Have you gotten your interactive video feet wet yet? In the following pages, Donahue and Donahue offer non-computer people an introduction to this powerful instructional medium that is particularly suited to adult learners. Lin Olsen and Robert DiFazio of Digital Equipment Corporation tell how their organization used interactive video to cut training costs and improve the timeliness of new-product training. And Xerox Learning Corporation provides a brief glossary of videodisc terminology for beginners.

Understanding Interactive Video

By THOMAS J. DONAHUE and MARY ANN DONAHUE

Many experts predict that within five years interactive video will be the dominant medium in the technical training market. For trainers, the rapid growth of interactive video presents both an opportunity and a challenge.

The opportunity exists in the widespread possibilities that come with a new technology. In this case the opportunity is multiplied by the combination of two popular, multifaceted training tools: television and the computer. As trainers become more familiar and comfortable with interactive video, the probabilities of innovative training are likely to increase with mind-boggling speed.

The challenge is becoming familiar with a powerful new instructional medium, one that promises to affect the way we work in the near future.

Interactive video defined

Interactive video is a technology that enables a learner to communicate with and to control a video learning program by using a computer. It uses a special electronic interface (circuit board) to connect the computer and a videocassette recorder or videodisc recorder. This combines the power of video with the microcomputer so that video segments can be mixed with computer menus and programs. This has been done for several years with large mainframe computers; now that personal computers are commonplace, interactive video training is affordable and appropriate for any number of learning situations. For instance:

- Pilots and police officers challenged by video segments of life-and-death situations can use the computer to "branch" to their decisions' consequences, without endangering human life.
- A computer novice can learn to operate the IBM Personal Computer in a few hours by using the computer while watching video demonstrations interspersed with exercises on the computer's monitor. As each task is successfully completed, a more sophisticated task is presented.
- The American Heart Association's mannequin used to train cardiopulmonary resuscitation (CPR) has been connected to an interactive videodisc. If the student presses incorrectly, a voice instantly says, "too low," "too

soft" or another directive.

- Spanish language students can visit a Mexican village via interactive videodisc. The first person they meet says in Spanish, "You're an American tourist, aren't you?" Depending on how the students answer this and other questions, they end up at a fiesta or in jail.

All of these programs are now in use, and dozens of new programs are being generated every month. At the 1983 National Exposition of the American Society for Training and Development, more than two dozen vendors displayed interactive video programs, authoring languages and hardware.

A host of 20th century advances such as television, videodisc, videotape, microcomputers and analog to digital electronic conversion have joined to make interactive video the newest, most effective educational tool in the trainer's bag.

The interactive videodisc can perform the function of every kind of educational technology, from slate and chalk to computer-based instruction. The contributions of slide-tape, filmstrips, language laboratories, teaching machines, programmed instruction, viewgraphs, standardized tests and educational television are incorporated in the interactive videodisc and can be flexibly intermixed at different levels.

Trainers generally agree that people retain about 25 percent of what they hear, 45 percent of what they see and hear, and 70 percent of what they see, hear and do. Interactive video programs keep the learner seeing, hearing and doing. The learner constantly makes decisions and solves problems, so the learning process is accelerated and retention is improved. The interactive program adjusts to the learner and skips material that is too simple, reducing learning time even further. The student can make the most effective use of the learning time available.

Rod Daynes, former director of the Videodisc Design/Production Group of the University of Nebraska, defined four levels of interactive video instruction.

Level one uses a consumer videodisc player with very limited memory capability and no computing ability. It is essentially a playback machine for the videodisc with which the user can control the point of entry into the disc. Dr. Joseph Clark of the University of Washington recently produced a level one disc for biology teachers with more than 6,000 slides covering all aspects of the biological sciences. Some automobile dealerships are also using this kind of program to orient prospective customers.

