Cinema Server = s/t(story over time)

An Interface for Interactive Motion Picture Design

by

Stephan J. Fitch

B.F.A., Motion Picture Production
Tisch School of the Arts
New York University
New York, NY
1988

SUBMITTED TO THE MEDIA ARTS AND SCIENCES SECTION, SCHOOL OF ARCHITECTURE AND PLANNING, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS OF THE DEGREE OF MASTER OF SCIENCE
AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY
FEBRUARY 1993

Signature of Author

Media Arts and Sciences Section
January 15, 1993

Certified by

Glorianna Davenport, MA
Assistant Professor of Media Technology

Accepted by

Stephen A. Benton
Chairperson
Departmental Committee on Graduate Students

Cinema Server = s/t(story over time)
An Interface for Interactive Motion Picture Design

by

Stephan J. Fitch

Submitted to the Media Arts and Sciences Section,
School of Architecture and Planning,
on January 15,1993 in partial fulfillment of the requirements
of the degree of Master of Science at the
Massachusetts Institute of Technology

ABSTRACT

Over the past hundred years, cinema has evolved with a few giant steps and many small ones. The crux of the giant steps has been the extension of film language. In general these steps have been enabled by a comparable jump in the flexibility of the technology.

Digital movie delivery environments invite interaction and personalization on the part of a participant viewer. This invitation to the viewer to shape his/her experience, requires powerful scenarios which will ultimately be shaped by people whose propensity is to communicate through making. Today's tools for making and paradigms for interactive intervention are paltry and require new thinking. This thesis includes such scripting and previsualization tools which link directly to the front-end browsing interface that is supplied to the viewer. Therefore all scenarios for editing and the delivery of the content will have been demonstrated and tested before a single roll of film has been shot.

The thesis prototype includes an interface for browsing a large database of movie titles and an interactive multithreaded narrative which is controllable using this interface paradigm. The browser uses the metaphor of a video tape box as a presentation device. The multithreaded narrative uses indicators on the box as interactive controls. The browser will be displayed large screen, living-room style and will be controlled by a remote device.

This thesis will offer a foundation for designing tools, creating narratives, evaluating the cinematic quality of future experiments in interactive cinema and the delivery of such digital movies over current and future network paradigms. The model of such environment is appropriately called CINEMA SERVER.

The research for this project was sponsored in part by Bellcore Labs, Intel Corporation and the Movies of the Future Consortium.

Thesis Supervisor: Glorianna Davenport, MA
Title: Assistant Professor of Media Arts and Sciences

TABLE OF CONTENTS

PART I:

PART II: IMPLEMENTATION OF THE CINEMA SERVER

TABLE OF FIGURES

THESIS READERS

Dr. W. Russell Neuman _____

Principal Research Associate

Audience Research

Mr. Michael Peyser _____

Independent Producer

Hollywood Pictures

1.0 INTRODUCTION: WHAT IS THE PROBLEM?

How do consumers select movies? What knowledge do they build up of the artists or process which help in that selection? A viewer may select and watch a movie based on theme (action, adventure, mystery), or credits (director, actor), or word of mouth, or perhaps by browsing for a movie to rent. While there are many movie afficionados, there are many more people who never read past the starting credits and have little knowledge of the range of creators involved in the making a particular movie. This means that the viewer is unaware who their storyteller is or what part individual departments played in shaping their experience. This lack of knowledge may limit or decrease the frequency of a viewer's satisfaction in choosing a movie. On the other hand, knowing who Terry Gilliam or Ridley Scott is and choosing a movie based on prior experience with that director's style does not guarantee a hit either. What if the story is bad, the dialogue canned, the characters predictable, or the soundtrack cheesy? It will not matter that the cinematography is great and the camera direction impeccable: the film will be a flop. In the best case, the producer has a vision for a movie which to some degree is similar to that of the director. The producer chooses a particular director because he is familiar with the director's style and feels that it will best serve the producer's vision of the story. Well, maybe; but it is more likely determined by a lot of other things besides the vision of the story. Quite frankly it's a "crap shoot," where the packaging of a story is more likely based on numbers than story purpose and a passion for filmmaking. The dilemma of choosing a good movie rests in the outcome of this "crap shoot." To provide the viewer with knowledge of his/her storyteller(s) is irrelevant; this is why we have critics.

Providing an intuitive browsing interface to a large database of movies, where a range of reviews from television news anchors, newspapers, magazines, books, behind-the-scenes looks, and talk show interviews can be easily accessed ("point and click," gesturing, voice command, etc...) may aid the viewer and improve their odds in this movie rental gamble. If the viewer wants to learn more about the making of the film and for that matter view the script, the storyboards, or the resumes of the film production crew, this information could be easily incorporated into such a browser.

