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Interactive Videodisc

A Cure for Teaching Blight

Interactive videodisc is an exciting new tool that promises to revolutionize the way information is transferred in teaching and extension. Although videodisc technology is not new, interactive video is a relatively new audiovisual medium that is rapidly becoming a competitor in the information/ education market. This article summarizes interactive videodisc, giving plant pathologists the basics they can use to more effectively teach plant pathology in the next 5–10 years.

Interactive video can be described as any video program in which the sequence and selection of messages is determined by the user's response to the material (6). Loosely, interactive video resembles a cross between a television, a microcomputer, and a videogame. It stimulates the user with colorful video and graphic images while describing these images with two channels of audio. The user is required to respond to these visual and auditory stimuli to be able to continue with the demonstration. By choosing another topic, answering a question, or making a decision about the material presented, individuals choose their own paths through the instruction by interacting with the material presented to them.

In most cases, instructors not only want to teach their students a concept, they want to be sure their students understand the concept and can apply it. This is what education is all about. With videodiscs, students become active participants in their own learning process. Educational video includes all forms of video—videotapes, films, television, and videodiscs—but many of these are linear, requiring the viewer to be no more than a passive observer. The laser videodisc has proved to be the most interactive form of video because of its mass storage capacity, fast and random access to the information, sharp imaging, and durability.

Description

Although interactive videodiscs have several advantages over other audiovisual tools on the market today, interactivity takes more than the videodisc to achieve. Several components, including videodiscs, videodisc players, a microcomputer, and computer programs, are designed to combine images and sound from the videodisc with computer text and graphics to form a truly interactive learning program.

Videodiscs. The laser videodisc is 12 in. (30.5 cm) in diameter, similar to a long-play (LP) record. Information is etched into grooves as a series of microscopic pits. The spacing of the pits is varied to represent the frequency-modulated signal. On playback, a laser beam follows the groove, reflecting the pattern of the pits and recovering the information electronically (16). The grooves, called tracks, are arranged in a series of concentric circles. Each circle or track has the capacity to hold one slide or one frame of video information. These tracks not only store visual images, they also contain two channels of audio information, which can be reproduced at a higher quality than the sound produced by a standard LP album (2). These two audio channels allow narration in stereo, in two different languages, or at two educational levels. The channels can even contain two entirely different discussions of the same video sequence.

Videodiscs store a tremendous amount of information that can be recalled rapidly. Each side of the disc contains 54,000 still frames or slides, or 30 minutes of video, or any combination of the two. This means that 675 carousels of slides will fit on one laser videodisc. A laser videodisc can be truly interactive because random access of any still frame on the disc is available in a maximum of 3–5 seconds. Each frame on the disc has an address that can be called up at any time. By quickly accessing any frame on the disc, the user can review segments from past lessons.

Interactive discs have some options that other discs do not. These are the ability to freeze a frame, or to advance slowly a frame at a time, or to show a scene in fast motion (scanning), all with good resolution. Slow and fast scanning can also be done in reverse, with good resolution.

The characteristics listed above can be found only on laser videodiscs with a constant angular velocity (CAV) format. The CAV disc maintains a constant 1,800 revolutions per minute, with each revolution containing one frame of visual information (7). Because each frame or picture occupies its own track, the laser beam can easily be bounced back one track at the end of each frame to start the same frame again. This automatic repeat provides the crystal-clear freeze-frame option, one of the main advantages of interactive videodisc technology (15).

Finally, the laser videodisc is extremely durable. The etched surface of the disc is coated with a reflective material. Light reflecting from the pits gives the disc its shiny, iridescent appearance. The entire disc is then covered with a thick coat of vinyl or plastic that protects it from scratches, fingerprints, and dust. Videodiscs do not wear out because a beam of light is all that comes in contact with the grooves.

Levels of interactivity. The videodisc player is required to retrieve the information from the laser videodisc. Also, the extent of interactivity depends

This simple illustration shows how an interactive videodisc system could help diagnose the cause of a plant malady. With an interactive computer program combined with a videodisc, a user can determine through a series of prompts the cause of a plant problem.