Level two uses an industrial player with approximately 1,000 bytes of memory, which contains a simple program with branching. Computer code is actually contained on the videodisc. Level two systems are faster than level one systems. They are more flexible, more rugged and more easily controlled by the user. Lincoln College of Law recently produced a level two program which provides simulated courtroom experience for law students; the students choose whether or not to object to evidence, describe the basis for their choice and see the results.

Level three combines all the capabilities of the video player and the microcomputer for a broad range of instruction possibilities. Sophisticated branching is possible for learning complex concepts and tasks. The introduction to the IBM Personal Computer, for example, allows the student to get assistance, repeat, jump ahead or go to the main menu at any time.

Level four uses two videodisc players and allows almost instantaneous feedback and more complex branching. These advanced capabilities are needed in training pilots, tank commanders, race car drivers and people in other complicated occupations.

Videotape vs. videodisc

The nature of the training program is likely to determine the selection of videodisc or videotape. However, if a trainer is developing programs or making a major commitment to interactive video, the benefits and disadvantages of both tape and disc should be carefully considered.

In the most common videodisc format, a laser stylus reads an electronically coded signal that resides just below the disc's surface. The signal is separated into audio and video, and these signals are sent from the disc player to the television monitor.

The videocassette tape recorder also reads signals, but the technology is quite different. For our purposes, the main difference between videotape and videodisc is that on tape, signals must be sequentially accessed rather than randomly accessed as on disc.

Interactive videotape has two major disadvantages. The seek-time or shuttle-time is longer, and if an individual wants to move back and forth within a program there can be a significant wait while the tape rewinds. The second major disadvantage is that the tape cannot give clear resolution to a single frame. If one wants to leave a single picture or diagram on the screen for a period of time, that image must be shot to run continuously, as the tape continues to run. Recently developed tape interfaces allow exact location of a

[redacted]

single frame, but single freeze-frame playback still leaves something to be desired.

Tape tends to wear out, while discs are nearly indestructible. Videotape also requires sequential access, that is, each succeeding frame must be viewed or passed over before getting to the next frame. Trainers who choose tape as a medium often use linear instructional designs to avoid the long shuttle-time while the recorder seeks the portion of the tape to be viewed next.

Tape also has some significant advantages. A tape is less expensive to reproduce in small quantities than a disc. Videotape decks are in common use throughout the country. A program is relatively easy to change even after the master is made. Shuttle-time can be significantly reduced by using two tape decks and alternating between them, and tapes can be designed and edited to minimize shuttle-time.

Videodiscs allow quick random access to any portion of the video program. Discs are better for single-frame viewing: They allow very good resolution, precise location and prolonged viewing. On the negative side, discs are expensive, relatively inflexible and not yet in widespread use throughout the country.

One of the technological problems in combining video with the computer is locating the beginning and end of a video segment so that it can be called up at any time during the program. Each frame on a videodisc is addressed with a unique frame number, so any segment is relatively easy to locate on a videodisc.

Videotape players have several methods of keeping track of frame locations. The counters available on most home videotape recorders are not accurate enough to use in interactive video. Neither is the pulse code which is a standard part of the video system because it, like the counter, is only relative. One frame is differentiated from another by the relative number of pulses rather than an absolute address.

For interactive video, a special time code laid down on an unused audio channel is absolute and far more exact. The most accurate time code is the SMPTE code developed by the Society of Motion Picture and Television Engineers. The SMPTE code counts exactly 30 pulses per second—one for each frame of a standard videocassette.

