The MIT Media Laboratory Videodisc: The Process and Interactive Model

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Abstract

In 1985 twelve groups or programs from different schools and departments at MIT came together to form the Media Laboratory, an interdisciplinary research facility exploring new applications of expanding media technologies.

The lab's director decided to produce a videodisc to serve as the laboratory's first 'annual report', reporting to our 'stockholders', the research sponsors, about our 'product', research. Could demonstrations of research from such diverse groups be compiled together on one cohesive and entertaining videodisc? What design structure would best accommodate both a linear and interactive presentation? Unique production methods and design structures would have to be developed and implemented.

An additional goal was to present this videodisc in an interactive kiosk using innovative methods to accommodate the variety of individuals utilizing it. Interactive models were needed for this personalized form of interaction which would permit changes in the amounts and levels of sophistication of the information delivered.

Appendixes supply background information on the videodisc medium and it's interactive components.

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I. Defining the Problem

A. Facing Reality

The videodisc has amazing capabilities, such as random access (actually controlled access in a short amount of time), dense data storage, and interactive programmability. The promise, however, that the videodisc would become a popular broad based publishing medium has not yet been realized because of a lack of standardization of both hardware and software. Few producers are lucky enough to create an interactive videodisc that will be used in very controlled conditions, such as corporate training or point of purchase, where they are targeting a limited audience. This allows them to take full advantage of all the features their interactive configurations will support. But what about the producer who wishes to produce a highly interactive videodisc and appeal to a broad, diverse audience?

Unfortunately, the videodisc is rarely viewed in controlled situations using consistent hardware configurations. Usually, either a) the hardware isn't there, b) what is there doesn't work, or c) what is there isn't compatible. The videodisc producer is therefore forced to design the videodisc for both linear and interactive viewing. The challenge is to minimize the compromises while accommodating both structures.

A safe compromise is to assume the videodisc will be viewed on an average videodisc player equipped with a small microprocessor (such as the Sony LDP 1000A) that allows chapter and frame searches. It is then hard to go wrong if the videodisc is designed to default for viewing in a linear fashion while retaining the basic interactive options these players provide. This strategy is mandatory for the producer who wishes to have widespread distribution in uncontrolled situations and still provide a coherent program.

B. The Product

The Media Laboratory has been in existence for one year, and the lab's director, Nicholas Negroponte, thought it was the right time to issue a report, an 'annual report', on the state of the lab. Since the facility was so new and made up of such diverse groups, the hope was that an 'annual report' on one videodisc would help to illustrate the interdisciplinary aspect of the lab and the coherence of it's shared research goals. The major goal would be to produce an 'annual report' with content that balances both the information disssemination and public relation needs, while still providing an entertaining presentation.

One of the lab's research groups, the Architecture Machine Group, published an optical videodisc, "Discursions" in 1983 (Arrons), that highlighted then current research projects as a method to share and disseminate information. Since the 'product' of the Media Lab is research, it was decided to repeat the idea of "Discursions", by creating video segments of research demonstrations (commonly known as 'demos'). Only this time, since there are twelve groups for the same amount of videodisc space, there would have to be less depth given to the research and settle instead for a broader look at a larger animal. This approach definitely decreases the value of the videodisc as a medium for conveying technical information but at the same time increases its appreciable viewing audience by a hundred fold. The goal was to provide a videodisc with sophisticated information delivered in an entertaining fashion. We had to constantly weigh what would be worse; the boredom and confusion of too technical a format, or the surface education most entertainment formats provide?

Aside from the research demonstrations, the videodisc provides a overview of what some of the research groups are all about. This is important since it is very tough to get a sense of the lab by merely walking the hallways and poking your head into doorways, where often, all you see is someone working at a terminal. This difficulty is evidenced by the many people who work in the lab and know little about what the other research groups do.

C. The Audience

We wanted to appeal to a larger, broader audience then just other researchers. We needed to be informative as well as entertaining. To do this we had to make the Ed Sullivan Show (Browne) of research demos. Our foremost goal as an 'annual report' was to communicate to our 'stockholders', in our case, the research funding sponsors. Most of our sponsors are large corporations involved in related fields of research, with the personnel responsible for awarding or consulting on the awards for research funding knowledgeable in many of the lab's research areas. The videodisc demos are not meant to educate these people, but rather to inform and entertain them, while offering others in their corporations a means to understand, and hopefully, appreciate where the corporation money is going.

Our primary intended audience is international corporate management, especially American and Japanese. It was with these people in mind, an educated group, with diverse interests, that the videodisc was produced.

A secondary audience, which is vast and also varied, are the masses of curious people who come through the Media Laboratory wanting to see what we're all about. These groups can be very distracting to the people working within the lab, especially if they are important enough to warrant a live demo. It was hoped that most of the curious could be satisfied by a videodisc demonstration. This is more then they could hope for before the disc, since many of the demos are complicated, taking time and valuable equipment to set up ("Reconfigurable Video", chapter 4, "NewsPeek", chapter 5, and "Conversational Desktop", chapter 7).

D. Design and Structure

Early in the pre-production stages the producer needs to arrive at the design and structure of the videodisc. Making these decisions involves weighing many factors such as the intended audience, the video content, and whether there will be any control over the hardware configurations. Will there be a linear viewing default? Do you want divided modular chapters or transparent chapters? Do you need to store single frames for interactive purposes? If so, where will you put then?

1. Linear and Interactive Considerations

We knew the videodisc would be viewed linearly most of the time, so that became our first priority. The audience was too wide and diverse for us to have any control over the hardware, so we planned the disc for linear play on your basic videodisc player. However, even at this minimum level, we could take advantage of the interactive capabilities of the videodisc for the users familiar with the player's potential of chapter and frame searches.

Since our content was about different research projects it seemed natural to subdivide the disc into chapters. These chapters can be viewed in a logical, linear order but the modular structure still allows viewers to search to a specific chapter. We actually ended up with well over twenty different research projects, but for the sake of simplicity we combined many of the shorter 'demos' into single chapters and structured the videodisc with 10 chapters on each side.

Chapter search signals were put on all chapters but the picture stop function was only used on the last frame of each side. The reason for so little use of the picture stop function was because history had suggested that most users would find it annoying to have to press the 'play' button at the end of every chapter (as on the "Discursions" videodisc). Also, it was felt that since you could go from the beginning to end of each side without interruption viewers would tend to do so. The picture stop was only employed on the last frame on each side, in order to rid that nasty habit the videodisc player has of zooming back to the beginning of the disc as soon as it plays the last frame (the last 30th of a second in linear play mode). With the last frame as a still frame, we would give the viewer the option of going back to the beginning, viewing the table of contents located on this same frame, or ejecting the disc, and hopefully, flipping it over to view the other side.

We also use the capability of the videodisc players to monitor either audio channel, both, or none. We used audio channel 1 for the english narration mixed with the ambient soundtrack. The mix on audio channel 2 included japanese narration, ambient soundtrack, and 'talking heads' (persons talking while on camera) in english, only their volume is brought down so that the japanese translations could be heard clearly over it.

2. Dividing Up the Pie

The decision of how to best spend the precious real estate, one hour of real-time video, went through many phases. One of the first premises we used was to make real estate proportional on the amount of research funding the groups or programs had. The logic behind this was that the videodisc was primarily designed for research funding sponsors, and what they were willing to fund is what we should show them. This strategy was soon abandoned when it became evident that some groups would receive 10 seconds of real estate and one would receive none (the Film/Video Section, which is completely supported by academic funding). This strategy would certainly not be condusive to our secondary goal of sparking new interest in previously unfunded or underfunded areas of research. On the rich side, Electronic Publishing would receive 24 minutes, an amount they could fill, but not without going into more technical material which would of provided a lopsided content level compared to the other groups. There was also the matter of, could you make one research group interesting and entertaining for 24 minutes? Ultimately, the goal of providing a look at the entire Media Lab required that we adapt a different premise for the the division of 'real estate'.

The emphasis shifted to research projects, not research groups. We choose at least one research project from each group.

Many of these 'single' research projects ultimately expanded into a more general coverage of the entire research group. This provided substance and the opportunity to make a entertaining presentation, but at the expense of providing little depth to specific projects. So we were back to covering all the groups or programs, only now without rigid real estate allocations.

Although we were committed to give excellent coverage of the major research funded projects, several additional factors affected the final allocations of real estate. One criteria was how long could we hold our audience for any specific video demo. We couldn't expect to always be entertaining, but we certainly didn't want to be painful. Some subject that was captured rather dryly but was of widespread interest could hold longer then a more esoteric subject of the same dry calibre. Also, if the material was visual it added a great deal of 'holdability', since much of our footage in the Media Laboratory is people sitting at computer terminals (and there are only so many ways to make this interesting).

Both side 'A' and 'B' contain 10 chapters each. These chapters vary in length and content, from chapters 1 and 11 being, effectively, one frame of text serving as the "Table of Contents" for each side, to the 15 research demos. In between is an "Introduction", a "People" chapter describing the staff and faculty of the lab, and two appendixes at the end of each side that contain miscellaneous information, including short clips and frames from "Discursions", test charts, production and research credits, and relevant paper title pages.

Side A Real Estate Layout

chapter	length	title
	1:00	Opening Sequence
1	:15	Table of Contents
	1:00	Chapter Previews
2	2:30	Introduction
3	4:40	School of the Future
4	4:00	Reconfigurable Video
5	3:50	NewsPeek
6	4:00	Synthetic Holography
7	3:50	Conversational Desktop
8	4:30	Synthetic Performer
9	:10	People
10	:15	Appendix A
total	30:00	

Side B Real Estate Layout

chapter	length	title
	:15	Opening sequence
11	:15	Table of Contents
	:30	Chapter Previews
12	3:30	Vivarium Project
13	4:40	Computer Graphics and Animation
14	3:30	Advanced Television
15	2:30	Audience Research
16	4:15	Eyes as Output
17	3:15	Graphic and Typographic Interfaces
18	2:00	Movies of the Future
19	3:30	Snipits
20	1:50	Appendix B
total	30:00	

E. Client/Producer Relationship

There is no 'standard' relationship between client and producer. The relationship varies with the kind of project and the personalities involved. In our case there was more then one client and sometimes that client wanted to become involved in the roll of producer. For the most part the author was the producer and the lab's director, Nicholas Negroponte, was the ultimate client: however, this role of client was delegated for some chapters to the different research group directors. Although this helped to assure coverage of the research group to the satisfaction of the group directors, it also resulted in a variety of stylistic approaches that compromised the total videodisc look. Never the less the participation of the group director as client was sometimes necessary to obtain their full cooperation. Other group directors had neither the time nor interest to serve as clients which thereby gave us free rein.

Sometimes the director had other goals in mind then just demonstrating on going research. Spatial Imaging's director Steven Benton was interested in producing a piece that explained how to make a hologram, as he was often ask to explain this to their visitors. We reached a compromise by producing a longer piece, specifically for his group, that included how to make a hologram, and cutting a shorter version, "Synthetic Holography", for the disc that only briefly explains the process of producing a hologram. This entailed extra work for us, but at the same time it provided us with the active involvement of the group as well as direct access to people and hardware.

1. Clients as Producers: A Production Class

The task of producing an one hour videodisc is huge, and, depending on the resources, subject, and quality desired, can easily take more then a year's time. To help in the production process an academic class was offered in which graduate students from other groups assisted in the production process, learning production skills as they evolved programs. An effort was made to recruit students from the different research groups to hopefully provide better insight and access.

The class was composed of six students, five from four different research groups in the lab, and one, cross registered from Harvard's School of Education. Most students covered their own groups and the Harvard student covered the Advanced Television Research Project since he came from a broadcast television background. In essence, the students producing a product for their own groups were both client and producer. This familiarity and interest in the subject matter proved fruitful, both in terms of motivation and insight. It was especially helpful in terms of access, we could get directly to people and equipment needed. In terms of actually calendar production time saved it was a trade off, as more time then was expected was spent by the author teaching and assisting the students in their newly acquired production skills.

II. Production

A. Research on Research

It would seem a rather clear chore to gather the information about research in the laboratory, but this proved more difficult than we anticipated on the most fundamental level.

1. Mapping the New World

First we needed to find out just who were the research groups and programs we were covering. There seemed to be more then one list circulating and the listed groups were constantly changing. This was an infant research laboratory, and we soon realized we'd have to live with this evolution and finalize a list at the last moment.

Many groups remained the same, but the following list illustrates the evolution of others:

Electronic Publishing

Computer Graphics and Animation

Human Computer Interface

Advanced Television Research Project

Film and Video

Spatial Imaging

Learning and Epistemology was changed to

Learning Research

Telecommunications was dropped to bring in

Speech Research

Experimental Music Studio was made into

Music Research, then for a brief moment

Music and Cognition, then back again to

Music Research

Computers and Entertainment became

Entertainment Research

Visible Language Workshop became

Graphics

and the new program on the block (as of June 1986) was Movies of the Future.

