



INTEGRATING COMPUTER GRAPHICS  
AND THE VIDEODISC: NEW INSTRUCTIONAL  
TECHNIQUES POSSIBLE WITH IVIS

Technical Report No. 17

October 1983

DIGITAL EQUIPMENT CORPORATION  
EDUCATIONAL SERVICES  
12 Crosby Drive  
Bedford, Massachusetts 01730

**digital**

TECHNICAL REPORT

INTEGRATING COMPUTER GRAPHICS  
AND THE VIDEODISC: NEW INSTRUCTIONAL  
TECHNIQUES POSSIBLE WITH IVIS

Jesse Heines, Lin Olsen,  
and Roger Bowker

ABSTRACT

Digital Equipment Corporation has developed a new system for integrating computer graphics and the videodisc. This system is called IVIS, the Interactive Video Information System. The unique characteristic of this system is that it allows images generated by the videodisc to be overlaid with computer graphics of industry standard quality (resolution of 960 pixels horizontally by 240 vertically). This quality is achieved by converting the NTSC videodisc signal to RGB rather than using the more common technique of converting the RGB computer signal to NTSC.

The power of this integrated medium offers CAI course developers a number of new techniques for communicating information to students. This paper introduces some of these techniques, emphasizing CAI applications of overlaying. Controlling software is explained, including extensions to a graphics editor for specifying videodisc sequences. An IVIS CAI course on the installation and maintenance of a new printer is described, highlighting applications of the system's unique instructional features.

-----  
This paper has been submitted for presentation at the 25th International Conference on Computer-Based Instruction sponsored by the Association for the Development of Computer-based Instructional Systems (ADCIS).

### SOME PROS AND CONS OF VIDEODISCS

As a storage medium for video images, the videodisc is unequalled. Not only can the disc store up to 30 minutes of prerecorded video per side, but each component image of that video can be displayed individually to yield over 54,000 still frames. These capabilities can make the videodisc an important instructional tool for all subjects that exhibit significant visual components.

Even with all of its advanced features and exceptional still frame capability, the videodisc is still not an appropriate medium for all types of visual displays. It is not, for example, a good medium for displaying large amounts of text or fine line drawings, because even the most rock solid image generated by the finest NTSC television cannot match the distinctly crisp lines that can be generated on an RGB computer display of even medium resolution.

Another problem with putting instructional materials on videodiscs is that the discs cannot be altered once they are pressed. (There has been much talk about "write-once" discs, but they are not yet economical.) This characteristic can make it difficult to revise instructional materials once they are tested, and to correct errors that pop up only after the disc has been in use for some time.

### SOME PROS AND CONS OF COMPUTER GRAPHICS

Computer graphics, on the other hand, offer excellent resolution for many types of line figures. However, the natural images that are easily displayed from a videodisc are very difficult to produce by computer. While some computer graphic systems allow limited animation, the types of systems commonly used for CAI only allow the instructional designer to animate very small entities, such as a few special characters. Full screen motion of the type we are used to seeing on television is virtually impossible on systems commonly used for CAI today.

Unlike the videodisc, computer graphics are particularly well suited to displaying text on video screens in a large number of sizes, fonts, directions, and colors, with special attributes such as blinking, bolding, and reverse video. Most experienced CAI screen designers would agree that one should almost always use as little text on the screen as possible (illustrative diagrams are the preferred communication vehicle). When text is used, however, the screen resolution must be fine enough to allow that text to be read and understood easily.

eighth color but that need to convert to IVIS mode without the roll associated with the first acquisition of synchronization.

- Video mode -- the signal coming from the video source is displayed directly on the monitor with no switching between graphic and video sources. This mode is used when all the information is coming from the videodisc.
- IVIS mode -- one of the eight colors (selected from the 256-color palette) is designated as transparent, allowing both graphic and video images to be displayed on the screen simultaneously.

In IVIS mode, the screen can be completely devoted to the videodisc by setting the background color to transparent. With the screen background set to any other color, only the computer-generated text and graphics are displayed. To overlay computer graphics onto a videodisc image, the screen background is first set to transparent, allowing the video image to show through. Other graphics are then drawn on the transparent background in any of the remaining seven colors, effectively blocking out the video at those points and simultaneously displaying their information.