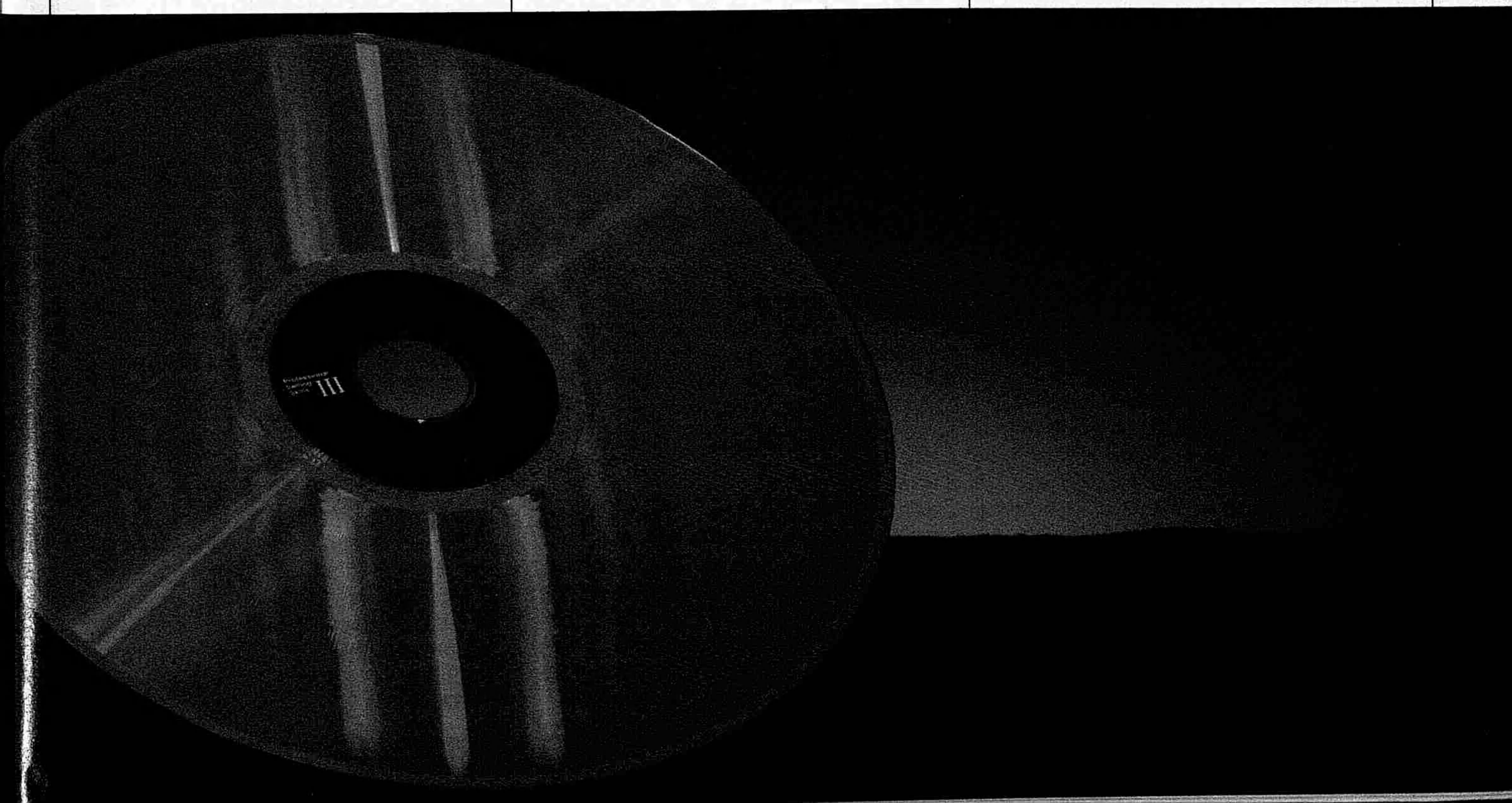
Several companies are now producing a "universal video interface"; it is typically a circuit board that fits inside the computer or a separate chassis that can attach to any computer with an RS232c port (most microcomputers have one) and a videodisc or videotape player.

In the future it is very likely that videodisc machines and videocassette recorders will have a computer interface built into the machine. Even cables that connect the video recorders might be standardized.