2. Learning about the Environment

Then there was the matter of finding out just what these groups did. There was new literature regarding the Media Laboratory but this was very general to allow for change, and the more specific information usually came from the groups and programs prior to their moving into the new lab. This dated information was sometimes fine, but many groups had gone through significant changes since its publication. For instance, the Architecture Machine Group splintered into four new groups; Electronic Publishing, Computer Graphics and Animation, Human Machine Interface, and Speech Research, each with their new specific areas of research.

Some groups had produced videotapes in the past to document their research. We viewed these to gain information, to see how the group represented themselves, to see how well they worked, and to determine if we could use any of this older material. This approach proved fruitful: Music Research had co-produced a decent eight minute video with IRCAM in Paris which we could use. Since their director was not interested in spending time on a new demo we ended up using only this footage, but cut to a four minute version, "Synthetic Performer", chapter 8.

The best method seemed to talk with the people from the research groups themselves, so we either approached the group directors directly or went through one of their research staff or students. They would usually give us their canned demos and from there we would discuss how best to convey their essence. Often, they were taken aback with the limitations of the real estate. We'd then console them by expressing how much one could say in three to four minutes if the chapter was well conceived and executed. This was our cue to stress the importance of their involvement and cooperation to achieve a mutually satisfying piece, within the production timeframe, which was often a problem. Many directors were in the mist of research projects and wanted to delay shooting as long as possible to include the most recent results. We could accomadate a limited delay from some groups, but it was important to get started on the bulk of the projects.

It should be stated that the difficulty in reaching or communicating with most of these people was acute. They were very busy people, everyone in the lab was, and an in person meeting was often hard to coordinate. The saving grace was electronic mail. This provided convenient correspondence, and in some cases, as with the lab's director, accounted for 90% of all communication.

B. The Art of 'Demo'

Two main methods were used to videotape the research. One, used in the past by the Architecture Machine Group, was an actual demonstration of the project. The other was a sort of informational documentary format; these sometimes include short demonstrations but they are more general, less specific, something like the three to four minute 'special segments' on nightly network news.

1. Some Acts to Follow

We analysed "Discursions" in order to decide what worked and what did not. We felt some of their chapters, such as chapter 10, "Interactive Movie Map", which demonstrates the Aspen Project, and chapter 12, "Communications News", the predecessor to "NewsPeek" (chapter 5 on the Media Lab videodisc), were seriously compromised by a lack of narration.. Not only did they miss out on delivering additional information, but also where the sound suddenly disappeared many viewers questioned whether their sound system had died.

Chapter 21, "Put That There", on the other hand was quite successful, although no narration was used, it did include significant on-camera talking. This demo could credit most of it's 'holdability' to the strength of the visuals (a short clip of "Interactive Movie Map" and "Put That There" can be seen on the "MIT Media Laboratory" videodisc in chapter 20, "Appendix B"). Chapter 11, "Movie Manual", was fairly successful, with a homey delivery from an on camera narrator/researcher, but it wasn't visual enough to merit its length.

All these video demos portrayed researchers giving demos, but in chapter 20, "Phone Slave", the researchers actually portrayed characters using their prototype. In order words the researchers became actors. This same method was used to present the next stage of this prototype's development in the demo "Conversational Desktop", chapter 7 on the Media Lab videodisc. Performances are somewhat less then professional, so its success depends upon whether the viewer is interested in the hardware or the entertainment value. The production time also increased as some of the 'actors' were very stiff and required extensive coaching to losen up and numerous retakes. We decided from this experiment that unless we could provide good acting we would not attempt enactments with any other groups.

There were no real models for the informational documentary format on "Discursions" but there was on nightly news. However, in all fairness, our segments were a cross between informational documentaries and 'public relation' pieces for corporations, as we did not have the non-biased viewpoint that the nightly news, in theory, provides. It was a fine line to walk, and we slipped back and forth, between providing information or a sales pitch.

We used the informational documentary format often as many research groups had not developed projects far enough to warrant a full chapter about a single project. This format also allowed us to use any and all visually interesting material that even remotely related to the research group. In the end this seemed the best method to capture the essence of most of the groups.

2. Capturing the Essence

The actual production process of each chapter varied from gathering all the video in one shoot, to shooting many times over a nine month period. Some were shot one time with one idea in mind, others were reshot as their ideas changed. There were many times when we headed in one direction then realized it's folly and quickly changed strategies. We really couldn't be sure of the 'holdability' of many scenes until we were in the editing room.

There are built in limitations to the film/video medium when trying to convey technical information, and we did not want to cross these boundaries. As an example, chapter 14, "Advanced Television", describes some of the methods the Advanced Television Research Project is exploring to improve the broadcast television image. The concepts of line and motion interpolation is interesting on a surface level to many people, but to try to provide any technical depth, in a linear program, for that small percentage of people who would be truly interested, seemed like a small payoff for the amount of real estate it would necessitate. Had this been an interactive videodisc, we could of afforded the option of a very technical presentation, down to still frames of complex formulas and computer programs, without compromising the entertainment value or engulfing large tracks of real estate. At one time, early in the design process, we planned on dealing with this problem by structuring side A for linear viewing and side B for interactive viewing.

Another factor which we had to come to grips with was the matter of the ethics of the 'demo'. There is an unwritten law (maybe it is written somewhere) that you should not fake anything. Some groups took this more seriously then others. One group wanted us to tape prototypes for research that "is about to work" but didn't quite, so in this case we faked it. All that the fake entailed was to imply that a gestural input from a hand tracking unit commanded the computer to change the perspective on a 3-D graphics environment. What we did instead was to command the computer directly to repeat a specific perspective movement and move the hand accordingly, as if it were providing the input.

Speech Research, on the other hand, insisted on shooting everything for real in their demo, "Conversational Desktop". This not only involved long waits between input to the computer and their results, but also a 50% increase in production time for them to correct software bugs which reared their ugly heads. Once we had the footage there was the decision on whether or not we should condense the computer response time in the editing room. For the sake of real estate, pacing, and entertainment we did.

3. The Ed Sullivan Show

Most demos are inherently dry. A person sits at a terminal, types in some commands, and then something happens on the terminal screen. Wow! Not the sort of stuff most people are interested in watching for a hour. Luckily for us we didn't have to satisfy the average prime time addict; ours was a slightly more sophisticated viewer. Still, we had to provide action, motion, color, anything besides merely the strobing terminal screen. Unfortunately we didn't always succeed in this endeavor. Chapter 16, "Eyes as Output", is an example of such a failure. A person in front of a terminal, talks and points. We were trapped in this piece as this was the only research project and the only research person in the group. Not too many options.

Whenever possible we shot close-ups and hunted up cutaways of a relevant nature. Still, we were faced with a limited subject. Since the 'holdability' was seriously lacking, an attempt was made to get out of the piece while the getting was good (shorten the piece). Here is an example of how we shortened the presentation, from what was said without editing;

"Consider the situation, of well, a wall of a room portrayed here in graphics. If we think of this room now, we can then imagine someone looking about this wall, about so big here, and this little flying dot is their momentary point of regard on the scene."

to what we cut it down to;

Consider the situation of a wall of a room portrayed here in graphics, and this little flying dot is their momentary point of regard on the scene.

But we ran into another problem, in that the subject matter just did not make any sense when it was shortened beyond a point. We were stuck and had to bite the bullet. It is no coincidence that this demo is on the end of the second side.

At the other end of the spectrum there were naturals. Chapter 3, "School of the Future", is about the introduction of computers into an elementary school. Kids are visual, even where they are in front of computer terminals. We did not have to scratch our heads much to find supplementary visuals: they were all around (and climbing on our tripod). Again, it was no coincidence that this demo is placed at the beginning of the first side.

The Ed Sullivan Show was a variety show, and that's what we were making in a research vein. The Ed Sullivan Show had some dogs and some winners. So did we. So how do you tie it all together in an entertaining manner? First, you don't show all your winners at once, but then you don't make side B your best side.

We started the videodisc with a visually appealing opening and alluring soundtrack. This opening is important as many first impressions are made here which are hard to change. Next we had to do some business and provide the viewer with the "Table of Contents", not too exciting, but it is only viewed for fifteen seconds. As a sort of 'hook' we showed "Chapter Previews", short clips from the chapters, which hopefully will spark interest for further viewing. After a minute of these comes the Introduction; although full of rather bland information, the introduction did allow us to use any good visuals we had shot to date, so it holds fine. The research chapters come next.

We started with "School of the Future" because not only was it visually interesting, but it was guaranteed to appeal to a general audience appeal. It also starts the videodisc off with a sort of benevolence associated with kids. "Reconfigurable Video" was next, mostly because at one point it was called "Electronic Book", but the subject still does relate in that it demos an education tool that can be used in the schools. "NewsPeek" is next, related to its forerunner in terms of electronic publications, it is a research project involving the personalized delivery of several news sources. This demo is visually and delivery wise a little dry, but "Synthetic Holography" is next and that has popular interest and many interesting visuals. Hopefully this will provide a momentum to carry us through "Conversational Desktop". To reward those that made it thus far we give them "Synthetic Performer", a demo full of music. This is the last demo on side A, and we used it here to put people in a pleasant frame of mind, hopefully encouraging them to turn over the disc and watch the other side. The rest of this side is single frame storage to be used as reference material. It includes the "People" chapter, listing the faculty and staff of the lab, and "Appendix A", which provides production credits, test charts, and relevant still frames.

Side B starts with a shorter clip of the "Opening", "Table of Contents", and "Chapter Previews". The first demo chapter is "Vivarium Project", a research project that is developing entertaining methods for elementary school children to learn about computers. Next is "Computer Graphics and Animation", not real strong on delivery but some nice animation sequences. Then "Advanced Television" and "Audience Research", both a little dry, but not too painful if the viewer has any interest in the subjects. Nothing more need be said about "Eyes as Output". "Graphic and Typographic Interfaces" holds well for its three minutes, although you're not on the edge of your seat. The last two demo chapters were mostly placed here so we could drop in last minute video, as they were produced late in the schedule. They include many short demos, most of which are quite dry. "Appendix B" includes single frames and clips from "Discursions", more credits, and entertaining production outakes. Side B is definitely the weaker side but efforts were made not to make the disc too lopsided.

C. Production Equipment

1. Optimal Quality

We all would like to achieve optimal quality in whatever we do, but life, and video production, is full of compromises. Still, it is fun to dream. To get the finest quality images one would shoot film, the larger the format the better. For us 16mm film would have been good, 35mm better, and 70mm ridiculous. A 16mm camera with prime lenses would of been an excellent choice, since its aspect ratio matches closely with that of video. For videodisc production, film should be shot at 30 frames per second, instead of the usually 24 frames, in order to match the video frame rate, and hence receive perfect still frames without the normal problems of the 2 to 3 pulldown. Animation would also of been captured with film instead of direct to 1" videotape because many of the images were rendered on higher resolution systems then NTSC. And for the fonts, we couldn't really ask for better quality then the ones from the Graphics group, but we could of asked for a better user interface thereby saving many frustrating hours. No camera can get a great image unless there is good lighting. A large set of lighting instruments as well as talented crew to set them up would greatly improve any production.

For sound, wireless microphones would have allowed our subjects to move with greater ease. For double system both camera and tape recorder need to be equipped with time code generation. The film would then be transferred using the Rank-Cintel Flying Spot Scanner system directly to 1" videotape and then synched up and edited using a fully computerized frame accurate time code editor equipped with a list management system. So much for dreams; however, film was out of the question when the budget was considered, as was a large lighting crew.

2. Reality

In all actuality we were very well equipped, especially if you consider the Media Lab is not a video production house. We had two choices of three tube broadcast quality video cameras; an Iegami 350 or the RCA component format Hawkeyes. We opted for the Hawkeyes. There were more of them, they were highly portable, and the picture and color quality was better. We used a fluid head tripod and lit most of our demos using one Lowell Omni lighting kit, which proved adequate in all but the wide shoots which needed significant fill lighting. Sound was recorded, usually in mono, directly onto one of the videotape soundtracks.

Guidelines as to form were given to all the student producers in the beginning, and as a rule they were generally observed. Some of the guidelines included use of music, closeness of close-ups (no 60 minutes's close-ups of only eyes and noses), and the necessity of good coverage including 'cut away shoots'.

In post production we transferred the high speed 1/2" component tapes from the Hawkeyes directly to 1" and at the same time make work prints with a time code window for rough editing by students in the component editing room. Rough edits were then used as guides in the one inch editing room to produce fine cuts. Although this was not a time code editor the time code still saved many hours in search time. Logs of the 25 hours of video material were keep on a Apple Macintosh and updated periodically.

