pressed to allow field testing for errors and problems. That charge is not applied towards the eventual costs to mass produce the videodisc, but might save money required to press a disc a second time.

The videodisc has essentially three advantages over videotape. First, because of its clearer still frame capability, the videodisc is a superior system when large amounts of text need to be presented for the student to read. Also, because the laser reading method does not touch the surface of the disc, the disc player can maintain a still frame picture on the TV monitor for hours without damaging the disc. Videotape players will only stay in PAUSE mode for two or three minutes before automatically going to STOP in order to protect the videotape from being damaged. Therefore, videodiscs are very appropriate for applications where it is important to use libraries of still pictures or written material for study.

Second, videodisc provides much faster access time to find a given video segment than videotape. The superior access speed of videodisc is often used in comparisons of the two media to discount the use of videotape. While this is often a valid determining factor, it is one that should be considered in the light of the true demands of the learning situation. That is, not all instructional situations truly require the kind of rapid access the videodisc can provide. For example, slower paced or teacher led lessons might not be affected by the delays, while a computer simulation of a social situation might be.

The third advantage of videodisc is the durability of an individual videodisc over a videotape. Videodiscs can be handled and even slightly scratched without affecting the image it will produce. Videotapes are more sensitive to the environment and will naturally deteriorate some over time.

Videotape

Videotape is also a viable and effective medium for many interactive video applications. Videotape recorders have quickly become a common item in both schools and homes through the 1/2 inch VHS and Beta consumer formats. The videotapes in these formats, and many of the machines themselves, can be used in certain interactive video systems. Other systems require specific industrial grade 1/2 inch videotape recorders.

Videotape recorders are only used in the more advanced level three systems. Level two is impossible to employ on tape because the technology does not exist to store computer programs on tape for later reading by a recorder. Level one interactivity is by definition a videodisc player using just its remote control device. Videotape recorders can be used by remote control, also, but unlike the videodisc it still must access points on the tape sequentially, and therefore slowly.

Videotape has three advantages over videodisc for interactive video. The first of these advantages is that it is a read/write medium. That is, if you decide you do not like a scene that has been shot on videotape, it can be shot over and reedited onto that same tape. A videodisc is "read only" which means the only way to modify a disc is to repeat the expensive mastering process. Thus, even if you are developing materials for videodisc it is a good idea to thoroughly field test them on videotape before mastering. This can be done easily for most projects, because most materials are usually recorded on videotape before being sent to be pressed anyway.

Another potential advantage of videotape is the longer play times available on one tape over the play time on videodisc. The videodisc holds 30 minutes of material per side or one hour for one disc. A standard size VHS videotape will hold two hours of material. This in combination with the added expense of videodisc mastering can create a difference in presentation approaches that might be tried with videotape as opposed to videodisc. However, as with the issue of faster access time with videodisc, this factor may not be relevant for a given application.

Finally, an interactive video program on videotape is cheaper and quicker to produce. The videodisc production costs would include all the same costs as for videotape plus the extra mastering charges. In addition, greater care must be given to creating the desired layout of materials to give to the disc pressers. For smaller interactive video projects these factors may be significant.

Software Applications

The potential of interactive video for instruction is just beginning to be tapped. The idea of video learning materials under computer program control is still new enough that educators have not had time to fully explore new and innovative approaches of teaching that fully harness its capabilities. Currently, the instructional form that interactive video takes in the classroom or training setting often resembles other forms of instruction common in these settings. If the use of video is added to CAI, it is logical that the same CAI instructional formats can be used. However, other formats also become possible for the instructional designer to implement.

Thus, the six program types of interactive video presented here reflect both common CAI formats plus new formats. The six types are tutorial, simulation, drill and practice, educational games, guided presentation, and assessment.

Tutorial

A tutorial program resembles the theoretical structures and procedures found in programmed learning materials popularized in the 1960's, where the learner is presented new information, quizzed on it, and then branched for further interactions based upon the accuracy of past responses. These programs stress active responding on the part of the student, and make use of extensive feedback and branching to previously taught or similar material when a student is not mastering the specific objectives.

The principles of the tutorial approach when applied to interactive video closely resemble the combination of the teacher as an effective tutor and the computer as a patient programmed instructor. Interactive video adds the live motion and voice of the teacher to the testing and branching capabilities of the computer. In addition, supporting visual aids for new concepts can be incorporated into the video sequences.

A level one videodisc, Introduction to Economics, developed by the Minnesota Educational Computing Corporation, provides an approximately seven week mini-course relating to major economic concepts (Kehrberg and Pollack, 1984). This program creates an active learning environment by instructing and querying the student as well as providing feedback. Individual student manuals also provide reinforcement activities and serve as a reference.

This approach of programming classroom course content onto videodisc is likely to become more popular in the near future. Rather than replacing teachers, it provides a rich source of visual examples and problems to use within the course presentation. In this sense, the interactive video program becomes analogous to a textbook.

Interactive video tutorial approaches are also being used in industrial training situations where workers need to learn complex work activities such as electronic assemblies. These applications take advantage of the tutorial's ability to teach facts and the video's ability to visually show the work setting and tasks. Such programs often incorporate workbooks and additional lab time to complement the interactive video component.

Simulation

Simulation of real settings and events is a powerful teaching tool. It might be the evolution of a species, the assembly of an electronics board, a social interaction, or the budgeting of a small business. Natural consequences of actions can be visually presented, thereby allowing learning by experience without the cost or danger of setting up the real situation. Interactive video combines the unique benefits of computer simulation with the ability to visually represent community-based settings and situations. Real life situations can be depicted and decision points can be built into the lesson, therefore, enhancing the learning process for students or trainees.

An example of educational simulation for the hearing impaired is DAVID, an acronym for Dynamic Audio Video Interactive Device (Sims, et al, 1979). The system and accompanying programs were developed at the National Technical Institute for the Deaf to assist students with speechreading skills. Interactivity is programmed into video lessons that simulate job interviews, social encounters, and situations in the business world. Students see the situation presented, self-select a conclusion, and see the consequences. Several potentially dangerous or embarrassing situations and varying conclusions are incorporated.

The Project LIVE level three courseware on life enhancement skills is another example of simulations of real life settings and decisions for students. Content development areas include problem solving, asking for help, relating to others, and positive thinking. Multiple lesson courses for each area incorporate simulated decision making situations for handicapped learners to respond to. The situations are presented in a wide spectrum of settings to enhance generalization. This may be particularly useful for special education populations who often have less exposure to, and therefore less practice in, real life social interactions.

The Puzzle of the Tacoma Narrows Bridge Collapse is a level one videodisc that uses simulation for instructional purposes. The program depicts the 1940 collapse of a bridge in Tacoma, Washington. It is designed for high school to college math or physics classrooms and includes a student workbook. Students are involved in a series of experiments on harmonic motion which led to the collapse of the bridge. They also test hypotheses and take quizzes on the conclusions drawn.

Additional teacher assistance, workbooks, and other traditional materials are often incorporated into interactive video lessons. The use of simulation does not replace lab experiments, fieldtrips in the community, or on-the-job training. Instead, it enhances learning by providing students the opportunity for trial learning and repeating practices as needed.

Drill and Practice

The teaching approach known as Drill and Practice is as old as the chalkboard and flashcard. The student is given a set of work problems to reinforce learning of facts that have been previously introduced. While reported research has found CAI drill and practice to be an effective learning tool, it is often attacked because it does not take full advantage of the capabilities of the computer (Fletcher, 1983). Interactive video drill and practice programs will not use all of the capabilities of this medium either, but may also be worthy of consideration. Perhaps animated characters presenting materials and asking questions may provide the motivation that is necessary for young learners to benefit from drill. If young children were required to interact with Big Bird from Sesame Street perhaps practicing numbers, addition facts, or Spanish vocabulary would be easy and exciting.

Such an example can be seen in the previously discussed DAVID system. It provides eight different types of drill and practice to hearing impaired students. One type of exercise is on phoneme discrimination, identifying differences on the lips, between the words "wish," "fish," and "dish." Drill on sign language vocabulary would be another possibility.

Educational Games

Another teaching technique commonly found in the classroom is the use of educational games. This approach is often used to provide motivation in the learning process. Games can be designed for any age group to reinforce concepts in math, social studies, and other content areas. Combining the technique of simulation with games can promote creative thinking. Also, problem solving skills may be best learned by playing well designed games in the classroom.

Interactive video game features can be added to the program types described thus far, such as tutorial, simulation, or drill and practice. Creative design can both motivate and teach students across a range of subjects and abilities. One example of gaming features being added to existing materials is the concept of repurposing level one videodiscs. Videodiscs, and videotapes, that were developed for straight educational viewing can be supplemented by later adding level three computer programs. One way this is being done currently is to write a program to quiz students about the video materials, and award points for correct student responses. Thus, a straight video has been turned into an educational game.

The possibilities of an interactive video game are exemplified by the animated video arcade game called Dragon's Lair. A path with various choices is presented to the player and quick reflex actions guide "Dirk the Daring" along the chambers of an old mansion. This program uses a random access laser disc which allows for rapid starts at any point on the disc. While it is not an educational game, Dragon's Lair vividly shows interactive video in the gaming format. Animation or live action could also be used to develop games where different branches or routes to be taken are intrinsically educational. The student would be allowed to see real life situations and have control over the course of a series of events.

Guided Presentation

The guided presentation format incorporates the concept of retrieving information from anywhere on a videodisc or videotape. It is particularly suited to the fast access capabilities of the videodisc player. This speed along with the ability to vary program pace gives this particular technique a characteristic uncommon to other formats discussed thus far. The guided presentation may become a common way of visually storing an encyclopedia of facts, descriptions, and pictures.

The Sears Catalog videodisc is an example of an existing level one guided presentation. It provides a menu similar to a traditional catalog index to allow the user to choose the materials to be viewed. If interested in a particular home product, an additional decision point permits the user to see a demonstration of its use. In this case, the order of presentation is varied more than the pace. This format can also be applied to museums, art collections, and similar large bodies of materials.

