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A Demonstration of the Genigraphics: An interactive videodisk for computer graphics

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A Demonstration of the Genigraphics: An Interactive Videodisc for Computer Graphics

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Contents

"From the cave dweller's crude design created with animal blood and scrawled on the wall of his home to today's sophisticated 2D and 3D computer-generated graphics, imagery has played a vital role in man's ability to communicate and learn.

"This need for visualization has been most evident in the development of present-day imaging technology. Four seemingly disparate fields--education, science, broadcast, and entertainment--have become less dependent upon the confines of the written word, turning instead to the powerful ability of imagery to convey messages."

St. John Nancy, Technical Program Offers Insight on Computer Graphics, Atlanta, GA: ACM Siggraph 88, Siggraph Show Daily, 1988

My interest in visual communication and in the potential of technology to enhance communication is the foundation of my thesis project. The original proposal of this thesis said that I intend to incorporate different techniques in order to design a certain application of interactive videodisc. Although the substance of the videodisc was missing at that point, the challenge was not. I wanted to combine substance and techniques in one project while achieving both functional and aesthetic goals. I wanted to choose the appropriate techniques in order to create effective communication. And I wanted to learn and to practice the different steps that are involved in the production of an interactive project. The challenge was in creating an environment that derives from these considerations and still works as one unit that provides the user with an efficient tool for gathering information as well as with an enjoyable learning experience.

This seemed to be possible to achieve by using the potential of the medium that is called interactive videodisc. A videodisc can contain a great amount of frames (up to 54,000 on each side), each of which can be viewed separately and independently of the one that is next to it. It also can contain visual information that comes from different sources such as computer graphics, video, film or slides. And all this stored information can be controlled by a program that is prepared to serve the potential users of the particular videodisc.

These advantages, which are unique to this medium, guided me in choosing the subject of this videodisc. I looked for a subject that would justify communicating through the interactive capabilities of the media. I hoped that using different techniques would support and reinforce the level of communication, and I tried to stay close in content to the area of computer graphics and graphic design.

Justification and Suitability to the Media

To use a computer graphics system one has to make the right decision at the right time-- to choose from a menu the right options in the right order. This is not an easy task to learn. Computers, in general, are not very friendly and they tend to intimidate, especially a beginner. The more complicated the computer system is, the more complicated the learning process might be.

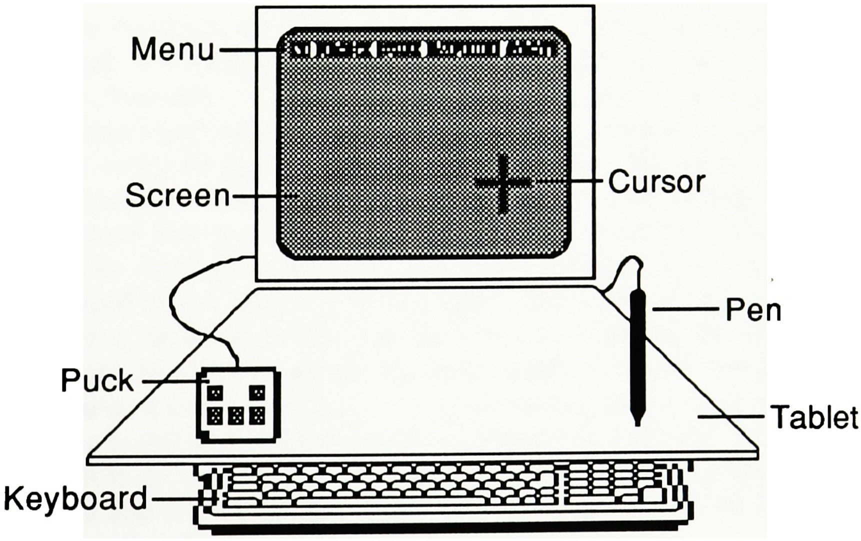
Computer companies provide manuals in order to make the user's learning and adjusting process easier. But manuals are separated from the machines. A manual describes literally, in a linear fashion, the machine's components and how to use them in order to achieve certain results. The user should be able to accurately interpret this description, and to correctly apply it on the machine to get the desired results. This literal, linear approach does not consider misinterpretation and does not provide help.

The interactive videodisc is a non-linear medium and can simplify a non-linear process such as a learning process. One possible application of this medium is a simulation training tool which can replace the traditional linear manual. Such a training tool that is made to teach computer graphics (which is a tool in itself) can provide a user with the opportunity to choose from a variety of given options in a non-linear fashion. It can enable the user to learn or to investigate a subject according to his own level and to follow the path that fits his own needs.

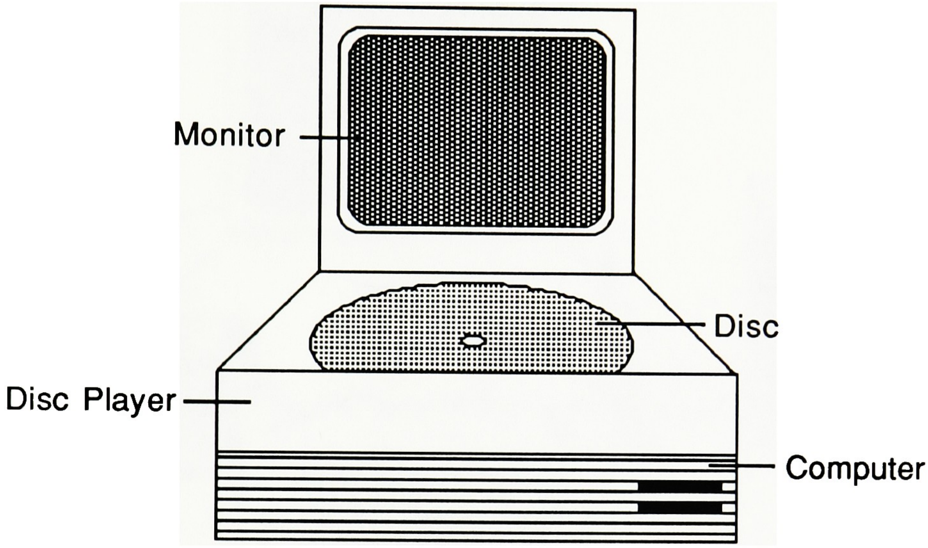
The efficiency of this training tool can be reinforced by incorporating visuals that derive from different techniques and sources. Different techniques are suitable for different purposes. In "A Demonstration of the Genigraphics," some images were recorded frame-by-frame on the OMDR (Optical Memory Disc Recorder) and some images were recorded as a sequence on videotape. These images include still frames, an animation and a short video, which were created with different techniques and which eventually were put together on a videodisc. But the interaction capabilities of this system come from a program which is created on a computer and which controls the videodisc. This program also determines the graphics overlay and activates the touch screen, which is the user interface. And this interface is the means with which the user is interacting with the videodisc or, from his point of view, his access to information about the Genigraphics.

"A Demonstration of the Genigraphics" is a prototype and the Genigraphics is only a representative computer graphics system in the prototype. An advantage of a prototype is that it can be changed as a result of evaluation, and thus developed for new needs. This is the reason that I tried to establish and maintain a consistency of organization and presentation. I tried to provide a method that would be easy to expand or to apply to a different type of computer graphics system.

The Genigraphics is a typical example of a computer graphics system that allows a user to create object graphics by choosing, in a nonlinear fashion, from the many options provided. It is also an example of a system that does not provide the user with help in making the right choices at the right time. The user interacts with the machine through a set of typical interface tools such as a pen, a tablet and a puck. These electronic controls allow the user to reach the resources of the computer and to create, modify, color, store and retrieve artwork and animation. The learning process can be time-consuming because it takes time to acquire the necessary operational skills and to learn the language that allows the artist and the computer to communicate. The goal of "A Demonstration of the Genigraphics" was to make this process shorter and easier. The tasks were to record the operational process step by step on a videodisc, to create a program that controls the disc, and to have an interface that allows a user to interact with the videodisc at his own pace.



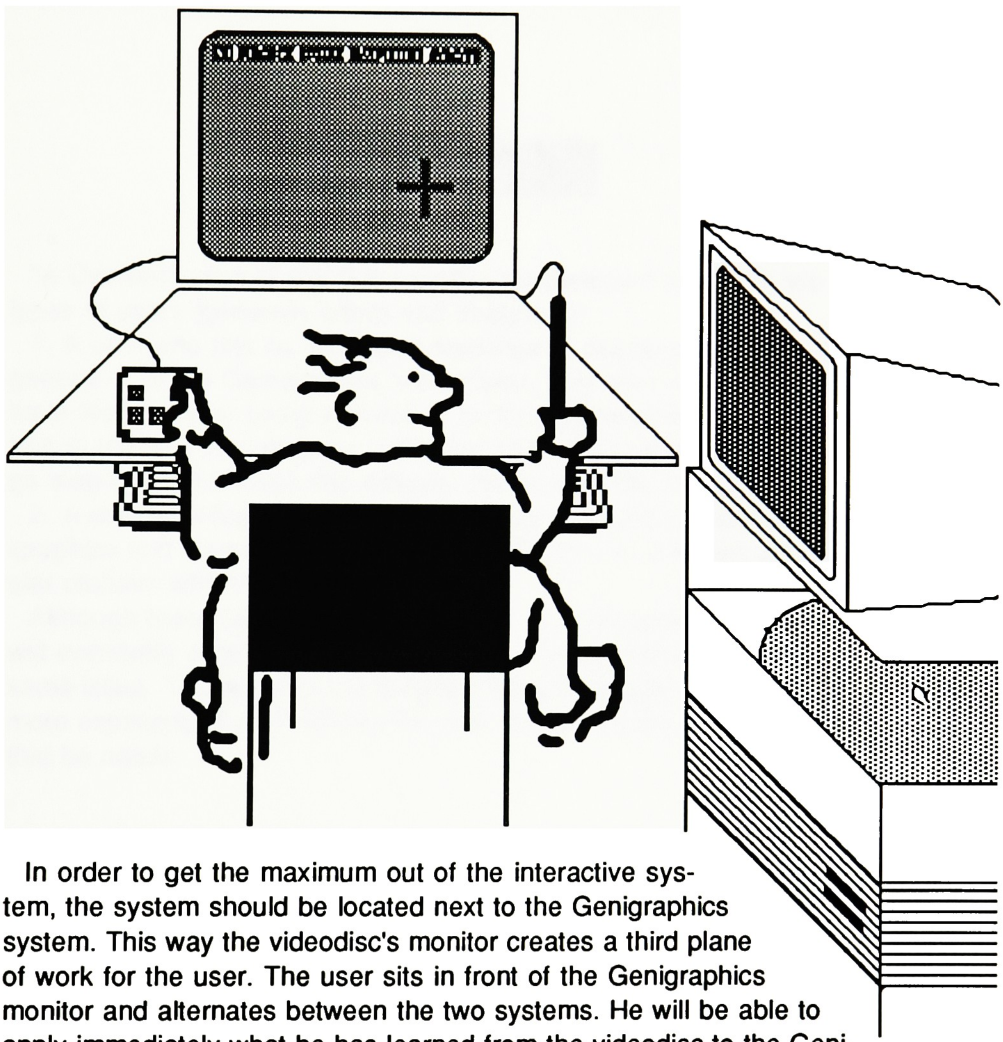
A typical videodisc environment contains a monitor, a computer, a disc player, a disc and an interface device. The monitor is connected to the disc player and to the computer and it can display images that are stored on the disc, and graphics overlays that are stored in the computer. When a user activates the interface device through the graphics overlay he is actually activating the program that controls the images on the disc.



