Development of the Plant Pathology Laser Videodisc

F. H. Tainter,* G. L. Schumann, and T. A. Evans

ABSTRACT

Laser videodisc is a technology that is just beginning to be used to enhance agricultural and forestry education. We share our collective experience in producing a laser videodisc of plant disease images. This experience will be useful to other novices in the use of emerging technologies such as the laser videodisc to enhance their productivity and avoid costly errors and should be invaluable to anyone considering the production of their first videodisc.

ON MOST UNIVERSITY CAMPUSES one sees an almost overwhelming array of new technologies that have the potential to make teaching more effective. Some of these include telecampus (which is the creation of multiple campuses connected by an interactive video network), interactive video, CD-ROM, and laser videodisc. It can be discouraging to watch an expert zip through a demonstration of an expensive new technology and not feel confident in reaching a reasonable decision about appropriate applications of the technology in one's own classroom. How could the technology be used? How does one become skilled in using the technology? Who would develop the teaching materials? Would students use and/or have access to the technology? Is the expense justified in improved teaching effectiveness?

Less than 5 yr ago, the authors of this paper were novices in the application of electronic technology in the classroom. We all teach courses in plant pathology, however, and were concerned about our ability to present high-quality visual images to our students, especially since much of our subject matter is related to microscopic features of pathogenic organisms and plant diseases that are more active during the summer growing season rather than the academic year. Despite our amateur status in teaching technologies, we were able to learn about one facet of this technology—interactive videodisc—and create what we think is a valuable teaching tool.

We suspect that there might be a number of other instructors who could benefit from a review of our experiences in producing a laser videodisc and some interactive teaching materials. We would certainly do some things differently, and perhaps more efficiently, if we were starting again with our current knowledge.

THE IDEA

In 1988, a student approached the senior author about the possibility of working toward a Master's degree in Forestry utilizing electronic technology. She was aware of how laser videodisc technology was being used to teach medical students and to update automotive mechanics (luppa, 1984; Schwartz, 1985) and felt that similar efforts could be successfully applied to forestry. We were unable to obtain the necessary funding to produce a simple disc and buy the necessary hardware (about $12 000 at that time), but the student wrote an article based on a graduate seminar that summarized laser videodisc technology, its present applications, and argued for the production of an archival disc by the American Phytopathological Society (APS) (Rowe and Tainter, 1989).

At about the same time, the USDA Share Disc II was produced including approximately 1500 plant pathology images that had been assembled at the University of Minnesota. The second author of this paper was able to obtain some internal funding from her college (Food and Natural Resources at the Univ. of Massachusetts) to purchase a videodisc player, a personal computer with a videoboard, and a monitor. With advice and programming by a colleague, she created some demonstration interactive teaching modules about plant diseases, which combined text on the screen with the videodisc images using a software program called Quest (Allen Communications, Salt Lake City, UT). A major limitation of the USDA videodisc was the small number of images and the narrow range of host plants represented. The image base

Abbreviations: APS, American Phytopathological Society; SEMs, scanning electron micrographs.
was simply not large enough to support a classroom effort in general plant pathology.

THE FUNDING

The third author was aware of the article by Rowe and Tainter (1989) and was also aware of the demonstration materials that had been created using the USDA videodisc. In 1990 he learned of a new competitive grants program, the USDA Higher Education Challenge Grants, which provides funding for innovative teaching efforts in higher education with matching funds from participating institutions, mostly of value-of-time in faculty efforts on the project. Even though the three coauthors did not know each other at that time and knew very little about videodisc technology, a joint proposal was prepared and submitted.

The first proposal was entitled, "Development of Interactive Videodisc Technology for Teaching Plant Pathology," and was for the amount of $45,675 with a duration of 3 yr. The project had four specific objectives: (i) develop a plant disease videodisc library, (ii) develop illustrative modules or lessons to teach basic principles of plant pathology, (iii) evaluate the efficacy of these modules, and (iv) disseminate the videodisc library and modules and information on their use.

In 1991, a second proposal was submitted entitled, "Interactive Software and Hyperlecturing Using a Plant Disease Videodisc Library," for the amount of $31,485 and of a 2-yr duration. It had as objectives: (i) expansion of the plant disease videodisc library, (ii) development of a computer-based database linked to the videodisc to provide an efficient means of sorting and reviewing images on the videodisc, (iii) development of advanced learning modules, and (iv) exposure of the principal investigators to the use of hyperlecturing software developed at the University of Delaware.