The American Heart Association has designed a guided presentation simulation which uses a manikin for training persons in the use of Cardio-pulmonary Resuscitation (CPR). The manikin is interfaced with an Apple computer and Sony disc player to allow information about student CPR practice to be analyzed. The program gives appropriate performance feedback on a TV monitor for the student. Ample practice time is available with information being presented in an order and at a pace appropriate to the specific CPR trainee.

Assessment

An integral part of any educational or training program is diagnosis of entry student skills and deficits, and assessment of student learning. Formal testing sessions, as well as informal assessments, are common for placement in classes at all levels. Tests are standardized on various populations and are, therefore, reliable instruments for use by teachers, therapists, psychologists, and other professionals.

Combining video with a computer assessment program allows for animated or real-life presentation of materials. Pictures and/or a narrator can accompany the presentation of questions. This kind of audio and visual presentation eliminates the need for reading. Also, the two audio tracks available on videodiscs allow the use of two languages, or two levels of difficulty, with the same presentation.

An example of an interactive video assessment program that utilizes this feature is the Math Assessment program developed at Utah State University. A series of questions related to the understanding of early math concepts is presented in lively animation in either English or Spanish. The student chooses the correct answer by touching the screen which is specially designed to receive the response. After a certain number of correct or incorrect responses are given, the computer chooses the next appropriate question as designated by the assessment tool. The use of this form of interactive video introduces a true standardization of presentation for testing situations. Further developments in this area are needed.

Summary

These six instructional formats of interactive video are not meant to be exhaustive. They do represent, however, a variety of teaching methodologies that lend themselves to this new media. The combination of video and computer for instructional purposes will allow for new and exciting ways for both children and adults to learn in either school or training settings.

While the six formats have been presented separately for learning purposes, they obviously can and are being combined in individual programs.

As previously mentioned, gaming features a_e often implemented into simulations, tutorials, and drill and practice. Also, simulations of events can be presented periodically within a program which is primarily tutorial. Providing drill and practice of specific facts may be a remedial component of a larger tutorial or simulation program.

An early and sophisticated look at the possibility of integration of different program types in CAI is provided by Stolurow (1975). He proposes a truly intelligent master program that has access to a wide variety of demographic and performance information about the student to match to various teaching strategies. The emergence of interactive video and artificial intelligence systems may soon elevate this concept to the realm of feasibility.

Section 2

Development of Interactive Video Courseware

The development of interactive video materials is a most challenging endeavor, in that one is simultaneously engaged in producing both video and computer programs. Additionally, these combined programs must fit together in an instructionally sound manner. When the efforts from these two skill areas are successfully combined, the results can indeed be satisfying for the developers and effective for the learners.

The interactive video development process can be divided into four general activity areas which encompass 17 specific steps. They are:

Instructional Design

Step 1 Identify project resources.
Step 2 Define learner target group(s).
Step 3 Determine instructional content and objectives.
Step 4 Select hardware system.
Step 5 Design instructional interactivity.
Step 6 Develop instructional flowcharts.

Video Production

Step 7 Develop storyboard and videoscript.
Step 8 Plan for video production (preproduction).
Step 9 Produce video materials (production).
Step 10 Edit video materials (postproduction).

Computer Production

Step 11 Design computer courseware.
Step 12 Write computer programs.
Step 13 Integrate video materials into computer programs.
Step 14 Debug computer programs/courseware.

Courseware Finalization

Step 15 Write accompanying documentation.
Step 16 Field test and revise courseware.
Step 17 Market and distribute courseware.

A detailed discussion will be provided for each of the 17 steps within these four areas. Furthermore, many of these steps will be clarified with practical examples drawn from our experiences in developing interactive video courseware through Project LIVE.

Instructional Design

The educational value of an interactive video production can only be as good as the quality of the instruction. That is, if the material is not relevant and presented in an effective manner, the technology will not meet its potential as a learning tool. Furthermore, the nature of the instructional design will determine the amount and complexity of the subsequent computer and video work. It is for these reasons that instructional design is a critical stage of development.

A structural process in addressing this first stage of development can aid in reducing problems and saving time in later computer and video production. Based on our experiences, we have found the following six steps to be helpful in providing this structure. These six steps define instructional design in its broader sense.

(1) Identify project resources,
(2) Define learner target group(s),
(3) Determine instructional content and objectives,
(4) Select hardware system,
(5) Design instructional interactivity,
(6) Develop instructional flowcharts.

While there is a natural sequencing implicit in the listing of these steps it is not intended to suggest that one can simply proceed from step 1 through step 6. In other words, these six steps are interdependent. For example, while content and objectives (Step 3) have implications about hardware and interactivity design (Steps 4 and 5), the converse is also true. That is, decisions made about hardware and interactivity may uncover new teaching possibilities which, in turn, influence content and objectives. Similarly, a situation might exist where a hardware system is already in place and its capabilities will dictate content, objectives, and interactivity.

Step 1: Identify Project Resources

A realistic budget is important regardless of the size or ambitions of the project, in that the amount of money and resources available will determine the nature of the instructional design possible. It is therefore important to tailor your production goals and objectives in accordance to the necessary resources to meet them.

Table 2 presents a list of the budget items that Project LIVE found necessary to accomplish its objectives in interactive video courseware development. Of course, the exact budget items and their actual dollar

Table 2
Potential Budget Items for Consideration

Personnel	Equipment	Production
• Instructional designer	• Microcomputer	• Transportation
• Content specialist	• Videotape/disc player	• Film, developing, processing
• Computer programmer	• Interface card	• postproduction: slide transfers, titling, dissolves
• Video producer	• TV monitor	• printing documentation
• Actors	• Camera	• duplication of tapes
• Production crew	• Video editing deck	• materials packaging
• Typist	• microphones, lights, etc	
	• videotapes	
	• computer diskettes	

amounts will vary for each individual project. For example, important to the success of any project is a representation of knowledge and skills in the areas of instructional design, the content area to be taught, video production, and computer programming. On larger and more ambitious projects each of these areas can become a major effort requiring the participation of several persons, whereas for a modestly budgeted project one staff person may be responsible for two or more skill areas (e.g. instructional design and computer programming).

As a final note, advice from both video and computer specialists will be most important in getting a handle on costs. That is, how much does an interface card cost? What is the cost to press a videodisc? What are costs of different video production options? These are just a few of the types of costs you will need to consider when planning what courseware to develop and the manner in which it will be presented. In essence, the importance of identifying project resources and accurately estimating their costs will become increasingly clear with the number of decisions to be made during the remaining steps.

Step 2: Define Learner Target Group(s)

The main benefit of defining target groups is to incorporate the learning characteristics and needs of that group into the design of instruction. The design and development processes can then flow naturally from the identified learners' needs. The content area specialist for the project should be aware of the acknowledged learning characteristics of the targeted student groups. Research studies on learning and optimum instructional approaches are available in the literature across many different student populations and subject areas. In some cases, materials further address the application of computer and/or video media to specific student disability groups or age levels.

While developing Project LIVE curricula, several learning characteristics of the mentally retarded were considered. One helpful literature source was a chapter by Allen and Goldberg (1980) entitled "Learning Characteristics of Mentally Retarded." It presents the learning deficits of the retarded (e.g. poor attending skills, reading deficiencies, short-term memory deficits) and itemizes the implications of those deficits for developing instructional media. The five guidelines presented include: 1) directing attention to the specific learning point, 2) reducing the information load during the presentation, 3) presenting instruction in a structured and repetitive manner, 4) involving the student actively in the learning process, and 5) instruction in generalized learning. Each of these factors had an impact upon the final formats used for presentation of content and feedback.

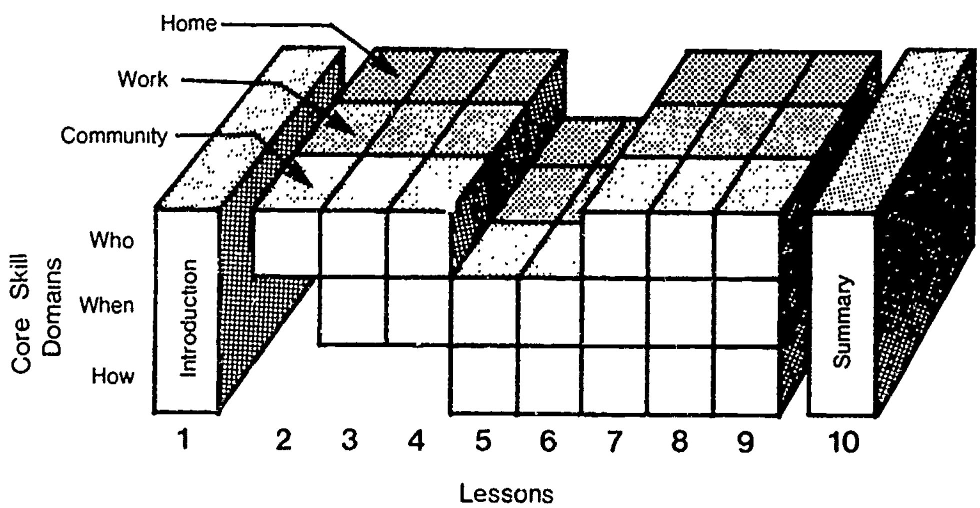
Finally, it is possible for one curriculum to be appropriate for an age or intelligence level other than the primary target group. Curriculum may be matched to students by mental age rather than simple grade level. Thus, handicapped learners might benefit in high school from the same curriculum that normal learners studied in junior high school. With very little extra effort, a curriculum might be made suitable for a much wider audience.

Step 3: Define Instructional Content and Objectives

One effective method to define instructional content for a new curriculum is to use a <u>top-down</u> approach. That is, one starts by defining the top, or most general, level of content, proceeds to defining the specific content, and finally determines the exact learning objectives for the curriculum. This provides an orderly flow of content definition and increases the probability that the final curriculum will be instructionally sound.