For my thesis project I am using a DEC RGB monitor, a Panasonic disc player, a Vax computer with the IVIS hardware and the Producer software. The software can control the videodisc player, make graphics overlays and control a touch screen. I wanted to have graphics overlays on top of the video images that come from the disc. I thought that since the graphics overlays are created separately and look different from the video images they could be a good graphic device for the menu with which the user would interact. I also thought that a touch screen would be a good user interface for that project. I preferred to have this simple and direct means of interaction rather than to use an interface device that would involve another tool (such as a mouse, a joystick or a pen.) The touch screen device does not require any operational skills or previous knowledge. I thought that it is important to provide the user an easy access to the information that he needs and to let him concentrate on learning to operate the Genigraphics rather than on learning to operate the videodisc.

User Scenario

When using "A Demonstration of the Genigraphics," the user responds to information that appears on the screen. The screen demonstrates on one plane a process that actually takes place on two. The Genigraphics consists of a tablet plane and a monitor plane, and the Genigraphics user uses them simultaneously.



In order to get the maximum out of the interactive system, the system should be located next to the Genigraphics system. This way the videodisc's monitor creates a third plane of work for the user. The user sits in front of the Genigraphics monitor and alternates between the two systems. He will be able to apply immediately what he has learned from the videodisc to the Genigraphics and to practice his skills.

An ideal situation would be to combine the two environments. This can be done by having the touch screen display and the Genigraphics display appear on one monitor, and switching between the two

displayes with a controller. This idea was tested by Tom Young, a former AVI student, and was found unworkable because the connections between the two systems were not compatible. I still think that if this method were applied to different systems It could be a good solution to this environmental problem.

User Profile

"A Demonstration of the Genigraphics" is designed to serve two types of users (generally artists and designers):

1. A user who has no previous knowledge of computer graphics in general or of the Genigraphics in particular. This user might want to have the option of being introduced to the Genigraphics components and to the way they operate. After that he would probably be able to go step-by-step through the subjects provided in the menu.
2. A user who has experience in computer graphics or with the Genigraphics and wants to acquire more information, or who has a particular problem which has to be solved.

Although these two user groups have a different background, they will eventually acquire the same information when investigating the same issue. The beginner will browse through the options, while the more experienced user will be able to go directly to the particular detail that he needs.

Once the background of "A Demonstration of the Genigraphics" was established, some kind of practical strategy had to be taken. The strategy had to suggest how to apply the project's objectives and assumptions to a real working interactive environment. I wanted to teach both the artwork and the animation capabilities of the Genigraphics. The first decision was to teach by demonstrating. I chose nine images for this purpose.

The immediate strategy was to videotape in real time (30 frames per second) a user creating these images. The idea was to show each action that the user takes, such as moving the pen and pressing the puck. This idea was dropped because a process recorded in real time takes a lot of frames of the tape and eventually of the disc. A user interacting with this system would have to use the "play" mode to watch the real-time process, and it would have taken him a long time to find his way on the disc. I also could not afford to plan on using so many frames on a disc when I did not know how much disc space would be available to me for this project.

The disadvantages of using real time images brought the idea of using still images and recording one frame at a time. In this case the user would browse through the images in steps, using a "step" mode, and view one frame at a time. This strategy required determining the exact steps needed to create each image and animation. It also required determining a fixed screen design which would maintain the consistency of the display. This requirement raised a new problem: How to show each action that the Genigraphics user is taking in one still frame. The user is working on two planes at a time; when he moves the pen on the tablet he actually moves the cursor on the screen, and when he presses the puck's right button he actually selects an image or a menu choice on the screen.

There were two problems to be solved at this point:

1. How to demonstrate the correlation between the tablet plane and the screen plane.
2. How to simulate this process in a still image that would appear on one plane of the videodisc's screen.

A solution for the first problem came in the idea to add a short real-time video sequence that would demonstrate the user's actions and the correlation between the two Genigraphics planes. This sequence was named Tools Demo and was first included in a submenu I called Introduction, or Help, and was later located in a submenu I called Tips.

The solution to the second problem was a little more complex. The first approach was to separate the two Genigraphics planes into two still images, one image showing the action taken on the screen plane and the second image showing the action taken on the tablet plane.

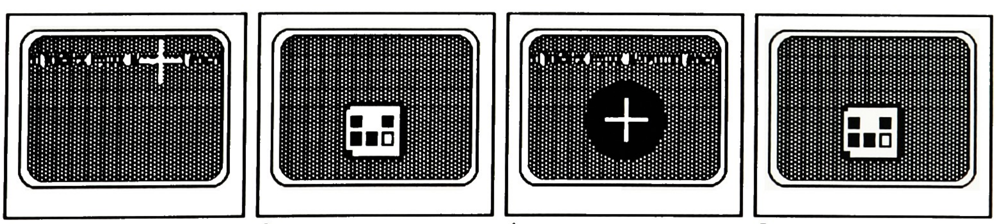
I thought of using still photographic images to demonstrate the tablet

plane: A hand holding the pen, pressing the puck and typing on the keyboard. I actually recorded these images on the OMDR and on the Genigraphics' paint system but the results were unsatisfactory. With the keyboard and the puck in shades of grey, and with some lighting problems, the images were poor. It was also not a good idea to show a hand on the keyboard because it is impossible to see which letters are pressed with fingers covering the keys. The last objection to these photographic images was that this kind of imagery looked outdated. I thought that it did not fit well in a project that is trying to demonstrate a new kind of computer imagery in a new medium. So I decided not to use photographic images and not to show hands but rather to use a more abstract and schematic kind of imagery. I made computer illustrations (on the Genigraphics) of the pen, the keyboard and the puck and I used color to denote the button that should be pressed. Although these images seemed right at the time, they were eventually used only for the opening of the Tools Demo video.

While doing these experiments I was also trying to analyze the correlation between the two images that were made to represent the two Genigraphics planes. I realized that if the user could understand the correlation between the pen and the cursor (that the pen "moves" the cursor on the screen), it would be redundant to show the two actions. In other words, if the videodisc presented only the cursor's destination on the screen the user would figure out that the pen "moved" the cursor to that spot on the screen. Since Tools Demo would take care of demonstrating the correlation between the pen and the cursor, my decision was to avoid redundancy and not to show the pen on the tablet plane.

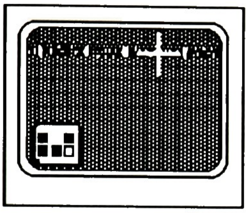
The only other device on the tablet plane, besides the pen, is the puck. I found another redundancy in showing the puck on the tablet plane after every movement of the cursor on the screen plane. Each step in the process of creating an image usually consists of the two actions that happen on the two planes:

1. The cursor is moved to the correct destination on the screen.
2. The puck's right button is pressed to activate the selected destination.



1 2 1 2

It is important to demonstrate the first action that happens on the screen's plane because the cursor destination usually changes in every step. But the second action, on the tablet plane is usually the same: The puck's right button is pressed to activate the cursor's selection. This means that by separating the two Genigraphics planes into two still images, every second frame would generally look the same. In order to avoid this redundancy I decided not to separate the two Genigraphics planes to two frames, but rather to incorporate them in one frame by placing an image of the puck in one of the corners of the screen's plane image.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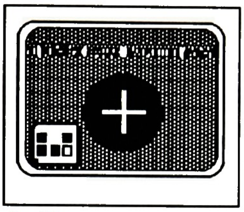
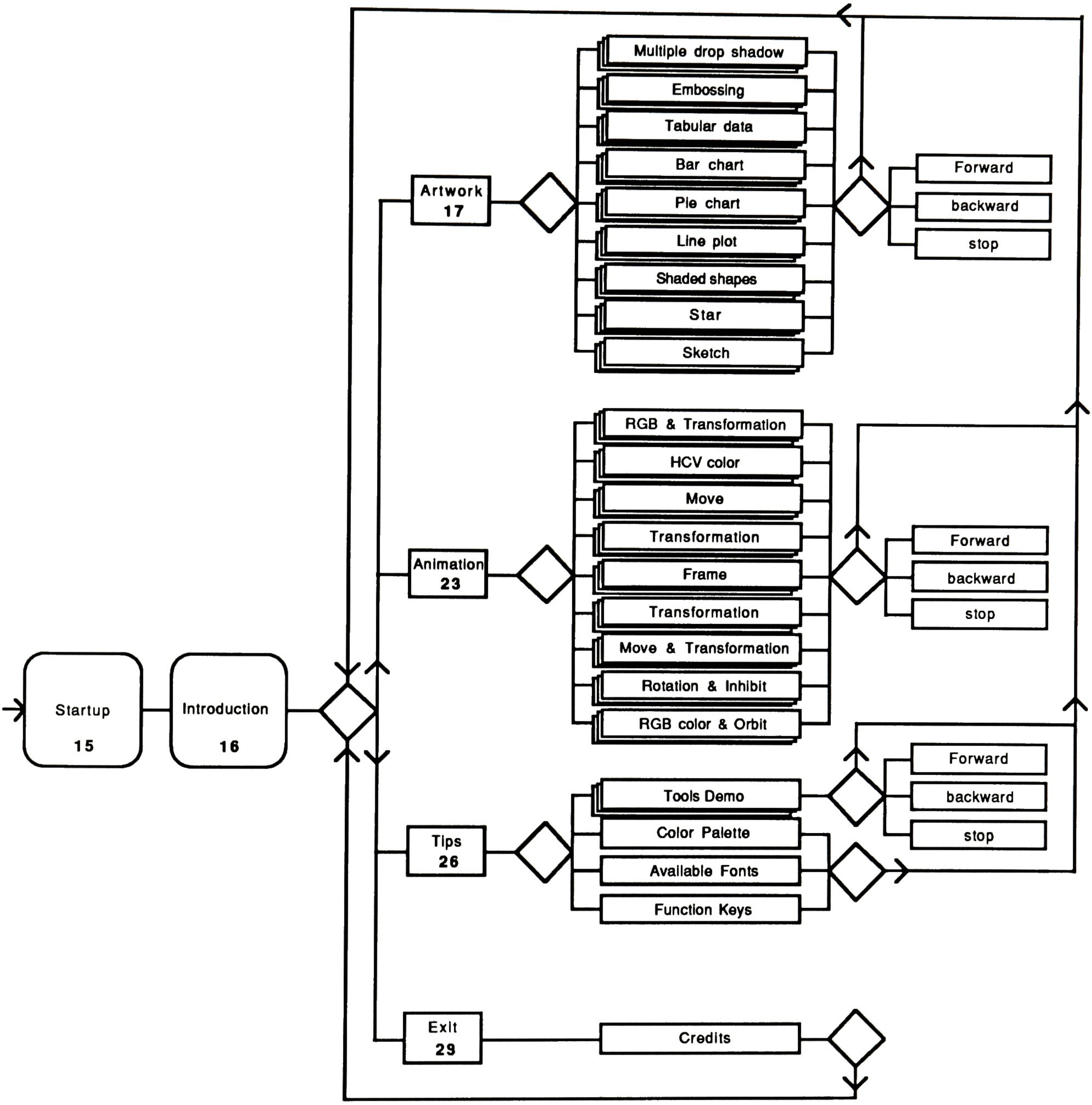

1+2

This solution, though violating the imitation of reality, offered a logical solution to the second problem. Since the Genigraphics images and the puck image had to share the same screen, I had to make up an illustration, or an icon, of a puck that would not compete with the Genigraphics images. The illustration of the puck that I had created before on the Genigraphics was not distinguished from the other Genigraphics imagery. I thought it would be a good idea to recreate the puck with the IVIS's graphics overlay. This way the puck could be visually distinguished, and the correct button could be highlighted through the control of a program stored in the IVIS.

I planned to use a separate frame only when the Genigraphics user should input information through the keyboard. Some cases required a big space to contain all the information to be entered. In addition, the keyboard is really used separately from all the other Genigraphics interfaces and it does not cause any immediate result on the screen. I planned to create the keyboard image, like the puck, later, with the IVIS's graphics overlay.

