ROCHESTER INSTITUTE OF TECHNOLOGY

A Thesis Submitted to the Faculty of
The College of Fine and Applied Arts
in Candidacy for the Degree of
MASTER OF FINE ARTS

COMPUTER GRAPHICS
AND THE HARVARD INTERACTIVE VIDEODISC PROJECT

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May 23, 1988
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1.0 Introduction

The optical videodisc is one of many new technologies which mixes and blurs the boundaries of conventional communication-storage media. Until recently, publishing, film, video and computer systems have been distinctive forms of media with different purposes, processes, designs and applications. However, new technologies are changing this; examples include: computers and video in broadcast, special effects, computers and publishing in computer typesetting, and film and publishing in pre-recorded video cassettes.

From its conception, the videodisc has served the overlap of two media technologies. One is film and publishing in the form of disc movies. This application was presented with much fanfare in the mid-seventies. Such discs were recorded in the Continuous Linear Velocity format (CLV). One problem with CLV discs is that they cannot use the single frame or random access features on disc players. The disc did very well at first, but lost favor toward the end of the seventies and is all but nonexistent at present. The reason for this is fairly simple. The videodisc manufacturers cannot offer an affordable home record feature, while vide tape manufacturers can and do. The public not only wants to watch movies at home, they also want the capability to record programs at home.

The other area of media technology serviced by the videodisc is the integration of publishing, video and computer systems in the form of interactive videodiscs. This application utilizes the Continuous Angular Velocity disc format (CAV). This thesis will be concerned with the CAV disc in general, the Harvard Disc project specifically, and the use of computer generated animation as the interactive menu medium.
On a continuous angular velocity (CAV) disc, one revolution of the disc contains one frame of the video signal. NTSC video displays 30 frames per second and, hence, a CAV disc spins at 30/rps or 1800/rpm. This also means that the linear velocity increases as the read optics move out to the edge of the disc. Because the vertical retrace intervals on adjacent frames line up, still-framing is accomplished by backing up one track at a time and replaying that frame. Backing up once per field yields reverse and skipping a track becomes fast motion. Slow motion is achieved by playing the same frame a number of times and then moving to the next frame.

Random access on the disc is accomplished by the use of a time code equivalent frame address. This means that each frame 1 to 54,000 has a unique numerical reference. A single frame can be found and retrieved by accessing the disc through frame numbers. Most disc players on the market presently have single frame random access available as a standard feature.

Mastering a videodisc begins with a one-inch time coded field corrected video tape. The information on the tape is then transferred into a frequency modulated (FM) signal which is etched onto a finely polished glass master disc. The write laser used in this process turns on and off in direct proportion to the on/off pulse of the FM signal, producing microscopic pits in the glass master. The glass master is then used to produce sub-masters and, finally, the plastic discs. The plastic discs are coated with a reflective material and two such discs are glued together with the plastic on the outside to protect the reflective material.
In reading a disc, the transfer process is simply reversed. A read laser is focused through the plastic coating and bounced off the reflective layer. Optical sensors pick up the reflected laser and the time delay between pit and no pit reflectance recreates the FM signal. The FM signal is then redefined as NTSC video which is displayed on a monitor. Audio is transferred and redefined in exactly the same way.
3.0 The Harvard Project

The Harvard Disc project is a level three system incorporating a touch screen monitor, disc player with RS 232 port and a computer with overlay graphics, an extensive data base, and parsing software (Appendix A).

This disc system is in essence a game. All the user's moves (inputs) are tracked by the computer and the case budget (the money allocated for the case expenses by the law firm) as well as the punitive verdict (the money awarded to the plaintiff by the court) act as the score. The award ranges from $150,000.00 maximum to $0.00 (case lost), depending on the users understanding of legal procedures and the points of law presented in the case. The user is expected to play the game many times, developing his/her skills in procedural law, the points of law presented and trial practices (arguing a case in court).