Once the general content area is defined, the instructional designer and/or the content specialist on the team should assume leadership roles to define the specifics of what is to be taught. An important design tool to use in this task is the scope and sequence plan, which schematically represents the content to be developed. The scope of the content refers to the subcategories being taught, and the sequence represents the order in which these subcategories are introduced. A sample scope and sequence chart for a curriculum of Project LIVE is shown below. This chart shows content and order for a ten-lesson curriculum teaching who, when, and how to ask for help.

Scope and Sequence



Finally, interactive video is a new and powerful medium that can present content in original ways that are either difficult or impossible through other teaching formats. In general, it is a good idea to be creative and not simply duplicate instructional materials that are already effectively covered through conventional modes. One way to uncover unique content areas that lend themselves to interactive video is to conduct a needs analysis for the defined learning group(s) within the general area you wish to address. Examining existing curricula materials is often helpful in this process.

Step 4: Select Hardware System

The main decision to make in choosing an interactive video hardware system is whether the final product will be for videodisc or videotape. There are inherent differences in the two media that can affect the design and development of interactive video materials. However, materials on videotape can always be pressed onto a videodisc at a later time. A full discussion of the advantages of these two media is provided in section one.

Once the major decision between videodisc and videotape has been made, all additional hardware to include in the system must be selected. This includes the microcomputer, interface card, and monitor. One critical piece of information is that the monitor must be a video monitor, and not a computer monitor. Additionally, most interface cards cannot use the standard television VHF or cable connections. Do not purchase a television to use for interactive video until you are sure it has the necessary monitor connections to hook to your interface card.

The needs and capabilities of the intended learners are obviously a key consideration in determining input/output devices. For example, when physically handicapped students are potential users, the software should support multiple forms of input. Both CAI and interactive video programs can be developed to support input from either the keyboard or a special hand controller, such as a joystick, mouse or single switch device.

One pragmatic criterion for determining additional hardware to incorporate into a system is its cost and availability. This needs to be measured against the increased strength of responding offered by the hardware. For example, a touch sensitive monitor can be an effective input device for some applications. However, it is also an additional cost that any end user must bear to be able to use the software. At this time, most schools and training programs will not have one available.

This step of the instructional design process is also the time when thought needs to be given to necessary development equipment. If a top quality product is planned, then the video equipment used for production must also be of high quality. The decisions on what equipment to use can be complex and difficult. An informed video person should be consulted before money is spent on new purchases.

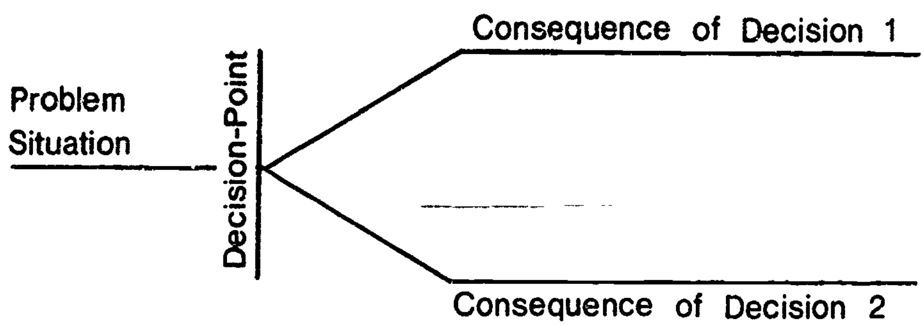
Video production will require at least one video camera, microphones, lighting, and a video editing system. In addition, a microcomputer must be chosen if a level three program is being developed. Many such efforts are developed for Apple II computers, but IBM PC's and Commodore 64 computers are also often used. Each machine has its own set of users which may determine which to use for a given application.

Step 5: Design Instructional Interactivity

There are many possible formats for interactive video. Part of the excitement of development is the realization that the possibilities for student/teacher/video interactivity are extremely broad and varied. The chosen instructional approach will help guide developers in the determination of the exact form of interactivity regardless of whether the chosen application is tutorial, drill and practice, simulation, game, guided presentation or assessment. Let us draw examples of formatting strategies from some of these applications.

The branching strategy described in the tutorial approach allows the learner to respond to a question about the content and receive appropriate feedback depending on that response. The vertical line in the figure below represents the decision point in a problem situation. The designer deter-

Scenario Format



mines what video segment the user will be shown next depending on the response. That is, the responses will dictate when the user is allowed to move to new material, branched through more remedial feedback, or given the same question again.

The user can also be allowed varying levels of control over the order in which content is viewed. One straight forward way to do this is through a menu of options which lists either topics or levels of difficulty within the curriculum. The curriculum content and the target audience will determine how much interactivity is needed.

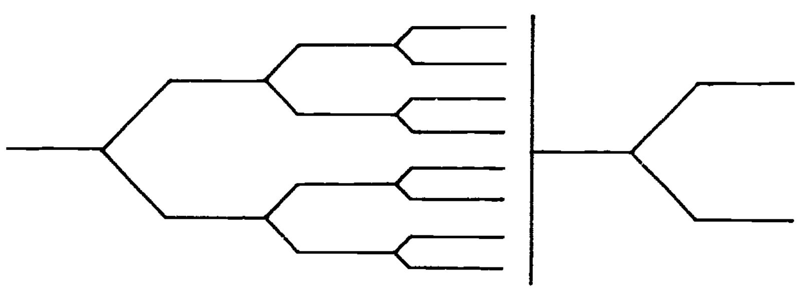
Instructional issues in the tutorial approach are plentiful. Answers to the following questions will help guide the designer of a tutorial interactive video.

- Will the question be true/false or multiple choice? If multiple choice, how many options will be presented?
- What form should the feedback take? Should it be solely informational? Or, should motivational feedback be incorporated?
- Are incorrect responses handled similarly or differently from correct responses?
- What form of stop criteria will be used with question items?

  How many times can an incorrect response be given before the correct answer is given to the user?
- How much student control will be allowed? Can students choose the order of lessons? Can they determine when to take a test?

Other formats may be chosen to make the video a real-life simulation. If such is the intended application, then the points of interaction should allow the user to determine the course of events in the simulation. The format below shows the nature of this type of interactivity. The

Vignette Format



vertical lines, again, indicates a decision point. This format allows the student to choose the route and eventual ending of a given situation.

If the intended application is to be an educational game, the format could be one of repeated presentations and responses similar to those outlined above. A combination of different formats could be incorporated in order to provide maximum motivation and excitement during the game. Various key strokes or input devices (eg. joystick) could be required so that the user gains a greater sense of control over the video.

Additional interactive video applications may require the innovative design of other formats. There is a wide range of possibilities, and it is important that these formats be designed and understood by the project staff so that corresponding flow charts can be generated before computer programming begins.

Step 6: Develop Instructional Flowcharts

A useful tool in later computer production is the flowchart. A flowchart for each lesson or unit is a visual representation of the instructional flow of the curriculum. Such a diagram can be very important to clarify the detailed instructional flow for the later computer programming process. All choices and consequences of choices are visually represented by specific symbols. Listed below are examples of common flowcharting symbols that can be used.

○ = beginning, end, pause, or discuss points

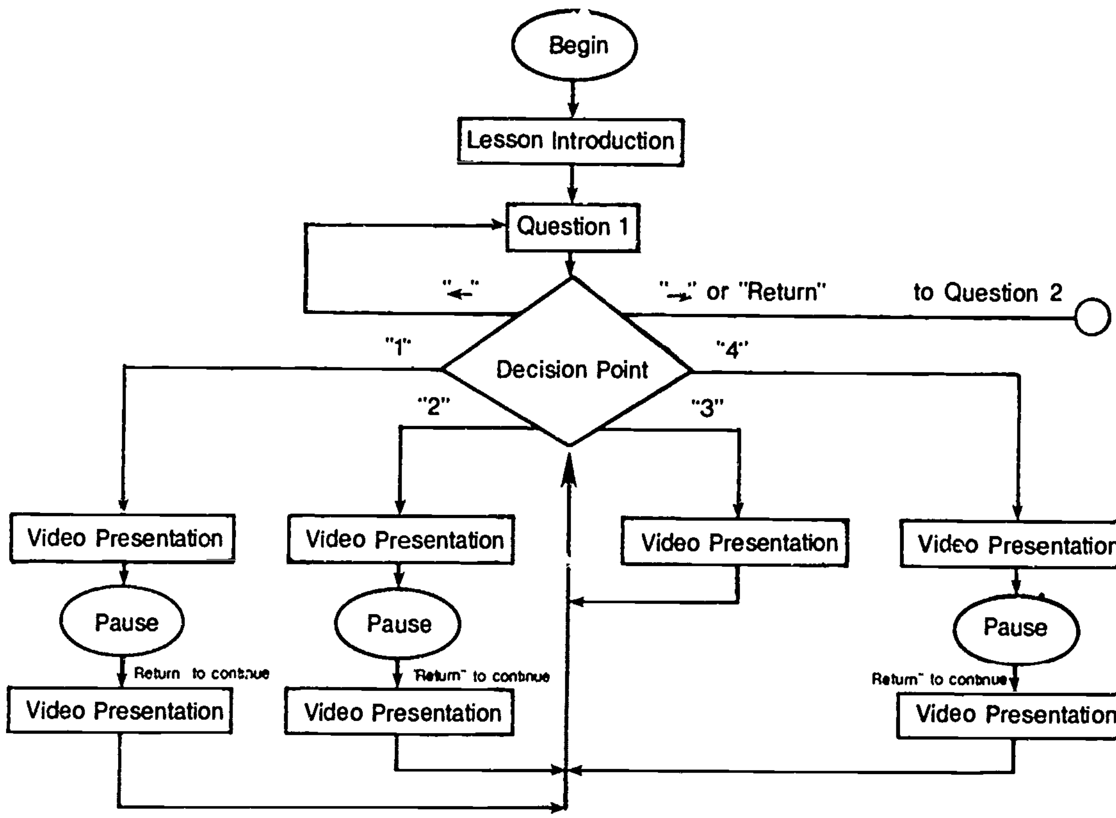
□ = narration, motion sequence, or series of still frames

◇ = decision point where user must make a response.