THE TASK

Both proposals were accepted and funded, so we were then committed to making the new technology succeed and be useful. As members of APS we were able to establish an agreement for its publishing arm, APS Press, to publicize and distribute the videodisc at a low price. APS Press also publishes a series of commodity-specific plant disease compendia, each of which contains a collection of high-quality color photographs. By agreement with APS Press, as publisher of what was to become the Plant Disease Video Image Resource, we were given permission to use the disease compendia photographs copyrighted by APS (about 4500 images) as the foundation collection for the videodisc.

All other slide contributors who still held the copyright on compendia photographs were required to sign permission-to-publish forms. It was difficult to obtain permission forms for every image within the 12-mo time limit we had established for creating the collection. In some cases contributed slides had been produced by individuals now deceased. In other instances, different individuals submitted the same slide, each claiming to be the photographer. International contributors and institutions were particularly difficult to contact for permission within our time constraints.

Convincing people to contribute slides was an interesting experience, again given our time limits. A number of potential contributors knew little or nothing about videodisc technology and either wished to contribute later or would think about it and contribute later. Fortunately, several key individuals volunteered early to contribute some important sets of slides. These included scanning electron micrographs (SEMs) of fungi, nematode slides, slides of vegetable diseases, tropical agriculture and plant disease slides, and a number of other significant collections. We solicited slides from individual specialists in specific subject areas to try to create a collection of images representing all pathogen groups and a broad range of host plants.

PURSUIT OF QUALITY

Some slides incorporated onto the videodisc reproduced better than others when the check disc was reviewed on a monitor. Original slides reproduced better than copies. Scanning electron micrographs, and to a lesser extent transmission electron micrographs, reproduced especially well, again with original slides reproducing best. Slides representing closeup views of host symptoms or pathogens were better than field views of diseased crops. The color bases used by the specific film process such as Kodachrome, Ektachrome, Agfachrome, or Fujichrome each reproduced somewhat differently, but these differences were less than those involving the sharpness of the image itself.

We also found that horizontal slides tended to fill the entire monitor screen but that vertical slides only filled a portion of it. For field views especially, this often resulted in an unacceptable loss of resolution. For closeups or for views of simple composition, vertical slides posed no problem. Printed signs and labels on drawings or field plots did not reproduce clearly and were not readable in many cases. Were we to do this portion of the project over, we would likely have been somewhat more selective of contributed slides and would have allocated at least 6 more months to search for additional contributors.

FINDING THE IMAGES

The final videodisc collection comprised more than 9500 images. Clearly, a descriptive and easily accessible database would be needed to allow instructors to search for images of interest. Contributors were requested to submit data with each slide following an established format containing information such as host, pathogen, disease name, and a brief description containing key words related to the image. We assigned a number to each image. In addition, we were required, as part of the publishing agreement, to include a credit line for each image following copyright guidelines. Contributors were requested to submit the data on a diskette in the standard format, but most submissions required substantial editing and standardization by the authors. In addition, the authors had to create the entire section of the database for the 4500 disease compendia images from APS Press.
The creation, correction, and standardization of the database for the collection proved to be an extremely time-consuming project.

APS Press provided access to a software program called TextWare (TextWare Corp., Park City, UT), which converted the database into a very user-friendly searching tool in which key words are used to quickly identify the numbers of potentially useful images. The software allows the user to view entire image descriptions, and subsets of the database can be easily printed out for further use. Unlike many database softwares, TextWare searches for key words on the entire image description rather than a single information line, which results in more complete and faster searches for images.

A major deficiency at this point is that the image in question cannot be directly reviewed from the TextWare program. Because of programming constraints, this level of interaction could not be achieved. One only obtains a list of image numbers that must then be viewed after the database program is exited. It is a little awkward but not too time-consuming, because database searches can be completed almost instantaneously after key words are selected. The new 4.0 version of TextWare has the ability to access external programs, which should allow for direct viewing of images.