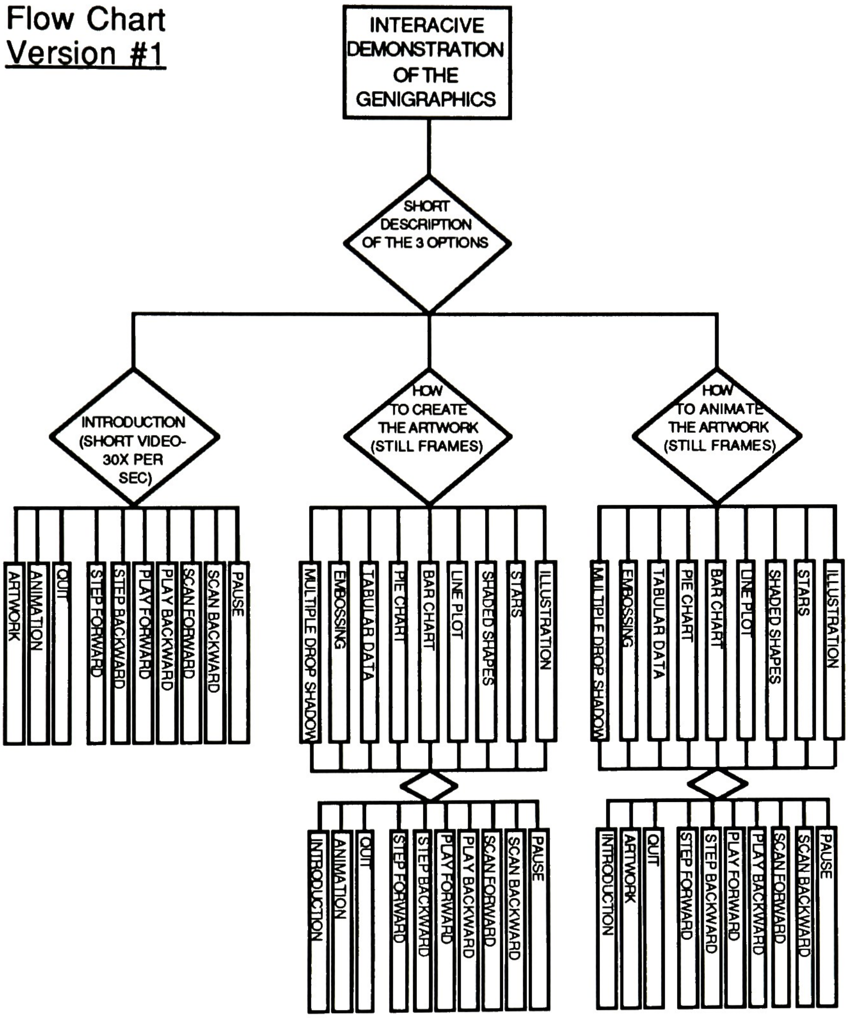
Flow Chart

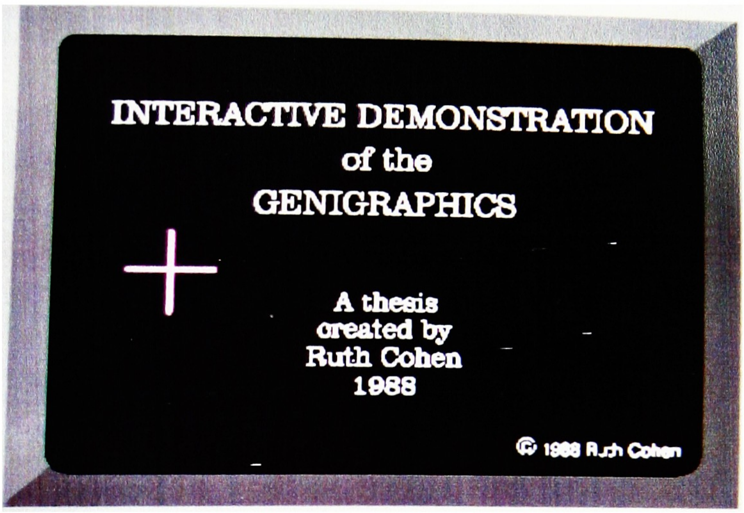


The numbers in the flow chart are the reference to the page number within which the option and the suboptions are explained in detail.

The flow chart is an illustration of the paths and choices in the program with which the user can interact. The final version of the flow chart evolved, as the project developed, from this original version.

Flow Chart
Version #1

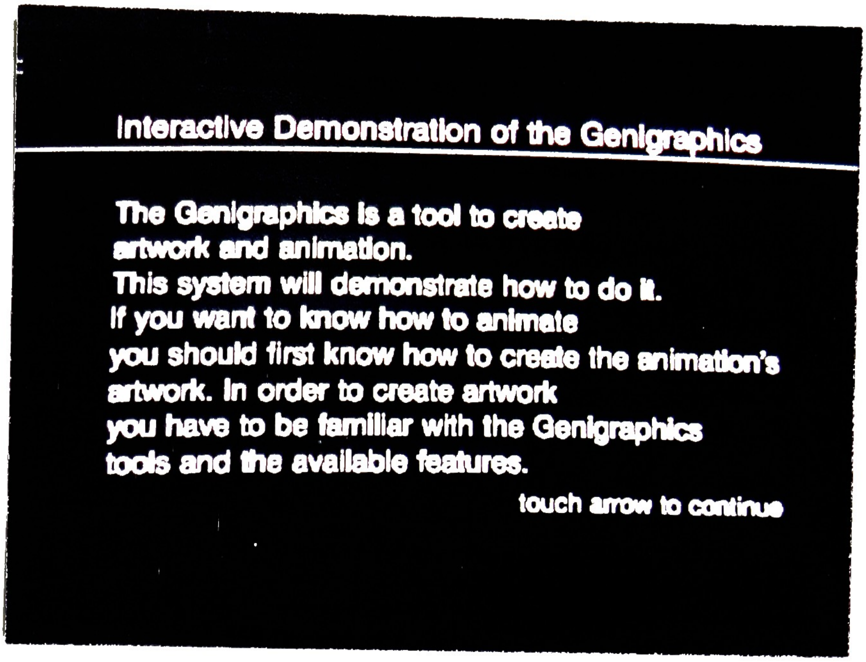


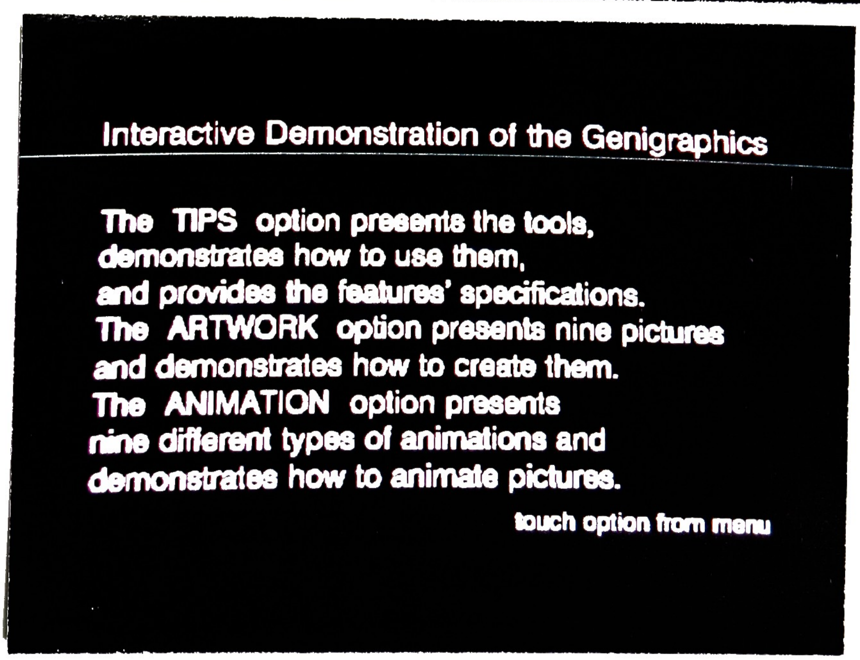


This image is the last image of the start-up routine. This routine comprises 45 frames of animation that were created on the Genigraphics and were recorded on a 3/4" tape.

According to Aaron Marcus in <u>Screen Design Guidelines</u> "The first meaningful visual impression a user has of a system is the appearance of the start-up and the sign-on screens. For first time users and for demonstrations, an eye catching animation should appear that uses the company logo, product name and distinctive elements from the interface to follow. For experienced users a simple, logically organized, friendly sign-up is appropriate."

I wanted to have a fun start-up which would briefly demonstrate some objects and animations that could be created on the Genigraphics. I also wanted to use a minimum number of frames of the disc. The start-up had to give a new user a "feeling" of the Genigraphics' character, and it had to be short enough not to bore an experienced user who wants immediate access to information. I tried to get around these conflicting needs by making the animation very short but also complex. I thought that such an animation, in which many actions happen simultaneously, might be effective and attract for a while even the more experienced users that access the system more often.





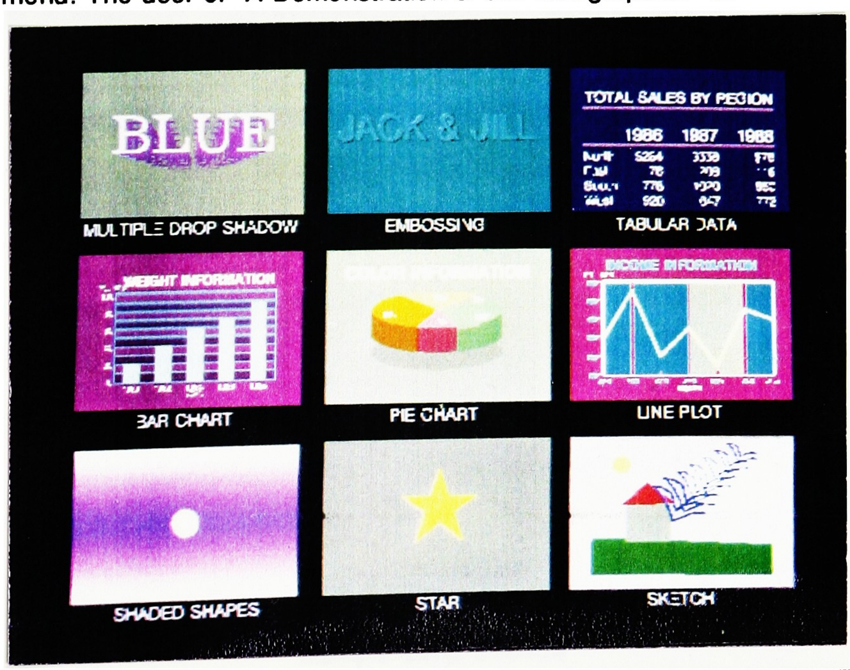
These two still frames were created on the Genigraphics. They are only for a first-time user. An experienced user can avoid them and move on to choosing an option from the menu.

The Genigraphics is a tool to create and animate images. "A Demonstration of the Genigraphics" demonstrates these two capabilities separately. The artwork option shows how to create images and the animation option shows how to animate these images.