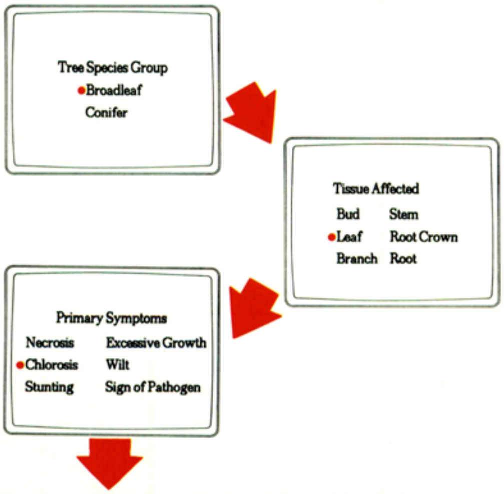
For example, "our specimen" is oak leaves with chlorosis on the margins that were collected near a manufacturing plant. By choosing "chlorosis" from a list of symptom classes, a composite screen showing examples of the range of chlorotic symptoms appears. The user could then select the illustration that most closely resembles the sample.

The sample's appearance prompts the user to select the symptoms illustrated by the marginal chlorosis in the left central screen. From this selection, the computer provides a more detailed listing of biotic and abiotic situations capable of causing marginal chlorosis. In this case, further questions, such as whether other plant species in the area were affected and the geographic range of the injury, reveal that a fiberglass insulation manufacturing factory was located across the street. By comparing the sample symptoms with those illustrated for fluoride injury, the user could correctly diagnose that the injury resulted from fluoride pollution.

Although the user may not wish any further information, an extension agent might want to know how to confirm fluoride as the source of injury. The program could also show how to collect and package tissue samples, where to send them for analysis and the cost, and what concentrations of fluoride to expect in plant tissues, or even in cattle that might graze the foliage. Finally, a listing of any human hazards and precautions could be printed out for the user to take home.

This example shows that interactive video can be a very powerful tool. Its usefulness, however, depends on the design of the program and the quality of the corresponding disc. The design process must be detailed enough so that all possible cases will have been included.

Our Specimen



on whether a microcomputer and various peripheral devices are added. Several levels of interactivity can be obtained by using a laser videodisc and different types of players plus other components of an interactive system.

Level 0 is a monitor and a videodisc player designed for playback only. The television monitor used with a videodisc system differs from a computer display because it must amplify sound as well as receive and display visual information (7). Therefore, a high-resolution television monitor is used.

The level 1 videodisc system is also a videodisc player and a monitor. A level 1 player, however, has the capability built in to show any frame or video sequence on the disc in any order.

The level 2 system has a built-in microprocessor and a small amount of memory. This system can run short programs that are stored on the disc and loaded onto the player when the disc is in use. These simple programs pull up a sequence of frames from the disc, including questions about the material being presented. If the viewer responds incorrectly to a question, the program may branch back to the beginning and review that lesson.

Level 3, the most interactive videodisc system at the present time, consists of a player, a monitor, a microcomputer, and an interface that links the computer and the player. This level combines the managerial and interactive powers of the computer with a library of visuals on the videodisc (16). Lessons can alternate from video and audio to computer text and back. Some systems can even overlay graphics and text on video. With the level 3 system, an unlimited number of different lessons can be designed from a single videodisc.

Authoring systems. Because most people are not computer programmers, they must seek the help of computer programmers to design lesson plans with elaborate systems of testing, branching, and switching back and forth between computer text or graphics and videodisc images. Consequently, computer software called authoring packages has been developed that turns complicated programming language into simple, understandable commands educators can use to design their own lessons using the interactive videodisc and a computer. Authoring packages reduce computer programming to a decision-making process, with the decisions based on the instructor's own instructional design or lesson plan (1).

The authoring software should not be confused with the final interactive programs themselves. The authoring package is a tool used by the course designer to write or program a lesson that will provide access to certain frames on the videodisc and text or graphics from the computer. The interactive lessons display a certain sequence of images from the videodisc, corresponding to the lesson, and alternate them on the screen with graphs and computer text to teach a lesson or a skill.

Authoring packages are designed by computer programmers and educators together so that the packages incorporate sound instructional design practices (5). Many systems have what is called open architecture, which is adaptable to all kinds of peripherals, such as touch screens, printers, light pens, or voice synthesizers. Some may be able to use graphic and textual overlays or animation.