As proposed by John Ciampa, the system will provide the user with a simulated adversarial experience. The disc will be a realistic experience; real procedural, evidentiary and trial practice problems will be illustrated by a fictitious case. The visual, textual and audio information will be variable according to the user's participation, as well as the results. The Harvard system will allow the user to repeat sections which are not clear the first time through. It will also allow various levels of inquiry into the material supporting the correct moves. Where a question of law arises, provided the user frames the issues correctly, appropriate statutes, rules and case law will be perusable first in a cursory mode where relevant language is highlighted; secondly, in a comprehensive mode where entire statute sections and/or opinions are accessible at the user's own speed; lastly, in a back-
ground mode where supporting arguments, historical background and other more remote material can be reviewed.

As to trial practices, the simulated experience will be the lesson, in that a question asked or not asked will lead to different paths from which the user can learn without the disastrous results of a real trial. Supporting material can be called for during recess periods or only after the verdict, depending on the section. The supporting material for the trial practice methods will consist of strategies common to established professionals. The user will share the choices, reactions and rationale of experience practitioners operating in the identical situation. During the inquiry, the disc frames can be slowed down in order to demonstrate more carefully the non-verbal behavior of prospective jurors, witnesses, opposing counsel and/or the trial judge.

The case will involve a suit by a plaintiff claiming to be the victim of false arrest and police harassment. The user will act as counsel for the plaintiff. The user will learn the plaintiff's side of the story from pre-trial investigation and other discovery, including client and witness interviews, as well as other documents and photographs which will be available given the appropriate "strokes" (keystrokes or screen touches).

The first step for the user is to read the referral memo sent by the senior partner to the user (a junior member of the firm). It defines the problem, the methods of interaction and scoring.
This is the memo the user will read upon activating the disc system:

"Tried to get you last night at home, no luck. Here's one for you. Mr. Block sounds to me like he has an actionable case. Let's give it all we've got. I spoke to him briefly yesterday and told him I was bringing you in.

He's a fine black community leader type, kid's are all doctors, and so forth. He had some trouble with the cops just because parked in Snob Hill area waiting for his daughter who was visiting. There was an article in the News one day last week. I think he wants to do something about it.

BOSS (Appendix A, Photo 6C) Any time you need a strategy tip, I'll be happy to help. Just buzz me on the intercom by touching it on the screen and the BOSS button, or the '1' key, and we can chat via interoffice electronic mail, but keep in mind that my time is expensive, so I will have to limit it to one contact in the investigative phase, one contact in the pleading stage, one contact in the jury selection, one contact in the direct examination and one contact in the cross examination. Five for a nickel. Anything beyond that will cost the case budget $500 per consultation.

LA and IA (Photo 6C) The same is true of our law assistant and our investigative assistant; just buzz them on the LA button for the law assistant or the IA button for the investigative assistant; or, touch the '2' button for the law assistant and the '3' button for the investigative (fact) assistant.

The investigative assistant can obtain any news articles, police or other reports and records, photos or other exhibits and can also serve subpoenas. At trial, he will keep track of all the case file: all the exhibits, depositions, interrogatories, trial transcripts, etc. You just tell him what you want. His time costs $50 per hour, including personal benefits. Every stroke, including the buzz on the intercom counts for some part of an hour. The same with the law assistant except she costs $75 per hour and will provide legal memos, briefs, notices, motions and pleadings as indicated by you.

In every case, you will have the opportunity of phrasing the request yourself by keying it into the black input block at the bottom of the screen. Should the request be understood by the person you are addressing, you will
be rewarded by a reduction of four strokes. If it is not understood, you may select from a menu of options.

Naturally, it is your responsibility to see to it that any legal process is correct before it is filed and/or served. If you find something you feel is incorrect, simply touch it on the screen or key in the problem words. If you are right, a correct version will appear; if you are wrong, you will have simply wasted some strokes.

CASE FILE (Photo 5C) To review the legal actions that you have undertaken, simply touch the file on the screen or the 'c' key. The case file holds all of the following: decisions and opinions, depositions, pleadings, notices, legal memoranda, interrogatories, interviews and motions.