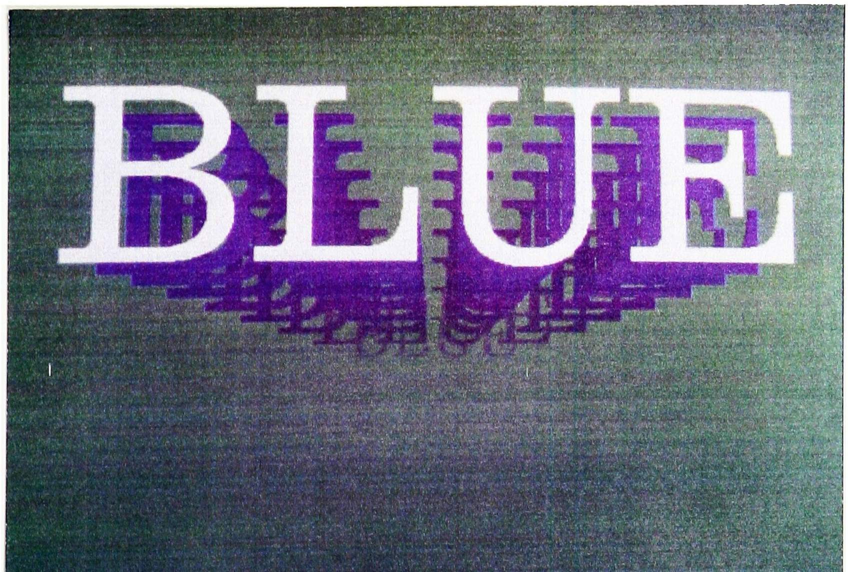
Since I chose to teach how to use the Genigraphics by demonstrating, I had to choose the appropriate images and to determine the stages to be demonstrated. First I decided which imagery could represent the Genigraphics and be demonstrated in the artwork option. I picked nine visual applications that I thought a Genigraphics user might want to create. The nine are: multiple drop shadow, embossing, tabular data, bar chart, pie chart, line plot, shaded shapes, star and sketch. The next step was to create Genigraphics images which would represent these visual applications--a multiple drop shadow image, an embossed image and so on.

In order to make the learning process short and effective I tried to avoid redundant elements and to make each image as simple as possible. At the same time, the color choices and the layout design were just as important. Simplicity and good design seemed essential, especially for a system that is supposed to serve designers.

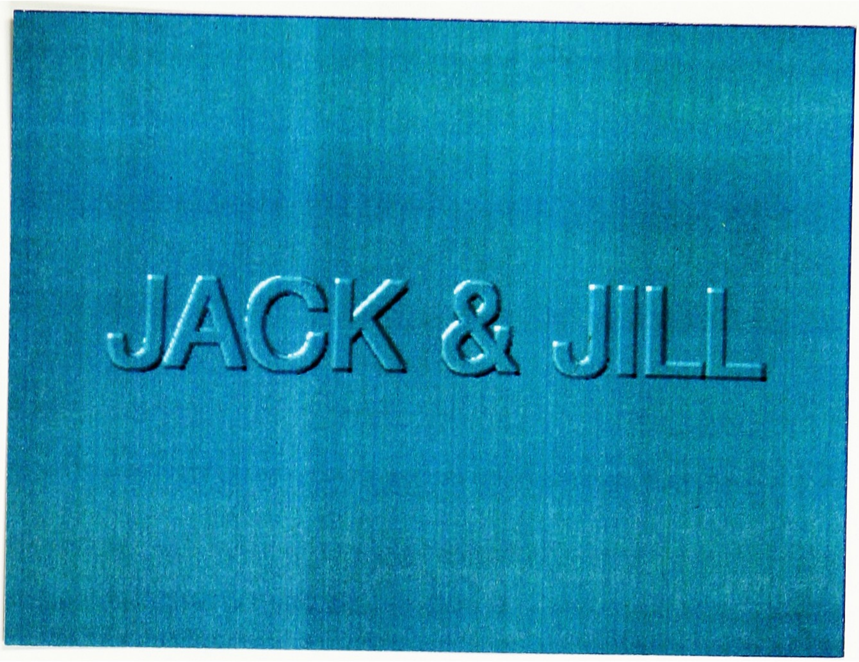
The image below is the submenu that was created from these nine images. It appears when the artwork option is chosen on the main menu. The user of "A Demonstration of the Genigraphics" can choose



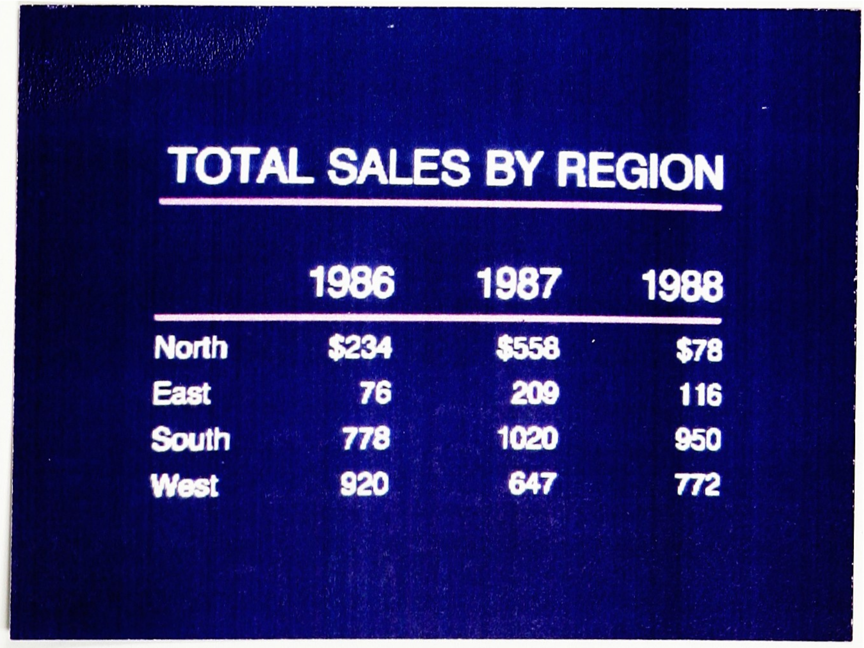
from this submenu a "picture" that he wants to learn how to create. When he touches the chosen picture on the screen, the program retrieves the sequence of frames that demonstrates the process of creating it. When he is viewing this sequence he can step backward and forward through the process, and he can, at any time, make a new choice from the menu.