D. Modular Editing

The demos were produced one by one over the months in segments; in most cases these ended up as chapters. Made as separate enities, each segment still strongly reflected the individual input of the producers and clients. In the author's final edit of all the chapters, an effort was made to bind the whole disc together into a single coherent product.

1. Structural Unity

Many features were designed to help promote a structural unity. The same narrator was used throughout the videodisc for both the english and japanese versions. A similar style music soundtrack was produced and used throughout many of the chapters. Titles and credits followed the same format and design. And, as mentioned before, chapters were arranged to maximize coherence between subjects as well as to provide a balance of the entertainment aspect when the disc is viewed linearly.

2. The Mastering Process

The demos were edited into fine cuts and these fine cuts were compiled into the master 1" videotape for pressing. Most of the video was 4th generation, with some exceptions being computer graphics dumped directly to 1" videotape (3 generations) or archival footage (5 generations and up). The videotape was cut with field two dominance.

Sound was transferred from the fine cuts to the master, with ambient sound on channel 2 and any english (besides narration) on channel 1. These two channels were then mixed down into one channel on two separate submasters. One submaster was for the final english channel where the talking heads dialogue would be normal volume. The other submaster had the talking head dialogue lower in volume so the japanese translation could be clearly understood. Channel 1 was used to directly record music from a Yamaha DX-1 synthesizer. On channel 3, which is normally reserved for time code, we laid down the narration tracks. These submasters were then used to mix down the three tracks to a single english (channel #1) or japanese track (channel #2) back on the master videotape.

III. Personalized Forms of Interaction

Originally this videodisc was planned to be used in an interactive kiosk in the lobby of the Wiesner Building. Partly to provide the public with information but also to help relieve the pressure for live demos. Since the Media Laboratory researches communication technologies we felt there should be special and innovative use of the interactive medium and hence the following methods and strategies were developed.

A. Identifying the User

How do you know who is viewing the videodisc? With proper research one can come close to identifying the main user types, in our case, international corporate management, fellow researchers, students, and the media curious. These groups can be further broken down into many subgroups or categories such as cognitive learning preferences, areas of interest, or the amount of time they have to view the program.

1. Purpose

Why do we want to know about the user? As in education it is important to understand the student or in our case the user.

"The overall goal of the Adaptive Learning Environments Model (ALEM) is to establish and maintain school environments that ensure optimal opportunities for learning success for most, if not all, students through the provision of adaptive instruction. The design of the program is based on the premises that students learn in different ways and at different rates and that one alternative for maximizing learning is to provide instruction which adapts to those differences" (Wang).

Our videodisc example is informative or educational in nature but the audience is not sitting (trapped) in the classroom. Still, the better we are in adapting our presentations and interactive methods to individual differences, the more the viewer should learn or remember. (Although, there have been some studies that surprisingly conclude that students learn least from the learning method they enjoy the most (Clark)!)

Still, even if this were true, we have a non-captive audience, one that can lose interest at any moment, isn't it more important for them to enjoy and become involved so that they might indulge longer?

2. Methods

How do you find out who the specific user is? You can let them try to tell you by having them answer telling questions;

Do you have much background in media technologies? a) none, b) some, c) significant.

Would you prefer to a) browse through the disc interactively or b) would you rather be presented with linear program?

How much time do you have to view the disc? a) 2 minutes, b) 7 minutes, or c) 30 minutes

or you could have them pick from a list their proper category;

Category A - I am a newcomer to media technologies, with lots of time, and a special interest in computer animation. I would prefer a linear presentation.

Category B - I know a little about media technologies, with two minutes to spend, and a general interest. I would prefer a linear presentation.

Category C - I am familiar with media technologies, would like to spend a total of ten minutes, and would like to browse in an interactive mode.

This mode of query assumes, of course, that they will tell the truth and they have the proper knowledge to pick their correct category. You could give them a test to perhaps collect more accurate data. The Italian videodisc, "The History of Photography", uses a test at the beginning to find out the users previous knowledge on the subject. They also use a test to find out the user's visual preferences so when they need to show an example of an artist's work and they will know the user prefers, say, landscapes over still lifes.

The key is to define accurately the different user groups. These groups can then be analyzed as to their most common interests, methods in which they communicate comfortably, their most intuitive learning styles, or even as simple as the colors or shapes they tend to identify best with.

For instance, we could anticipate viewing by the following groups: a group of prospective freshman students looking MIT over, a group of Japanese scholars, or some sponsors from DARPA (Defense

Advanced Research Project Agency). Now these groups all are very different, both in their interest, their level of technical or research expertise, as well as the methods they might prefer to interact with.

The group of prospective freshmen might prefer a broad over view of the lab and some its research projects. They would, of course, want english narration, probably enjoy upbeat music as background, with an editing style to match. They would love some interaction, (the higher the tech, the better), although it should be on a friendly interface level since they probably are not too familiar with many of these new input devices. Graphics would be fancy, and the color lookup table could be changing frequently to keep their MTV eyes entertained. An upbeat, colorful, general presentation would be a safe strategy.

Using the pre-packaged categories, they would probably enter: some technical knowledge, with lots of time, general interest, and english narration.

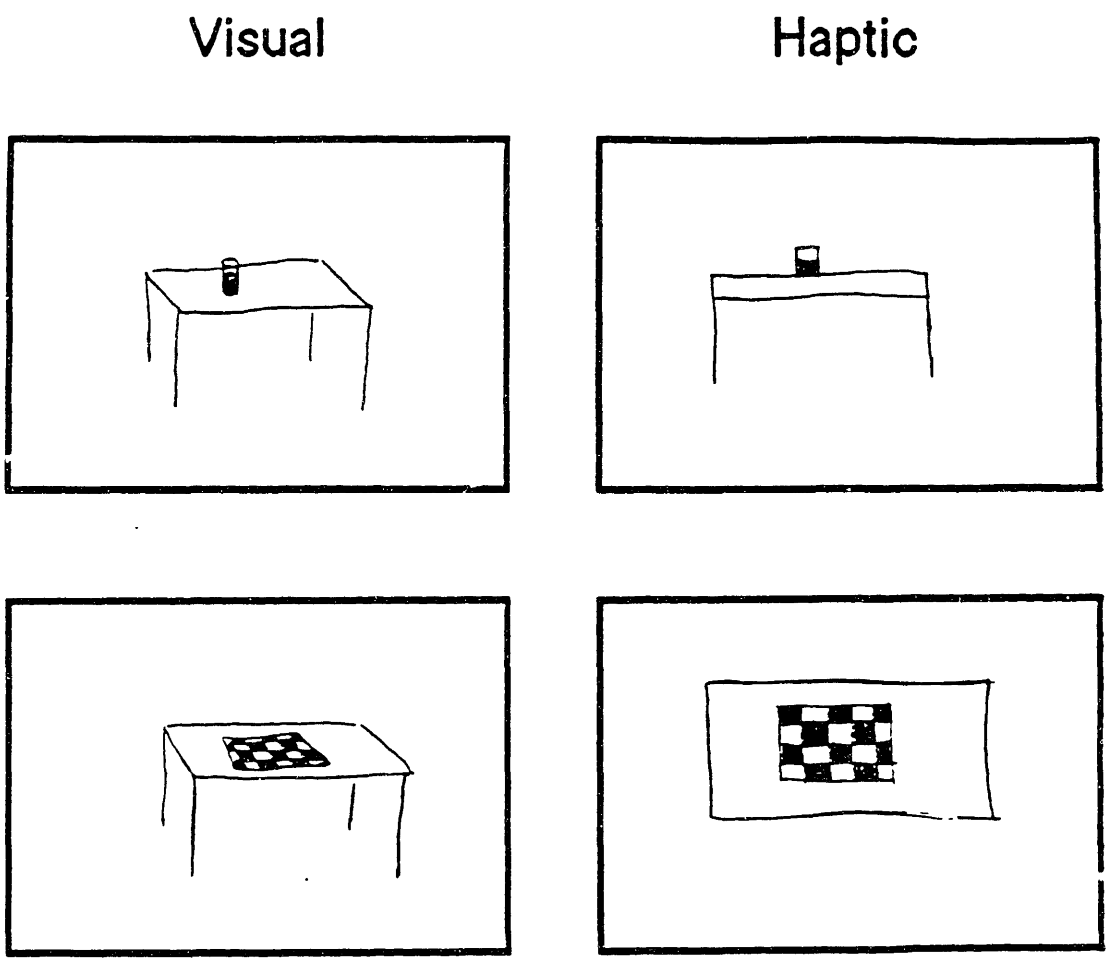
The group of Japanese scholars would be handled a little differently. They would be a much more serious group but never the less they would enjoy a little fun. Narration in Japanese, with music and editing much more gentle. They might enjoy some interaction, but mostly on a novelty level. They would be presented information on a sophisticated level in their areas of expertise, and average sophistication for other areas. Graphics would be understated and tasteful. A respectful, gentle, specific presentation.

The DARPA group might like to be wowed at a technical level, after all they are footing the bills, so let there be hardware, and a good user interface. Since they are always on a tight schedule, they'd received a condensed overview of the lab with a voice recognition system to input their interactive choices and a voice synthesis system to reply. The music would build up to when we get to the demo they are funding. Here the tone would change to a serious, sophisticated presentation.

This method of identifying the user doesn't take into account the different individuals within these user groups (i.e., Johnny is very shy but brilliant, Susan is outgoing but could care less about high technology). Although identifying the general user groups would be useful at the pre-production stage (in deciding just what and how to shoot) when you get down to a one person interaction it would be nice to get more specific about just how this individual prefers to access information, and then what information.

There are several tests used in social research that evaluate various cognitive preferences. These same tests could be given in simplified forms at the beginning of presentation. Two factors that could be helpful to test are haptic perception and locus of control.

Haptic perception in individuals can be broken into two categories, those that prefer visual input or those that prefer haptic or kinesthetic sensory input. The visual person prefers to gain information visually. The haptic person likes to feel experiences physically, and has difficulty remembering and learning from experiences otherwise. The visual person could learn and experience significantly from watching the motion picture "Easy Rider", whereas the haptic person needs to ride that Harlee Davidson down the concrete snake to know what it's about. Figure 1 shows the results from one haptic test used by social scientist which helps to illustrate how the two types visualize differently.



Although this test would be difficult to administer and interpret on an interactive system there are other tests used which could easily be used. An example of one such test which would determine haptic preference follows;

Think of a very familiar building (e.g. house of your friend, court house, town hall, dormitory), a building which you know from the outside and inside, which is neither your home nor your school or office building.

1. How many floors does the building have?
2. Were you:
   A. sure
   B. not quite sure
   C. unsure of the given number
3. When you thought of the number of floors, did you think of :
   A. how many floors you have to climb
   B. did you count the floors singly
   C. did you think of the whole building as it appears from the outside.

On one hand, it would seem the visual person might do better on an interactive system since there is so much visual output. They could easily accept and assimilate the conbination of graphics, text, sound, voice, and video into a coherent experience. But in terms of the input of interaction the haptic person might be better suited since they like to experience firsthand. It's not so important which of these two groups would do better, but rather, how these two groups might learn differently and more effectively on an interactive system. For the haptic person you'd want them to feel like they are in the driver's seat, with a high interactive input level, for the visual person, the interaction would be secondary, maybe even not preferable, but rather an emphasis on the images versus the 'full' experience.

Another cognitive factor that could be easily tested in a simplified form would be locus of control. This would test for a person's belief about amount of control one has over life events. Persons who feel they have control over their life events and are responsible for them are labelled Internals. Externals are those who believe life events are controlled by other factors, such as luck, destiny, or higher, more powerful beings (God, the boss).

The Media Lab's Audience Research Group conducted a study (Gagnon) that hypothesized that those labelled as Externals would do better in an observational (linear) condition, while Internals would do better in an interactive condition. The logic being that internals believe in personal control and therefore might be better able to utilize it.

These tests would not necessarily determine whether interaction should take place or not, but rather to indicate the degree and method of interaction most appropriate. The advantage of these tests over direct user query, "Would you like a linear or interactive presentation", is that they would probably answer more honestly since they would not know the consequences (the degree or method of interaction), and hence they wouldn't change their answers to accommodate what they think would be best for them.

The more we know about a user the better, but there are limitations on how much information we can get from the user without annoying or boring them. This is why its important to develop quick, simple, transparent, and accurate methods for their identification so that the producer can best choose what methods of interaction and information is most appropriate.

B. Methods of Interactivity

The range of possible forms or methods of interaction is endless but the here is an attempt to describe four variations.