Recent history has shown that when labor-intensive analog processes are imported into the digital domain, cost reduction and financial profit often follow. Film production is filled with the tediousness of managing complex information. As many of these labor-intensive tasks are imported into the digital domain, the financial risks for studios will be reduced. Meanwhile benefits of an expanded digital cinema include a variety of new possibilities for communication and entertainment. For instance, the video movie browser which we decribe later suggests that if a particular selected film is digital, the audience may be able to alter it, view different endings, choose their own rating, increase the documentary style in a docu-drama or increase the comedy of a "thrill-omedy;" or similarly, they may be able to increase or decrease the sexual content or the level of violence which takes place in the film. When these alterations are an integral part of the producers vision, the audience can manipulate these narratives' story variables using the simplest of controls.

This thesis centers on the idea that "*movies on demand*" will need a new paradigm to help viewers to browse and select titles, and that a digital movie

browser should support the interactive adaptation of a movie narrative based on any number of variables. The underlying graphical elements of such a browser, which we will call *Cinema Server,* must be familiar to the user.

Currently, the only physical representation of cinematic material which viewers are accustomed to handling are video boxes. Information regarding style, length of film, year made, production, writers, directors, director of photography, rating, movie stills, as well as reviews and a synopsis of the film are displayed on the video box so that the viewer can make a decision to rent, not rent, or buy. The goal of the thesis prototype has been to bring this box to life and add depth to the experience of browsing by cross referencing the data using a digital database for indices across wider reviews, other films produced, directed, and/or written by the creators of the film. The prototype incorporates video trailers which replace the still pictures currently designed into the box as movie illustrations. On-demand viewing of digitized trailers and scenes from the movie will be made available by texture-mapping the motion video directly onto the 3D video box graphical interface so that the browser maintains visual consistency.

As consumers become more informed of the available info-tainment associated with a production they will become more creative in making their movie selections. This thesis discusses a range of issues related to the dynamics of personal intervention as they apply to large scale cinematic browsing of feature films. For instance, sometimes consumers might choose to spend long periods of time in the browser comparing different movies without ever selecting one to rent or download to their television or computer. As in hotels today, this browser would occupy its own channel devoted to the

selection of movies on demand. Given its potential popularity the channel might be a paid channel. We imagine that this channel might be as popular as viewing the films themselves and as widely viewed as music television stations.

> *This is a special business to be in. And people on the outside sense it. That's why they not only love to go to the movies, it is why they have become fixated on the inner workings of the industry. They want to know how we make the magic. As much as "Entertainment Tonight" and its ilk can be irritants as they accelerate the blockbuster mentality, the mere fact these programs exist is a recognition of the specialness of what we do.*
>
> Jeffrey Katzenberg, Disney Head, internal memo

By incorporating the paradigm of the videobox into our interface for browsing interactive motion pictures, we can offer the user a range of interactive controls which are easily interpreted by the user. Adjusting these controls is part of the "entertainment" provided by the movie industry. Many of these controls are suggested on the current videotape box; for instance, the rating (R/PG), the running time, the type of film... Running time could be modified by a user who wanted an "abridged" version of a movie. The action adventure slider mirrors the "sex and violence knobs" which Nicholas Negroponte has referred to.[1] The box thus evolves naturally as a paradigm for interactivity.

While traditional features can certainly be tailored or recut for the purposes of a constrained experience, they were made to be what they are, linear films. We propose that the browsing paradigm of the video box can also be used as a transparent interface for interactive multithreaded narratives[2], a new kind of

---

[1]Nicholas Negroponte, "The Impact of Optical Videodiscs on Filmmaking. June 1979.
[2]Simpson Garfinkle, "Picking up the Narrative Thread with MIT's Glorianna Davenport." New Media Age, vol.1, no. 4, June 1991, p. 14-16.

feature which is designed to be presented to a participant viewer for viewer manipulation prior to runtime and within the constraints set by the moviemaker. A short section of such an interactive multithreaded narrative has been developed as part of this thesis to demonstrate the feasibility of such an idea and to comment on the tools which will be necessary to create these new features.

> *"With the arrival of electronic cinema it became apparent that film grammar was limited in what might be called its vocabulary of tenses... Digital code offers formal solutions to the 'tense' limitations of mechanical cinema. Past, present and future can be spoken in the same frame at once."*
>
> Author, Critic, Educator Gene Youngblood
> Cinema and the Code

As the very "stuff" of cinema becomes touchable by the viewer for the first time in movie history, the need to provide satisfactory representation of the content captured in the motion picture frame gains significance. It is clear that the same utility used to browse though a selection of digital movies should be a shell to the tools which will allow the viewer to alter its cinematic variables. As this shell poses itself to the issues of movie browsing it will reveal the structure of the production process and story design for the making of these interactive narratives. The browsing interface described in this thesis assumes that the legal issues have been resolved and that the medium for storing a large database of digital movie titles is trivial. We also assume that the issues of providing real-time manipulation of such digital video streams over a networked environment is compliant. It is the goal of this thesis to explore the aesthetics of a browsing interface, and to discuss the integration of tools to assist in the making and delivery of these new digital movies.