Costs and equipment

The equipment and professional expertise required for a custom-designed interactive video program is expensive. The first copy of a well designed, professionally produced one-hour instructional disc is likely to cost more than $100,000, although a nonprofessional or in-house program can be produced for about 20 to 50 percent more than is currently spent to produce a videotape of the same length. The more branching, the more expensive the product.

Most of the cost is for the professional personnel needed, but specialized equipment is needed too—not the least of which is a television studio and a computer (see Peter Schleger's article on page 62 for another view of



equipment, personnel and studio requirements). Many off-the-shelf interactive video programs are being developed for the microcomputer; these will be an economical alternative for many users.

In addition to a computer and a video playback device, an interface is needed to allow switching between computer control of the monitor and video. The recent development of interface technology has enabled interactive video to become practical for use with microcomputers. The interface can be a circuit board that fits in the back of the computer, or it can be a separate "black box." The interface may cost less than a hundred dollars or more than a thousand dollars, depending on the specifications. It pays to shop around.

Most video interfaces require special cables and equipment. A home videotape recorder is usually insufficient to run interactive video programs because they typically do not have a solenoid, the wire coil that enables the tape to switch to fast forward and reverse electronically. Some home video players now have solenoids but still cannot be used because they are unable to read the control track in fast-forward or rewind modes.

Another recent breakthrough allows a single monitor to read both the digital signals produced by a computer and the analog signals produced by a television set. For some time it has been possible to read computer output using a television set, but resolution suffered and satisfactory color graphics were practically impossible. Now a single screen can produce television images, high resolution color graphics and readable 80-column print.

Program development

Developing an interactive program usually involves a team consisting of a subject matter expert, a systems analyst, an instructional designer, an editor, a producer, a director, a project manager and various technical experts, such as programmers and camera technicians. The most costly portions of the project are usually the instructional design and the video production.

After the target audience definition, needs assessment, goal setting and content outline are completed, a flowchart is constructed which defines the menu(s), video segments, questions or exercises, computer-assisted instruction units, help segments, branches, loops and all other aspects of the program. Based on the flowchart, the script and programs are written, edited, validated and refined.

A storyboard is then prepared in a standard format. After the production phase, the programmer or film editor assembles the program according to the flowchart. A pilot version is tested, corrections prepared and the master copy assembled.

Most developers of interactive video use ¾-inch or 1-inch videotape to test their design and, once the master program is completed, transfer it to ½-inch tape or disc for distribution. A low-quality proof disc can be used to test a pilot program, and later a high-quality disc can be mastered.

Mastering of the disc is done by a disc production house and generally costs between $2,000 and $10,000. Prices for mastering an interactive videodisc have dropped dramatically during the past two years.

The Shoemaker's Children: How Digital Uses

By LIN OLSEN and ROBERT DI FAZIO

The history of the development of educational technology has been a continuing effort to bring together the short-term economy and convenience of linear presentations with the long-term efficacy of interactive instruction.

Self-paced instruction (SPI) in print is the first generation of educational technology. It provides a consistent set of materials that may be used where and when needed, at a learning speed determined by the student. The degree of interaction available to the student depends on the course design and on whether or not the SPI course is supplemented by lecture/labs.

The second generation of educational technology has been variously labeled computer-aided instruction (CAI), computer-based instruction (CBI) and computer-based education (CBE). CBE has been widely applied to training applications in business, industry and government since the 1960s. Using terminals connected to large mainframe computer systems, CBE courses allow the student some degree of interaction with the information that is presented in text and graphics forms. The student can elect to repeat drills, ask questions of an instructional database, manipulate graphic images, demonstrate progress and generally follow his or her best learning pace. Studies of CBE programs in schools have shown over 50 percent increases in learning and recall rates among students.[1]

The cost of using a large time-sharing computer for CBE applications has been estimated at between $5 and $15 per hour per student, and some CBE courses are now being implemented on minicomputers in order to reduce costs to as low as $2 per hour.[2]

The third generation of educational technology represents a number of discrete technologies coming together in a total systems solution. Systems-based education provides fully integrated natural image video, high-resolution graphics and text, audio capability and the interactive flexibility of a powerful microprocessor-based computer system.