PHONE (Photo 7C) To talk with opposing counsel, journalists, parties or witnesses, and others, simply touch the phone on the screen or the letter 'p'. A Rolodex will appear, whereupon you touch the card with the first letter of the last name of the person you wish to talk with or type the first letter of the last name on the keyboard. The person you wish to contact will appear.

QUESTIONS Once the dialogue has commenced, you may interrupt by touching the screen or any key. This will freeze the screen frame and the last spoken phrase will appear in the bottom of the frame as subtext. At this point, you may touch (on the screen) or key in the word or words about which you wish to inquire further. The subtext will disappear and an empty block will appear in which you may phrase your inquiry by keying it in. If the witness understands the question, an answer will appear and three strokes will be taken off your score. If the witness does not understand your question, you will be charged a stroke and a menu of possible questions will appear on the screen. You may select the one and only one which you feel will yield the most useful information. You may choose to ask none, in which case you may backstroke to the point of departure.

Should you choose to ask a question, make your selection by touching the letter next to the question on the screen or the same key on the keyboard; you will be charged on interview keystroke.

The answer will appear as still frames with subtext. You may question the answers using the same method: touch the word or words which make the point you wish to press and proceed as indicated above, or you may backstroke to the point of departure. The further in you go (questions you ask), the more backstrokes it will take.
to get back. Of course, you may not wish to get back if you feel the route you have taken is more direct than the one volunteered in the monologue. Then again, it may have been a bad idea to interrupt at all. In fact, it may have been a bad idea to interview this particular witness. It's all up to you.

DEPOSITIONS Should you choose to depose a party or witness, the same procedure as described under QUESTIONS will be followed. Here the questions have the additional problem of being legal as well as strategic and the strokes cost more.

You have all the services of the inside people and computers, as well as the information from the outside people at your fingertips, use them all you want, but remember you pay for them out of your budget and you only have so much. How much? The client can be counted on to count. He will let you know when it's costing too much. That's between you and him. While we're on the subject of counting, of course your hours add up as well, $150 per hour. We will keep track of them for you in the form of keystrokes. Every time you touch the screen or input key, we will charge some part of an hour of your time, in addition to whatever other costs are incurred, unless you are having to back yourself out of a dead end, in which case, I must remind you, those backstrokes are double.

For a clear view of what each kind of stroke is worth, call for BILLING by touching the yellow pad (Photo 4D) and indicating Time/Money or the ' ' key. There you will find a listing of charges for each kind of keystroke and how much you have spent. Be careful, going over budget may cost you the client.

REVIEW To review this memo, touch the yellow pad and indicate 'review' or touch the '& ' key.

OUTCOME As far as the outcome of the case, that will depend on whether, with tolerable expenses, you have gotten the right information out of the right people, in the right order; whether you have filed the correct notices, pleadings and/or motions; whether you pick the right jury; whether you elicit the right testimony; whether you make the right objections, legally and strategically; and whether you cross examine well."
Designing the menu for an interactive system involves many steps. It is not exclusively the domain of graphic design; psychology, human factors (how we interact with machines) and computer science all play a role. The basic challenge is to design a menu that is understandable to the user and easily invoked.

Methodologies for designing an interactive menu are still poorly developed. There isn’t a right or wrong method, only varied approaches. What follows is the process we used in developing the menu for the Harvard Disc.

A. Who is the user? This important first step involves generating a user profile and defining common characteristics within the user group. This information will determine the way information is displayed and delivered throughout the entire disc. The user’s learning style and visual literacy are particularly important in developing the menu structure and iconics.

1. User group - second year law students.
2. Motivation level - highly motivated, competitive individuals.
3. Learning style - reading, library research.
4. Computer literacy - good to excellent.
5. Environments typical to all users - classroom, library, law office.
6. Visual literacy - fair to good, use and understand symbols on a daily basis.
7. Circumstances of use - special interest game.
8. Place of use - library by serious users and the lounge by groups.