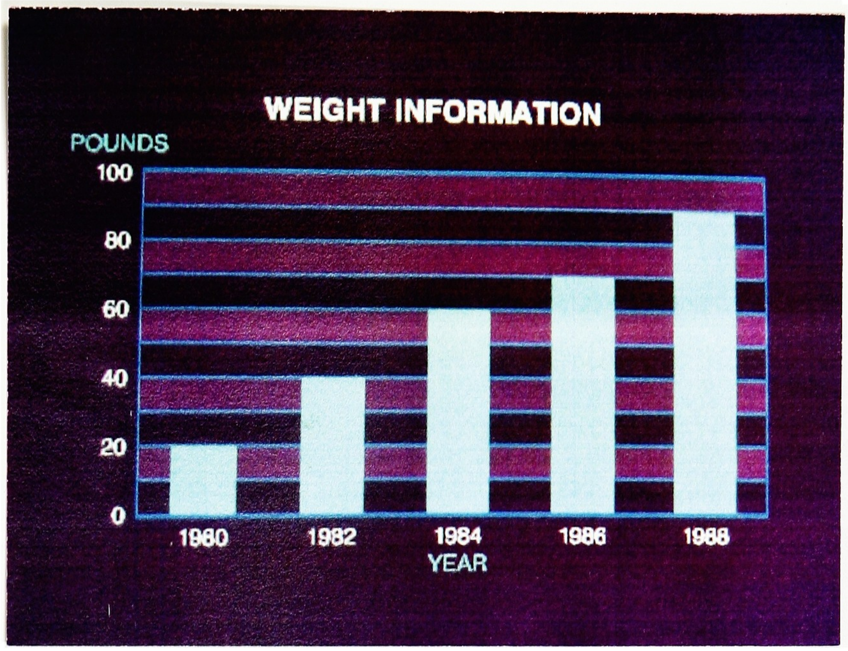
Multiple Drop Shadow



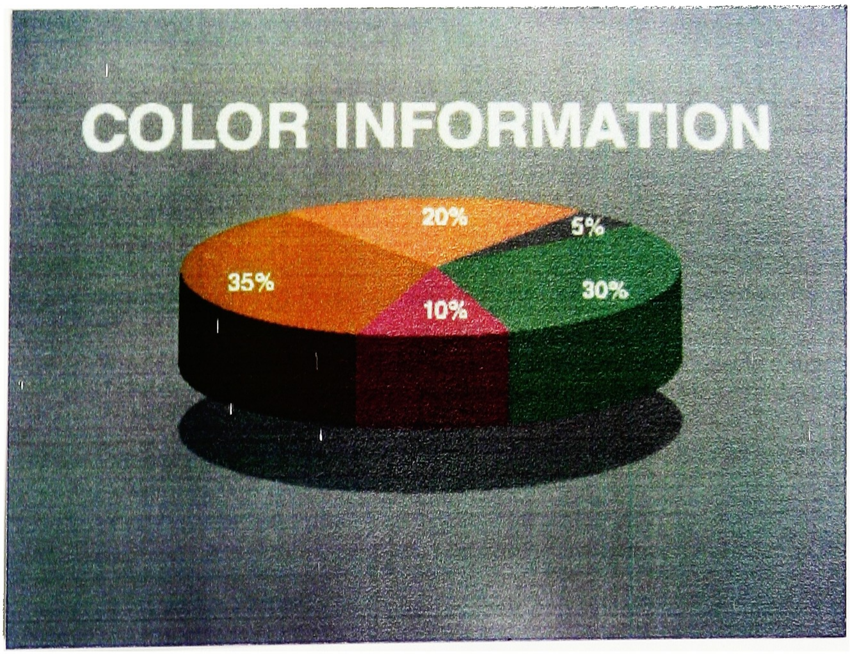
Embossing



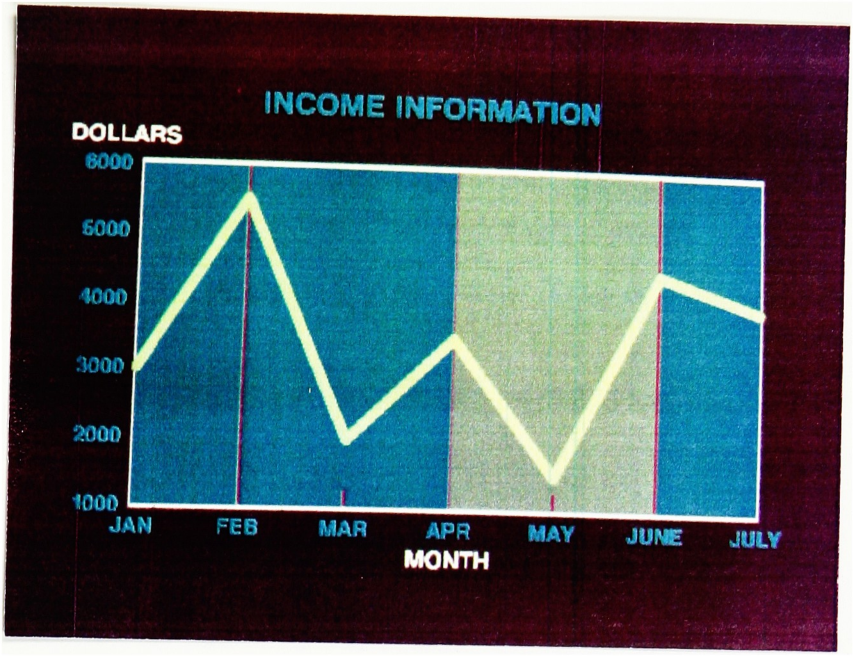
Tabular Data



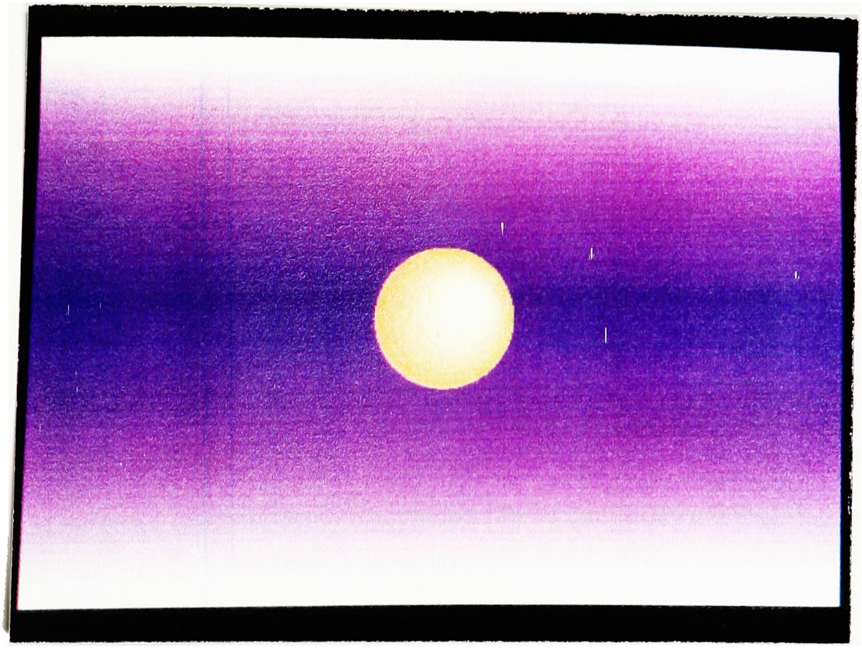
Bar Chart



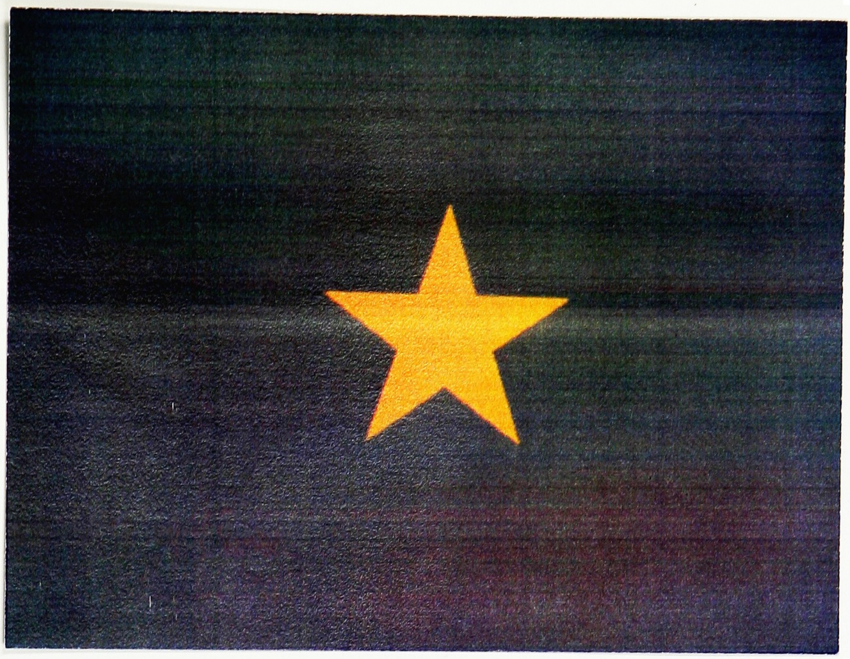
Pie Chart



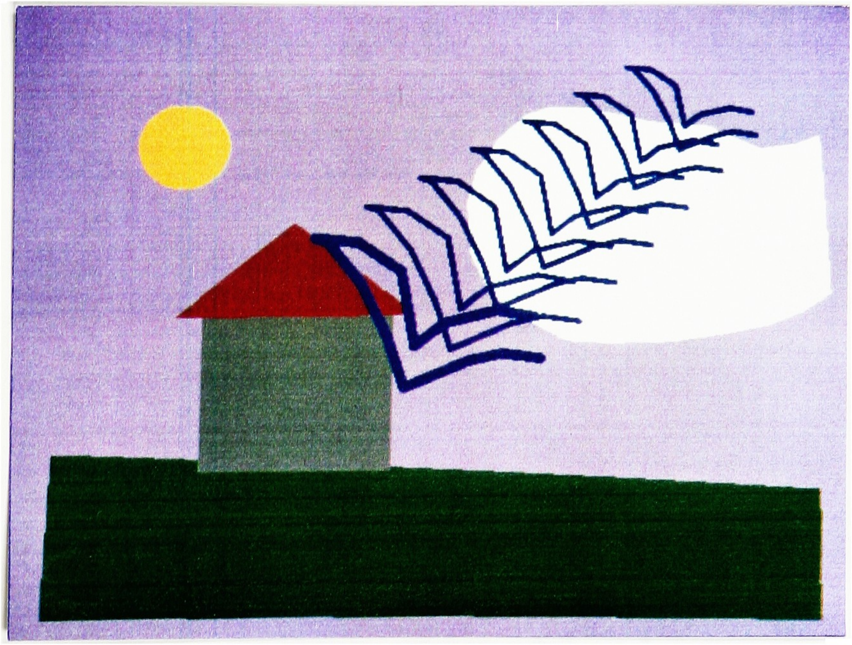
Line Plot



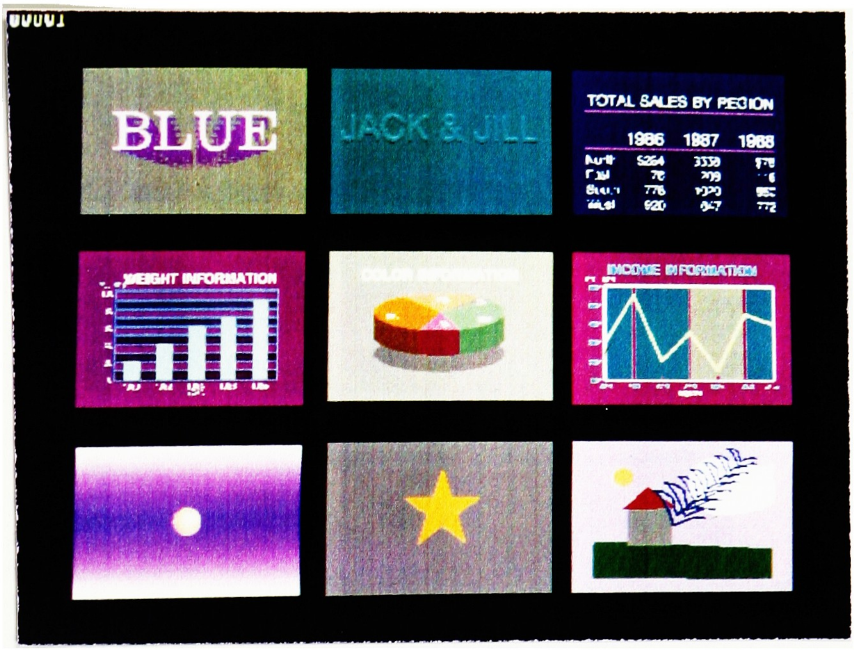
Shaded Shapes

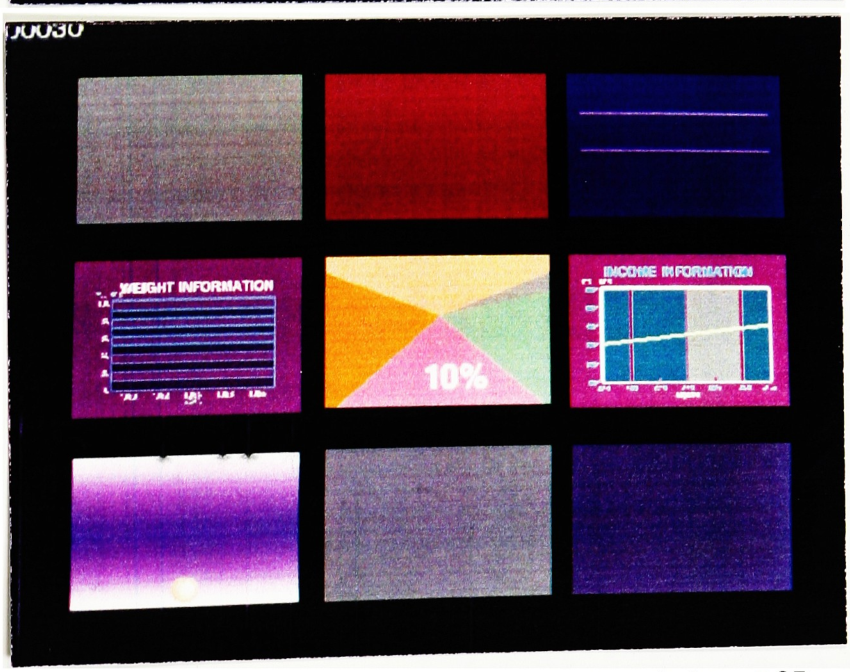


Star



Sketch





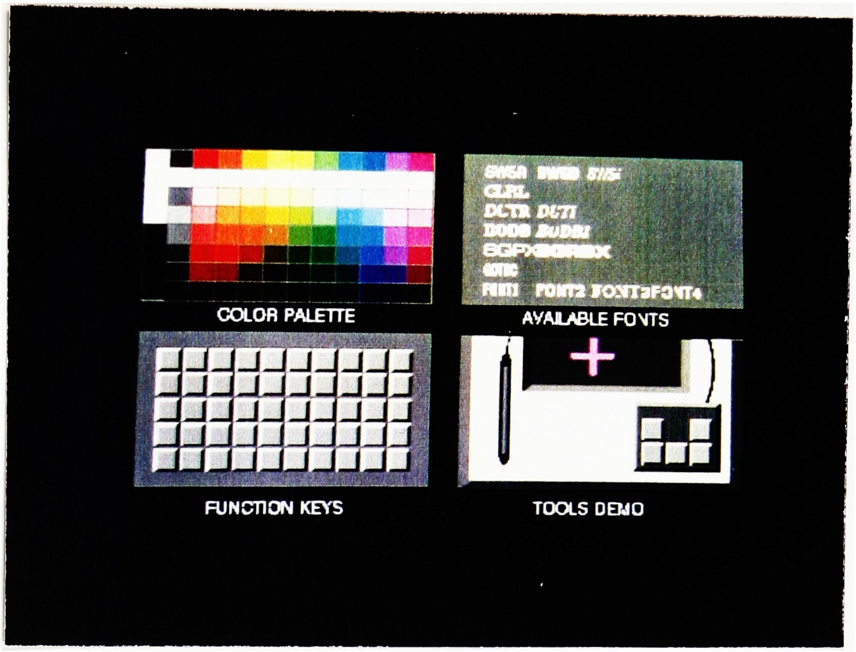
The Genigraphics has eight types of basic animation choices: RGB color, HCV color, move, transformation, frame, orbit, rotation and inhibit. First I had to decide which type of animation would fit which

image of the artwork submenu and then I could actually animate each image. The animation submenu is the combination of all nine animations on one screen. It appears when the animation option is chosen on the main menu. This sequence is made of 60 frames of animation that appear at 30 frames per second. The program that controls the videodisc was to create a loop that would make the videodisc player repeat the sequence over and over until a user chose one of the animated pictures by touching it on the screen.