2.0 BROWSING

Selecting movies as a cultural & psychological phenomenon

I have always been taken by the all-night newsstands of the metropolitan cities. It seems that at any hour of the day you may find more than a handful of people standing around flipping through magazines and newspapers -- browsing, looking for nothing in particular, but for something which may interest them or catch their eye. The selections for some people are almost completely random; for others there appears to be a method. It is evident by their choices of magazines that they are searching for something specific in fashion, or something specific about automobiles. The environment for browsing at newsstands is a social setting. It can be compared on some level to the theater where everyone is there for the same reason but view the screen privately. In the theater we are both alone and together at the same time. The interaction between us is no more or less than our interaction at the newsstand, where our eyes are alone tucked inside a journal or newspaper; and yet we do this in the presence of other humans and this creates and illusion of interaction which we cherish and are drawn to. Traditionalists have feared for a long time that with modern technology we will witness the extinction of the theater. They argue that the shared environment of a movie is part of the cinematic and storytelling experience, and for this reason they fight to keep theaters alive. Anyone who has seen a horror film in New York's Times Square will agree with that. Recently I watched Spike Lee's film, *Malcom X* and noticed that as the character of Malcom changed (played by Denzel Washington), the audience seemed to change with him. This is Cinema working in real time.

When browsing in our local video rental store very little of the illusion of interaction occurs. It is a mostly frantic and dreaded situation where success is the result of luck. It's like a game show where the contest is to find a hidden movie title (which you are not sure you are looking for) before someone else discovers it and takes it away. Like the experience at the newsstand, we don't always know what we're looking for: an action/adventure with Mel Gibson, or a romantic/comedy with '*what's her name from that movie that won that award last year - the one that takes place in Africa.*' This lack of explicit intention characterizes browsing only in the video store where we are also somewhat frantic and competitive with everyone in the store who quite possibly are looking for the same movie. If it is a new release and the start of the weekend, you can bet your last dollar that even if the store circulates twenty copies of the title you're looking for - all 20 have been taken. The newsstand does not carry as many titles of magazines and books as there are titles of movies in a Blockbuster or Videosmith store, but they always seem to have plenty of copies for everyone. The newsstand has all the covers of the magazines displayed openly where a slow glance over the rack will almost surely guarantee something you might be looking for. You can pick it up and it readily reveals its contents to you. Movie browsing is much different; the covers of the boxes all look the same and the boxes are all the same size, when in fact they are diverse in content. Where we have learned over time what the cover of National Geographic looks like, we have no visual cues which tell us that one film is a Disney Comedy, or another, a Paramount Pictures Action film. Furthermore, films are often misclassified. For instance, a few years ago Jack Nicholson and Meryl Streep were in a movie entitled *IronWeed,* which I cannot imagine described as a comedy. However, more often than not, in spite of the film's dramatic content and depressing feel, you'll find this film in the comedy section

of your local video rental house. The same situation frequently occurs with a Mickey Rourke / Faye Dunaway film released around the same time entitled *Barfly*. So, the first problem we encounter with browsing for video titles is the limited quantity of them. The second problem is that all the boxes look more or less alike, and so we have no visual cues to tell us that it is a Woody Allen movie. Third, the classification of the video titles are often incorrect, and yet this is a primary cue as to where we should start looking. Fourth, if we find the title we are looking for we cannot casually browse its contents before renting and so, more often than not, we are renting based on some previous knowledge or exposure to advertisements: in short, we are renting the movie blind. Fifth, most movie rental houses organize their movies in alphabetical order, which means if you don't know the title of the movie you're looking for, your only hope is that it's been classified correctly (it is indeed a comedy in the comedy section) and that you will recognize the box. This collection of "ifs" can make movie renting difficult. Finally, some rental houses project moral judgment on films and will not carry films which they consider to be profane, pornographic or which deal with subject matter the corporation deems inappropriate (homosexuality, etc.). This further limits access to movies and adds one more layer of censorship to the already over-censored distribution and production of movie titles.

Summary of issues with analog browsing:

1. There are a limited quantity of video titles.
2. All the boxes look alike - no visual cues.
3. Classification of the video titles are often incorrect - we must remember titles.
4. We cannot casually browse a movies contents before renting.
5. Most movie rental houses organize their movies in alphabetical order which means if you don't know the title of the movie you're looking for and you cannot recognize the box, you're screwed.
6. Rental houses project moral judgment on films and will not carry films which they consider to be profane, pornographic or which deals with subject matter the business feels is inappropriate (homosexuality, etc.).

Fig. 1, Browsing Issues Summary

Network Delivery requires browsing - blindness to the pool

Enter the digital browsing network we call *Cinema Server* which is designed to overcome some or all of these limitations. It is clear that network Delivery of digital movie titles offer some benefits. However, it is imperative that the procedure for browsing solves the issues of analog browsing and provide new features for interactive storytelling. The most difficult browsing issue will be to provide a viewer with the illusion of interaction with others while browsing. Though this is probably the most crucial and interesting part of providing a Cinema Server browsing interface, its implementation is beyond the scope of this thesis. I will, however, share some thoughts on this and its relation to efforts being made by networking software companies, hardware video compression board manufacturers and operating systems.