1. Menus

On the simple side, one of the easiest methods of interaction to understand and implement would be choices from a menu. This could entail a list of chapter titles, rows of digitized images from each chapter, or a combination with titles, a brief description, and a single image. The user would merely touch the subjects of interest and the computer would deliver the material. This is a common method of interaction used today and requires no special hardware or intense programming.

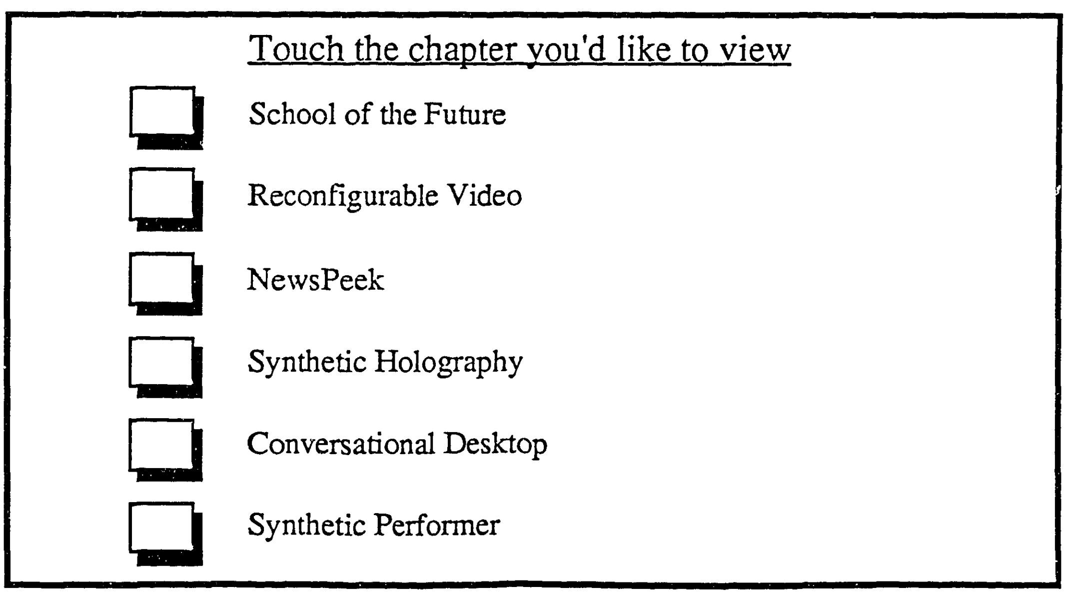


figure 2 - an example of an interactive menu with chapter choices.

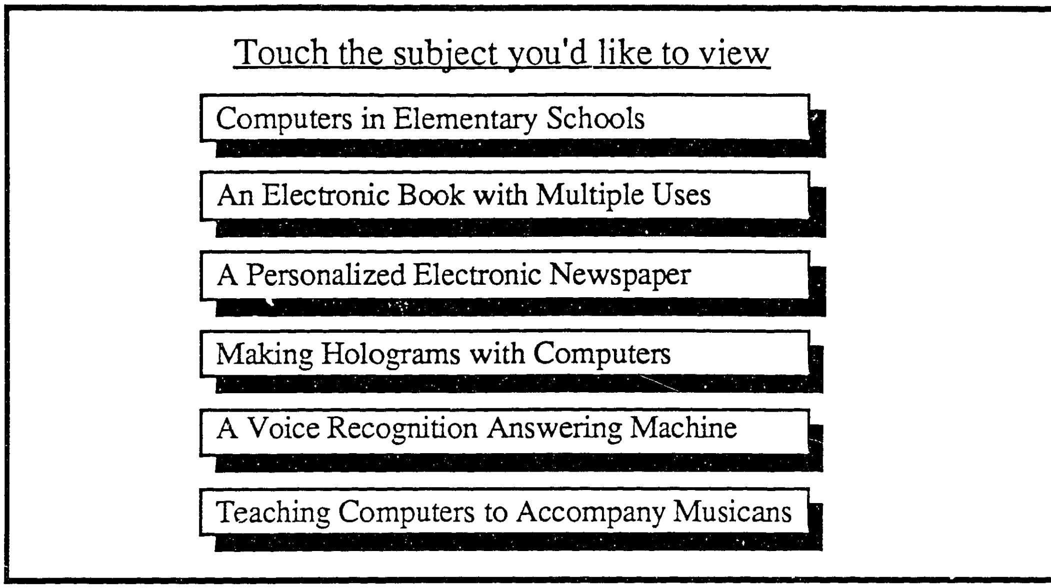


figure 3 - an example of an interactive menu with subject choices.

The real beauty of using this method is that it uses so little real estate, but on the down side it is rather boring. One solution to the staticness of most menus is to introduce a dynamic motion element to it. This can simply be a computer graphic overlay that cycles through a motion sequence. But, sadly, most graphics on smaller computers are too slow and have poor resolution. Another solution is to store some high resolution graphics on the videodisc. This can be done using very little additional real estate yet create an illusion of real time motion. A new breed of videodisc players are now able to jump from frame to frame, within the vertical interval, up to 500 frames (17 seconds) apart. By storing images in a sort of visual 'bank' one could program a computer to control the disc player to jump about frames in varying succession to create animation sequences that would normally take up much greater space. This could incorporate both simple and complex images, from a computer graphic sphere bouncing about the screen (calling attention to the different choices on an interactive menu), to a wave crashing against the shore. One could store the wave as a simple loop which repeats itself over and over, or one could store key frames or more than one wave which when played in varying successions would appear to be the random surf.

Here is an example of a simplified 'bank' of similar images that could provide a motion when viewed linearly or could be reconfigured by computer control to provide different motion.

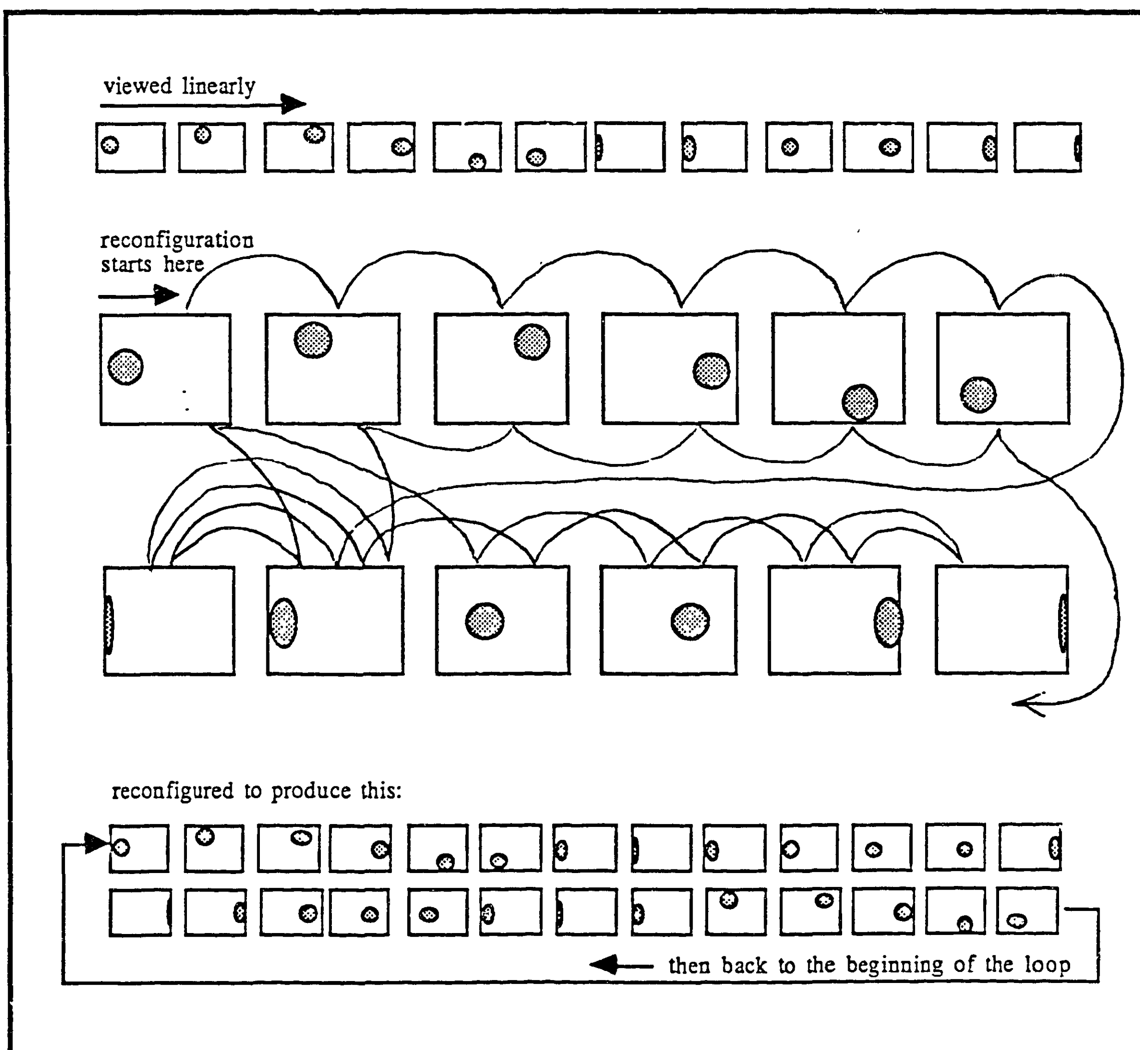


figure 4 - shows a visual image 'bank' that could be reconfigured with an interactive videodisc system.

This idea of image 'banks' could be used for even more simple applcations. There is something about a single static frame of text on a videodisc that puts one to sleep. If one were to merely store three single frames with the same information, but with only different grain, and then play these frames as a loop there would be an increased dynamicness about the menu. This little extra edge is important when trying to engage a viewer to interact. It could also be used to call attention to a specific area of the frame. By using the same grain on most of the frame and only a corner with the dynamic grain movement one could direct the user's attention to this corner where, say, an interactive decision is needed.

2. Magazine

The Media Lab's Electronic Publishing Group has been involved in research and development of personalized electronic newspaper and magazines, and have produced working prototypes as demonstrated on the videodisc ("NewsPeek", chapter 5). Many of their concepts and features could be directly transferred for interactive use with videodiscs. One research project, EMAG, Electronic Special Interest MAGazine, (Salomon), involved creating a database out of the information of a monthly magazine, and then presenting the magazine in an electronic personalized form. The user viewed headlines and photographs in a similar format as the magazine, when they touched the headlines (on a touch sensitive screen) they received more of the text body, when they touched the photograph they paged forward to the next photograph. Related articles, advertisements, and photographs are listed in the margins. The computer keeps track of the choices of the user and begins to understand the user's preferences (i.e., they prefer color action photographs and articles of a technical nature).

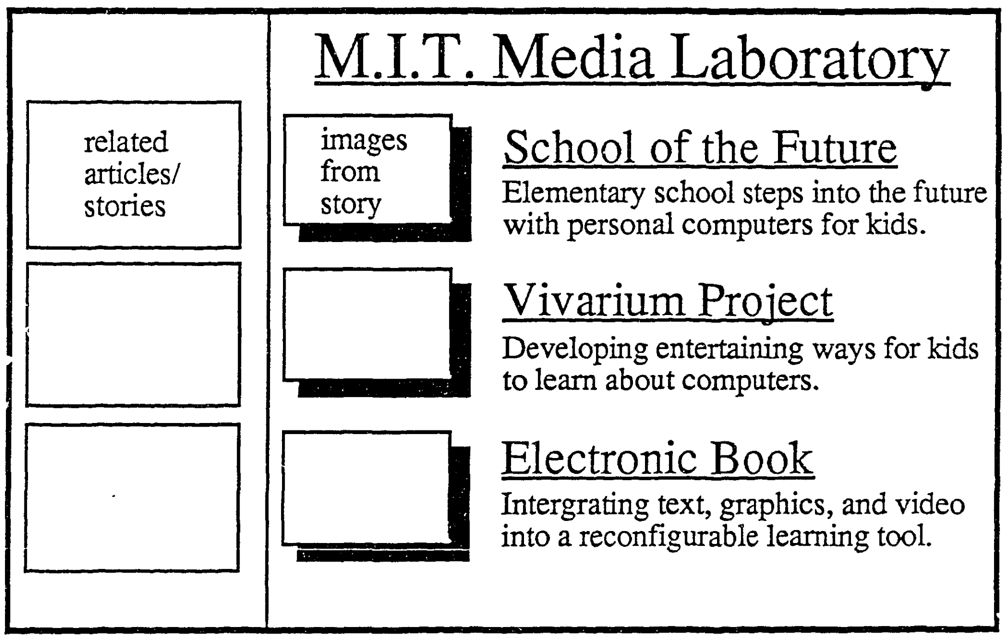


figure 5 - shows an interactive menu modelled after a magazine format.