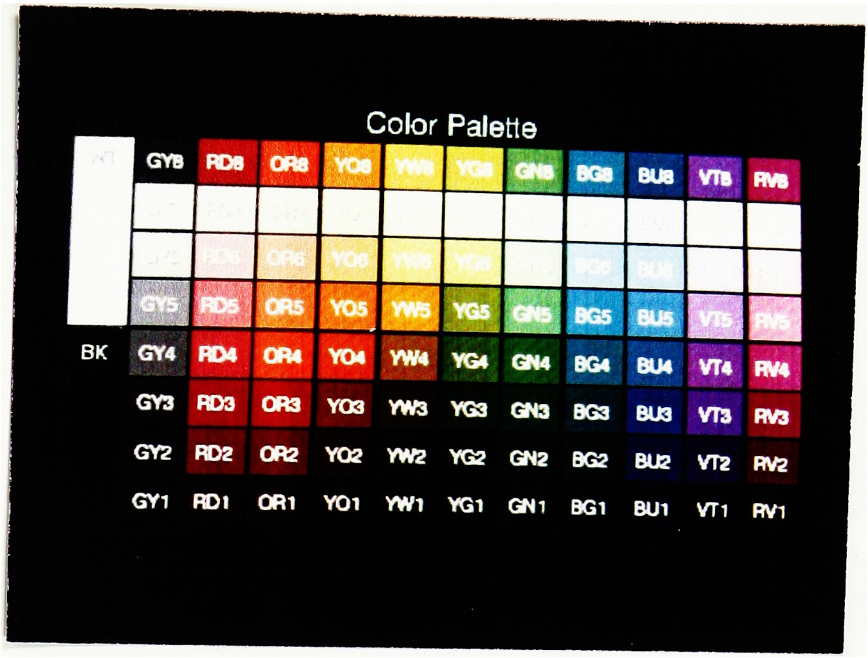
First I created one sequence made of 30 frames that include the nine animations that the user can choose from. The top image in the previous page is the first frame (frame #1) and the bottom image is the last frame (frame #30). The Genigraphics calculates the in-betweens of these given start and finish frames. In order to have a smooth loop in the animation submenu, I added 30 frames to the original sequence. The last frame (frame #60) was identical to the first frame and the middle frame (frame #30) was identical to the original last frame. This was made by the "posting" technique that makes it possible to manipulate the original sequence, repeat it, or make it go backward by changing the frames' positions. This technique was not used in the demonstration of each of the animations. It was only used for the representation of the submenu, to make the animation sequence repeat itself smoothly in the loop.

The animation sequence is made of the artwork submenu image and each of the nine pictures is animated by one or two of the function choices that are available in the Genigraphics' animation menu. Each animation represents the particular kind of animation through which it was created. The one exception is in the piechart animation. This animation represent the *frame* choice in the Genigraphics' animation menu, but it was actually made by the *transformation* choice. In other words, a user who chooses the piechart animation of this submenu will learn how to use the frame-in choice in the Genigraphics' animation menu, even though the animation was created by the *transformation* choice. This is because the *frame* choice controls the whole screen. You cannot frame in to a designated area of the screen, such as to one of the nine pictures. So in order to achieve the illusion of the *frame* choice I used the *transformation* choice, which allowed me to get the same effect by enlarging only the objects that are in the piechart picture. But this solution caused another problem. The enlarged piechart covered the whole screen, and also some of the other pictures that were supposed to appear. To solve that problem I made the piechart picture the first picture, or the first sequence of objects

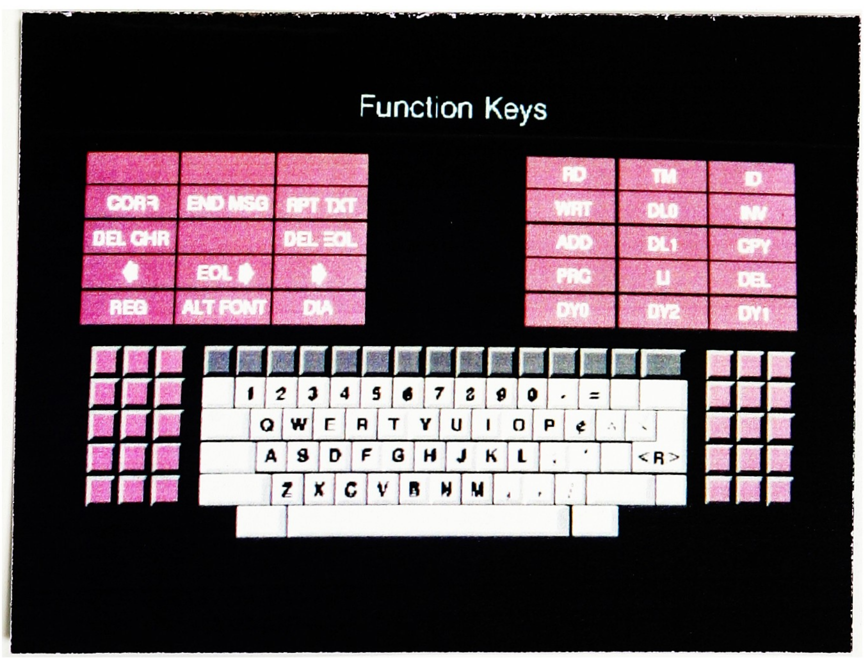
to appear on the screen. I created masks (black areas) which appeared right after the piechart picture and blocked the area around this picture. This process made the piechart animation look like it is framed-in and left the other eight animations visible and functioning within their areas as well.



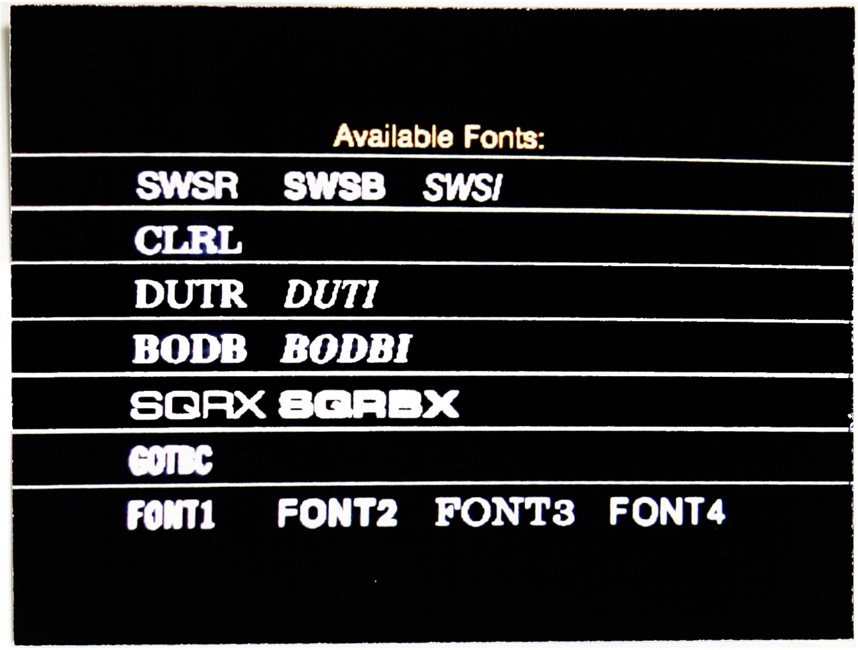
This image is the submenu that appears when the tips option is chosen on the main menu. Each picture of the four was created on the Genigraphics and represents the topic named under it. The pictures of the color palette, the available fonts and the function keys are only reductions of the original images. The user can see a full-screen image once he touches a picture on the sensitive screen. The Tools Demo option represents a one-minute video sequence that demonstrates the correlation between the Genigraphics user and the Genigraphics interface devices. This option was created particularly to give new users some understanding of the Genigraphics interface. It shows a user creating an image on the screen, and the focus is on the way he uses and interacts with the interface.



Color Palette



Function Keys

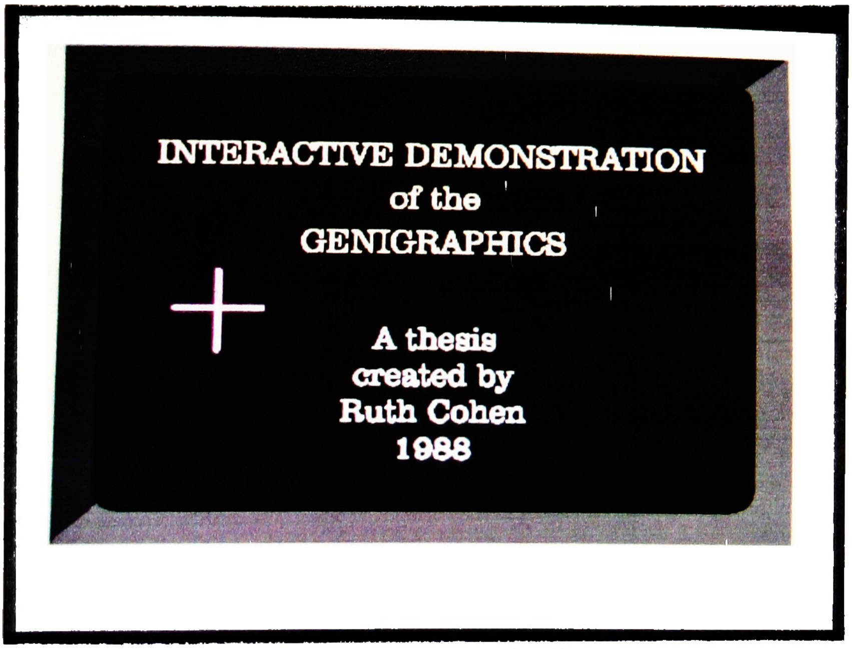


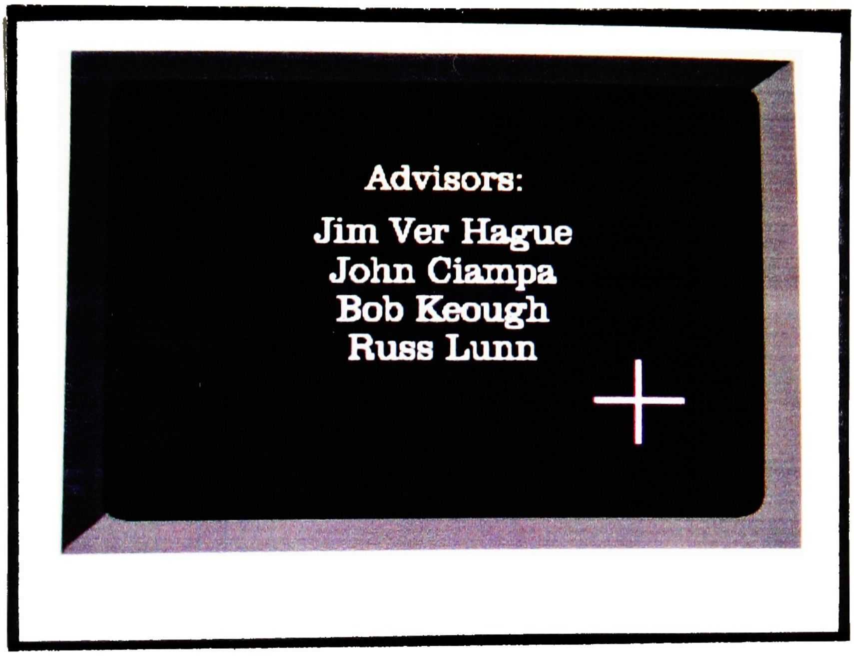
Available Fonts

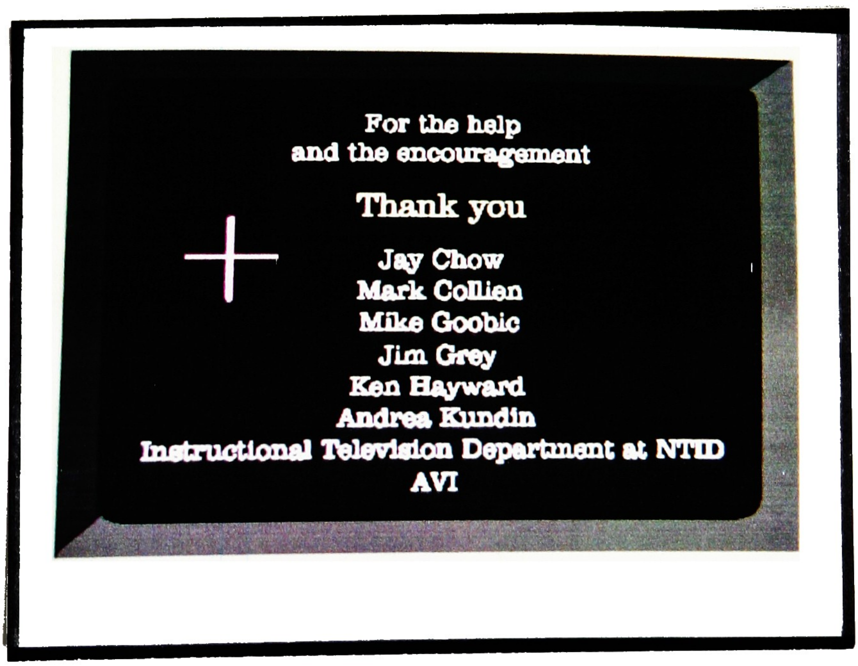
Tools Demo

Exit

The exit sequence is the submenu that appears when the exit option is chosen on the main menu. This sequence is made of three frames of credits that were created on the Genigraphics. The program that controls the videodisc holds each frame for three seconds. After all the frames are displayed the system is supposed to turn off. Actually it gives the option to start over. This option was made only to avoid having to turn the system back on frequently during a presentation.