Additional symbols can be used as desired to communicate additional information about the process. For example, an outline of a TV monitor might indicate a motion sequence. A square could then represent the use of one or more still frames, and a rectangle indicate an action by the computer independent of video.

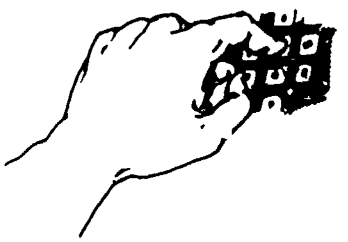
The primary reason for flowcharting interactive video is to be sure that all options follow logically to the conclusion of the lesson. Each chosen route must lead to proper feedback and/or video presentation. If a loop back to a decision point is required, it must be appropriately charted and programmed. When this process is completed, the instruction will be presented in the precise manner that the designers intended.

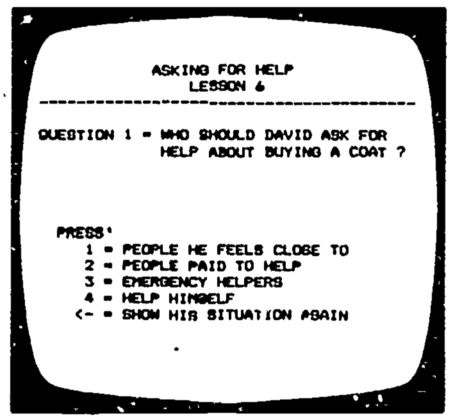
The flowchart below depicts the flow of a portion of Lesson 6 from the <u>Asking for Help</u> curriculum of Project LIVE. The lines and arrows indicate the routes that the user can take. Each of these routes can be accessed by



striking a key on the computer keyboard. In this example, the "<--" key allows the students to see the problem situation again. The "1", "2", "3", and "4" keys represent the four answers to questions posed in the lesson by the narrator at the decision points. The "-->" key tells the program to move ahead to the lesson's next problem situation. The flowchart represents all response options which were defined during the instructional design.

The response options of the flowchart will be programmed during the computer production phase of development which comes later. Thus, the TV monitor shown below is the corresponding computer screen for the decision point. This computer screen is printed on the monitor at the conclusion of the video segments which led to this decision point.





Examination of the flowchart reveals that the user is looped back to the decision point following each video presentation for "1", "2", "3", or "4". This allows the user the opportunity to view as many different answers as many times as desired before moving to the next problem. The intent here is to show several possible solutions to a problem.

There are many routes that an interactive video program can take, and the flowchart is intended to be a visual aid to clarify the computer system design and programming. Feel free to use it as a tool that can be shaped to meet the needs of individual projects. Thus, the creation and use of new symbols to represent different activities truly serves a purpose.

Video Production

The actual development of learning modules can begin once the instructional design has been defined from the global conceptual level down to specifics of content. Both video and computer production require preplanning and design work of their own to ensure high quality. Video also requires substantial post production work on such things as editing, titling, and the generation of any desired special effects.

This video production section preceeds the computer production section though computer programs design is happening simulataneously with video work. However, final testing of the programs is dependent upon having a copy of the video mastertape. Thus, the completion of the video materials is followed immediately by debugging of the computer programs and testing of the combined interactive video courseware. The four video production steps discussed in this section are:

(7) Develop storyboard and videoscript,
(8) Plan for video production (preproduction),
(9) Produce video materials (production),
(10) Edit video materials (postproduction).

The tasks within each of these steps are common to any video production effort. However, the degree of complexity, cost, and amount of development time can vary greatly between projects. As mentioned previously, decisions on these factors should be made during the instructional design process. Thus, video production tasks can be more easily scheduled and accomplished.

It is important to consider hiring a video director for all but very simple video productions. This person's initial role is in helping to develop a budget at Step 1 of the entire development process. Now the director must assume leadership in transferring the visual concepts of the curriculum into a video reality.

Step 7: Develop Storyboard and Videoscript

Developing the necessary script for a video production involves a two-stage process:

(1) storyboarding - the generation of situations, events, and characters for each scenario, and

(2) scriptwriting - the actual writing of dialogue.

Care must be taken in interactive video script development to create situations and dialogue that meet two criteria. First, they must meet the instructional objectives previously defined and second they should be realistic from a video production standpoint. This is best assured by involving both instructional designers and video personnel in both storyboarding and scriptwriting.

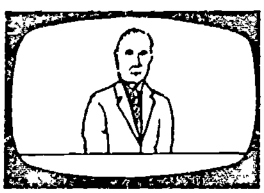
Storyboarding. A storyboard is a series of drawings which depict the major action points of an event. Each drawing should have a caption to provide the necessary information about corresponding audio which must be written later. The purpose of a storyboard is to visually portray an event's flow of action to assist the writers in eliminating unnatural or choppy sequencing in the eventual script.

The instructional designer is the most appropriate person to generate initial storyboards and scripts. This facilitates continuity from the instructional design phase of the project to the actual production of video. Development of specific video scenes and dialogue is more likely to be a natural extension of the design phase. Thus, considerations such as performance levels and interests of the intended audience will not be lost.

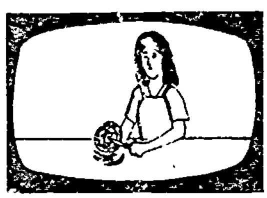
The video director's input to the storyboarding process is invaluable. This input can help avoid creation of impractical and unrealistic scenes by novice script writers who do not understand lighting and audio requirements. For example, a location which seems like a great shooting site, may actually require extensive lighting control or even a more sophisticated camera than is available. The video director can identify and help correct such problems, thereby saving time and trouble later.

The storyboard on this page shows a short video segment used in Project LIVE. The first picture shows the narrator on camera. The audio is identified as being an introduction to the next problem situation which the viewing learners must make a decision about.

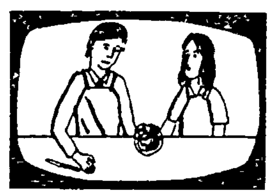
Model of Storyboard for Lesson 7



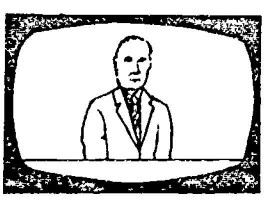
Narrator up—
Introduce first
problem



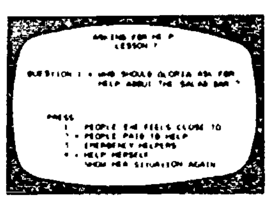
Gloria preparing
lettuce



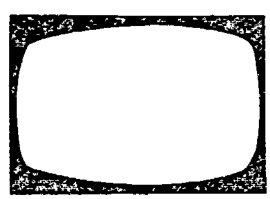
Co-worker tells
Gloria not to
cut lettuce



Narrator up-
Who should Gloria
ask for help?



Computer Screen



The second picture shows Gloria preparing lettuce for a salad bar. The third picture depicts a co-worker approaching Gloria. The corresponding caption indicates that a dialogue is occuring between the two as to how their boss wants Gloria to prepare the lettuce. That is, should she tear it or cut it?

The fourth picture is of the narrator again who is now asking the learners who Gloria should ask for help. The last picture of the storyboard shows the computer screen that will list each of the four response options as the narrator repeats the question. That is the end of the presentation of this problem situation. The video segments for each of the four possible responses were similiarly laid out in storyboard form.

Scriptwriting. Three methods of presentation available to interactive video script writers were used in the above example. They are: (1) narrator-up, (2) still frames with voice-over, and (3) motion sequences. They can be used separately or in combination to present situations in a varied and interesting manner.

The narrator-up method, which is sometimes referred to as a talking head, is an easy to produce technique for introducing material, asking questions, and giving feedback. However, care must be exercised to not make narration segments too long, confusing or boring for the learners. This technique is generally looked upon as a weak production format, but it can be quite effective when used in a discriminating fashion. For example, Onder (1980) explains 27 techniques to make the talking head "interesting as well as credible."

The narrator-up format is used in Project LIVE lessons to introduce problem situations and provide feedback to responses. The function of this feedback is primarily to inform the learner(s) about the accuracy of their responses, but also can serve to motivate them to continue. Feedback can either be given subsequent to all responses or only following a specified portion of responses. The content of the narration script will, therefore, be dictated by the instructional design of the program.

The second presentation format is the voice-over technique, where one or more still pictures are accompanied by either the voice of a narrator or the voices of actors. These still pictures may be created by either transferring 35mm slides to video or creating special graphics. The photographer or graphic artist who will eventually produce the still pictures must be given adequate information about the action being implied by the picture.

Project LIVE used some still frames with voice over narration to present problem situations. It is a less expensive way to tell a story than a full motion sequence, because the videotaping of scenes is eliminated. This technique was also used at the end of motion sequences to visually show the different response options for the question being posed by the narrator.

The third presentation possibility is a motion sequence using a conventional script with actors. These sequences are more complicated than simple narration or slides and will require a more detailed storyboard of action. Locations must be generally defined, but the actual shooting sites can be determined later.

The dialogue between actors should be natural and unstilted. Conversations should be written in a style that is familiar to the intended audience. For example, dialogue between teenagers might vary greatly from dialogue between adults.

The length of a motion sequence may vary depending on the instructional purpose. One challenge of script writing, however, is to minimize the complexity and length of scenes while still conveying the sense of reality. In general, the longer a scene takes the higher the probability of losing the attention of the audience. Additionally, the opportunity for student interaction is reduced.

Step 8: Plan for Video Production (Preproduction)

A successful production depends heavily upon good organization and scheduling on the front end. This is true of development projects in general, but is especially so for video where many different people and tasks must be coordinated. Preproduction tasks can be categorized into three areas: (1) the hiring of a production crew and actors, (2) the scheduling of all production activities, and (3) development of both a production script and a shooting script.

Hiring. The most immediate need is for a production manager to assist the director in subsequent hiring and scheduling. This person can then assume many day-to-day tasks of coordination that the director won't have time to deal with. These tasks will be discussed more fully under scheduling.