This magazine format could easily be retrofitted to the videodisc data. Photographs would come from video still frames, text could come from the narration stored as a closed captioned signal and formatted to the screen in a method similar to the magazine style developed in a research project called News Plus (Electronic Publishing, 1986). The user could quickly scan the article headlines choosing only those articles of interest, they might want to read further text, or see if the visual data is of interest. They could page through several photographs and if they are sufficiently interested they could view real time video segments.

The advantage here is the rapid scanning possible by headlines and iconic photographs on a single screen. A user could effectively scan the contents of the entire videodisc with less then 10 frames of information. Now true, this would be merely a surface look of the content, but that's all a table of contents is, it's primarily a tool to access the desired information, not a conveyer of that information.

3. Television

Many people prefer to experience or learn with purely visual input, without having to read. Many were raised in the television age and are adept at receiving information from almost concurrent sources, such as zapping (switching) between channels to keep tabs on more then one program at a time. An early research project at the Architecture Machine Group was called Spatial Data Management (Bolt). In this project the user viewed a large projection screen with up to forty video images of varying sizes moving concurrently. The sound background was a mixture of all the sources, but if the user pointed to a specific image its soundtrack increased in volume, above the others, and its image enlarged and was highlighted.
Again, this method provided the user with the ability to quickly

scan many sources at the same time and choose what was of interest to them.

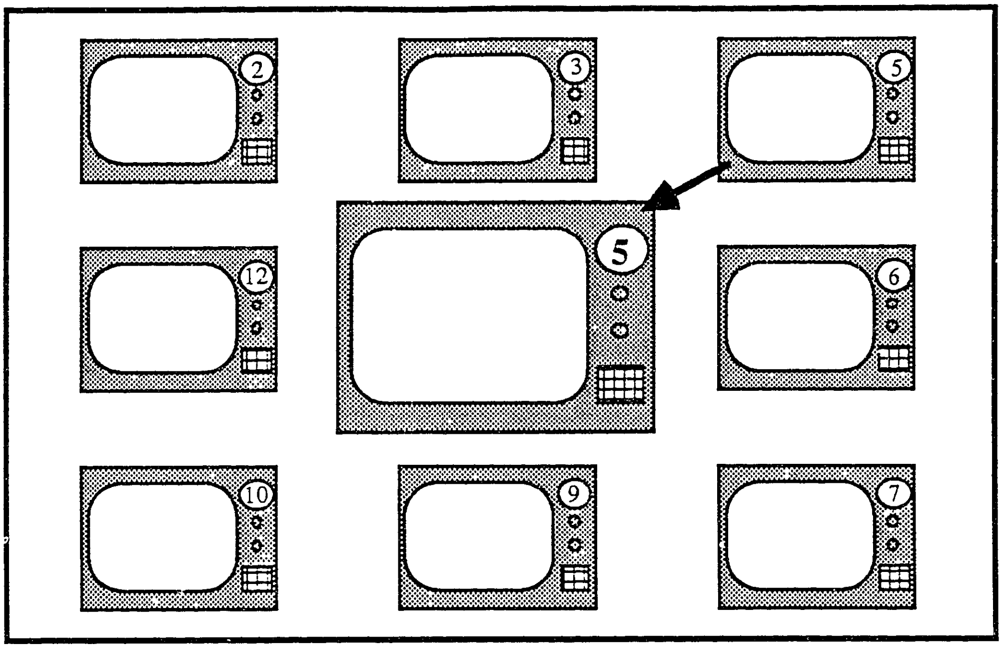


figure 6 - illustrates an interactive menu using multiple real-time video segments.

A simplified version of this would involve a screen with nine separate video images. Eight smaller images, bordered by computer graphic representations of television sets, would appear along the border of the screen, with a larger image in the center. The center image would contain the image of current interest with its volume easy to hear above the others. The user, by touching the image of interest around the border, would decide what is to be viewed in the center "television set". If they touch the center image again, they would get the full screen version of the video segment.

A reasonable method to store this interactive method on videodisc without having to occupy vast amounts of real estate or require powerful digitizing and storage capabilities would be to take the eight sources and choose forty seconds of material that best represents each segment. Combine these eight, forty second pieces concurrently on the same forty seconds of the videodisc, with each segment occupying the center position during its most intriguing five seconds. It would then be a relatively simple matter for the computer to figure out what image the user is pointing to, then tell the videodisc to play that five second segment with its image in the center. This means there is only five seconds of "out front" sound video in the center position for the user to view and base their decision whether to view more. Figure 7 shows how sound video segments could be increased or decreased thereby using more or less videodisc real estate.

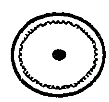
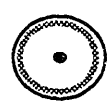
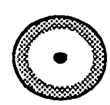
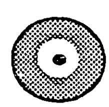
number of separate images	center position length	total time	disc space
4	:02	:08	
8	:05	:40	
20	:15	5:00	
40	:30	20:00	

figure 7 - demonstrates the amount of real estate the interactive television can use.

4. Surrogate Travel

This employs some of the methods developed by the Architecture Machine Group in the research project Aspen (a short clip is shown in "Appendix B", Chapter 20). This project's goal was to "movie map" an area, in this case the town of Aspen, so that a person could 'visit' this town vicariously and explore it under their own control. The group recorded an eight block section of downtown Aspen on film, driving straight, turning left, turning right. and then transferred the footage to videodisc in an order or structure that permitted quick access to related shots. Two disc players were utilized in conjunction with a computer with a large database of all the shots and a touch sensitive screen. A user could "drive" down a street, touch the screen to signal a left hand turn, the computer searches it's database, first to find out where it is now, then to find the proper segment for turning left, the computer tells the non-playing videodisc player to search out the segment and get ready to play, when the left hand turn approaches the video switches between the two players and you're ready for the next decision.

We could use this same method to explore or tour the Media Laboratory in the Wiesner Building. Footage could be collected in a similar manner, recording all the corridors and laboratories. Another method would be to enter all the dimensional data of the building's architecture into a large database and feed that to a real time computer graphics generator. Such a machine, like the Trillium Flight Simulator highlighted in the "Computer Graphics and

Animation" (chapter 13), could be used to produce the desired footage and then transfer it to videodisc and access it like the Aspen project. Some time was spent in the fall of 1985 entering the 4th floor dimensional data for just such a use, but this feature was dropped when the emphasis shifted away from an interactive videodisc to a linear format.

An even more exciting option would be to integrate the Trillium with the interactive system so that whenever the user "tours" the building they view a new sequence in real time. This would provide a more exciting and richly interactive experience since there would be infinite possibilities of paths and the user would 'control' his/her personalized voyage through the building.

So, here is this user cruising around the computer representation of the Media Lab, looking for areas of interest. Objects would be created in the database that represent information stored on the videodisc. A television icon located in the holography lab could represent the 4:00 minute video segment on the disc. Or a blue notebook sitting in the large optic's cabinet represents a thesis about an optics project and is stored as digital data on the videodisc. The user would need only to touch these objects to access them. Besides the entertainment value, another advantage of this method is that the user gets a sense of place feeling from exploring the lab this way. And if they were to visit later in the flesh, they would have a much better understanding of what is where, something that's not easy to come by in this lab.

Of course, on the practical side, either method would be very expensive. Recording segments in a smooth flowing manner is expensive in cost with the storing of the segments on videodisc expensive in real estate. Employment of a real time computer graphics system is expensive in up front costs of the hardware, at least $50,000, as well as expensive in human labor entering the dimensional database of the building. But there is hope on the horizon, as Alan Kay predicts the large animation generators of today that sell for $100,000 will be replaced in 10 years by PC sized boards for under $500.

B. Information Delivery

All these interactive methods could employ two other parameters. The amount of information delivered and the sophistication of this information.

1. Amount of Information

The amount of information can be broken into many divisions but we will use a model of 3 categories: outline, condensed, and unabridged. Outline would consist of about 5% of the segment. This would mean a 4:00 minute segment in outline form would be about :12 seconds. This could include about two sentences of information with accompanying video. The condensed version would be about 30% of the total segment. A 4:00 minute segment would now be 1:12 which could contain the information of about 80% of a double spaced page of text like this thesis.

2. Sophistication of Information

The sophistication is also broken into 3 categories, although more divisions could easily be defined. Our model includes; simple, average, and in-depth. (Thought should be given to the names given these divisions since some users would not want anyone to think that they choose the "moron" division, although it was appropriate for them.) Simple would be narrated in layman's terms, no technical jargon ("media blab"), with uncomplicated graphic overlays. Average could include some technical terms and more difficult concepts but should speak on the level of the average predicted user. In-depth would be on a technical journal level, difficult concepts are fine as long as there is clear, concise communication. These graphic overlays could include complicated formulas and detailed labels.

Since there is finite space on the videodisc one quickly runs into real estate problems. How do you provide a 4:00 minute unabridged, simple version and a 4:00 minute unabridged, in-depth version from the same 4:00 minutes of real estate? One way is take advantage of the dual audio channels on the videodisc. Audio one is a simple explanation or switch to audio channel two for the technical, in-depth narration. For the model above we need three versions. For this you could employ the audio still function which is standard on many systems now. This function stores five seconds of audio on one frame of video. The player plays over the frame in real time and sends the digital audio information to a memory buffer which then plays back the audio over the next five seconds. This means you need one of these frames every five seconds for every "sophistication" version you employ, which is not very real estate intensive but a little distracting to the visual aesthetic. Another option would be to add a CD player to the hardware configuration which could then provide ample audio storage for many more levels of sophistication levels as well as music choices.

Displaying different levels of sophistication for the graphics would be an easier problem to deal with. You could either store different versions of the graphic overlays for the same videodisc frame in the computer or if you desired high resolution graphics you could store the different versions on separate frames without too much strain on real estate space.

These two parameters would not have to be used globally either. For a subject that the user knows intimately they would want a unabridged, in-depth version with a direct access to the database, but for another subject that they know little about they might prefer an condensed, average presentation. These decisions could be made interactively throughout the program or decided at the beginning from the information gleaned while identifying the user. By adding these features the possibly viewing options expand exponentially for each new parameter introduced as evidenced in figures 8, 9, & 10.

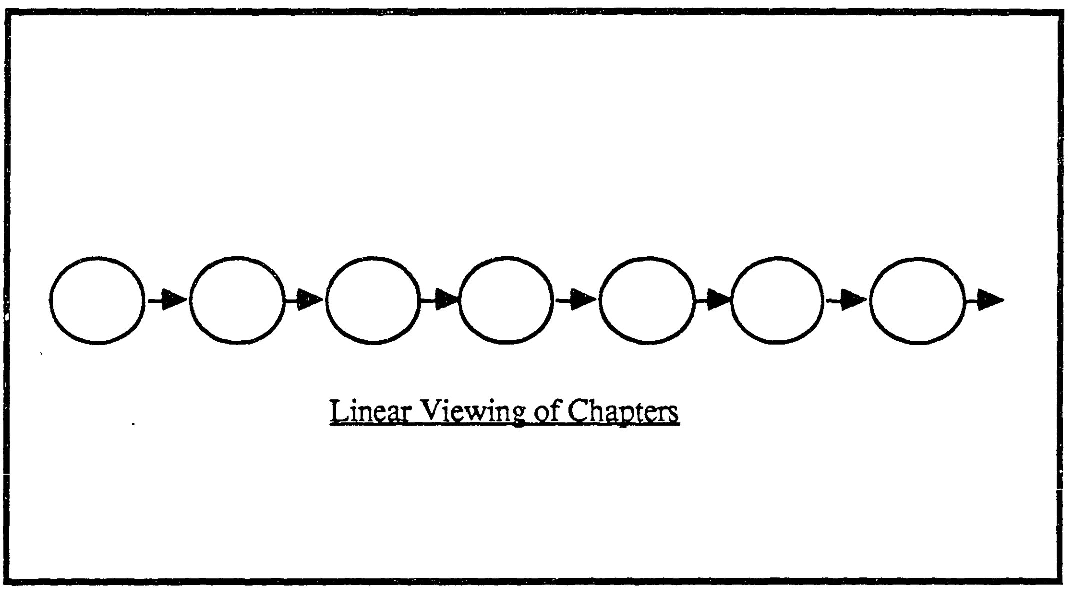


figure 8 - illustrates there are no options when viewing the chapters linearly.

figure 9 - illustrates the options for viewing one chapter using three interactive parameters (3 x 3 x 3 = 27 options)