9. Number of users - one or more players at a time.

10. Frequency of use - many times by a single player.

B. What type of system will be used? This question will define the parameters and interactive capabilities of the system. Options such as voice activation, touch control and overlay graphics can be accepted or neglected based on the system profile.

The Harvard Disc is a level three interactive system which, at the time of this writing, is the highest level of interactive videodisc interactivity. It means that the disc is controlled by a computer programmed to expect a great deal of user input. There are two proposed methods of interacting with the system. If the user wishes to browse over a section, he/she can use the menus that are provided for all the sections of the disc. By simply touching the desired menu item, the user can move quickly from one section of the disc to another. If the user requires more information than the menu item provides for, he/she can type the inquiry on the keyboard. If the system understands the request, it will respond by finding and displaying the required information. If it does not understand the inquiry, a menu of possible requests will be generated and the user can touch one option. The system configuration to allow for these two types of interactions is as follows:

1. CAV disc player
2. Computer to interface with disc player
3. Touch screen
4. System software (disc control)

5. Parsing software (system vocabulary)

C. Having developed an understanding of who the user is and what the system constraints are, the next step is to design a flow chart of how the user will move through the system. This is important in understanding how many menus will be needed and what special software and programming will be required (Appendix B).

D. The final stage in this four part design process is the menu selection. It is not simply a matter of designing finished graphics; other factors must be taken into account.

1. Feedback The system must respond to the user. This response must be immediate. If the user's inquiry cannot be acted upon immediately, then the system must explain that. There is nothing more deadly in an interactive system than a blank unresponsive screen. With the Harvard Disc, there is only one point were the system response is not immediate. If the user types in an inquiry, the system will have to search its vocabulary for known words. This may take as long as 20 seconds. While the system is processing, the menu area of the screen will flash the word "searching" to ensure the user that something is happening.

2. Environment In a simulation type disc, an environment or setting is important. For the Harvard Disc, the environment chosen was a law office. It was chosen for two reasons: first, it reflects the metaphor of the disc; and second, it is a familiar environment to all second year law students.
3. **Syntax** By syntax I mean the vocabulary of the system. The Harvard Disc expects the user to understand terms and references analogous to law and will expect input and frame its reference responses around this vocabulary.

4. **Screen Design** Here I'm going to depart from my initial premise that there aren't any right or wrong methods, only varied approaches to designing an interactive system to propose a single rule. The more transparent the invocation process, the better the interaction will be. This simply means that if the process by which the user invokes a system response is consistent, fast and meaningful, then that process can become secondary to the information.

There are two menu designs for the Harvard Disc. The main menu is a full screen computer animated desk top which responds to touch. By using an animated desktop as the main menu we resolved a major design problem. How to give the user all the possible avenues of information retrieval and storage in an easily understood invoked manner. By animating each item on the desktop, the main menu is able to hold over 80 possible options without reverting to innumerable text screens. There are four primary options within the main menu: an intercom to contact coworkers, a phone to contact anyone outside of the law office, a case file to store any information regarding the case the user thinks will be of use at the trial, and a law pad to keep track of expenses.

The second menu structure relates to all menus below the main menu level. A simple data based colored band was
chosen. The band will always be in the lower part of the screen and never exceed one half of screen height; the default size being one third of screen height. If more room is needed than the lower half allows for, then the information can be scrolled up and down by the user. All information, be it instructions, questions or responses, will appear as overlay data-based text in the band. The primary reason for the sub-menus being computer generated overlays was simply disc space. There would not have been enough room on the video disc to have all the possible image menu combinations as disc frames. The reason text was chosen instead of some form of iconics was two-fold; first, computer generation time would be too long if computer based drawn forms (programmed drawings) were used. Second, because of the large amount and diversity of information that needs to be presented, consistent use of understandable icons would have been close to impossible.
E. Genigraphics Animation

A total of 15 seconds of real time animation was generated for the Harvard disc. It was produced over a 4 month period on the Genigraphics D-Plus. The Genigraphics is a two dimensional system utilizing the interpolation of key frames to produce movement.