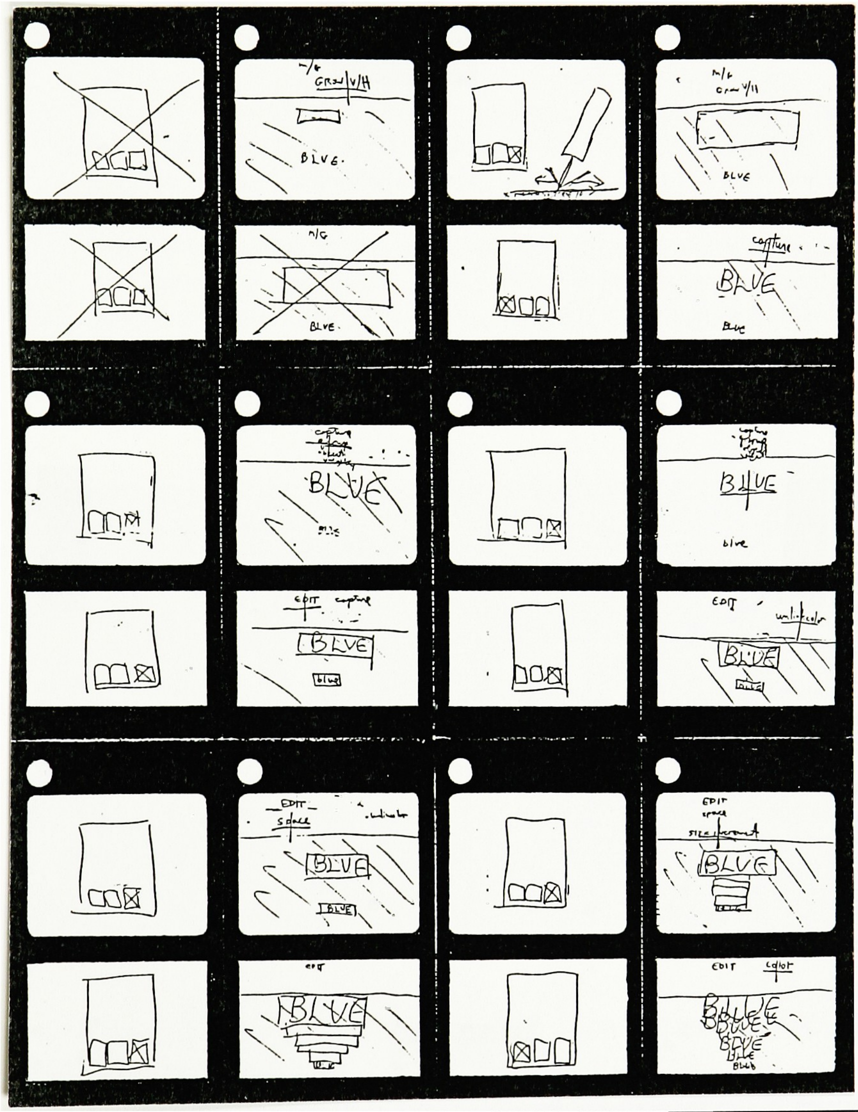

Advisors:
Jim Ver Hague
John Ciampa
Bob Keough
Russ Lunn


For the help
and the encouragement
Thank you
Jay Chow
Mark Collien
Mike Goobic
Jim Grey
Ken Hayward
Andrea Kundin
Instructional Television Department at NTID
AVI

Storyboard

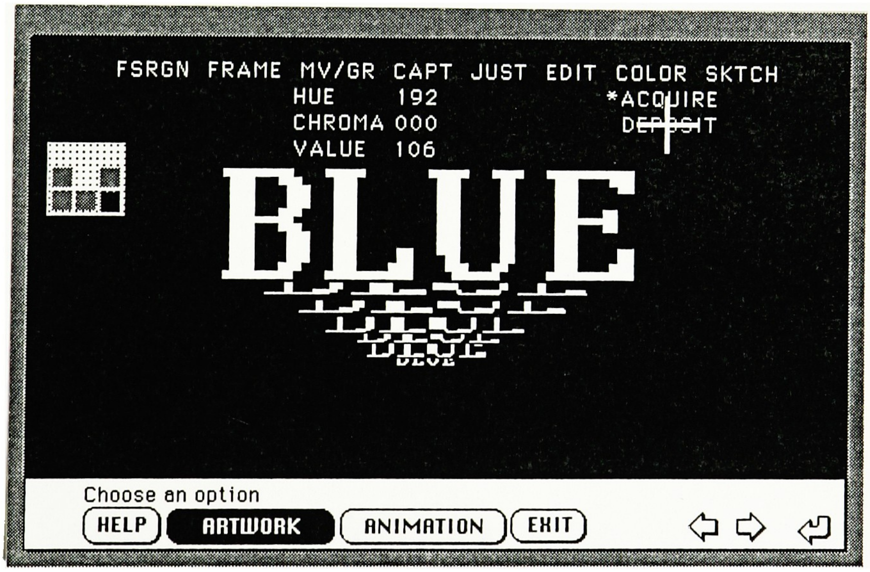
After the art work images were designed and created I had to go back and determine the exact steps that it took to create each image. I illustrated these steps in a storyboard. Each move of the pen, press on the puck or menu selection was translated into a sketch. I did the same thing with the animation option: After each image was animated I could go back and illustrate the process on the stotyboard.

Latter, when I was recording the Genigraphics screen on the OMDR , I used the storyboard sketches to remember the stages used to create every image and animation.



The process of designing an interactive videodisc takes place on different levels simultaneously. The images and the flow of the program have to be planned, designed and tested at the same time. Since it is very expensive to master a disc and since a laser disc cannot be erased or changed, It is important to check the concept and the effectiveness of the interaction before the disc is produced.

The way I chose to do this was with a "mini-prototype" of the project that I created with HyperCard. This mini-prototype contained a stack for each type of option in the program. Each stack contained examples of the menus and the screen designs which appear in response to the user's selection. The images imitated the Genigraphics images in black and white, and the menus suggested the graphics overlay design. Instead of touching the menus on a touch screen, the user clicked with the Macintosh mouse on the HyperCard buttons. From the way people responded to this mini-prototype I could learn what needed to be improved. This was the tool to test how self-evident the menus and the design were. The observations that were made through these tests were easily applied to the program, since it is so easy to change a program that is designed in HyperCard. The last version of the mini-prototype became a reference for the final menu design and the final program of the "real" prototype.



An example of the Hypercard "mini-prototype"

Once the animation of the "start up" sequence and the animation for the animation submenu were created on the Genigraphics, they were ready to be recorded. The Genigraphics is connected to a tape recorder and the recording process is just another feature in the animation menu. As with the other Genigraphics features, it is a simple process if you know the right order. One has to call up the animation file (which is an image and an animation table) from the disc, select the right choices from the Genigraphics animation menu, and the rest is done automatically.

The Tools Demo is the only video sequence on the disc that was recorded in real time. It was recorded with a Hitachi-Z-31 video camera in the Genigraphics lab. Jay Chow, as the actor, had to create the same image over and over. The same sequence was shot several times from different angles and distances, and later, segments from all these shots were edited into one sequence. The main concern while recording was to find a balance between the lighting on the user's hands and the lighting on the screen. More lighting made the images on the screen less legible while less lighting left the tablet tools and the user's hands too dark. The solution was somewhere in between. But when the screen was recorded separately the lights were turned off to enhance the legibility. This is the reason that the screen changes colors and brightness throughout the edited sequence.

A storyboard for the Tools Demo was made only after recording. It contained an illustration of the steps that were taken to create the image on the screen. Another list of images was made to describe and locate all the shots that were recorded on the tape. This was made by viewing the window dub that I made from the master tape. A window dub is a copy of the master tape that contains a window that shows the time code that was recorded simultaneously on both tapes. The window dub is good for making a rough edit and an edit decision list (EDL). An EDL is a list of the in and out points (in time code numbers) of segments of frames, in the order in which they should be edited. This list of numbers can be entered in an editing system which will then make all the edits automatically (on line edit). Although I planned on using such a system, eventually I used the Convergence ECS-90 Video Tape Editing System, in which one enters the in and out points of every segment and initiates the edit. The advantage of this system was that it allowed me to view each edit after it was performed and to make changes in the frames' entry numbers when necessary.

All the other images that had to be recorded were still images and had to be shot one frame at a time. This included all the sequences that demonstrate the process of creating each image from the Artwork and the

Animation submenus, the still images from the Tips and the Exit submenus and the submenus themselves (except the animation submenu). This was a much more complicated process. First, because there are many ways to record one frame at a time. The options that I considered were slides, film (16 mm with the Bolex), tape (using the Genigraphics controller) or optical memory disc. I determined that I would have to record about 1200 still frames. If I used slides it would have meant 1200 slides. Slides have very good resolution, but to produce that amount of slides was too big an expense. In addition, since all frames had to be transferred eventually to 1" tape, I had to consider the availability of the transferring process and its costs. Recording on film was also not suitable for that reason. Recording on tape, using the Genigraphics controller to record one frame at a time, would have been too time-consuming. The optical memory disc, though it has relatively low resolution, seemed to be a good solution. The disc is relatively inexpensive, it can be transferred directly to the 1" tape with out any inbetween process, and I knew I might get this service at NTID.

At that point I could began to record the Genigraphics screen on the OMDR and test the results. This led to the following series of experiments:

I. First I recorded directly from the Genigraphics to the OMDR. This means that I took the"video out" cable from the Genigraphics and connected it to the "video in" of the OMDR. The results presented the following problems: 1. The top part of the Genigraphics menu was not visible unless the "under scan" mode on the monitor was selected.

2. Sometimes the Genigraphics' cursor disappeared or was hardly visible, particularly when on top of certain colors. 3. The visible parts of the menu were not always legible. 4. The colors of the recorded images were distorted.

Problem #1 was caused by the fact that the Genigraphics has a fixed recording area that cuts out most of the menu area. This adjustment prevents the menu from showing on the screen in a regular Genigraphics recording. I could not rely on the "under scan" mode because not all monitors have that kind of adjustment . A Digital Effects Box (DEB) is a device that can shrink each recorded frame to a new fixed size. Using this device, however, was beyond my means, so the next idea was to try to shoot with a camera off the screen.

II. In this experiment I had a camera in front of the screen. This time the "video out" cable from the camera was connected to the "video in" of the OMDR. This experiment solved the screen's size problem but increased the other problems. The cursor and the menu were even less legible and

the color quality deteriorated. Shooting off the screen caused more loss of quality than shooting directly from the Genigraphics. The result of adding gain to improve the visibility of the cursor and the menu was video noise.