One of the first activities of the production manager is to assist the director in hiring a production crew. There are several production crew functions that must be performed during taping regardless of the size of the project. These functions are: (1) camera work, (2) lighting control, (3) audio control, and (4) set design. Additionally, graphic design expertise may be used to develop instructional visual aids.

An experienced camera person is essential for scenes where the camera must follow actor movement or be zoomed in and out. Maintaining a stable picture and keeping the action "framed up" correctly is a learned skill. The director can use these and other camera techniques in the shooting of scenes to greatly enhance the impact of the final product on the viewer.

Setting up for good recording of sound is also very important. An otherwise well produced interactive video program can have its instructional power seriously lessened by poor quality audio. There are several types of microphones that can be used in different scenes. The basic choices are wired, wireless, or boom microphones.

A simple and common approach to audio recording is to use wired lavaliere microphones for each person in a scene. The obvious drawback is having to keep the wires out of sight of the camera. This can become complicated when several people are in a scene or if movement is required.

A more sophisticated and expensive approach to sound recording is to use wireless microphones. This eliminates the tangle of wires for the actors and offers more flexibility of movement within the scene. Boom microphones are very expensive and require a highly skilled person to operate. The boom microphone must be kept very close to the sound but out of sight of the camera.

Similarly, the proper set-up of lighting to obtain a high quality visual image on tape is important. The entire set must be adequately lit without any one spot being too bright. Also, the placement of lights is critical to avoid shadows in a scene. This usually requires some time and expertise to do correctly.

For Project LIVE productions, the director assumes responsibility for determining the best lighting and audio set ups. However, one of the production crew members is then assigned to make sure the necessary equipment is available and set-up properly on shooting days. This responsibility plus other smaller tasks such as slating scenes for shooting, and keeping track of people and props can be assigned to a "grip" if the size and budget of the production allows it. The final need in a production crew is for someone to produce any graphics and 35mm slides required, as well as any sets for in-studio shooting.

Actors play a significant role in the success of a interactive video program and should be chosen with care. Candidates can be auditioned in an actual videotaping session with a test script. Careful scrutiny of the tapes will assist in the selection of those actors whose appearance and voice quality are suitable for the production. Another important consideration in the selection decision is the availability of the people during the planned videotaping times.

Scheduling. The amount of time required to perform the production manager's job will depend upon the number of scenes and actors to be scheduled and kept updated. The job can either be performed on a part time basis by a project member or will require someone to be hired specifically to handle these responsibilities. When videotaping will occur at different locations in the community, this job can become a time consuming one.

The first task of the production manager is to code all of the narration, still frames, and motion sequences. Keeping track of all these segments is essential during production. Project LIVE used the coding system on the next page to identify each video scene, slide, and actor.

A motion sequence (video) scene was assigned a code with a "V" plus a number identifying that scene according to its sequential order. Slides were similarly identified using "S" for slide plus a number. Project LIVE used a total of 110 such slides for the Asking for Help curriculum. The slides often depicted situations in the same locations as motion sequences as well as at different sites. When these pictures needed to be shot with the same actors and location as a motion sequence, it was indicated on the shooting schedule. All actors were also listed using "A" plus a number.

Video Scenarios	Character/Actor #	Slides
V_{14} - living room	A_{24} - Paul's friend - Lee	S_{24} - Paul - upset
V_{15} - Paul's workplace	A_{25} - Paul's boss - Sue	S_{25} - Paul - confused
V_{16} - Physical plant	A_{26} - David's co-worker - Ray	S_{26} - David - wanting raise
	A_{27} - David's boss - Terry	S_{27} - David - rush job

Sample Coding System

After each video scene, 35mm slide, and actors have been listed, locations for shooting need to be identified and arranged. Approval from store managers or owners must be received in order to videotape in most sites. Maintaining contact with one person at a given site usually factilitates communication and avoids later confusion. All this information is compiled onto the video scenario master on page 43.

Using one site for as many scenes as possible is a good way to minimize the amount of coordination necessary. Once a site is approved for shooting, the director needs to make an on-site visit to check out lighting, space, acoustics, etc. Thus, fewer sites also reduce the number of such visits.

Project LIVE

Video Scenarios Master

Learning Through Interactive Video Education

Lesson	Video	Page	Description	Characters	Actor	Location	Prop/Slide
1	V11	11	workplace	Worker boss	A-15-Patti A-16-Arden	Arden's office	tools
1	V12	12	lost job #2	friend Cindy	A-17	Patti's house	couch
1	V13	12	push car	person 1 person 2	A-19 A-20	street by CSB	car
1	V14	12	checking movie	person 1 person 2	A-21 A-22	Patti's house	newspaper
2	V15	6+	upset about girlfriend	Paul Friend Boss	A-24-Lee A-25-Sue	R-T work-room	paper jogger boxes labels S_{24}, S_{25}
2	V16	16+	pay raise/ rush job	David Co-worker	Kamden A-26-Bill	physical plant	large boxes S_{26}, S_{27}
2	V16 a	18+	if 1	David Boss	Kamden A-27-Terry	foreman's office	none
2	V16 b	20+	if 2	David Boss	Kamden A-27-Terry	foreman's office	none

Production scheduling can proceed once the lists of videos and slides are coded, actors have been hired, and sites arranged. The shooting schedule shown on page 44 should include all relevant information for each shooting day. Some of this information will be used again during the development of a production script.

Video Shooting Schedule

Learning Through Interactive Video Education

Day May 24

Camera Crew Theresa, Raymond

Photographer Arden Van yes

Actors Kamden, Bill, Terry

Props large boxes

Location U of A Physical Plant

List Video Scenarios

2	V16	16+	pay raise/ rush job	David Co-worker	Kamden A-26-Bill	physical plant	large boxes S_{26}, S_{27}
2	V16 a	18+	if 1	David Boss	Kamden A-27-Terry	foreman's office	none
2	V16 b	20+	if 2	David Boss	Kamden A-27-Terry	foreman's office	none

Scripts development. Before actual production can begin, the video director should take the final written script prepared earlier and enhance it for two different purposes. First, a production script is needed to identify all scenes and how they will be eventually edited together in post-production. An excerpt from a Project LIVE production script is presented on page 46. It shows how notes were added to the original audio script. The notations written on the left column of the sheet include identifying code numbers of individual segments, the location of each scene, and video notes.

In this excerpt, the code V16 identifies a problem scene about David and a co-worker. The consequence scene for response one is identified by V16a, which indicates it is the first feedback scene for the V16 problem scene. These codes are written on a slate before each take during shooting.

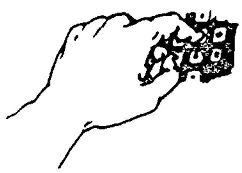
The middle column of notes identifies the shooting location for each scene. The third column for video includes notes indicating freeze frames, narrator shots, voice over, and computer frame. The director uses this space to include all details necessary for the video postproduction.

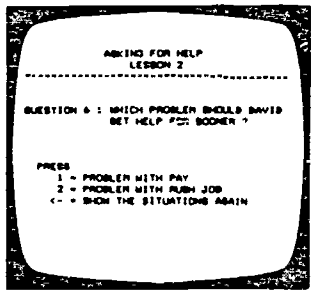
The other necessary modification of the orginal script is to make a shooting script. This script will be used by the director to note camera actions planned for the shooting of the scenes. An example of this type of script is shown on page 47. Again, the director has added notations to the left column of the sheet. These notations refer to specific technical information about how the scenes will be shot. For example, long shots, zooms, close ups, and angles are indicated. This script will be used during the actual production.

Program ____________
Page ____________

Production Script

Code	Location	Video	Audio
2 V16	physical plant storage area		David: You know, there are a lot of boxes here to finish in one hour. Do you think I'm going to make it? Worker: (looking at David's progress and the uncompleted work) Hmmm. I don't think so. You can't finish the rest of these boxes in one hour. What are you gonna do?
S 27 V3		FF ↑ V ↓	Narrator: Another problem David has is that he's supposed to finish this rush job in an hour but David cannot finish in time. David needs to ask his boss what to do.
S 26 S 21		NARR UP #'ered FF's Computer Frame 7 secs. black	Question: Which problem should David get help for sooner? Press "2" if David first should ask his boss for more pay or Press "2" if David first should find out from his boss what to do about the rush job.
2 V160	Boss's office	NARR UP Cut	**If 1** Narrator: Here's what might happen if David first asks his boss for more pay. David: (approaches boss's office and knocks) Boss: Yes? Come in. David: Hi, Mr. Jones. I've been meaning to talk to you about something. I've been working . . . .





Program ________
Page ________

Shooting Script

Video	Audio
LS, boss walks up Z axis to David - short Zoom to MS	Boss: (approaches David who is stacking boxes) David! Stop stacking those boxes for now. I have a rush job for you. See these boxes that need to be made? I need them folded and taped in an hour. I'll show you how.
CU boxes	(Boss shows David how to put a box together.)
MCU boxes	Then after you finish taping each box, stack them over here. You understand?
medium z shot	David: Yes, I see what to do.
	Boss: Good. This is really important. It has to be done one hour from now. That's when we will start filling the boxes. Thanks, David. (Boss walks away.)
Leaves back down Z axis Zoom to MCU David looking perplexed MS c̄ worker on Angle behind him	David: (starts to make boxes and continues for awhile) You know, there are a lot of boxes here to finish in one hour.
CU	Do you think I'm going to make it?
MS, short zoom as worker walks up to David & boxes	Worker: (looking at David's progress and the uncompleted work) Hmmm. I don't think so. You can't finish the rest of these boxes in one hour. What are you gonna do?
F.F. shoot 35mm slide CU MS OVS - worker	

Step 9: Produce Video Materials (Production)

This step refers to the actual shooting of all the individual video scenes and 35mm slides identified on the production script. All the preproduction planning, hiring, and scheduling (Step 8) has been completed, and the necessary equipment and supplies are available. The chances of the production being smooth and timely is directly related to how well those details have been identified and organized.