CREATING INTERACTIVE LESSONS

While the videodisc was being produced, a format for the interactive, menu-driven lessons in introductory plant pathology was refined from the demonstration lessons created for the USDA videodisc as described earlier. The goals of the lessons were to provide text appropriate for introductory plant pathology students while emphasizing the images available on the videodisc. While not available when we started the design work, the excellent resource book by Imke (1991) would have been helpful in the development of the interactive programs. Text overlays were designed to maximize the visibility of the image on the screen. Directions are simple and involve direct menu choices and arrows to move backward and forward in the lessons (Fig. 1). Individual modules are short, and students can exit at every screen. The few directions are apparent on the screen, so a student is capable of using the program almost immediately.

A few preliminary teaching modules were created at the end of the second year and demonstrated at the annual APS meeting in Portland, OR, for input from other plant pathology instructors. Reception of the videodisc and teaching modules was generally favorable, but most participants expressed conservative opinions about their ability to obtain funding for the hardware and had difficulty envisaging how they could use this technology in their classrooms. Many questioned how such expensive equipment could be made accessible to students while maintaining its security. Other instructors expressed concern about learning the Quest authoring system, so they could create their own teaching materials. References to help potential users to overcome these concerns include Alessi and Trollip (1991) and Semrau and Boyer (1994).

The final set of interactive lessons includes 37 modules that introduce all of the major plant pathogen groups and describe aspects of example diseases within each group. A glossary of more than 850 terms related to plant pathology was compiled. It is accessible from every screen of the lessons by pressing G. Thus, during the course of a lesson a student can easily “look up” a term in the glossary by pressing G and typing in the desired word. Whenever possible the text definition appears on the screen accompanied by an image from the videodisc (Fig. 2). The student then returns to the lesson without losing his or her place. There is also a feature that will try to locate the correct term even if it is misspelled. When the exact word is not found in the glossary, the computer presents a numbered list of the nine nearest words in the glossary. This is especially useful for many scientific terms that have plurals derived from Latin endings or for students who have trouble spelling.

The Glossary of Plant Disease Terminology is a small, stand-alone program that uses a simple binary search technique based on a keyword to locate a record in the Plant Disease Video Image Resource database. The pro-

![Fig. 1. Example of a lesson screen.](image1)

![Fig. 2. Example of a glossary screen.](image2)
gram can be used in stand-alone mode with the database or it may be accessed from within Quest instructional lessons and is written in Borland Pascal 7.0.

As the lesson package and glossary neared completion, another technology, the laser barcode reader, was discovered by the authors (Fig. 3). In the third year of the project, a demonstration of the laser barcode system and the interactive computer lessons was planned for the International Society of Plant Pathology in Montreal, Canada, and the next APS annual meeting in Nashville, TN. The completed set of lessons with the illustrated glossary was better received when colleagues viewed it the second year. Part of the reception was due to the addition of the glossary, but in many cases instructors who were not familiar with computer technology were impressed with how simple it was to use the lessons.

Another reason for the increased enthusiasm for the videodisc was the demonstration of the laser barcode technology to access the images. With the barcode system, neither a computer nor an authoring system is necessary to access the images and create teaching materials. Barcodes that correspond to image numbers (like those used for pricing in stores) can be produced with simple programs and newer versions of popular word processing programs.

Instructors can then use word processing to create text or teaching exercises such as identification practice and add barcodes for images to accompany them. Barcodes are electronically or physically added to the teaching materials wherever an image is useful. Materials with barcodes can be photocopied to produce multiple copies for distribution to students. The potential outcome is similar to that of a textbook with 9500 color pictures. One of the greatest assets of the laser videodisc is that one can access the images randomly and repeatedly. Thus, an instructor can use images in a text format and then use any of the images again for quizzes or review sessions or entirely different teaching applications. Because the only time requirement lies in preparation of the text, instructors can easily modify lessons and prepare text at different levels for different student groups using the same images. An entire barcode system can be purchased for less than $1500.

CURRENT LIMITATIONS AND USES

The biggest obstacle to creating interactive lessons, apart from the initial hardware cost of the interactive computer (about $3800) and the videodisc ($500 minus 15% for APS members), is the problem of learning to efficiently use an authoring system. For Macintosh owners, Hypercard seems a logical and easy choice, but for IBM users the myriad of authoring systems is overwhelming. Fortunately, Kearsley (1986), Alessi and Trollip (1991), and Semrau and Boyer (1994) offer a variety of suggestions on how to approach the problem of accessing images from a laser videodisc by means of authoring systems. We purchased Quest as our authoring system because of its teaching support capabilities and programming support at UMass. It is not a program that is easily mastered, however, and we have yet to become proficient at it. However, one of the UMass programmers created a program that creates new lessons automatically when we submit ASCII files in a simple format of image numbers and accompanying text. Thus, we can readily create new teaching materials using our current format. Some other instructors are interested in producing foreign language versions of our set of interactive lessons for international use.