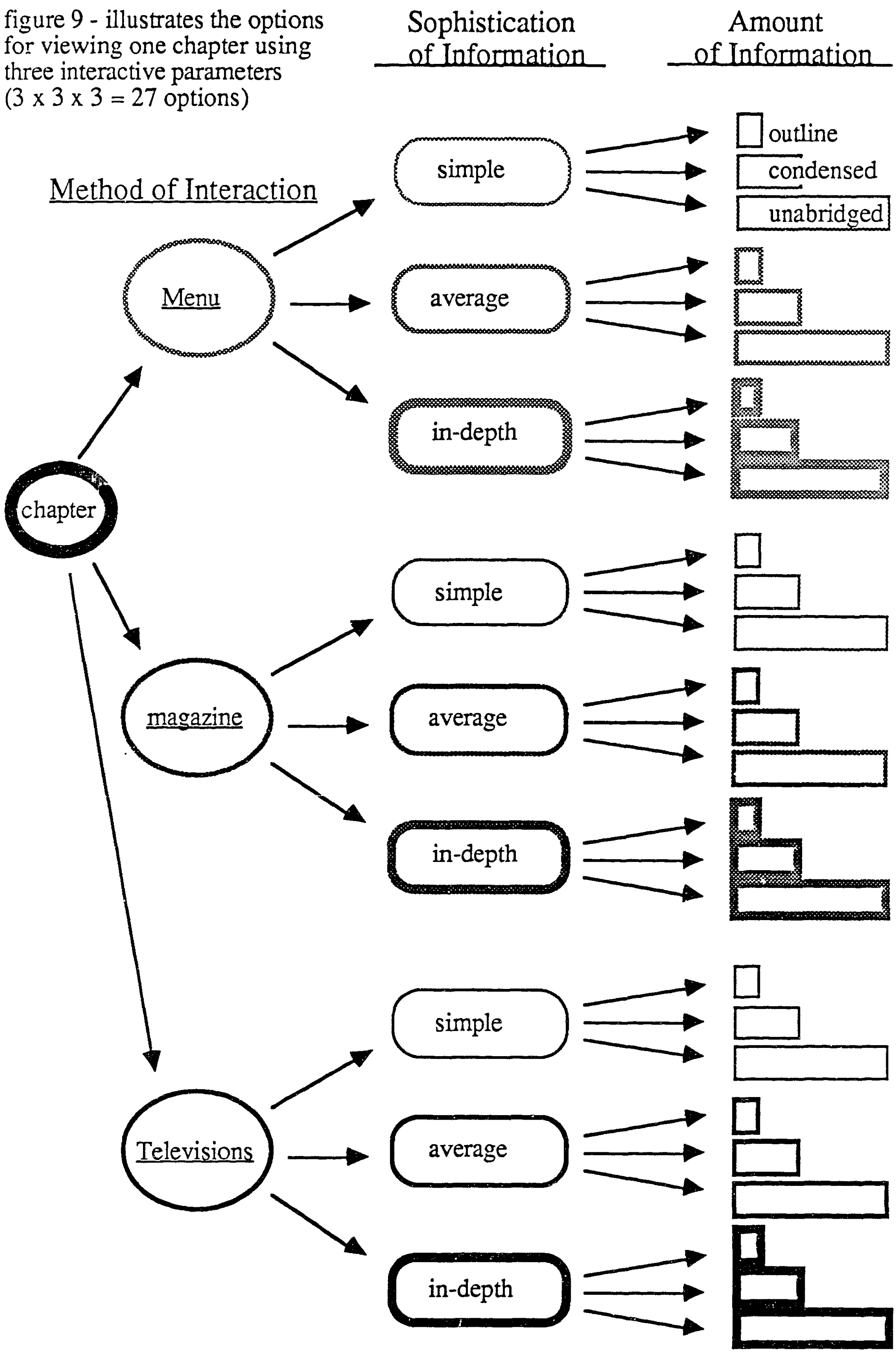
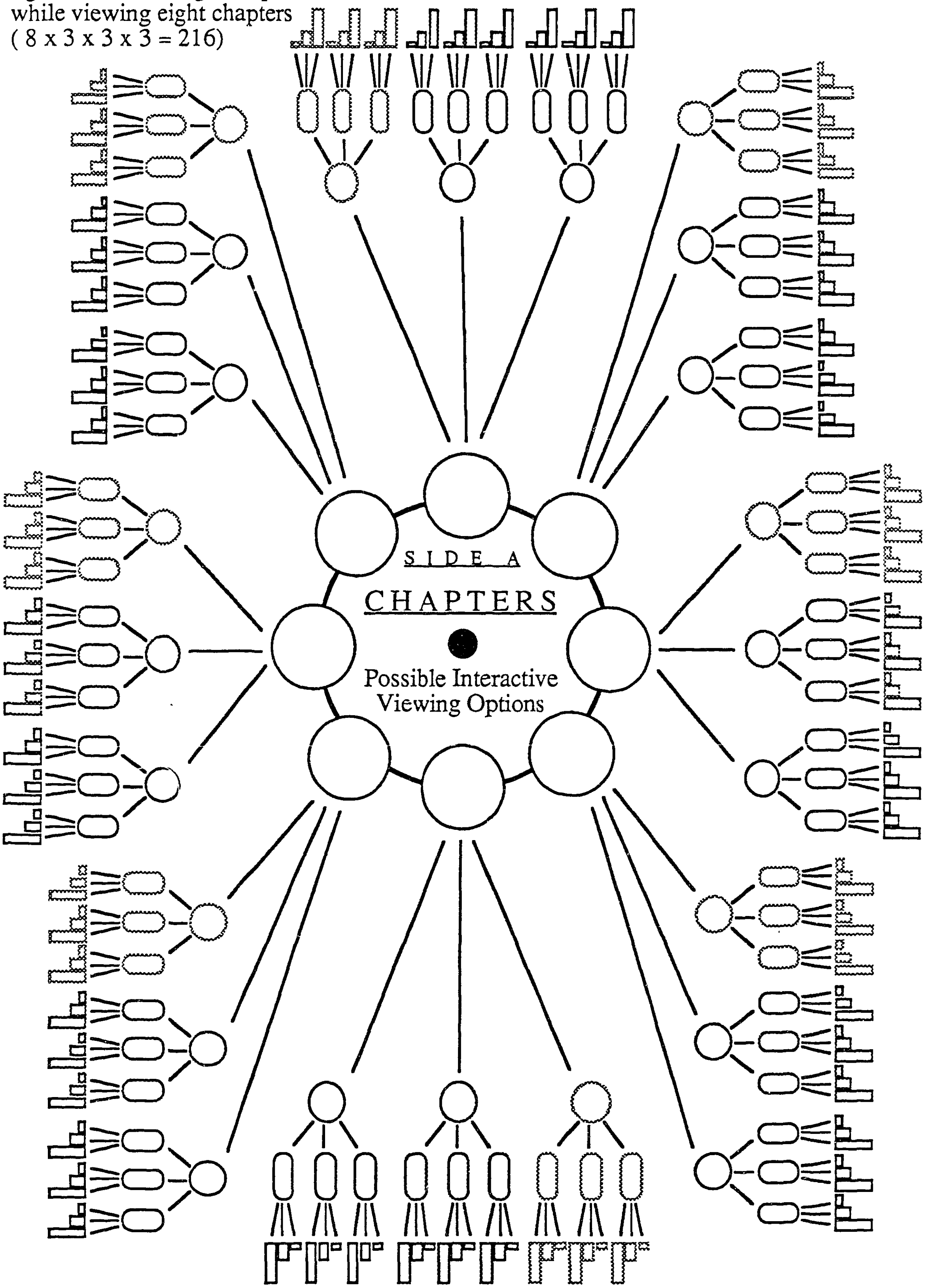


figure 10 - showing the options
while viewing eight chapters
(8 x 3 x 3 x 3 = 216)



IV. Concluding Remarks

This 'annual report' videodisc posed many content and technical problems that had to be overcome to produce a successful product. As producers manipulate and experiment more with the polylinear movie forms many of these problems will be solved as their understanding of the medium increases. Hardware, especially computational power, will continue to improve at a rapid rate. The maturity and friendliness of software will also improve which should allow for an increased number of meaningful applications.

The 12" videodisc is already receiving competition from the CD and CDI discs, but it still has the distinct advantage of being able to supply real-time video. CD's have the advantage of being digital and writable CDs will soon become a common peripheral for many personal computers (the hardware will be out there). But for highly visual real-time video presentations we will continue to see the 12" videodisc with a CD included optionally in the configuration.

Increased computer power will allow for more extensive use of a database, improved graphics, someday real-time computer graphics, and improved input devices. Voice recognition systems will be refined and cheap. Eye tracking will be possible on a practical level, with the computer knowing where the user is looking ("Eyes as Output", Chapter 16).

As software matures and the industry realizes the importance of the human interface we will begin to see more powerful use of the medium as producers actualize its potential. A videodisc, such as this 'annual report' will be able to deliver both a general presentation as well an extremely technical presentation to the individual wanting access to formulas and databases. This will change the very form of the informational documentary as producers will be able to create, not for one generic audience, but for numerous specific audiences. To make this happen, though, and create a truly interactive medium, the producers must know who their users are so that they may personalize the interactive experience, and hopefully, help to make the next step forward in this medium's evolution.

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VI. Appendixes

A. The Videodisc

The videodisc has been around for over ten years now, but has yet to reach the potential early forecasters made of widespread use with innumerable applications. Some of the many reasons for this slow start are the lack of standardization of hardware and software, lack of computational power for a reasonable dollar, high production costs, cautious market acceptance, and a general immaturity of how to handle this new medium.

The videodisc and interactive videodisc systems are making inroads to the industrial market (although in 1985 Japan sold, for the first time, more videodiscs then 1/2" videotapes to the consumer market). Part of the reason is that companies like Philips were slow in releasing the videodisc and that gave the 1/2" videotape enough time to enter, compete, and eventually win the consumer market. Why consumers preferred 1/2" videotape to videodiscs is open to argument, but certainly the capability of recording and the longer playing format of videotape gave it a great advantage.

Both mediums output the same video signal, that is (in this country) NTSC, which is thirty frames per second. Normal movie film shows 24 frames per second, but shows each frame twice with black in between. So, effectively, the viewer is seeing 48 frames per second, only frame each is repeated. The reason for doing this is to reduce the flicker of the changing frames. (Old motion picture projectors changed frames at a reduced rate and thereby produced a noticeable flicker.) Video displays each of its thirty frames as one half a frame first, and then the other half. These halves are called fields, field one and field two. Video displays its visual information as tightly packed horizontal lines, 525 lines per frame, which appear as a solid image when viewed from a distance (one can see these lines when viewing a television set from couple inches away).

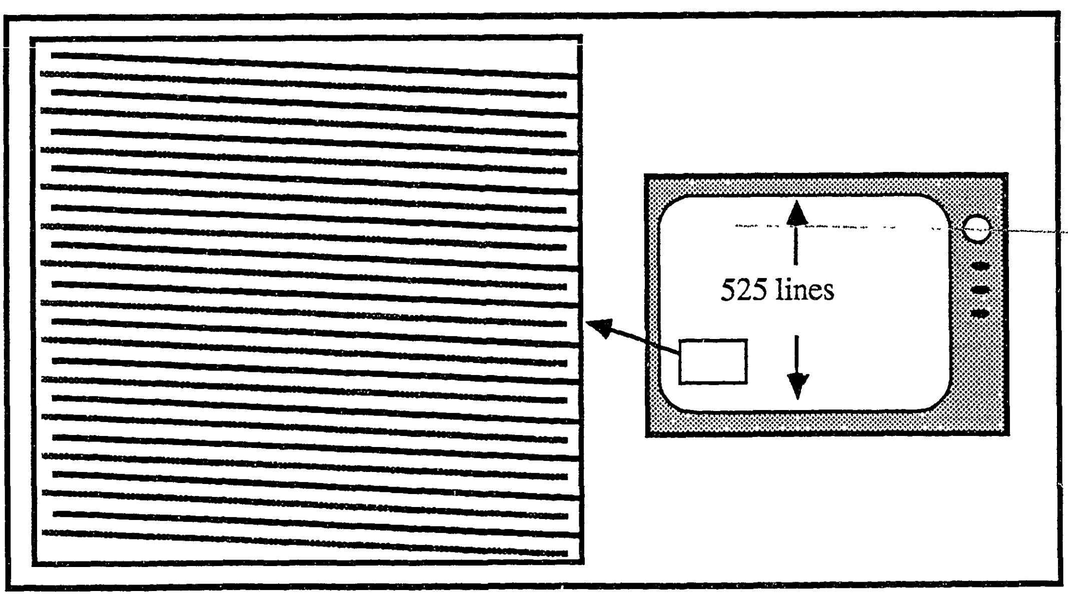

figure 11 - shows how television is made up of horizontal lines of information.