Interactive video for non-programmers

Authoring languages are a real boon to instructional designers who do not know how to program a computer. More than 100 authoring languages have been written for instructional designers during the last few years. By following a particular format or answering questions presented by the computer (e.g., What type of question do you want to ask: multiple choice, matching, true-false or fill-in-the-blank?), an instructional designer can design an interactive video or computer-based lesson in English. It is no longer necessary to learn a programming language or hire a programmer.

Authoring languages are a large enough topic for a separate article, but a beginning list should include Whitney Educational Services, INSIGHT, The McGraw Hill Authoring System and Bell & Howell's PASS.

Selected resources

- *The Handbook of Interactive Video* was written by Steve Floyd and Beth Floyd and published by Knowledge Industry Publications, White Plains, N.Y.
- Michael Deblois recently completed a book entitled *Video Disc/Microcomputers Courseware Design* published by Education Technical Publications, Englewood Cliffs, N.J.
- *Video/Computers* by Sippl and Dahl was published in 1981 and just slightly predates the advent of interactive video using microcomputers. The book gives an easily readable technical explanation of video, computers and communications, but does not mention interfaces that actually enable the video player and computer to work together. It is published by Prentice-Hall, Englewood Cliffs, N.J.
- In addition to this journal, other publications such as Lakewood Publications' *Training* (Minneapolis); Cavri Systems' *INK* (New Haven); *Videodisc News* (Washington, D.C.); and *EITV* (Danbury, Conn.) regularly contribute to the information pool. *EITV,* a monthly magazine published by Educational and Industrial Television, devoted its June 1983 issue exclusively to interactive video.
- An annotated list of recent articles was published by *Educational Technology Magazine* in its February 1983 issue. ASTD members can obtain an annotated bibliography of recent articles by writing to John Eldridge, Director of Instructional Design, Global Technology Corporation, 2901 Druid Park Drive, Suite A102, Baltimore, MD 21215.
- Gloria Gery published a *Resource Guide to Computer Aided Instruction* in the May 1982 issue of *Data Training* (Boston).
- **Panasonic** (Secaucus, N.J.) occasionally presents a two-day, hands-on seminar in conjunction with **OmniCom Associates** (Ithaca, N.Y.) that uses the Panasonic system to produce a level two program as described in this article.
- The **Nebraska Video Disk Design Production Group** periodically presents a three-day workshop in Lincoln, Nebraska and each fall presents a symposium on interactive video.
- **Brigham Young University** in Salt Lake City, Utah also presents occasional workshops and seminars.
- **ARES Schools** in Minneapolis present a workshop that teaches trainers how to produce interactive video programs using the IBM Personal Computer.
- The **International Television Association** (Berkeley Heights, N.J.) usually plans several presentations dealing with interactive video at its annual conference.
- **Talmis,** a marketing organization in Oak Park, Illinois sponsors an annual conference in Chicago and is a good source of interactive video information.

Interactive Video to Train Computer Technicians

Applying systems-based education

In a hi-tech economy, the career lifetime of workers is now greater than the development and support lifetimes of the products they produce. This means that employees will have to be retrained many times. Nowhere is the trend more evident than in the computer industry, where a critical factor in the market success of technologically advanced products is the ability of the vendor to train field service technicians to repair and maintain them.

The research and development that led to the introduction of Digital Equipment Corporation's Interactive Video Information System (IVIS) was part of an effort to improve field service training methods. Two goals were important: improving the timeliness of training to keep pace with the introduction of new products and centralizing training to reduce per diem and travel costs.