Use of this authoring software makes designing interactive courseware relatively fast and easy but does not guarantee high quality. Designing a high-quality program takes a knowledge of good instructional design criteria and many hours in the planning stages before computer programming begins (5).

History and Development

History. The videodisc is not a new concept. In 1926, James Logie Baird developed what he named "Phonovision." This optical disc, produced for TV transmission, had only 30 lines of resolution, compared with the 525 lines standard today (2). The playback speed in 1926 was 12.5 frames per second, whereas the speed today has more than doubled, to 30 frames per second.

The next major development occurred in the early 1960s, when engineers with 3M Company designed the first videodisc capable of playing back full bandwidth images (2). Because lasers had only just been invented, these videodiscs were not yet laser-read. Not until the early 1970s did laser videodisc become a reality. At the same time, RCA developed the capacitance electronic disc (CED). The CED, however, was read much like a phonograph record by a stylus seated in a groove and, hence, was vulnerable to wear.

At first, both types of videodiscs were used simply to repackage existing media, movies (2). Videodiscs were placed on the market in competition with videocassette recorders (VCRs) for the home entertainment market. The videodisc had its advantages:

- The videodisc player was cheaper than a VCR.
- Videodiscs were cheaper to mass-produce than videocassettes.
- Videodiscs produced a higher resolution, better quality picture on the television screen.

As soon as the videodiscs became commercially available, however, the price of VCRs dropped and the videodisc lost its market. The most significant disadvantage to videodiscs on the consumer market was that they were not recordable. Consumers were willing to sacrifice a little quality to be able to record their favorite television shows or home movies. Home videodiscs were long-play but not interactive.

At this time, some companies had begun developing their "industrial" market by emphasizing the interactive qualities of the laser videodiscs (2). These companies were aware of a new discipline developing in the information/education field that could take advantage of the interactive qualities of the laser videodisc. This discipline, called instructional science, included educators, research psychologists, systems analysts, and computer programmers, all of whom had been developing computer-assisted instruction (CAI) in their own fields (2). Now, they could combine CAI with video.

In 1980, Discovision Associates (DVA) gained the largest single commitment to videodisc technology to that time from General Motors. GM purchased point-of-purchase devices and sales training and maintenance aids for their dealerships all over the country (2). By 1983, the movement toward interactive videodisc training and education had begun.

Advantages as an education medium. Several features of interactive videodisc programs made them a beneficial educational tool, and thus their development was encouraged. For instance, a picture of an object is more concrete than a name or a description and thus promotes better memory. Even more learning takes place when information is presented in two modes instead of one (3). With the interactive videodisc system, learning is reinforced in several different ways. Students first see the video image on the screen, then they read text from the computer, and finally they hear sound from the videodisc. In addition, they may be asked to answer questions or choose segments of material to view by manipulating some sort of control device (6). Stimulation of several senses at once also increases knowledge retention.

With interactive videodisc instruction, the student is responsible for the sequence, selection, and rate of the material being presented (6). The interactive program provides immediate and appropriate feedback, according to the needs and ability level of the individual learner (4). The system can test mastery of a subject before going on to something new (21). The management and record-keeping capabilities of the system allow for individual records to be kept, saving instructors a great deal of time (4). Learners become engaged in an interactive discovery process. They must take a logical approach first to identify the problem, then to solve it (21). This discovery process enhances learning, problem-solving, and decision-making skills (4).

Unlike many other audiovisual media, videodisc systems require little mainte-

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nance or supervision (14). Training can be carried out at many different locations at the same time with fewer teachers because the disc is the teacher (15). The clear visuals from the videodisc can also be used to enhance in-house lectures or laboratories, much like a combination slide and film projector (17).

Disadvantages. The laser videodisc system also has some disadvantages. The critical factors involved in the development of innovative interactive video programs are money, commitment, and time (7). Consequently, a major disadvantage of these systems is the expense of setting one up. The basic hardware alone may cost as much as $1,500–$3,500. The cost may be even higher if the instructional design requires any special input or output devices or peripherals to achieve its purpose. Laser videodiscs on the market today range from $25 to as much as $1,000, depending on the complexity or mass-marketability of the information they contain. The authoring packages used to design the lessons range in price from $200 to $5,000, depending on the amount of options they can offer. Therefore, an entire videodisc system can cost as little as $2,500 to as much as $12,000. This does not include the time cost of the designers and producers.