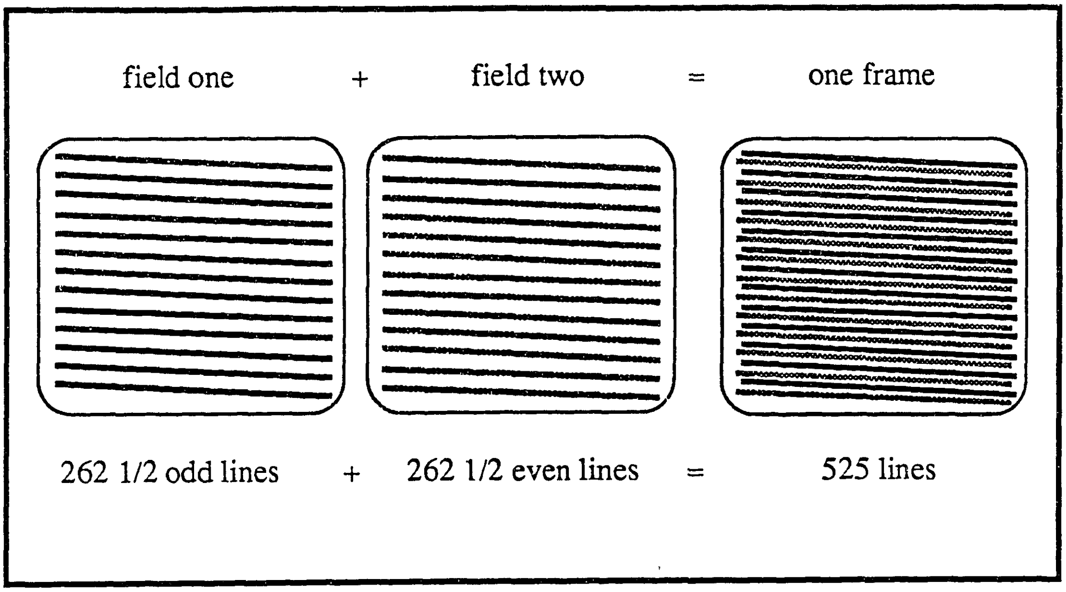

figure 12 - shows how two fields combine to makeup one video frame.

The frames are divided in half by first displaying the odd lines, line 1, 3, 5, 7, etc., as entire image with half the resolution or lines, and then the even lines, line 2, 4, 6, 8, etc.. Since these fields are displayed so rapidly, the brain cannot see the switching between them, and hence it appears as smooth motion.

Where the videodisc and videotape are different is in how they store this information. Videotape is like film in that it is stored in a linear fashion, you must view the frames in front or behind, one after another. This can be done is slow or fast motion, backward or forward, but in a linear order. This is merely because it is stored on a very long, 1/2" wide, and very thin piece of plastic. You can't look at some frames at the beginning of a tape and skip to some frames at the end without first spooling past all the frames in between. Videodiscs on the other hand store frames in

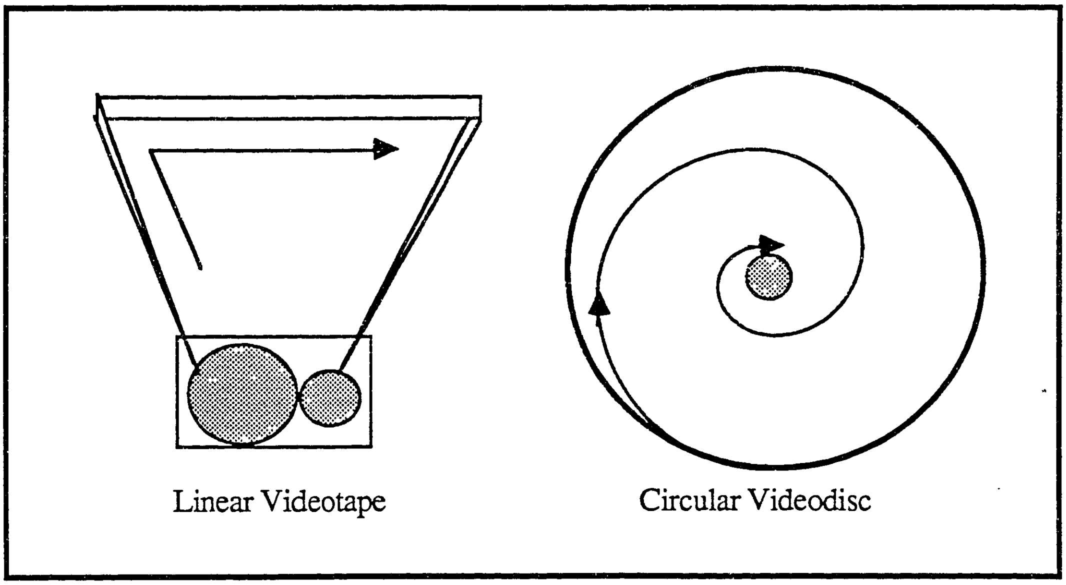

figure 13 - illustrates the fundentmental difference in how videotape and videodiscs store their information and therefore how they must access this information.

a circular configuration. This allows the laser that reads the information to "jump" around the videodisc, transmitting a sequence of frames at the beginning, then jumping to the end to transmit another group and so on, all in less then 1 1/2 seconds on the newer players and in 5 seconds on the older models.

B. Videodisc Formats

There are now two major formats of optical videodiscs. One is CAV, constant angular velocity, and the other is CLV, constant linear velocity. Both store the same information, a NTSC standard video signal, only in different patterns.

CAV stores its frames in a circular pattern. One frame is stored in one circumference or revolution of the disc. The videodisc player revolves the videodisc around, reading its information, one frame every 1/30 of a second, 30 frames per second, the same speed for the entire disc. The CAV videodisc can store 30 minutes of video per side, this equaling 54,000 frames (1800 seconds x 30 frames per second). So there are 54,000 thin circles of visual information, stored as tiny pits in a coded pattern, on each side.

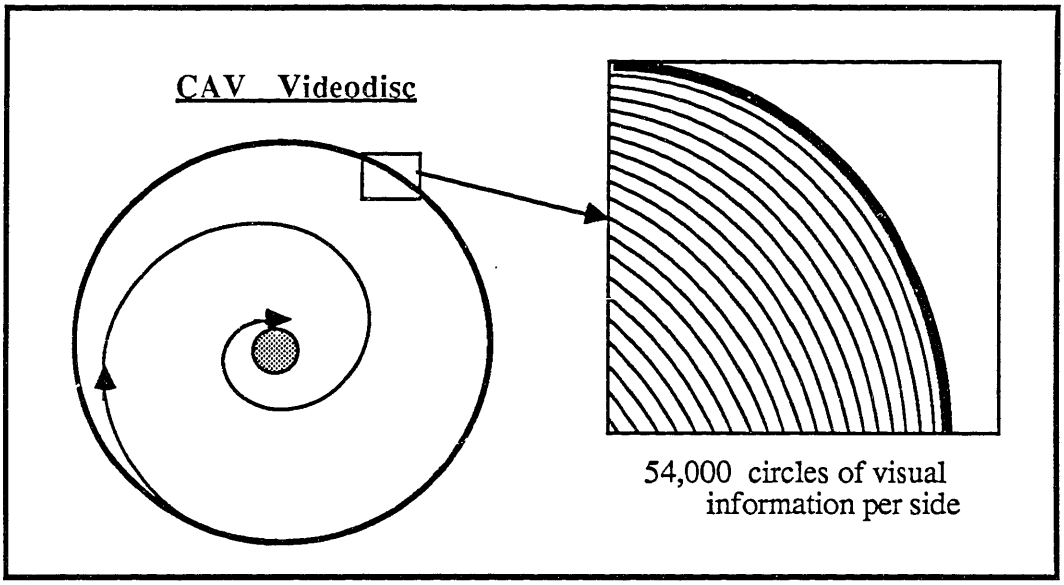

figure 14

A small laser emits light onto the reflective disc surface, if light hits a pit it is deflected returning an 'off' signal, if the light hits the reflective surface it is bounced back and read as an 'on' signal. The entire video signal is made up of 'on' or 'off' signals, which vary in length (although for digital recording they are all the same length), and form a code which can be converted into video. Since each frame is exactly one revolution long at some exact distance from the center this format is capable of labelling each of the 54,000 frames with a specific number (1 through 54,000) that allows the frame to be accessed at any time. This also allows the disc player to play the same frame over and over, since it merely has to repeat the revolution, and makes possible a still or freeze frame. And since there is no physical contact, only a disc going round and round with a light bouncing off of it, it can be left in the still frame mode indefinitely. The first frame is stored near the center of the disc and has less space for distribute the information then the outer most frame, which has a much greater circumference or circular path. Now each frame requires the same amount information storage, so there is a lot of wasted space as the frames work there way out to the edge.

CLV format stores the visual information in a spiral pattern. Each frame takes up the minimum space necessary in a long spiral path from the center to the edge. Because the inner spirals hold less information (frames) then the outer ones, the player must change the speed of revolution it turns the videodisc so that it still plays 30 frames per second. This is where it got it's name,

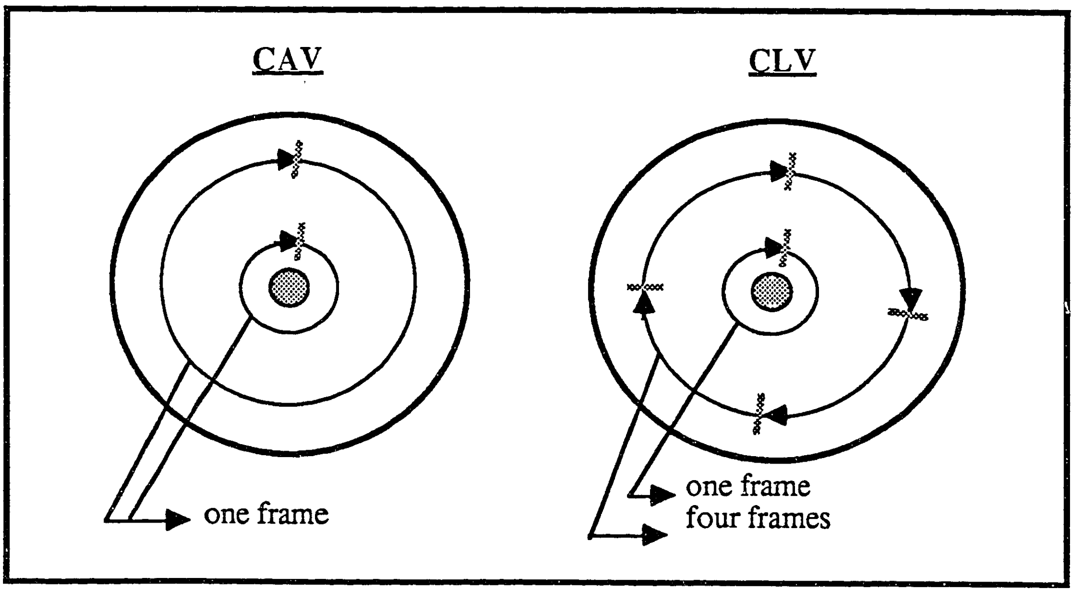

figure 15 - demonstrates how the CAV and CLV formats store frame information.

constant linear velocity, because it travels along this 'linear' spiral path at a constant speed. This way there is no wasted space, allowing this format to store an hour of video per side. This is a nice feature for linear programs longer then a half an hour, and allows for the storage of most feature films on two sides of one videodisc. But because there are more then one frame per revolution, with the number of frames per revolution changing constantly, there is no method to accurately access a specific frame making it unsatisfactory for most interactive uses. Also, you cannot still or freeze frame an image with the CLV videodisc, again, because there is more then one frame per revolution of the disc, and a videodisc player cannot read just part of one revolution without leaving a time gap with no information being read, while the player waits for the needed frame information to come around again.

C. Interactive Definitions

The videodisc, in and of itself, is a medium, which "is a technological system for conveying messages, operating intermediately between sender(s) and receiver(s), when they are separated in space, time, or both" (Bretz).

The Producer is the person or group of persons who were responsible for the production and design of the interactive design. The User is the person or group of persons who are viewing and interacting with the medium.

To make the videodisc interactive implies that there must be an interchange or two-way communication, delayed by time, between the Producer of the videodisc and the User, with the interactive videodisc system providing the means. The system must allow for the Producer to program the computer to respond to the User who is responding to the Producer's first initiation. The Producer communicates and responds according to how they programmed the software for the interactive system, so although they are not directly there, the ultimate senders and receivers are the Producer and User.