Intel Corp. and other companies promise a low-end video compression board and telecommunication software which will allow a viewer to dial-up and see the person they are speaking to in a small window on their computer screen. This social context has the potential of making browsing more fun and entertaining. Browsing might in fact take on some of the attributes of MUDS (Multi-User Dungeons) where people enter anonymously into narrative spaces -- and construct a thriller room.[3] Microsoft, Apple, and other manufacturers have made headway in solving networking issues so that users of a specified workgroup can share data with each other. Companies like Protocom and Starlight on the PC platform have developed a proprietary Ethernet board which allows video to be pumped across networks in real time over these same workgroups. Anthem Technologies and many others have already developed fiberoptic network cards

[3]Bruckman, Amy. "Identity Workshop, Emergent Social and Psychological Phenomena in Text-Based Virtual Reality." April 1992, unpublished.

which, with their extraordinary bandwidth, can display several video windows at a time in real time and provide data exchange simultaneously. We can imagine such an environment for interaction in the Cinema Server browsing paradigm, where viewers can have a visual sense of others on the network and can see what movie titles these users are browsing. In the video store it frequently happens that someone looking for a title will overhear another person talk about a movie and it may remind them that it is a movie they wish to see, or that it is a movie they do not wish to see. This level of interaction, though some may argue that it is a result of the renter not being able to browse through the contents of a movie, should be maintained in the digital browsing environment. This means that there should be audio throughput as well as video for each of the subscribers on the network. I should be able to select a movie and ask the other subscribers, "has anyone seen this and is it any good?" I can do this in the store and at the newsstand. This must continue to be an option in the Cinema Server browsing paradigm.

The blindness we as subscribers have to the pool of movies is to some extent the function of how intuitive we find the interface and the search and sort control panel menu. We would hope that there would be some intelligence to this interface, where I may be able to specify that I am looking for a film "that's a cross between *Bladerunner* and *Gone with the Wind*." Here the database should supply me with a palette of movies that best fits this fuzzy type of search. We would also want the interface to support my desire to grab a bunch of movies that I like, have the system perform a *context crunch* on them, and then display a choice of other movies similar to those I selected. Unlike the Video Store, the digital database provides a powerful engine which can take advantage of situations where I have only partial information: a word in a title, the art director's

name, the genre and year of release, etc. In each case, the database can search out multiple matches and display trailers on demand. I should also be able to describe the story verbally to the system, and it should do a voice to text translation and perform a story search. While this is also beyond the scope of this thesis, these ideas demonstrate a direction in which the *Cinema Server* should move.

Digital movies enable the maker and/or distributor to incorporate segmentation/granularity into story service

For those film artists with a vision for the potential of cinema, digital movies are welcome with enthusiasm. However most traditional filmmakers are not as enthusiastic or visionary about this new medium. I have witnessed many good friends struggling through film schools, wearily stomping through the streets of New York with their metal cans and bad attitudes, looking for lost prints, waiting for a screening room to view rushes, and dealing with the angst of editing and re-editing to draw out a work which is always short of the vision they had in their head when it started. To them, this vision of digital cinema is a nightmare - a travesty. My words fall on deaf ears: they will not listen to me, and no matter how delicately I try to put it, it sounds like rape. I am the executioner, banished from the kingdom of linear films to a private world of computer hackers who have the knowledge of what can be done with a database, but, for the most part, lack the passion for storytelling using traditional cinematic tenses. They have only half a sentence in which to formulate an idea. The storytellers refuse to speak to them and ultimately abandon cinema's future to an even more rigid structuralist demise.

With the understanding that a story can have many versions with the same theme, cinema poses itself as a software product. The potential for interactive multi-threaded narratives is obvious. It is for these movies the Cinema Server has been designed. The importance of a dynamic database kernel, a small file attached to each title that relates information about itself to the system so that it becomes configurable, is already well established. To the video editor, this file might be identified as an EDL (Edit Decision List), but a critical difference exists. In a digital network the list relates to more than a shot configuration; it also offers optional sound design possibilities, story elements, transitional effects, the full digital soundtrack, and pointers to related information such as reviews and trailers. It is of paramount importance that these new movies be designed with an understanding of cinematic language as it relates to story so that a maker can design a movie with a broader viewing audience in mind without compromising the vision. My hope is that if such a filmmaker were unfamiliar or uncomfortable with directing a comedy sequence s/he will seek collaboration from another filmmaker who is. Thus would spring into existence a new slider button on a digital movie browsing interface where I may be able to select a movie and specify a Martin Scorsese picture with a tinge of Woody Allen or vice versa.

Can the system learn from the viewer over time?