Early in 1979, one alternative to the traditional lecture/lab that was considered was to distribute linear video courses and workbooks to field service offices and to establish regional labs. A lecture/lab course was adapted for video and produced. Around the same time, an experimental stand-alone video system was designed. Neither satisfied the need for interaction between student and course content that is necessary for effective training. It soon became evident that what was needed was a fully integrated systems-based education capability.

IVIS has been designed as an optional hardware/software subsystem which, when interfaced with a DEC Professional 350™ personal computer, enables computer-generated text and dynamic graphics to be displayed over moving television pictures or still frames on an RGB (red/green/blue) color monitor (the type of monitor with the highest color resolution and best representation of graphics and text).

Lin Olsen is IVIS product manager and Robert DiFazio is industry/government training systems manager for Digital Equipment Corporation Educational Services, Bedford, Mass.

The hardware allows the user to select among external video sources, including videodisc, videotape, video camera and detuned cable or broadcast video. Selection between two external audio outputs provides for bilingual voice annotation, for example, or stereo sound. The system provides random access to 54,000 frames per videodisc side.

The IVIS control software is designed to provide self-paced interactive learning via video simulations that enable the student to observe real-life situations and problem solve on-line. Synchronization of computer and videodisc signals provides the system with the ability to render and simplify complex detail with high-resolution text, graphics and natural video images.

The first true test of the new system was carried out in December 1982 at Digital's Bedford, Massachusetts Educational Services facility. A course on maintenance and repair of the LA100 line printer was developed, including video simulation of technicians making repair calls in a customer's office and correcting a series of increasingly complex hardware faults. Voice annotation provided basic instruction, and dynamic graphics were used to highlight and reinforce details.

Students interacted with the system via a standard typewriter-like input keyboard. They could repeat sections of the video instruction, leave question messages for an instructor, look up material in an online glossary and freeze-frame particular images. They were presented with both natural pictures and graphic representations of parts and their connections and could rotate graphic images for three-dimensional views.

A three-hour IVIS course was given to a group of 10 Digital field technicians. A six-hour linear video, workbook and lab course was given to a control group. All students were pre-tested to ensure comparable levels of experience and ability. Both groups were given the same set of lab tests and the same final exam.

The lab tests consisted of three increasingly complex planted errors in the printer. In the first test, the IVIS group, which had relied solely on video and graphic images, took a half-hour longer to diagnose and repair the fault than did the control group, which had seen and touched an actual printer. In the second test, each group took roughly the same amount of time to solve the problem. In the third test, the IVIS group, which now had hands-on experience from the two previous tests, finished 20 minutes faster than the control group. It appeared that on the third problem the IVIS students' better retention of information was due to their freedom to review sections of the course in accordance with individual needs.

It is interesting to note that in presenting the results of the experiment to Digital's vice president in charge of field service, IVIS project engineers and course developers expressed embarrassment that the IVIS group had been slower to solve the first problem than the control group. The vice president's reply was simply, "But did they *fix* it?"

The point was not how fast the IVIS group made the repair but that they could make it without ever having seen or touched a real LA100.

Why decentralize?

Even without considering the time lost while a salaried employee is off the job, we estimate that per diem and travel account for some 60 percent of training costs. According to Digital field service estimates, the decentralized IVIS-based field service training program inaugurated in 1982 has the potential to save the company $50 million in 1987 over training cost projections without decentralization. That estimate takes

A Videodisc Glossary

Xerox Learning Systems recently introduced an extensive revision of its selling skills training program incorporating videodisc capability. The two-and-a-half- to three-day seminar, comprising seven discs (13 playing sides), is the first sales training system to use interactive videodisc technology, according to John Franco, the organization's vice president/general manager.

Xerox Learning Systems provided this glossary of terms that newcomers to the technology should know.