Production problems and delays will occur, however, regardless of the amount of planning effort. For example, actors will get sick or simply not show up, equipment will fail, or a shooting site won't be prepared. Also, if certain scenes are to be shot outdoors, expect some lost time due to weather. One technique for minimizing the impact of that problem is to schedule good weather and bad weather shooting alternatives for production days. Thus, affected actors can call at the last minute to find out which schedule is going to be used.

The important lesson for interactive video developers is to be flexible and adapt to changes forced upon the video production process. The heavy investment in time and energy for preproduction planning and scheduling should be viewed as providing the necessary information to allow flexibility, not rigidity. For example, unavoidable delays in one series of shoots can be compensated for by moving other scenes ahead of schedule. Thus, lost time is minimized over the long run.

The production manager continues to be a key person in this process. His/her most important role during production is to be the center of communications between the director and all actors and outside persons. One such example is finalizing arrangements with local businesses for on-site shooting days. Even if only a few such trips are planned, the director could easily become bogged down in peripheral details. It is important that the director be able to concentrate on the actual production effort.

The director should try to get more than one adequate take of each scene. What appears to be good at the time may not be satisfactory during later postproduction editing. Again, flexibility is maximized for a later step. Also, if the only take for a given scene is on a videotape that gets wrinkled (or damaged in some other way), the editor has no acceptable alternative of how to handle the problem.

The director will also want to have more than one option of how to later edit a series of video scenes together. Editing is definitely an art, and it requires these options in order to be exercised. The shooting script will identify for the director a number of ways each scene is to be shot. Such things as camera angles and distance will be varied to allow different editing possibilities later.

Systematic techniques for making multiple shots of scenes are acknowledged within the video and film fields. A good, nontechnical reference for those interested is Zettl (1976). The "master take" procedure is a common procedure which is discussed in Hodgdon and Kaminsky (1981). Briefly, a camera is set up at one angle for all the shots in a certain scene. Later, the camera is moved and many of the shots are taken again from a new angle.

This provides flexibility for the editor, but has definite drawbacks for modestly budgeted interactive video productions Obviously, more good takes of each scene are required. However, the biggest problem may be the additional pressure on amateur actors to deliver their lines twice the same way. Pacing and movement must closely coincide to allow later editing together of the different takes.

The production crew itself was hired and trained before production began and must now be well organized and know their individual responsibilities. This is true whether the crew consists of only two people or many more. Hours of time can be lost if even one small connector or cable is not available when it is needed. It must be clearly defined who is responsible for all equipment and supplies.

The three methods of presentation discussed in Step 7 will place different requirements on the production team. Narration, still frames, and motion sequences were previously identified and can be scheduled in the most efficient manner.

The motion sequences, which have already been discussed, make the most demands on time, energy, and money. A well planned shooting script will allow for the director to have an efficient videotaping session. Project LIVE spent 160 hours shooting 13 hours and 20 minutes of video. The edited video lessons totalled 3 hours and 10 minutes.

Narration will most often be videotaped in a studio where light and sound levels can easily be maintained. In Project LIVE, the narrator was always sitting or standing in front of a blue backdrop. The setup and breakdown time was less than for on location videotaping and the ratio of actual footage used to footage shot was greater thus indicating that narration segments cost less to produce than motion sequences done on location.

The photographer responsible for shooting slides (to be transferred to tape in Step 11) must be part of the master schedule as well. "Voice over" narration will define the content of these slides, some of which will be taken on the set of video shooting, while others can be taken independently. The production manager should also handle this necessary scheduling communication between the photographer and the actors. As with video, several shots should be taken of each desired slide to allow for choosing the best one during editing.

The ratio of 12:1 hours of shooting to videotape shot is offered as an indicator of the amount of time the production process demands. The ratio of 4:1 hours of video shot to hours actually used is cited to further illustrate the amount of tape necessary in order to edit a finished piece. The ratio of slides shot to those actually used (nearly 7:1) again demonstrates the need for producing much more material than will eventually be used.

Step 10: Edit Video Materials (Postproduction)

Postproduction is the final stage in the production of the videotape. It is when all the various elements conceived in the script and storyboard are pulled together and edited into a final form. Titling and special effects can also be added to bring together the segments into a linear unit.

The production script serves as a map for putting all the pieces together during the editing process. This script has the codes that correspond with the codes on the slate at the top of each take. Since several takes of each segment are logged on the tape, the editor can choose which looks and sounds the best. It is an art to be able to edit the best segments together so that the audio and video fit smoothly together.

A production house or TV station can then be used to create titles and special effects. The possibilities for using computer generated graphics in titling are only limited by budget constraints. Also, the addition of music enhances most video productions. It may be used throughout the production, or just during the opening and closing segments.

Special effects are also added at the production house. These can include processes such as transferring slides to tape. This process allows the slides to be seen as still frames for any specified length of time. Project LIVE made extensive use of this technique incorporating a narrator's voice-over which provided instruction or feedback relating to the still frame.

There are also several special effect techniques that can be used for transition from one scene to another. Two common postproduction transition effects are dissolves and wipes. In a dissolve, the picture at the end of one scene fades away as the beginning of the next scene gradually comes up in its place. On the other hand, a wipe replaces the old picture with the new scene on the screen according to some predefined pattern. The simplest form of a wipe replaces the old picture with the new picture moving from the left to the right. However, many sophisticated patterns can be used.

Fading is a transition technique that can be done before postproduction by the camera at the time of videotaping. Fading is a common technique where the end of one scene fades to black, and the very next scene immediately comes up from the black. The speed of the fading can be altered to provide different effects for the viewer.

Compu…er Production

The computer courseware will be developed very closely from the flowchart of interactivity which was written in Step 6. It is the design blueprint for whatever computer system must be written. A systems analyst will now take that blueprint and expand it into a thorough description of the computer programs to be developed.

There are four computer production steps. They are:

(11) Design the computer courseware.
(12) Write the computer programs.
(13) Integrate video materials into computer programs.
(14) Debug computer programs and instructional flow.

Step 11: Design Computer Courseware

Many important design decisions of the computer courseware will be easy given the earlier decisions of hardware system and instructional interactivity. The computer analyst on the project should have been involved in fact gathering and analysis during those earlier steps. The analyst can now provide the important linkage from instructional design to the programming work needed to make it real.

A key decision that must be made very early is what computer language will be used to write the programs. In many cases, this software decision is made at the time of choosing the system hardware (step 4). This is consistent with the accepted wisdom in computer purchasing of first determining required software and then deciding on the best hardware to run it.

Most interface card manufacturers offer an authoring language with their systems for such programming. They are typically intended to be used by persons with little or no programming experience. These languages work only with that specific interface card and whatever computers it supports. This can be a serious drawback if you want to be able to later transport programs to another computer environment.

Authoring languages that support interactive video development can also be purchased from third party sources. The complexity of these languages varies greatly, however, and can either be very simple or quite complex to learn to use. SuperPilot is an example of a sophisticated authoring language available for the Apple II series computers which includes specific commands for searching and playing video segments. It is an enhancement of the earlier Pilot language developed for teachers to write CAI programs.

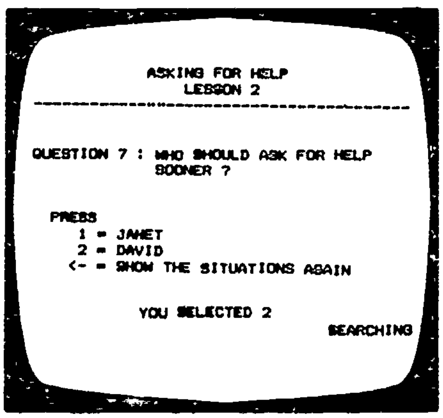
The purpose of authoring languages is to provide a simple template for creating programs. They usually follow the format of a tutorial program discussed in section 1. In a typical tutorial program, the student is presented some new information, asked questions about that information, and then branched to the appropriate next question based upon the correctness of their answer. Some authoring language go so far as to sequentially prompt the user for the next information, the next question, the next branching options. Thus, a total computer neophyte could successfully write an interactive video program.

The drawback to such regimented programs is their restrictiveness. When the developers want to move to a more sophisticated program design, they discover they cannot. Many authoring languages also have restrictions within the tutorial design, such as a maximum number of response options, an inflexible format for questions, and so on. Potential users should evaluate a systems ability to support future applications that they are interested in before purchasing it.

The alternative to using an authoring language is to write the desired interactive video programs in a regular microcomputer programming language. Project LIVE chose to use Applesoft BASIC on the Apple II after first evaluating several authoring languages. It provided maximum programming flexiblity and control with the interface card being used.

An important program design consideration is how to format the computer screens that users will see between video segments. Again, the intended audience should have a major bearing upon those decisions. However, there are some useful general guidelines for CAI screen development documented in the literature, e.g. Simpson (1984). These same guidelines also apply to interactive video.

Project LIVE divided the computer screen into three sections from top to bottom, and then used them in a consistent manner from lesson to lesson. The figure below shows a typical screen. The top six lines always identify



the curriculum and which lesson is currently running, as well as the current problem number. Thus, the user always knows where they are in the program.

The middle section of the screen is the largest and provides information about the current problem and its response options. A balance needs to be struck between providing enough information and keeping the screen uncluttered. The bottom of the screen is always used for brief one or two line special user instructions or messages. For example, after the response key "2" has been pressed, the bottom line says "YOU SELECTED 2" and "SEARCHING".

This computer screen format strategy was designed with the knowledge that the curriculum would be taught to a group of secondary handicapped learners with a teacher present. Thus, reading ability of the learners was not a critical issue. The screen might have looked far different had the curriculum been intended for single user learning.

The figure on the next page shows a sample video programming log used for the important program design phase of Project LIVE development. All the scenes are numbered and described in shorthand. In this example, Q1 stands for question 1, Q1W stands for question 1 feedback for a wrong response, Q1C stands for question 1 feedback for a correct response, and Nar stands for a narrative sequence.

The vital information on this log is the required branching for the end of each video segment depending upon user response. Thus, for video segment 4, if the "1" key is pressed the next segment to play is segment 7. If the "2" key is pressed, segment 6 is next. The corresponding frame numbers for each segment are also listed on this log since the computer programming is done in BASIC. The extra flexibility of a programming language over an authoring language also means details such as matching segments to their positions on the videotape are not automatically taken care.