Interface agents and user profile model systems are under development by several research institutes and software companies. These systems are being regarded as the next major step in operating systems and I will try to address these issues as they pertain to the Cinema Server browser. User models are reverse engineered in expert systems and in many other ways impact the world of artificial intelligence and the neural network/expert systems industry. There are a handful of programs on the Mac and PC platforms which deal with these

issues, and there seems to be interest from both Apple and Microsoft to bring this intelligence to an operating system level which would ultimately change the way we relate to computers. The more we would use the computer the more it would know how we use it and how we work, it would essentially learn from us. In the *Cinema Server* browser paradigm this should become an important feature. The system could learn about the subscriber's movie preferences and bring this information to the front of the interface, then offer suggestions to the subscriber based on this learned knowledge. For instance, I am a die-hard Scorsese fan and will most likely use the browser to view any text or video clip I can find of him. I will watch his movies and read interviews with him on the network. Once the system discovers my pattern, it will poll for new material on Scorsese and bring any new tidbit to my attention each time I log-on. It might bring up a newspaper article, or a movie trailer. If Scorsese died in the middle of the night, it might even call me to tell me.

For movies which I have already viewed or show no interest in, the system should learn to not offer them to me again, and may even find some harsh criticism from another subscriber or from a film reviewer and relay that to me just for a laugh. After I have viewed a number of films the system will begin to understand my taste and should customize the presentation of the interface to suit me. This should also be the case with the way the Browser is configured. If I always watch my movies with maximum Violence and the highest Sex rating, the system should learn this and present the control panel to me with those specifications as the default. The storage of user models raises important privacy issues: the subscriber should be able to specify whether this information goes back into the system for market study or remains private.

3.0 WHAT IS A MOVIE?

> *If mechanical cinema is the art of transition, electronic cinema is the art of transformation. Film grammar is based on transitions between fully formed photographic objects called frames. It is done primarily through that collision of frames called the cut, but also through wipes and dissolves. In electronic cinema the frame is not an object but a time segment of a continuous signal. This makes possible a syntax based on transformation, not transition. Analog image processing is one vehicle of this particular art - for example, scan processors. But it becomes even more significant in digital image synthesis, where the image is a database.*
>
> Gene Youngblood - Cinema and the Code

On the following pages I describe essentially the mayhem of filmmaking. Movies are comprised of *Visual Images* (capturing, preparing, editing, etc.) and *Sound* (mixing, foleys, ADR, scoring, theatre sound presentation). The process of preparing images and sound to tell a story (i.e., make a movie) is broken down into four phases: pre-production; the shoot; and post-production. Once a movie is made it enters the final phase: distribution. Clearly when the credits roll at the end of any given movie it is not simply the names of the writer, director, camera operator and editor we see, but many people all with their special tasks and talents contributing to a single vision. Film is a unified effort among several departments towards producing a meaning.

In this section of this thesis I will try to break down these four phases loosely. Each phase is much more involved than I can express on these pages, so I will attempt to extract examples from each phase and relate it back to the *Cinema Server*. I will also discuss the relationship between digital cinema and efforts in artificial intelligence and the creation of narrative story engines. I take the position that there can not be a simple mechanism, an intelligent story engine, which calibrates all the special tasks of a film production. Narrative Intelligence gurus need to realize that they must build a system which not only follows

narrative literary story structures and devices, but also has an understanding of the spontaneity in an actor's performance so that it can distinguish a good take from a better one. It must know what "art" is and be able to orchestrate the story events with light, sound, and camera movement. This is no easy job and we are far from obtaining this in reality. That is not to say that it cannot be done, only that it cannot be done in a laboratory using only editing theories and story structure hypothesis in the approach. To do it, the entire film process, from conceptualization of the idea through post-production must be tracked. Every decision from every department on the set of several motion pictures over the course of many years must be recorded. Very few of these tools have been developed, and not one fully integrated system exists. The *Cinema Server* attempts to pose itself as the seed from which a fully integrated system might be realized. To achieve this goal the information and entertainment industry must grasp the concept of the image database and the limits of the hardware on which these movies are to be run.

The State-of-Mind in Hollywood

We must first look at the current 'state-of-mind' in Hollywood in regards to its future and understand the four phases of production (getting an idea or vision from script to theater). While some studio's recognize the potential for interactive motion pictures, they have not yet made a bold step in its direction and have not fully considered interactive television as an option for distributing content. Ultimately feature-like 'interactive' movies will require networks, cable, satellite or something new. Therefore, when I describe the three phases of the production process in terms of Hollywood's 'state-of-mind' I am specifically talking about the current process of making linear films. The phases are described in some detail and are broken down as *pre-production*, *the shoot*, and