The degree of interactiveness of a system is commonly broken down into categories or levels. There seems to be many definitions and an expanding number of levels but what follows is a safe generalization.

<u>Level 0</u> is used to denote a videodisc that does not use any interactive functions. A feature film on videodisc would be such an example, it is played from beginning to end, linearly, and that's it. These videodiscs are usually made in the CLV format.

<u>Level 1.</u> These are CAV format videodiscs that utilize the standard functions on the videodisc player and are, hopefully, designed to take advantage of them. They are often modular in structure to take advantage of the chapter search function. Still frames with picture stop and dual audio choices are also often used, but overall they are linearly with some interactive options. The "MIT Media Laboratory" videodisc is a Level 1 videodisc.

<u>Level 2.</u> These videodiscs have small computer programs stored on them that are 'dumped' (transferred) to special videodisc players

with small micro processors in them, that in turn read these programs and operate the videodisc presentation according to these instructions. Although there can be more then one data dump per side the storage capacity is very limited and cannot accommodate complex interaction. With this limitation and the lowering prices of personal computers level 2 is being seen less and less.

Level 3. An external computer is now employed to control the videodisc player and any other peripherals. These usually include an input device, computer graphics for overlays, and a limited database program. The videodisc are often non-linear, in that they are structured in short segments distributed across the videodisc for rapid access time. The complexity of a level 3 videodisc can vary greatly, from almost linear to ones that are programmed for skip frame strategies, whereby every fifth frame pertains to one branch, and the player skips from frame 1 to 6, 11, 16, 21, etc., to show a continuous video segment.

Level 4. This is a recent classification to help describe those systems that employ elaborate databases. Most of these videodiscs are for archival use but can also be for discs that need intensive cataloging of frame information, like the Aspen Project, where the computer needed to know where it was in the town at all times. An art history videodisc would be another example, where each frame contains a piece of art and is stored in a relational database by artist, date, style, location, and size. A user could then ask the computer to see all pieces of art produced from 1873 to 1892 by a certain artist, that is large, displayed in London, and that is of a classical style. The computer would search its database, find the appropriate frames and present them.

D. Hardware

Enter the computer. Using a standardized communications link a computer can now run all the functions of the videodisc player. By entering a database of the visual and sound information contained on the videodisc one can program the computer to present the same stored information in various ways.

Now there are many different type of interactive videodisc systems that vary in hardware configurations and software capabilities. The following summary and diagram attempts to list the major hardware components.

The videodisc player can vary greatly in sophistication, from ones that can only play linearly to players able to skip 500 frames during the vertical interval (the period during which the television stops displaying one field and gets ready to display the next one). Most players can play both CAV and CLV formats. Other optional features include still frame audio, RS 232 ports, two-headed (two laser readers) players, and level 2 data readers. Prices vary from $300 to $5000.

Computers. These can be as simple as a $200 Commandor 64 to a large mainframe, depending on the performance and functions needed. The Commandor 64 can make the videodisc player run and search, but introduce any but the most primitive computer graphics and your sunk. On the other side of the spectrum the mainframe can control multiple players, produce high resolution graphics in real time, while delivering a personalized program drawn from a huge relational database.

The computer is the brain and central nervous system. It is needed to run and coordinate all other hardware. It decides what is viewed, when, produces the computer graphics, interprets input device data, and responses to this data. Up until recently, it took a large and expensive computer to produce a smooth high quality interactive program. Today a computer for under $10,000 (and dropping) can provide quality results. Prices vary from $200 and up, with the average at about $5,000.

The Monitor. This can be merely a television set, but to combine computer graphics with video usually requires changing the NTSC signal into an RGB (red, green, blue) signal which then must be viewed on a RGB monitor. Other optional features are stereo sound, screen size, and picture tube quality. Prices vary from $100 to $3000.

Input devices. This hardware is for the user to input information to the system so that they may interact with it. This can be a simple keypad with 'yes' and 'no' keys, or touch sensitive screen whereby the user can touch their choices directly on the monitor screen. Some other input devices are a light pen, a voice recognition system, a mouse, a writing tablet, a keyboard, a video camera, light sensors, joysticks, and the list goes on. Prices vary from a $20 keypad to sophisticated $100,000 voice recognition system.

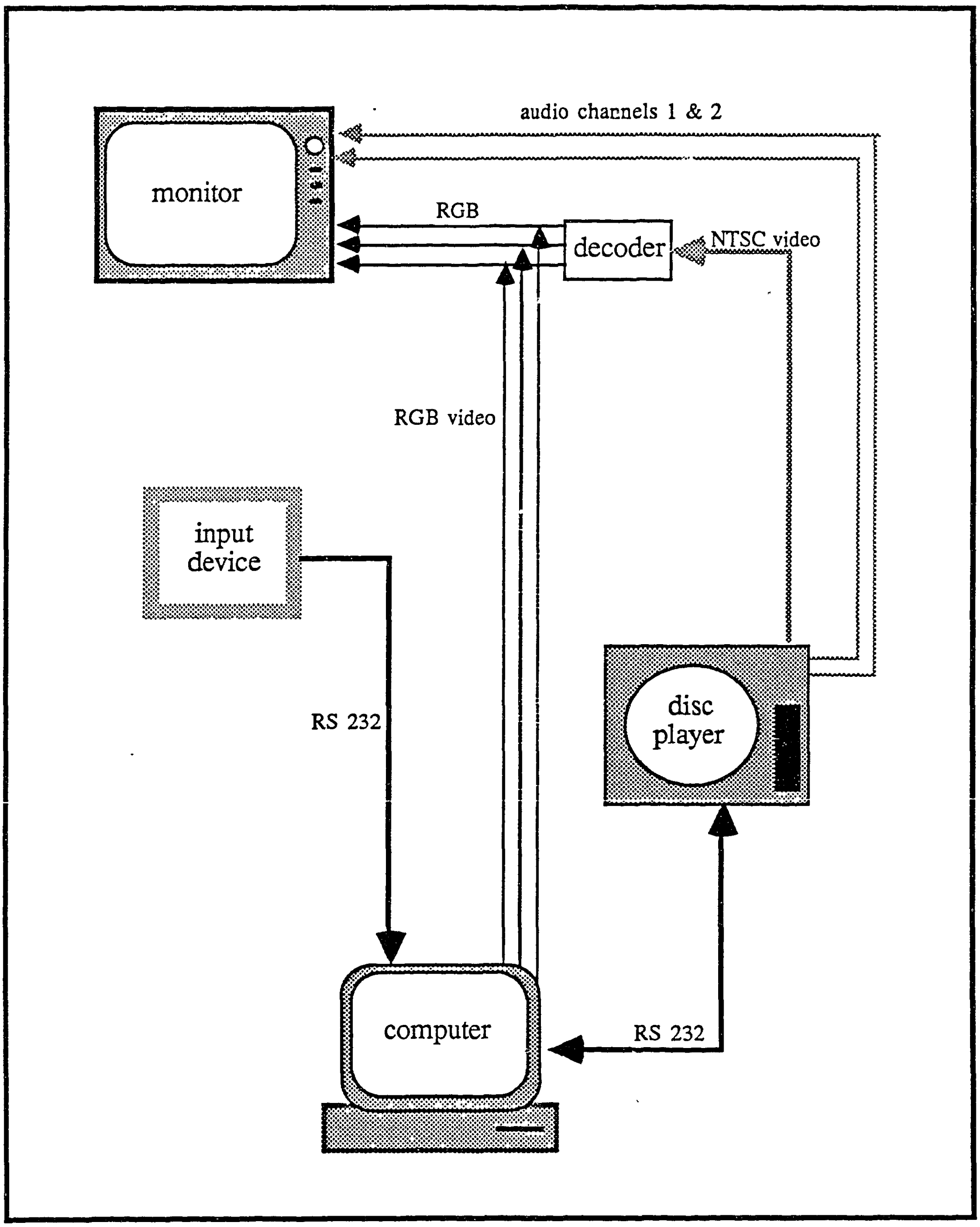

figure 16 - shows the major components and signal paths of a standard interactive configuration.

E. Software

Software for interactive videodisc systems are usually packaged into one unit called an authoring program. This authoring program is comprised of many smaller software programs. One to drive the videodisc player, a word processor to write the interactive instructions, a graphics editor to make computer graphics, a database manager to manage the database, and a software program to read and interpret data from input devices. All these programs are 'glued' together by the authoring program.

Like other software, authoring programs can vary greatly in compatibility, structure, and capabilities. The designer must first decide what they want the interactive system to do then find the authoring program that can do it. All to often the designer must work within the constraints of an authoring program ill suited for their application. Some basic considerations when choosing an authoring program are whether the designer must learn a specialized authoring language, does the program allow for global variables, what graphics and fonts does it support, how fast is it, is it a closed or open architecture (can you write your own specialized functions), and what programming language is it written in.

As an example, let's say you wanted a rather simple interaction to take place whereby the user is given the option of seeing more or less of a subject. You need first to ask them if they want to see everything or a condensed version. If they opt for the condensed version, then upon viewing a condensed segment you want to give the option of more information from that segment in case that you sparked their interest, otherwise they can continue.

Here is what the command instructions for an authoring program might have written in english;

Player, go to frame #100 and stop (frame #100 has a nice shot of the MIT skyline with the videodisc title written along the top)

Text editor, on top of the video image, write the words "Would you like to view a) the whole disc in a linear fashion, or b) see a condensed digest?"

Input device (a touch screen), what is the input?

(If input is 'a' then)

Player, go to frame #101 and play to frame #54,000 and tell me when you get there

(If input is 'b' then)

Player, go to frame #2000 and play to #3000 and stop and tell me when you're done.

Player to computer, "I'm done"

Graphics Program, draw a red square 4" by 6" in the center of the screen

Text Program, write the words "Would you like to know more about Holography?   a) yes   b) no" in the middle of the screen

Input device, what is the input?

(If input is 'a' then)

Graphics and Text program, erase yourselves

Player, go to frame #3001 and play until frame #5000 and then stop and tell me when you get there

(If input is 'b' then)

Graphics and Text program, erase yourselves

Player, go to frame #4000 and play until frame #5000 and then stop and tell me when you get there

This is of course, a very simple example. Introduce other player functions (slow motion, switching between audio channels, or fast forward), complicated computer graphics, a touch screen input whereby the user merely points to the objects of interest, a large database so you know where the user is pointing to and thereby know where all objects are on all frames, and you can see how it can get complicated very fast. This is one of the reasons why designers use flow charts to help map design strategies and program the authoring system.

F. Flow Charts and Design

A flow chart is merely a visual device to map the interactive choices and strategies. For most designers a flow chart is critical when planning complicated interaction. It would be easy to forget to shoot a minor interactive option or to realize that during editing that you made a dead end path. A flow chart helps to guarantee you cover all your design needs, but a flow chart is also a good way to get a sense of the whole. It's very difficult to grasp the 'whole' of a interactive program, so any method that aids this will almost certainly guarantee a better thought out product.

G. Market Applications

The market applications are growing as the videodisc acquires market acceptance, but for now there seems to be four major categories: Training and Education, Sales, Data Retrieval, and Entertainment.

Training and Education. The potential in this area is tremendous. If properly designed the interactive videodisc can provide information and knowledge in a personalized level previously unknown except through a human teacher. It is already being used as a teacher of CPR, corporate management, industrial safety, word processing, and radar technology. This application is probably the fastest growing.

Sales. Point of purchase sales are the most popular use. They usually entail a stand alone kiosk used in a retail store to demonstrate how the product is used and why you should buy it. It is a surrogate salesperson, used full time on specific products. One big advantage that General Motors has discovered is that people like the feeling of no pressure and are more likely to ask questions about a product to this machine then risk the invasion of a salesperson. GM uses it to show prospective customers the various car models in the various colors available.

Data Retrieval. These applications take advantage of the huge storage capacity of the videodisc. They usually employ large relational databases to search out the proper material. With 54,000 possible frames it is perfect for such uses as storing art collection data, a photographer's library, detailed anatomy drawings, or a stamp collection. It's a nightmare for a photographer to store 54,000 slides and then have to find one within this slide jungle. The videodisc would aid the user in finding the proper slide which could then be found by some filing system.

Entertainment. This is perhaps the least developed application, but promises to have an exciting future. It is now used in videogames, such as Dragonlair, to provide interactive branching of action games. They often employ skip frame strategies and animation sequences. It has yet to invade the home in a true sense, mostly because of it's high cost. Currently the Media Lab's Audience Research group is conducting a study to find out people's emotional involvement and entertainment responses to an interactive soap opera they produced using "Dallas" footage. Will people want to interact with narrative stories? Or is part of the appeal from the non-involvement that listening to a story passively provides? Ultimately this application will take us 'places' only science fiction stories could take us before.