Each object that moves, phone, intercom, notepad, and case file, was designed as a separate animation. The animation was created for forward movement. The reverse movement was a function of the disc player. The objects as well as the environment were designed to have the appearance of three dimensionality. This was achieved by shading layers of two dimensional objects and by building a false perspective into the objects. The appearance of three dimensional movement was achieved by scaling and moving vertices and faces in the X and Y plane.

The Genigraphics system functioned relatively well as an animation tool. It utilizes standard video time code as a means of timing. The Genigraphics system outputs directly to video tape, making viewing and editing fast and easy, and it supports point to point transformation, making it possible to turn one object into another.

The only problem that really arose in applying the Genigraphics to this project was that it is not a three dimensional system. If a Wavefront or Bosch had been used, the animation
could have been more elaborate and certainly more realistic three dimensionally because the algorithm included in the software of these two products are specifically directed to achieve maximum realism, conveniently.
5.0 Conclusion

This thesis has attempted to give the reader an overview of what a video disc is physically; what the interactive video format can provide; the considerations and steps taken in developing the Harvard Disc; and the form and function of the computer graphics within the Harvard Disc. Omitted from this paper is any detailed consideration of the system by which the animated sequences were generated. The fact of the matter is that it makes no difference how the graphics were generated. There are probably 30 or more systems that could generate the same type of animated sequence with varying amounts of complexity and detail. The more critical question is whether computer animation was used appropriately within the Harvard Disc. In retrospect, one fundamental problem is evident. Even though the desk does replace many otherwise boring text frames, it is a step the user will have to use many times within the course of the game; the novelty of touching something and having the same answer format becomes tedious by the middle of the game. A better choice might have been a single graphic with icons to represent each item on the desk and then text frames from that point on. It wouldn't have made for much of a thesis animation, but it might have made for a better disc.
1.0 Appendix. A. Still Photographs

The photographs in this appendix represent key frames from the Harvard Disc animated open and desktop.

Columns 1 and 2. Photographs A through D

Credits

This animation only runs when the disc is initiated. It basically runs through the major credits.

Column 3. Photographs A through D

Open

The front door of a law office is the game start frame. When the screen is touched, the door opens and the viewer moves past the door to a still frame of the desk.

Column 4. Photographs A through D

Legal Pad

The legal pad serves two functions. At the start of the game, it automatically moves forward and scrolls through the rules and referral memo. If it is touched at any point during the game, it moves forward and shows up-to-date case expenses.

Column 5. Photographs A through D

Case File

The case file, when touched, separates into eight files. Each of which when touched appears full frame with overlay text specific to that area within the case file.
Column 6. Photographs A through D; Column 7. Photograph D

Intercom

When the intercom is touched, it moves forward and text appears on the three buttons. These three options represent the people within the law office with whom the player can communicate. If one of the buttons is touched, the intercom moves back to be replaced by the computer terminal. Overlay text will fill the screen, explaining exactly how to further communicate with this person.

Column 7. Photographs A through C

Telephone

When the phone is touched, the rotodial portion of the phone moves forward and transforms into a rolodex. The player must touch the letter of the last name of the person to be called, causing the rolodex to flip back to that page, and then touch the person’s name. The person will appear full frame on the screen.
Appendix B

Glossary of flow chart symbols:

- Enter and exit points
- Animation from desk top
- Video disc still frame
- User interaction point
- Moving video or moving overlay graphics
Appendix B

START

STARTING FRAME

ANIMATION INTO DESK

CHOICE

PHONE ROUTINE
INTERCOM ROUTINE
NOTE PRO ROUTINE

GO TO TRIAL?

TRIAL ROUTINE

END
Appendix B

1. PHONE
   - ANIMATION INTO PHONE
   - STILL OF PHONE
   - CHOICE
     - BUSY SIGNAL
       - 1 CLIENT
       - 2 WITNESS
       - 3 OPPOSING COUNSEL
     - 4
     - 5
   - STILL OF PHONE
   - YES
     - ANOTHER CALL
   - NO
     - EXIT
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Bibliography