post production. The model for the *Cinema Server* addresses the process of linear narrative movie making as well as non-linear movie making. The server provides an interface for selection of digital titles to both forms. However, the backbone of its design was to address the potential for alterable movies by providing the viewer with controls over content and the delivery of these new digital narratives. Whether the film is a traditional narrative or a non-linear narrative, the production process is essentially the same, except that the non-linear (multi-threaded) narrative requires more shooting, hyper-linked story tracking, and previsualization tools (script and storyboards). The *Cinema Server* prototype as a thinking experiment lends itself directly to the whole process, and, in addition, addresses sound design, sound editing, and music scoring. No other tool currently exists in the industry which integrates all of these production issues (including distribution) while providing a single familiar interface to allow the viewer to select and alter a title. In the next few pages we will press our ears to the wall of the movie industry and grasp its concerns through the voice of Jeffrey Katzenberg, the head of Walt Disney studios. What I will try to establish on these following pages is a summary of the process of filmmaking and how it lends or fails to lend itself towards cinema's digital future. It is imperative to consider how multi-threaded narratives will emerge from this process and how the interface to these movies will look and act. It is my objective to demonstrate and describe the potential of the *Cinema Server* prototype as a viable option which links the filmmaking process to the delivery of the alterable movie to the viewer-participant.

The Katzenberg Memo

It was about two years ago that the infamous "Katzenberg Memo" leaked from the offices of Disney studio heads, into the underground fax network and into the

hands of the Daily Variety. The memo set Hollywood on its ear and for several months it was all anyone talked about. To some industry professionals it only confirmed existing sentiments about the state of moviemaking, but for others it was shocking news hearing that Disney, which was proclaimed the number 1 studio that year, had valid concerns about its future. Jeffrey Katzenberg tried hard to redefine the priorities of the studio and did a little polite Japanese bashing.

> *"As we begin the new year, I strongly believe we are entering a period of great danger and even greater uncertainty. Events are unfolding within and without the movie industry that are extremely threatening to our studio."*
>
> Jeffrey Katzenberg - Disney Head, internal memo

Katzenberg went on to criticize the studio for drifting away from its original vision of how to run the movie business and compared the studio's condition to one of decline, the fourth stage of a business' product life cycle. One of the strongest points he made was directly related to movie distribution. Noting that the 10 cent ticket price of the Great Depression was irrelevant when compared to the $7.00 dollar price tag of a film today and a $2.00 movie rental. In fact, Katzenberg suggested a rethinking of the industries approach to home video. He proposed increasing the rental title charge to $200 which would force video stores to charge $5.00 for a movie rental. When we consider his reaction to video rentals in light of the promise of future distribution systems and the impending doomsday for rental stores his concerns seem shortsighted. The crux of Katzenberg's memo was to call the studio back to basics. He proclaimed that "the idea is king" and that stars, directors, and effects were only there to serve the story. Without the story there would be nothing. He took a "just say no" approach to blockbuster mentality and asked the studio executives to turn away high-concept films, which generally cost several millions more to make. In

choosing the 25 to 30 movies they make a year Katzenberg asked that studio executives to exercise "intelligence and good taste" and hinted that if executives didn't have a "passion" for filmmaking they should find a new business. In response to growing fears in Hollywood that the Japanese were taking over, he asked that his people "calm down" and went on to explain that the Japanese were involved in an industry which they were not culturally capable of running.

> *"Filmmaking at its essence is about the conveyance of emotion. Not coincidentally, filmmakers by their nature are an emotional group - from the actors on the screen to the dealmakers behind the scenes. It is said to be a crazy business and most of its practitioners admittedly are, by normal standards, a bit eccentric."*
> *"The Japanese, on the other hand, culturally err on the side of withholding emotion. In saying this, I am not simply offering an American perspective. The Japanese are the first to tell you this about themselves."*
>
> Jeffrey Katzenberg - Disney Head, internal memo

Katzenberg assured his executives that the Japanese purchases of studios and theaters in the belief that they would control the software, and in essence achieve synergistic advantages of vertical integration with their hardware, was senseless. He went on to claim that this mentality was due to Sony's entry into the VCR scene with Betamax which lost to the VHS format.

> *"Sony chairman Akio Morita has concluded that history would have been different if Sony had owned an American studio and therefore been able to direct the market by putting film titles on Beta tapes. This thinking is absurd. By owning Columbia, Sony now controls less than 15% of Hollywood software output. Fifteen percent does not comprise a critical mass necessary to direct a market."*
>
> Jeffrey Katzenberg - Disney Head internal memo

In view of Katzenberg's memo as it relates to digital entertainment technology, as well as new directions for the motion picture industry, it would seem he was not interested or not aware of what has already begun to approach the public. Interactive Cinema - CD-ROMS, fiber-optics, 500 channels of cable and

telephone companies competing for a viewing audience instead of just a listening one. Fundamentally, that was not what this memo was about. Rather, it was Katzenberg pulling hard on the studio's belt preparing his people for a ride on the recession wave. When Katzenberg speaks of big-budget stars it may be helpful to see some statistics from a recent market study:

	Earnings of Actor ***Jack Nicholson***	***Earnings of Actor*** ***Arnold Swartzenegger***	***Earnings of Actor*** ***Julia Roberts***
1987	$11 Million	$18 Million	0
1989	$34 Million	$27 Million	
1991	$14 Million	$24 Million	$6 Million

	Average Production ***Cost Per Film in***	***Average Marketing*** ***Cost per Film in***	***Earnings of Producer*** ***Steven Spielberg***
1987	$20.051 Million	$8.257 Million	$23 Million
1989			$64 Million
1991	$26.135 Million	$12.064 Million	$27 Million

Average Feature-Film Earnings per Screen Actors Guild Member in	**Total Box Office Receipts in:**
1987 $5,087	$4,252 Billion
1991 $5,827	$4,803 Billion

Fig. 2, Premiere Magazine, FYI, Spetember 1992, pp.92[4]

Although some stars make huge sums of money for a given movie, most actors work on scale. Included in the earning for the above listed actors are profit points, merchandising, etc. In the golden age of Hollywood, stars such as Greta Garbo, Humphrey Bogart, Bette Davis, and Clark Gable were lucky to see a fraction of what some stars make today. Studios complain about the sums of money made by big-budget stars, but in general, consistently underpay the film production crew and are constantly engaged in what many consider union-busting activities.

---

[4]Taken from Premiere Magazine, from the following sources: National Ass. of Theatre Owners, MPAA, Forbes Magazine, Los Angeles Times, Screen Actors Guild, Writers Guild of America, West

The Process - Go With the Flow

Whether it's the old-fashioned way of doing business or a new high-concept film, getting the idea to a release print is what makes Hollywood a stressful and crazy business. It is also why it takes a "passion" for filmmaking for anyone to want to work in the industry. In the following diagram we see a flowchart which maps out this process.