Video Programming Log

Date 7/19/84
Page ____

Lesson 1

#	Segment Description	Time	Responses	Destination if → go to	Script Page #	Frame #s Begin	Frame #s End
1	Intro + Q1	6min 14sec	1=True 2=False	1/52 2/53	1-5	657	11881
2	Q1w + Q2	29 sec	"	1/54 2/55	5-6	12047	12914
3	Q1c + Q2	32 sec	"	"	6	13024	13972
4	Q2w + Q3	32 sec	"	1/57 2/56	6	14123	15095
5	Q2c + Q3	33 sec	"	"	6-7	15250	16237
6	Q3w + Discuss	17 sec	[Return]	S8	7	16392	16901
7	Q3c + Discuss	18 sec	"	S8	7	17054	17579
8	Nar + Discuss	1 min 53 sec	"	S9	7-8	17740	21108
9	Nar + Discuss	1 min 43 sec	"	S10	9-10	21244	24329
10	Nar	2 min 33 sec	—		10-12	24478	29054

Step 12: Write Computer Programs

The computer programming task becomes routine when the curriculum design has been worked out in stages beginning with the early instructional design steps. The programming is the implementation of that total design. If a simple authoring language is being used, the programs may even be able to be written by someone with no previous programming experience. In fact, that is the intent of these languages. For more sophisticated programs, however, a programmer will be needed to perform this job.

It is beyond the scope of this chapter to teach computer programming for specific interactive video environments. However, just a few general recommendations of how to approach the task will be given. First, it is helpful to work out programs on paper first rather than trying to "compose on the screen." Once a program module is coded on paper, however, it should be soon entered onto the computer and tested out.

Second, the programmer should thoroughly test out the smaller modules that will make up the program as they are written. The smaller pieces of the program can be developed and "debugged" of errors long before they are incorporated to make the total system. Most programming languages such as BASIC include some debugging commands to aid in discovering and removing persistent errors.

A final programming recommendation is to become familiar with the software language as soon as possible. Knowledge gained of its capabilities and limitations can even affect decisions as early as step 5 on design of interactivity. Additionally, the efficient use of programming time is increased if the programmer has already become familiar with the capabilities of the specific hardware and programming language chosen.

The interface card is the center of the interactive video system and will dictate many programming decisions. It is important, therefore, to purchase the card from a company that will provide good user support after the sale. Good documentation on the set up and usage of the card is an important predictor of fewer initial programming problems. However, there will undoubtedly be some questions which will arise at different times, and the company or dealer should be responsive.

Step 13: Integrate Video Materials into Computer Programs

The computer programs cannot be fully tested until the corresponding video materials are available to be integrated. Even if the final medium will be videodisc, a 1/2 inch videotape should be made to test the program. Since videodiscs cannot be modified, it is important that materials sent for pressing be totally accurate.

The videotape used to test computer programs does not need to be a final or "master" copy complete with all postproduction additions such as titling and special effects. The video director may create "rough cut" copies of scenes to look at after they are taped, but before the final editing. This is usually done with major video productions that will last for some time and gives the director immediate feedback if the shots will work during later editing. These rough cuts of scenes can also be copied onto a tape in the order they will eventually be in to allow the programmer to test the accuracy of the program's logic.

The process of integrating video materials varies for different interactive video systems, but generally includes three steps. First, a unique identifying number must be placed on every frame or picture on the videotape. Video is shot at the rate of 30 frames per second, which means a 30 minute sequence contains 54,000 (30 x 60 seconds x 30 minutes) individual frames. Secondly, each video segment that will be accessed by the computer program must be logged to obtain its beginning and ending frame numbers. Lastly, these frame numbers must be entered into the program in such a fashion that when a given segment is to be shown, the video player (disc or tape) can be given commands to locate the beginning point and then play until the ending point is reached.

A logger program to assist in the framecoding will accompany whatever interface card is purchased. Most manufacturers also sell an authoring language which can be purchased at additional cost. One benefit of these languages is that they simplify the procedure for identifying and logging segments by prompting the user step by step. After that is accomplished, the programmer only needs to reference specific video segments and not worry about their corresponding frame numbers.

Most programming languages such as BASIC will require the programmer to write the program to be able to access framecode numbers when a given segment is wanted. However, this can be easily enough done through the use of one or more arrays to store the framecodes. For example, a computer program for the video program log on page 57, might use an array named B with ten elements to contain the beginning frame numbers for the ten segments listed. Thus, B(1) would equal 657, B(2) would equal 12047, and so on. Another array E could hold the ending frame numbers.

Step 14: Debug Computer Programs/Courseware

The final testing of the computer programs requires checking that the program itself is free of errors, and that the logic of the instructional flow of the curriculum does not have flaws in it. This latter issue can become complex when the program is a videodisc simulation where video scenes can be part of more than one video segment. For example, a short scene to establish that someone is at work may be used at different points in a simulation of the person's day. However, an unnoticed wall clock could establish a time of day which would not have changed. Many such little potential foul ups exist for unwary developers.

Internal testing should proceed through two levels. First, the computer programmer must test and correct the program modules during development. Secondly, someone not involved in the programming should work with it for an extended period of time. The programmer is simply too close to the technical development to be able to find some small inconsistencies. As many different response options as possible should be tried to see if the results are as expected. This tester must have a good idea of the curriculum design and how it should be responding to best detect when problems are occurring.

Some interactive video situations call for ingenuity in testing. For example, many videodisc programs use two audio tracks and are thus difficult to fully test while on videotape (remember, one of our videotape audio tracks had to be used to record frame number locations). The simplest solution to that specific problem is to make two different videotapes for testing purposes.

Courseware Finalization

The completion of the video and computer programs marks the end of a major phase of the development effort. However, the steps that remain are equally as important. It is recommended that planning for these steps begin early in the project. The steps in the finalization process are:

(15) Write accompanying documentation.
(16) Field test and revise courseware.
(17) Market and distribute courseware.

Step 15: Write Accompanying Documentation

The documentation or user's manual that accompanies any interactive video curriculum is to aid the teacher in using the materials. It should be clear, concise, and easy to use even by novice instructors. The documentation must include information regarding the use of the hardware and software, the overview of the curriculum (scope and sequence), and suggestions for daily lesson plans.

A good user's manual begins with the basics of hooking up the hardware. A step by step narrative, including photographs or diagrams, is helpful. When writing the documentation, collaboration between people who are technologically oriented and those who are not will insure that the narrative is clear to the latter. The importance of being "user friendly" cannot be overstated.

Getting started, or booting up, the software is the next step that should be explained in terms that will allow for first time success. The manual should address possible glitches and provide the user with a trouble shooting or problem solving guide so that frustration does not unnecessarily occur (e.g., indicate that the caps lock key must be depressed on Apple IIe computers). All key functions need to be identified so that the user is knowledgeable about how to get started and continues use once started. Being able to easily locate this information is important; therefore, taking the time to write the material in a clear, understandable, and easily retrievable fashion is recommended.

The scope and sequence of the curriculum offers information that allows the user to plan for and incorporate the materials into existing coursework. The documentation should present the content, instructional design, and goals and objectives in an easily understood format. This overview section provides the teacher with the essence of what will be introduced during the course of interactive instruction.

The suggestions for daily lesson plans should be presented in such a manner that the teacher fully comprehends the content of the videotapes without having to preview them. All interactive options need to be outlined so that the teacher may guide the students toward certain choices if appropriate. Specific learning points should be highlighted along with suggestions for classroom activities to augment the video instruction.

External documentation is an important piece of the overall curriculum. One would not expect to teach a traditional paper and pencil curriculum without a teachers' guide. The documentation here serves the same purpose as well as offering needed technical assistance.

Step 16: Field Test and Revise Courseware

The interactive video curriculum along with its accompanying documentation is now ready to be field tested by teachers and students in the "real world." Identifying classrooms or training sites where targeted populations are available to participate in a field-based testing situation can be done early in the development process. The logistics of scheduling, setting up, and offering support services to these sites is now a task for the project staff.

An evaluation packet or data collection system must be developed so that teachers' and students' responses and reactions can be recorded and later analyzed. Patterns of interactions with the courseware may be of interest to developers. Formats in the tape as well as in the written documentation can be modified as a result of the information gained from the field test sites. Ideally, technical details have been resolved at this point, but it is always possible that some problems will still exist. Observing the equipment in the field allows developers the opportunity to see other factors that may influence performance of the hardware (e.g., physical constraints, power supplies, etc.).

Trainers may require inservice training on the use of the hardware as well as on the curriculum content and intended instructional procedures. An understanding of the flexibility of the media is essential so that the students may recognize the greatest benefits of interactive video. It is important to schedule adequate time before instruction begins for the teacher to become totally familiar with the system.

It is advantageous to have a large number of subjects in the field test. Having students that represent a range of abilities and learning styles will further allow the developers to analyze the appropriateness of the curriculum to various groups as discussed earlier in Step 2.

There are several aspects of the curriculum that need to be assessed. Project LIVE was interested in both teacher and student responsiveness, as well as specific gains in students' performances. Therefore, paper and pencil tests were administered before the introduction of the curriculum. Following the completion of the entire eight lessons (which took 2-3 weeks) the students were asked to take the same tests. These pretest and posttest results were then analyzed for gains recognized in the areas of knowledge and application. In addition, students filled out answer sheets that corresponded with decision points on the video. Because group instruction was the model, individual responses were not recorded by the computer.

The teachers were also asked to fill out questionnaires on each lesson. The answers to questions regarding participation of students, difficulty of lesson, operation of equipment, and use of the manual provided the project staff with information useful during the revision process as well as during future development efforts. Last, the teachers were asked to provide feedback on a series of questions relating specifically to the Asking for Help curriculum content and design.

The information learned from field-based testing, whether recorded electronically or in a conventional manner, can shed much light on areas of strength as well as areas that require revision. This field testing step is both enlightening and rewarding as it offers much needed information to developers as well as allows them to see their almost completed product in use with its intended audience.