Auto-stop: An automatic programmed stop and freeze-frame to terminate the normal "play" mode.
Branching: A program path can proceed in two or more directions. It can be predetermined through the computer program or determined by the administrator.
Bumper frame: Type of still frame that is used to separate video segments. Bumper frame is displayed until administrator gives keypad command for disc to proceed.
Dump: Transfer of control instructions from the videodisc into the player's computer (also called **loading**).
Encoded program: Control instructions for playback included on the disc during the manufacturing process and automatically executed as the disc is played.
Keypad: A hand-held remote-control device used by the program administrator to make viewing selections.
Keypad overlay: Metal cover that snaps on to keypad to guide administrator in using correct keys for a particular program.
Laser: A device that uses light energy to read information from the videodisc.
Level of interactivity: The potential for interaction determined by the capabilities of videodisc hardware.

- **Level one**—Usually a consumer model videodisc player with limited memory and no internal computer.
- **Level two**—Industrial model videodisc player that contains built-in programmable memory.
- **Level three**—A level one or level two player interfaced to an external computer.

Mastering: A process in which premaster videotape is used to create a glass master disc, from which copies will be made.
Menu: A list of program choices; a table of contents.

into account projected growth of the division, the cost of the hardware necessary to deliver the instruction and the cost of developing courses.

Based on a $2,000 per diem/travel/ tuition figure for one person taking a one-week course, we estimate that the break-even point for substituting decentralized systems-based education for centralized lecture/lab is currently 450 people. The cost of developing courseware is now higher than the cost of developing comparable lecture/lab courses. We expect those costs to decrease steadily as the applications technology matures and we gain more experience with it. Further reductions in the cost of hardware delivery systems will also lower the break-even point radically.

As has been the case with computer-based education, systems-based education will make its greatest initial impact in industries subject to consistently high turnover, such as banking and insurance, or rapidly changing manufacturing technologies. SBE systems can be located at branch offices to provide training within the specific working environment while ensuring a uniform level and quality of training throughout an organization.

General Motors Corporation is now working with Digital to develop SBE courseware to retrain thousands of electricians on-site. IVIS systems will provide interactive, self-paced instruction on how to maintain and repair the sophisticated programmable controllers and robotic equipment that are rapidly replacing 110-volt relay technology on the assembly line.

The fact that SBE applications can be run on small, low-cost personal computers means that they will increasingly become available not only to smaller organizations but to individual professionals as well. For example, today many automobile manufacturers supply their dealers with training and point-of-sale linear video presentations. It is not only conceivable but probable that as SBE courseware becomes more widely available through systems vendors, third-party developers and in-house educational services groups, mechanics will commute to training no farther than the boss's office.

Harvard University's medical school is considering SBE technology to teach anatomy, a notoriously grueling subject encompassing thousands of minute details and images that are currently presented in textbooks and colored plates. In the near future, teaching hospitals may use video recordings of surgical procedures with voice annotation by the operating physician to instruct residents and provide graduate physicians with continuing education in their own offices. The student has the advantage of being able to freeze-frame any image at any point in the operation—an impossibility in the operating theater.

SBE offers an unprecedented tool kit with which to create an interactive and dynamic learning environment that more nearly recreates the actual working experience for the student than has been possible with earlier generations of educational technology. The real challenge will be to develop new resources of creativity in order to exploit fully our new technological resources.

Nonlinear: A video program designed to allow viewer to select segments/sequence at his or her discretion.
Premastering: Assembly and coding of materials to be put on videodisc. A premaster is the fully coded videotape used for the videodisc mastering process.
Random access: Ability to go to specific video segment rapidly and directly in nonlinear sequence.
Replication: The process of creating videodisc copies.
Search: Rapid scan of the disc to locate a specific frame or segment.
Segment: One or more continuous frames intended for uninterrupted playback.
Step forward: Frame-by-frame advance of disc.
Still frame: A single frame intended to be viewed by itself, not in motion sequence.

References

1. *Microcomputers and videodiscs.* Creative Strategies International, April 1982.
2. *Ibid.*