Laser barcode pen is an excellent technology for accessing images for classroom lectures. The videodisc player can be used with any classroom video-projection equipment. The lecturer prepares a set of barcodes for images in the order required for the lecture and uses the barcode pen to access each image when needed. It is much simpler to go back to previous images using the barcode pen if questions arise during the lecture than it would be with a slide set. The lecturer also has access to the entire image collection for every lecture.

We were unable to evaluate the efficacy of the interactive lessons for teaching introductory plant pathology for several reasons. First, the production of the videodisc and the lessons required the entire 3-yr time limit of the project. Because so few people had the videodisc equipment, even finding opportunities to have lessons peer-reviewed was difficult. Only in recent months have various institutions purchased the videodisc and obtained the hardware with which to use it. To date, 61 videodiscs have been sold. A list of institutions that have purchased it include: Brigham Young University, California State Polytechnic University, Clemson University, Colorado State University, Cornell University, Iowa State University, North Carolina State University, Ohio State University, University of California-Davis, University of Delaware, University of Georgia, University of Maine, University of Massachusetts, University of Minnesota, University of Utah, and Virginia Polytechnic Institute and State University.

In 1994, the Stockbridge School Alumni Association purchased interactive computers and barcode systems for use by students at the University of Massachusetts. This equipment is secured in the student computer facility of the main library where it is accessible for extended hours.

Fig. 3. Accessing an image with a barcode pen.
each week. Each unit is in an individual room, and students must leave an identification card in the staff room while using the equipment. Following the first semester of student use, many students found the videodisc useful for laboratory preparation, review for tests, and as an aid when classes were missed because of illness.

The University of Delaware has had a long-time commitment to multimedia teaching and, at present, has five teaching laboratories with interactive videodisc stations for student use. Students taking plant pathology courses making use of interactive videodisc have easy access to the stations at teaching laboratories scattered across campus, most of which have extended hours of operation. Similar to the University of Massachusetts, students check out the videodisc using their university identification card.

THE FUTURE

Since the project began several years ago, other authoring systems have become available that are said to be relatively easy to learn and allow programs to interact with CD-ROM and other digitized image sources in addition to the videodisc (Kearsley, 1986; Semrau and Boyer, 1994). One of the repeated questions concerning the use of the videodisc is why we did not use CD-ROM technology in the first place. At this time, CD-ROM is not capable of rapid, random access of a high quality collection of 9500 images, nor can it store anywhere near that number of high-quality still images. Videodiscs provide high-quality images as needed while the computer memory is used for interactive programs. In the future, CD-ROM technology may be able to provide rapid access to large archival image collections.

If enough institutions find the current Plant Disease Video Image Resource a useful teaching tool, the image collection could be expanded in the future by adding to the master tape and creating a new version of the disc for a relatively low cost. Additions would cost about $1.50 per image. Because of preparation costs and labor involved in adding new images and the costs of producing the new version of the videodisc, a significant collection of perhaps 5000 new images would probably be required to justify the effort. Image descriptions would also have to be prepared for the database. However, a single side of a laser videodisc can include up to 54,000 images, so space is not a limiting factor. Up to 30 min of motion video could be included on the opposite side. A new version would offer the opportunity to include photographs from a number of recently published disease compendia, to obtain photographs for incomplete areas of subject matter, and to request slides from APS members who have high-quality photographs but were missed when the project began. It may be easier to solicit some of these collections now that the technology is familiar to more APS members.

CONCLUSION

We found that the diversity of our responsibilities and interests was an asset in the completion of the videodisc project. We are looking forward to the creative applications and use of our colleagues might find for the videodisc resource and hope to maintain a users group of instructors for trading ideas and teaching materials through the APS Teaching Committee. The project required more time and effort on our parts than we had imagined. The value with which many administrators and academic colleagues view this contribution compared with research publications remains disappointing, but we feel that our teaching effectiveness has been improved with the use of videodisc technology. We all have plans to continue to work on teaching applications of the videodisc.

REFERENCES