Step 17: Market and Distribute Courseware

The project director may choose to pursue a commercial publisher for marketing and dissemination once the interactive video couseware and accompanying documentation is ready. Programs that combine sound instructional design with innovative interactive video programming will certainly be welcomed by potential consumers. However, the relatively high cost of obtaining the necessary hardware will be an obstacle for many schools. Thus, making the courseware available for different combinations of computer and video hardware will make it easier for more schools and individuals to use it. For many, the interface card itself would be the only interactive video component they would not already have, and therefore need to purchase.

There are several ways to go about approaching potential publishers, including assembling a complete set of materials for distribution to each. Additionally, a short demonstration videotape explaining the courseware can be developed and sent to prospective publishers. Finally, and most simply, an abstract of the materials can be written and distributed. Any of these methods might elicit responses from potential publishers of interactive video materials.

LINC Resources, Inc. may provide marketing assistance for materials in the area of special education and rehabilitation. LINC is a contract project funded through Special Education Programs, Office of Special Education and Rehabilitative Services (OSERS), U.S. Department of Education. Its purpose is to receive OSERS products, evaluate them, and prepare individual marketing plans. Similar agencies may exist to assist developers in the distribution of materials in other content areas.

References

Allen, W. H. & Goldberg, K. E. (1979). Designing instructional media for educable mentally retarded learners. In R. Heinrich (Ed.), Educating all handicapped children. Englewood Cliffs, NJ: Educational Technology Publications.

Bennion, J., & Schneider, E. (1981). Videodiscs. Englewood Cliffs, NJ: Educational Technology Publications.

DeBloois, M. L. (1982). Videodisc/microcomputer courseware design. Englewood Cliffs, NJ: Educational Technology Publications, Inc.

Fletcher, J. (1983). New (and old) directions in computer courseware. In E. Baker & J. Herman (Eds.), The role of new technologies in schools: Collected Papers. Los Angeles, CA: UCLA Center for Studies in Evaluation.

Floyd, S., & Floyd, B. (Eds.) (1982). The handbook of interactive video. White Plains, NY: Knowledge Industry Publications, Inc.

Hodgden, D., & Kaminsky, S. (1981). Basic filmmaking. New York: Arco Publishing, Inc.

Hoekema, J. (1983). Interactive video: An elephant in search of a definition. Performance and Instruction Journal, 22(9), 4-5.

Howe, S. (1983). Guide to the design, production, and use of interactive video technology in secondary schools. Philadelphia, PA: Friends Central School.

Interactive video (Special Issue) (1983). Performance and Instruction Journal, 22(9).

Iuppa, N. V. (1984). A practical guide to interactive video design. White Plains, NY: Knowledge Industry Publications, Inc.

Kehrberg, K. T., & Pollack, R. A. (1982). Videodiscs in the classroom: An interactive economics course. Creative Computing, 8(1), 99-102.

Levin, W. (1983). Interactive video: The state-of-the-art teaching machine. The Computing Teacher, 11(2).

O'Donnell, J., Harris, D., & Sato, T. (1981). Videodisc program production manual. New York: Sony Video Communications.

Onder, J. (1980). Techniques to use with the talking head. Educational and Industrial Television, 12(2), 44-53.

Simpson, H. (1984). A human-factors style guide for program design. In Walker and Hess (Eds.) Instructional Software. Belmont, CA: Wadsworth Publishing Company.

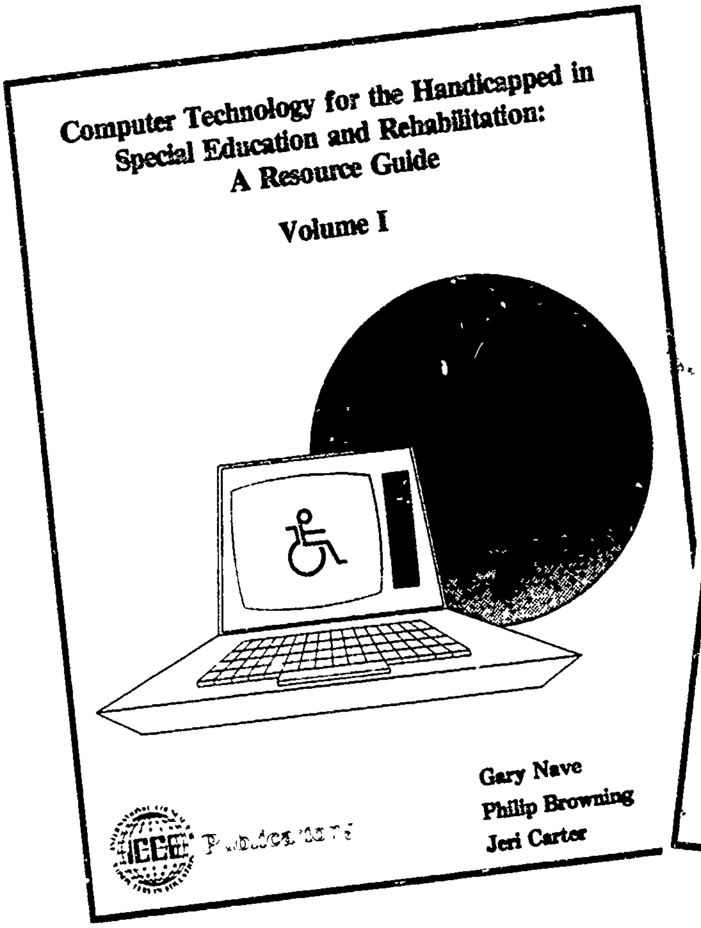
Sims, D., VonFeldt, J., Dowaliby, F., Hutchinson, K., & Myers, T. (1979). A pilot experiment in computer assisted speechreading instruction utilizing the data analysis video interactive device (DAVID). American Annals of the Deaf, 124, 618-623.

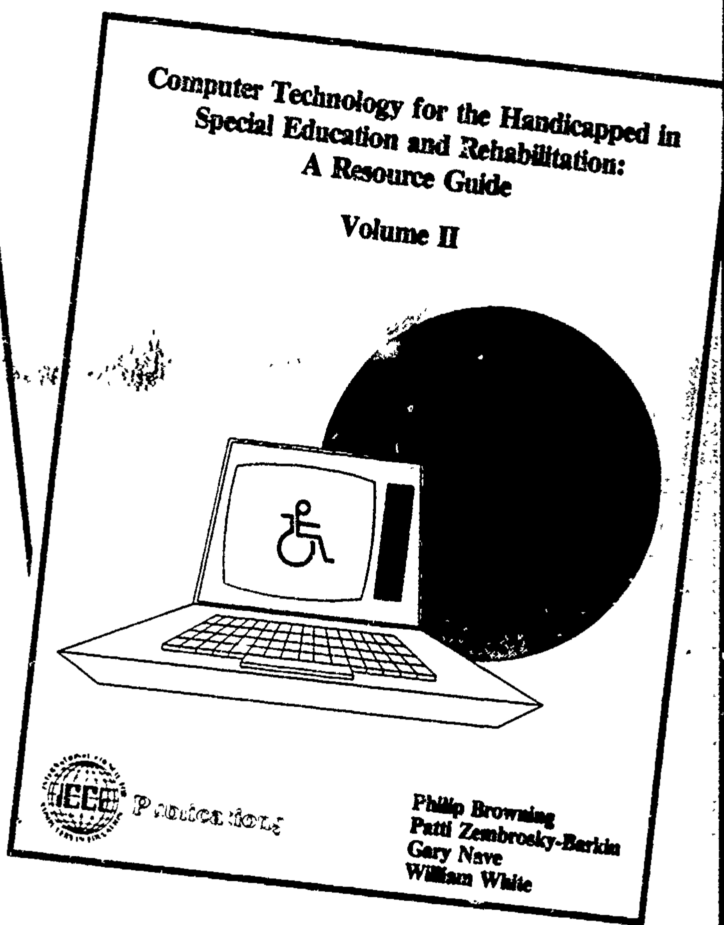
Stolurow, L. (1975). Computers in education. In Wortis (Ed.) Mental Retardation and Developmental Disabilities: An Annual Review. New York, NY: Brunner/Mazel, Inc.

Thorkildsen, R., & Friedman, S. (1984). Videodisc in the classroom. T.H.E. Journal, 11(7), 90-95.

Video (Special Issue) (1984). Electronic Learning, 3(7), 48-57.

Zettl, H. (1976). Television production handbook. Belmont, CA: Wadsworth Publishing Co., Inc.





Now available are two annotated bibliographies on one of the largest collections of literature on the application of computer technology with the handicapped. These two volumes present an extensive coverage of informational resources up to 1985. ***Resource Guide I*** describes 191 resources through 1982 and the newly published ***Resource Guide II*** describes over 300 more recent resources.

This library of materials provides an expeditious means for both becoming familiar with the breadth of activities in the area, as well as delving more deeply into specific subject areas of personal interest. ***Resource Guides I & II*** can be a useful source of information for educators, practitioners, researchers, administrators, students, and consumers on both special education and rehabilitation.

Comprehensiveness

- **Guides I & II** represent an array of computer applications including computer assisted instruction, computer management in both special education and rehabilitation, and functional aids.
- **Guides I & II** represent specific physical and developmental disabilities including mentally retarded, learning disabled, visually impaired, hearing impaired, nonvocal, quadriplegic, autistic, emotionally handicapped, and cerebral palsied.
- **Guides I & II** represent a wide array of resources including books, chapters in books, journal articles, research grants, organizations, newsletters, clearinghouses, special issues of journals, and unpublished manuscripts.

Utility

- All references are descriptively annotated in a manner to allow both professionals and interested lay persons to find them useful.
- An author index and subject index are provided in both *Guide I & II* to facilitate quicker searching for materials of interest. Many topics within the subject index are further subdivided to enhance its utility. For example, the general heading "Computer Assisted Instruction" is subdivided by "Disability Type."
- Contact persons, addresses, and phone numbers are provided where applicable to allow easier tracking of desired follow-up information.