Another disadvantage is the time-consuming process of designing instructional programs for interactive use. In most cases, programs are designed by a team made up of a media producer (who knows how to use the equipment), an instructional designer (who knows the best way to get the information across), and a subject matter expert (who knows what material is important and how it should be depicted) (21). The process of designing and producing either a videodisc or an interactive lesson requires preplanning. Exact needs must be analyzed, a strategy must be chosen, scripts must be drafted, and the right visuals that will enhance the script must be selected. Finally, the program must be field-tested to work out bugs (16). Each one of these processes takes time and a high level of expertise.

A final disadvantage of interactive videodisc instruction is that not every authoring system will support every peripheral or program the user may wish to design. An authoring package must be obtained that will meet the user's present and future needs. Also, a program designed on one authoring system cannot be run on another system. This is no different from incompatible PC software, but at present the market is flooded with many different kinds of authoring systems. The best way to cope is to decide on the options needed and then compare authoring systems to find one that offers the most desirable options.

Cost effectiveness. Although not all education is made cost-efficient by the use of interactive video, in many cases it is a means of providing high-quality instruction to remote sites. In industry, this type of training can save millions of dollars in travel, lodging, and other training-related expenses (3). Not only is the cost of the training reduced, but the time spent away from the job on continuing education is lessened. Each learner's ability is assessed at the outset, and only the unknown information is studied in depth (23).

Several situations in which videodisc technology would be a cost-effective alternative to traditional methods of instruction are:

- *The number of people to be trained is large.* Videodisc replication costs are quite low compared with those of other training media.
- *The people to be trained are either physically or geographically separated.* Videodisc instruction can provide consistent or uniform instruction to a widely dispersed audience.
- *A subject-matter expert is not readily available.* These experts often are scarce or expensive.
- *The subject of the training is either extremely expensive or dangerous.* Realistic simulations can be used in the place of real-life situations that might be life-threatening or might cause damage to an expensive piece of equipment.
- *Several outcomes to a situation are possible.* Videodisc instruction branches to provide consequences for each option the user may consider when troubleshooting problems or making managerial decisions.
- *Many different lessons are needed on the same subject.* The videodisc stores tremendous amounts of information and can be used for any number of lesson plans (10).

Selection Criteria and Process

Before investing in interactive videodisc equipment, one must determine whether the audience would benefit by the use of interactive video or whether computer-assisted instruction or traditional instructional methods are adequate. If interactive video is chosen, then decisions need to be made regarding the choice of videodisc software and the hardware to run it.

Videodiscs. The basis for these decisions is the design of the program. A videodisc may be available that could be "repurposed" or used with a new design instead of the one for which it was originally intended (16). If no disc is available, the user should be prepared for a considerable outlay of time and money. Designing a videodisc from concept to master tape takes at least 20 weeks (13). Gathering, shooting, and putting the video information for the disc on a 1-in. master videotape called premastering is the most costly part of the process (22). For example, 10 edited minutes of professionally prepared videotape may cost as much as $2,000 to shoot. After premastering, a check disc may be produced for $300. The final pressing of the master videodisc costs $2,500, with copies ranging from $15 to $20 each, depending on the quantity (22).

Authoring packages. Even more important than the videodisc to the design of the instruction is the authoring package that is used to create as well as run the interactive program. Currently, about 40 different authoring packages are marketed (5). As expected, the higher priced authoring packages offer more features and greater flexibility than others. Lessons created with simple systems need to be presented on two monitors, one for computer text and graphics and the other for video. With a more expensive graphics overlay device, the graphics and text can be superimposed over the video on the same screen (19).

Selection of an authoring package must be based on the capabilities needed to produce the lesson design. Different authoring packages offer different options. Input devices that may be added include touch screens, light pens, keypads, voice-recognition devices, and electronic sensors. Output devices include printers, voice synthesizers, and still-frame audio converters for narration of still frames (20). Selection should be based on instructional requirements, hardware requirements or configurations, contractual arrangements with system developers, ease of use, management features (record keeping), documentation and training offered by the developer or vendor, and cost (17).