#### THE IVIS HARDWARE

A simplified block diagram of IVIS is shown in Figure 1. Experiments with converting the computer-generated signal to NTSC resulted in intolerable visual quality. Colors bled into each other and shifted in hue and saturation, and the system was not able to display lines with single pixel widths. Industry standard text displayed 80 characters per line was illegible. Digital's engineers therefore converted the NTSC videodisc signal to RGB even though this approach is more difficult and expensive (though straightforward).

The real difficulty in building a system of this type is in the synchronization of the two video signals. Computer terminals and computer graphics subsystems are virtually never designed to be synchronized to external sources. With industrial quality videodiscs or video tape, it is reasonable to vertically synchronize the video source to the computer. However, if horizontal synchronization with an accuracy of less than one-third of a pixel is desired, a timebase corrector would be needed. It becomes a more attractive alternative to synchronize the computer to the video source than to require the expensive equipment needed to do it the other way. IVIS chose this route.

Even though the visual qualities of IVIS graphics and video are both excellent individually, the system's "pièce de résistance" is its ability to overlay the former on the latter. IVIS implements overlay like a chroma key. That is, one of the eight available Professional 350 colors is defined as transparent. (In non-mapped applications the transparent color is black, in mapped applications, color 0 is transparent and the other 7 colors can have any value selected from a palette of 256.) The video switcher compares each pixel from the bit-mapped memory to the transparent value as it is taken from the memory for display. It displays the contents of the bit-mapped memory for each non-zero pixel. When it finds a transparent pixel, it displays the corresponding value from the videodisc for a pixel's duration. With a bit map of 960 by 240 pixels being refreshed at 60 times per second, this means that the decision about which video source to display is made approximately every 60 nanoseconds.

The ability to overlay was an immutable design goal from the beginning of the project. Instructional designers conceived of a large number of applications for overlaying, and felt that this feature was critical to the system's success. Some typical uses of overlaying are:

- highlighting specific components in shots of a complex device by outlining or pointing to them,
- drawing hidden data paths to show how pictured components interconnect,
- adding orientation information at the top and bottom of the screen,
- "lighting" different LEDs on the same shot of a control panel while the meanings of these LEDs are described,
- providing student control features on the screen during a video sequence,
- using composite video images as menus and allowing students to indicate their choices by moving the cursor to different areas of the image,
- using the video image to hold a number of smaller images and displaying only those applicable to the subject being discussed,
- implementing exercises that ask students to identify or sequence specific components by pointing to them, and
- correcting slightly erroneous video information by blanking out the incorrect screen area, overwriting the error, displaying explanatory text, or programming around the error and ignoring the video.

needed to know to install and maintain these printers without actually working on them, providing they had adequate instruction. These factors and the strong visual component of the device itself led to the selection of this course as the first real IVIS application.

The course begins with an overview of the printer series, pointing out the salient features and describing the major components. This overview provided the opportunity to use straightforward techniques to highlight specific components as they were being described on the audio track. A picture of the entire device was displayed, and each component was either outlined or pointed to as it was discussed. At times part of the videodisc picture was masked to direct the student's eye to the relevant components. This was done by overwriting part of the transparent background with a block of a different color, usually black. Note that black, the normal dark background color of the screen, is a valid color just like any other. It still blocks the videodisc signal effectively even though it appears that nothing has been written.

Once an entire set of components had been described, it was often valuable to display a diagram showing how they interacted. An audio track to serve this function was recorded on the videodisc, but corresponding video had not been shot. The plan was to draw the diagram solely with computer graphics and play the videodisc audio track while the diagram built up on the screen. Using the WAIT function described above, display of the diagram could be synchronized to the audio track. (The graphics generally came up faster than the narration that was describing them.) This use of sound alone proved to be so effective that computer graphics were often substituted for video sequences that actually were on the disc but that were to be of inferior quality. Note that by using the AUDIO command described above to switch from one audio track to the other, course developers were able to make use of the entire 60 minutes of audio available on one side of the disc.

One requirement was to show actual video of a pair of switches so that students could locate them on the printers, and then simulate various switch positions as an exercise. In this instance, video showing the switches was first overlaid with computer-generated graphics, and then the switches were redrawn in a larger size. This technique allowed visual continuity to be maintained after orienting the student to the component at hand. Again, IVIS made it possible to take advantage of the best features of both the videodisc and the computer graphics media.

Several video menus were planned for the course. These consisted of nine blocks arranged on the screen in three rows of three. The eight peripheral blocks were filled with pictures of various printer components, and the student was directed to use the terminal's arrow keys to move the cursor to the picture of the component he or she wanted to study. (The middle block contained