III. This experiment was actually a continuation of the previous one. The dark screen that covers the Genigraphics screen was eliminated and the terminator switches in the back of the Genigraphics monitor were turned on. This made the menu and the cursor brighter and the recorded screen more legible. Although this experiment showed an improvement in the recorded image the cursor was still in some cases almost invisible.

IV. At that point I was only concerned with enhancing the cursor's visibility. An attempt to get information from Genigraphics did not work. So a "low-tech" idea was suggested: Stick on the screen, on top of the real cursor, a handmade sticker that looks like a cursor. I actually created a cursor from a phosphorescent material. This cursor was moved on the screen according to the real cursor's movement and the screen was recorded after each movement . But this experiment also did not work. The phosphorescent material needs complete darkness to glow in the dark, but the Genigraphics lab was not dark enough and also the screen itself reflected some light. A non-glowing "low-tech" cursor did not solve the problem either because it needed additional light. The best results of shooting off the screen came when the screen was recorded in the dark. Additional light only hurt the quality of the image on the screen.

V. The final idea was to recreate the cursor with the IVIS's graphics overlay. This way, I knew the cursor would be distinguishable and visible. After this decision was made I was ready to record all the still images. I recorded with an Ikagami camera that was mounted on a tripod and was connected to the OMDR. The Genigraphics dark screen was eliminated and the terminator switches were turned on. Once the camera was white-balanced and focused I could begin to create and record the steps of each sequence by following the steps in the storyboard. I was very careful not to make any mistake and not to record a wrong image because the optical memory disc is not erasable. The results, however, were still quite disappointing. The images lost a lot of quality in color and resolution through this process and I knew that they would lose even more after the transferring and mastering processes.

The recreation of the cursor had to be done after the disc was mastered and all the screen images could be viewed frame-by-frame. I planned to look at every frame and locate the new graphics cursor in the right position. Ultimately I did not follow this plan because of time limitations. It would have been a long and tedious process to recreate and position the new cursor with the IVIS's graphics on the 1200 frames.

The premastering process was relatively simple and short. The instructional television department at NTID was willing to transfer the recorded material to 1" tape. To avoid any need to perform edits on their 1" editing system they required that all material recorded on 3/4" tape be in one sequence. So my only task was to take the "start up" sequence, the animation's submenu sequence and the Tools Demo and put them together on one tape. This was done on the Convergence ECS-90 Video Tape Editing System and was a simple editing process.

All the material from the OMDR and from the tape was transferred at NTID to a 1" tape. After transferring, a longitudinal, non-drop time code, which is required for the mastering process, was added on channel 3 of the 1" tape.

Mastering a disc is the process of pressing a laser disc that contains 1" tape material on it. Once a master disc is pressed, duplicates of the original disc can be made. The main difficulty that I had in mastering my own disc was financial. It can cost several thousand dollars to master a regular laser disc that has a storage capacity of 108,000 frames. I needed to use only 3336 frames of that storage space.

For a while I thought that I would be able to "take a ride" on someone else's disc. My material would not interfere with the other material, since the disc is controlled by a program. I thought that if someone were planning to master a disc and did not need to use all the storage space I might be allowed to use some of this extra space. If this were possible, I would have had to pay for only a duplicate of the master disc, and a duplicate is very inexpensive. However, this plan did not materialize because it depended on other people's schedules, when I wanted to follow my own schedule.

The next option I checked was the shared disc service. This service allows clients to use a portion of a disc and to pay for only that portion. All the clients' material is transferred to one master disc and from that any amount of duplicates can be made. However, in the time I had I was not able to arrange for this service.

Eventually I heard of Magno Sound and Video, a company that masters check discs in 24 hours for $200. This seemed to be a reasonable solution for my situation. I sent Magno Sound and Video the 1" tape with the required information. This included the time code address of the first and last frame on the tape, and the field dominance of the tape. Unfortunately I got the wrong information about the field dominance and the disc was pressed with that improper data. So a second disc was pressed, this time with the correct field dominance. But when I received the second disc, I found that it was only partly usable. The images were drastically shrunk and the menu and other text were not legible any more. Sometimes they were practically invisible. In addition the disc itself was not operating properly. I could not see some of the frames because the disc player could not pause on certain portions of the disc.

At that point however I decided to complete this project despite the problems with that disc. And the next task was to concentrate on adjusting and improving the program that had to control this disc.

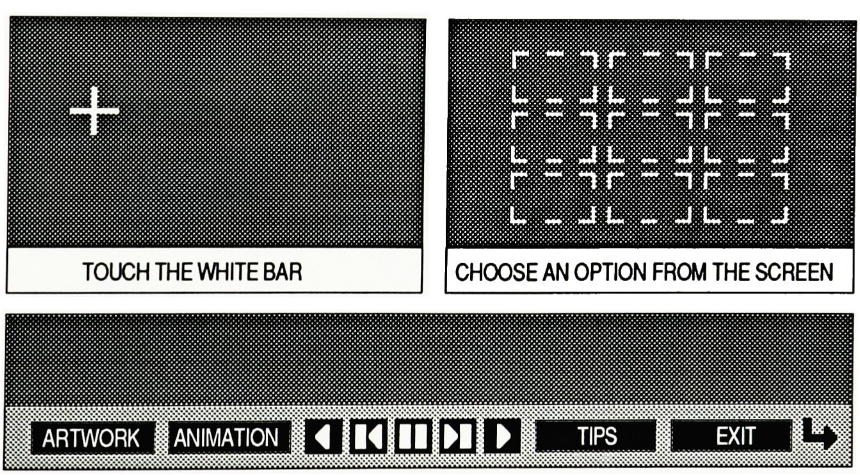
The programming was made with the IVIS Producer which has two functions: Draw and Design. Draw is a graphics package that includes text and graphics functions and videodisc calls. Design is a Pascal-like programming language used to control the interactive videodisc and the graphics overlay.

First I used Draw to design all the buttons that had to appear in the menu area at certain stages of the program. Each button is made of simple shapes defined by specific coordinates. After creating the buttons I defined each of the graphics as a touch-sensitive area that was later used in Design. For example, this is the program that creates the graphics of the button TOUCH THE WHITE BAR :

```
!FORM WHITE
.set fill_mode polygon
.bl (0,520 col=7) (959,599)
.cen (480,535 col=0,size=2,height=2) TOUCH THE WHITE BAR
```

And this is the program that makes this button, or the area of this button, touch sensitive:

```
!FORM CSTART
.menu (0,520)
.choice "start"
.area (0,520) (959,599)
.end menu
```



Examples of buttons created in Draw

Once I had all the graphics and all the touch-sensitive areas saved and organized in Draw files, I was able to begin writing the main program that would control all these files in Design. This program is responsible for controlling what happens when each button is touched and for retrieving the appropriate video or graphics images. It determines the next sequence of events, such as which video image will appear, at what rate, and which options will be available on the screen. Writing this program was a cumbersome task. The Design language is not very friendly, and neither is the Design manual. Operations such as retrieving the video or graphics images when buttons are activated were easy to perform. But some operations, such as the creation of a continuous loop in the Animation submenu, were very hard to perform. Another difficult task was to figure out how to control the backward and forward controllers (at the bottom of the previous page) so that the user would be able to activate them only within the appropriate segment of the disc. I did not want the user to be able to forward the disc past the last frame of his latest choice or to be able to back up past the first frame of his latest choice. Otherwise he would be viewing material that he did not choose to see. This task and some other complicated operations were eventually accomplished, but due to my limited programming background, they were sometimes solved rather clumsily. However, all these solutions are presented in a copy of the final Design program that is included in the appendix of this report.

I began to write the Draw and the Design programs before I had the mastered disc. I could do this because, as I described previously, I had basically designed and planned in advance the graphics overlay and the interaction. Since I did not have the disc, I viewed and tested the graphics overlay and the interaction on arbitrary frames from an available disc that I called Demo Disc. When I got my mastered disc I needed only to find the corresponding frame numbers and apply them to the program. The table on the next page shows how I kept track of the location of files and frame numbers during this process.

Frame #

	File Name (DRAW)	OMDR	Demo Disk	Thesis Disc
	ColorBars	1-3		
1	Blue (blue)	4-50	4	86-132
2	Jack (jack)	56-118	56	138-200
3	Data (data)	119-286	119	201-368
4	Pie (pie)	287-464	287	369-546
5	Bar (bar)	472-529	472	554-611
6	Line (line)	531-584	531	613-666
7	Ball (ball)	591-651	591	668-728
8	Star (star)	653-747	653	736-829
9	House (house)	749-827	749	831-909
10	Blue.ani (bluea)	829-880	829	912-962
11	Jack.ani (jacka)	881-920	881	964-1002
12	Data.ani (dataa)	921-999	921	1004-1081
13	Pie.ani (piea)	1000-1032	1000	1083-1114
14	Bar.ani (bara)	1033-1067	1033	1116-1149
15	Line.ani (linea)	1068-1113	1068	1151-1195
	Data.ani	1114-1185		
	Ball.ani (balla)	1186-1261	1186	1268-1343
16	Star.ani (stara)	1262-1301	1262	1345-1383
17	House.ani (housea)	1302-1378	1302	1392-1460
18	Startup	1379		
	Demo22 (demo22)	1380	2100	1462
	Demo33	1381	2200	1463
19	Tips (tips)	1382	2300	1464
	Palette (colors)	1383	2400	1465
	Fontslist (fonts)	1384	2500	1466
	Function (keys)	1385	2600	1467
	Artwork (art)	1386	2700	1468
	Exit (exit)	1387	2800	1469
	Advisors (advise)	1388	2900	1470
	Thank (thank) —	1389	3000	1471
	Toolsdemo (demo)	1390	3100	1472
	Jaydemo (demo+demo1)	Video (1800X)	3200-5000	1524-3328
	Animation (ani)	Video (60X)	6000-6060	3335-3394
	Startup (start+start1)	Video (45X)	6100-6145	3409-3453
	Start			3454

The task that I took as my thesis project was formidable, and some people were skeptical that I could overcome the obstacles to producing a videodisc. They were right and they were wrong. The project is done, but with many compromises, and it is working, but with some faults. I have described throughout this report the obstacles, the technical problems, the solutions and the results. The final images on the videodisc do not resemble the original images, and the final program is not as smooth as I hoped it would be. However, the images are there, and so is the program. As a prototype, this project can give some insights into how a final project could look and some insights into what should be avoided when producing such a project. The following are some suggestions for others attempting such a project:

1. Since the OMDR does not offer high resolution and good recording quality, it is a better idea, if possible, to shoot slides. Slides are easy to take and provide much better results. The optical memory disc is also not erasable. When recording a sequence I had to avoid making any mistakes, and if I did make any, I had to rerecord the whole sequence. If I had used slides I would have been able to reshoot only the mistaken image and later put the fixed image in the right place in the sequence.
2. I did not prepare a storyboard before recording the Tools Demo. This video sequence could have been more self-explanatory if it had been better planned. A storyboard can be useful to determine details and to get a clearer concept of a task.
3. The same video sequence would have worked better with the help of sound. A narration could make the sequence more self evident by pointing out the names of the tools and describing the user's actions. Generally, the addition of sound in such a project could reinforce the images and also add some entertainment to the learning process.
4. The forward and backward control buttons were too small for the average finger. Sometimes a user would try to touch a button and actually activate two buttons. When designing buttons it is important to leave enough space around them to prevent this.
5. If possible, it is important to check in advance with the mastering company what equipment is needed for playing the mastered disc. If you do not have access to the right equipment, even a good disc is useless. In this project, I eventually learned that my mastered disc could perform on a new disc player and on a big monitor, but I did not have access to this equipment.
6. Finally, If you have to rely on other people's help and support, be prepared to get some rejection and some aggravation. Just be willing to try again, to be resourceful and to not give up.

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