Hardware requirements. Once a suitable authoring package is chosen, hardware compatible with the system can be purchased. If the hardware is already in place, the choice of an authoring package will be limited to those packages compatible with the available hardware.

During program development, ease of use is an important factor to consider. Because many people are still computer-shy, a system designer has to make the mechanics of the system as simple and as transparent as possible (12). All different types of peripheral input devices are available to ease the discovery process. Specially designed keypads, touch screens, and voice-recognition devices can make the technology virtually inconspicuous, yet still provide an interface between the user and the system (9).

Applications

To give some idea of the types of interactive videodisc instruction in use today, we have divided the different applications into four categories: training, simulation, information and education, and archival storage.

Training. The interactive videodisc is an extremely useful training medium. It provides a high standardization to instruction and learning, and the operation is as easy for the average person as an arcade game (13).

An example of videodisc training is in CPR (cardiopulmonary resuscitation) certification, a lifesaving technique. The subject, being a hands-on skill, requires the instructor not only to present the information but also to evaluate the student's precision and ability. During the interactive CPR training, students receive instruction and are tested on two video monitors. They respond to questions and control the pace of the instruction using a light pen. To measure the student's skill at performing CPR, a number of sensors are placed in a training manikin that "feel" certain combinations of actions and feed these data into the microcomputer. The data supplied by the sensors enables the system to coach students aloud so they do not have to take their eyes off the manikin.

With this portable interactive videodisc teaching system, more people can be certified in CPR than ever before, and they can be certified faster and with higher standards of performance than they could be with a live instructor (13).

Several areas in the field of plant pathology could benefit by the use of interactive video training. For instance, in tree maintenance, incorrect pruning procedures can damage a tree beyond repair. Also, improper pesticide application can endanger crops, the environment, or even the health of the applicator. Interactive video could be used not only to train these arborists and pesticide applicators but also to test them for certification.

Simulation. Another type of videodisc instruction is the use of realistic video simulations. These simulations provide students with greater freedom and expose them to a wider variety of material than is normally possible because of the expense or potential danger of certain situations (22). Also, in situations where a series of decisions may result in several different outcomes, students are free to explore the decision-making process and the different outcomes that can result.

For example, an interactive drama has been developed in the field of medicine called "The Case of Frank Hall." This drama, which simulates a fictitious patient's entry into a hospital emergency room, provides students with a chance to practice their diagnostic skills. The students are allowed to explore the patient's history, present condition, and mental attitude and to recommend treatment or further examination, as they see fit. To enhance the students' involvement in the drama, interaction with the simulation is by voice commands received by a voice-recognition device attached to the system. The recommendations made by the students are run through a probability model, based on previously received information. The results are variable and are based on the number of outcome possibilities at the time (9).

Video simulations are also being used in the chemistry laboratory. Simulations can expose students to equipment that is too expensive or delicate for actual student use. Such interactive videodisc lessons can prepare students before they enter an actual laboratory. Many chemical reactions are too fast, too slow, or too hazardous for students to run themselves. By videodisc simulation, students can watch a fast reaction frame by frame in slow motion to determine the exact reaction time, or they can study in detail reactions that are too volatile for laboratory use (22).

Information and education. A number of laser videodiscs are currently on the market that can be used for different informational and educational purposes. An example is an annotated version of a movie that can be stopped at any time to display comments or questions about the movie up to that point. Existing discs, such as *Klavier im Haus, Midway, Raiders of the Lost Ark*, and *Waldo Pepper*, have been annotated in order to teach elementary mathematics and history, English as a second language, and other topics (8).

A disc designed by engineers from MIT's Architecture Machine Group is an interactive "movie map," or what is sometimes called surrogate travel. This tour of Aspen, Colorado, allows viewers to drive down all the streets of Aspen and see in any direction exactly what they would see if they were actually there. They can stop and ask for more information about a particular place and even see it in its historical setting. Viewers can also see what the town looks like during each of the different seasons (2).

In the plant pathology classroom, an interactive videodisc could be used to improve the scope of a class. Rather than emphasizing diseases of local or seasonal occurrence, the instructor could use disease examples of a much wider variety. Use of videodisc need not replace conventional hands-on specimen examination but could very nicely supplement it.

Archival storage. One final area in which videodiscs are used today is in archival storage. An archival disc is sometimes referred to as a visual database. It is a collection of still frames and motion sequences accompanied by sound. The archival disc is designed as a resource for browsing or for retrieving images. The disc does not contain a built-in lesson or preset path for the user to follow (19).

A variety of archival videodiscs is on the market. The National Gallery of Art, for instance, has developed a disc that takes the user on a tour of the gallery and gives a history of the gallery collection (21).

We believe that the time is appropriate for the American Phytopathological Society (APS) to consider production of an archival videodisc. APS could screen its membership for crop/disease specialists who would be willing to share their outstanding original slides by publishing them on a videodisc. If each cooperator would contribute $1.50 per slide to defray the cost of putting each slide on 1-in. tape, an archival disc would be produced with a relatively small additional investment from APS. Videodiscs could be sold by APS and return a fair profit to the Society.

Of much more value, though, would be the accessibility of the slide collection to disc users. The collection could include signs, symptoms, histological and ultrastructural effects, and perhaps some tabular or graphed information if appropriate. The disc user would have the responsibility to acquire the hardware and software and to develop access programs. These would reflect the user's unique needs. A well-prepared videodisc would be extremely useful not only for undergraduate and graduate teachers of plant pathology but also for extension specialists and teachers in related fields, such as horticulture, arboriculture, and forestry.

Because of their freeze-frame capability and referencing address, archival discs such as the APS disc would be perfectly suited to designing visual diagnostic keys of plants, insects, and diseases. Any time a visual image would improve understanding or awareness of a given subject, the interactive videodisc is a viable alternative to traditional audiovisual and teaching methods.

Future Trends

Videodisc technology has been steadily advancing since it was first conceived in 1926. The future of the information/education industry will be strongly influenced by interactive videodisc technology. At present, hardware capabilities are outrunning the ability of the educational community to use them effectively. With time, however, the number of users of videodisc technology will increase and the price will decrease, as has happened with calculators, microcomputers, and VCRs. Videodisc instruction will become more widely used by the general public.

Already, technological advances are making interactive video even more effective as a teaching tool. For instance, a feature called still-frame audio can compress up to 10 seconds of audio onto a single frame of video information. As the frame is played, the compressed audio is read by an external decoding device. With still-frame audio, each slide can have its own narration (15).

CD-ROM (compact disc—read only memory) is another form of laser videodisc technology that is gaining acceptance in the information/education field. These CDs can store vast amounts of digital information, computer text, computer graphics, and audio, but they cannot yet store full-motion video. The CD-ROM drive is not a stand-alone device like the portable CD audio player. CD-ROM must be connected to a computer before the library of stored information can be accessed (11).

One of the main drawbacks to videodiscs, as seen by the general public, is their inability to record. A major research thrust is to produce a videodisc that will record and erase like the videocassette. One of the latest developments is the optical write-once disc referred to as CD-WORM (compact disc—write once read many times). This technology allow users to record information on an optical disc much as they would on a computer diskette, but the entry cannot be updated or altered at a later time. An example of its use might be to store permanent student records (11).

In the future is another development similar to CD-ROM called CD-I (compact disc—interactive). As the name implies, these compact discs expand the capacity of the CD-ROM to include still and full-motion video stored in digital format. Adding video to the already available audio, text, and graphics on CDs increases their interactive capabilities considerably (18).

The following is a list of future trends as interactive videodisc instruction continues to develop:

- Lower prices
- More compact systems
- Increased capability, durability, and quality
- Videodisc system sharing
- Rapid replication and recordable videodiscs
- Improved still-frame audio
- Improved interface devices
- Computer control over several disc players (12).

Hardware will not be the limiting factor in the future development of laser videodisc technology, and with continued development, software limitations will likely diminish as well. As was the case with computers and other forms of media, the teachers and perhaps the extension specialists will ultimately determine the final success of the interactive video medium (16).

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