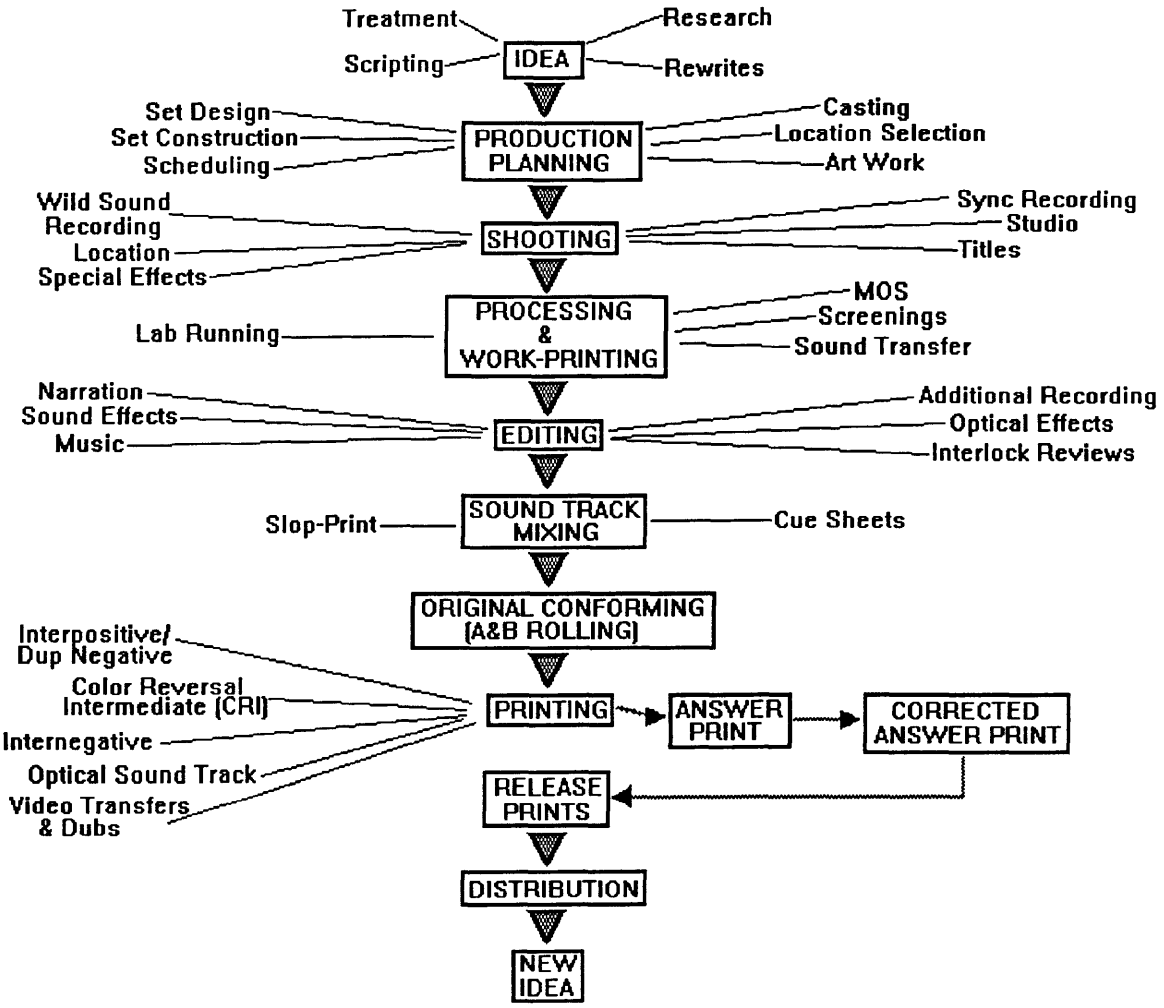


Fig 3, Idea Flow Chart

At any one of these steps a hundred problems can and often do occur. Many of these steps occur jointly with other steps; for instance, the film is being edited at the same time as it is being shot. The *Cinema Server* prototype deals directly

with this process, as it attempts to integrate tools necessary to bring the idea through this data flow to distribution. Companies investing in interactive television or digital entertainment paradigms must have a strong understanding of this idea flow. They must realize that the idea, originating as a multi-threaded narrative, complicates the flow and demands pre-production tools specifically designed to track and previsualize the movie before it reaches the shooting stage. The same tools must follow the shoot through the post-production process and into distribution. The *Cinema Server* prototype is a multimedia database with an intuitive interface which hooks into all the stages of this idea flow process.

Pre-Production (Scripting, Planning & Previsualization\Storyboarding)

> *"Storyboards are a tool for pictorially working out the visual details of a script. They can be anything from a few rough drawings showing the continuity of action, to elaborate renderings of entire sequences. Producers, directors, cinematographers, and production designers use storyboards to anticipate problems as well as to gain approval of ideas. For independents, whose budgets leave little room for reshooting, being able to previsualize a production in detail is essential. PC's provide these filmmakers with the ability to create more-finished and even animated - boards at less cost and with smaller staffs.*
>
> *No single tool exists for creating custom storyboards that can carry all the information required."*
>
> Stuart Cudlitz, MacWorld June 1989

Storyboard Systems - An Overview
Towards an integrated environment for planning and previsualization

Storyboarding techniques are heading in the direction of full computer simulation of key sequences or even scenes before production begins. When you consider the cost of any given production it should come as no surprise that tools which allow the filmmakers to prepare and previsualize a movie would be widely used and sought after. Tools such as the ones mentioned in this section

were developed out of the need to reduce production costs caused by continuity errors and poor shot planning as well as to help streamline the difficult and tedious aspects of editing, such as shot logging. Some of the tools deal specifically with the delicate synchronization issues of going from an analog to digital format. In a process tracking environment, where scripts, storyboards, budgets and schedules exist in digital format and are easily linked to each other through database and hypertext programs, it is now the synchronization and integration of digital video which must rise to the occasion and greet the filmmakers with opportunities which were not available in the past. The following is a list of applications developed to aid filmmakers in the pre-production process.

Feature Animatics:

Meg Switzgable and Thomas Brown, Co-partners in Foresight Films, have developed an interactive storyboarding methodology for their production entitled *Passing Thru Linden.* They use Screenplay Systems' Scriptor, and Movie Magic Budgeting and Movie Magic Scheduling/Breakdown programs. Brown uses an updated version of the electronic storyboarding techniques he first developed for Coppola. Brown's production team uses an off-the-shelf paint program called SuperPaint. Storyboards are drawn and then videotaped along with a script reading and sound effects. The storyboards are played back with the audio files and the producers are able to previsualize the entire movie before a single frame of footage is shot.

Movie Magic

Steve Greenfield, President of Screenplay Systems has integrated the script writing process with a budgeting and scheduling program. The scripting

program has links to storyboards, prop lists and even dialogue which is particular to a character. While this program is not designed for multi-threaded narratives, it has become the industry standard software for motion picture business production of the development (pre-production) process.

Hyperboards:

Writer/director Hal Barwood, used a Macintosh SE to write the screenplay and produce storyboards for a Lucasfilm romantic comedy. Hal used HyperCard and designed a shareware storyboard program called StoryCard, which enabled him to visualize sequences annotate the storyboards and link the result directly to the film's script.

The Abyss:

For James Cameron's film *The Abyss*, Michael Backes developed an application for creating 3-D sets. Since some of the sequences entailed some difficult special effects Cameron wanted to save headache and costly reshoots by being well prepared. In these virtual 3-D sets he could plan difficult shots - testing different camera angles and movements such as flybys. These animations could be used on location for setting up shots.

The Shoot

The second phase of production called *shooting* is getting the action on film. Frequently it is harder than getting the money for the idea (see fig. 4), in part this is due to the concentrated interaction of personalities which make movies happen. The shoot entails having hard-working, cooperative, creative, enthusiastic departments and talent in sync with the shooting schedule and the vision of the producers and director. The shoot is the most critical part of

filmmaking. In looking at the Production Chart below (fig.4), we see the hierarchy of departments in relation to getting the movie on film (the shoot).

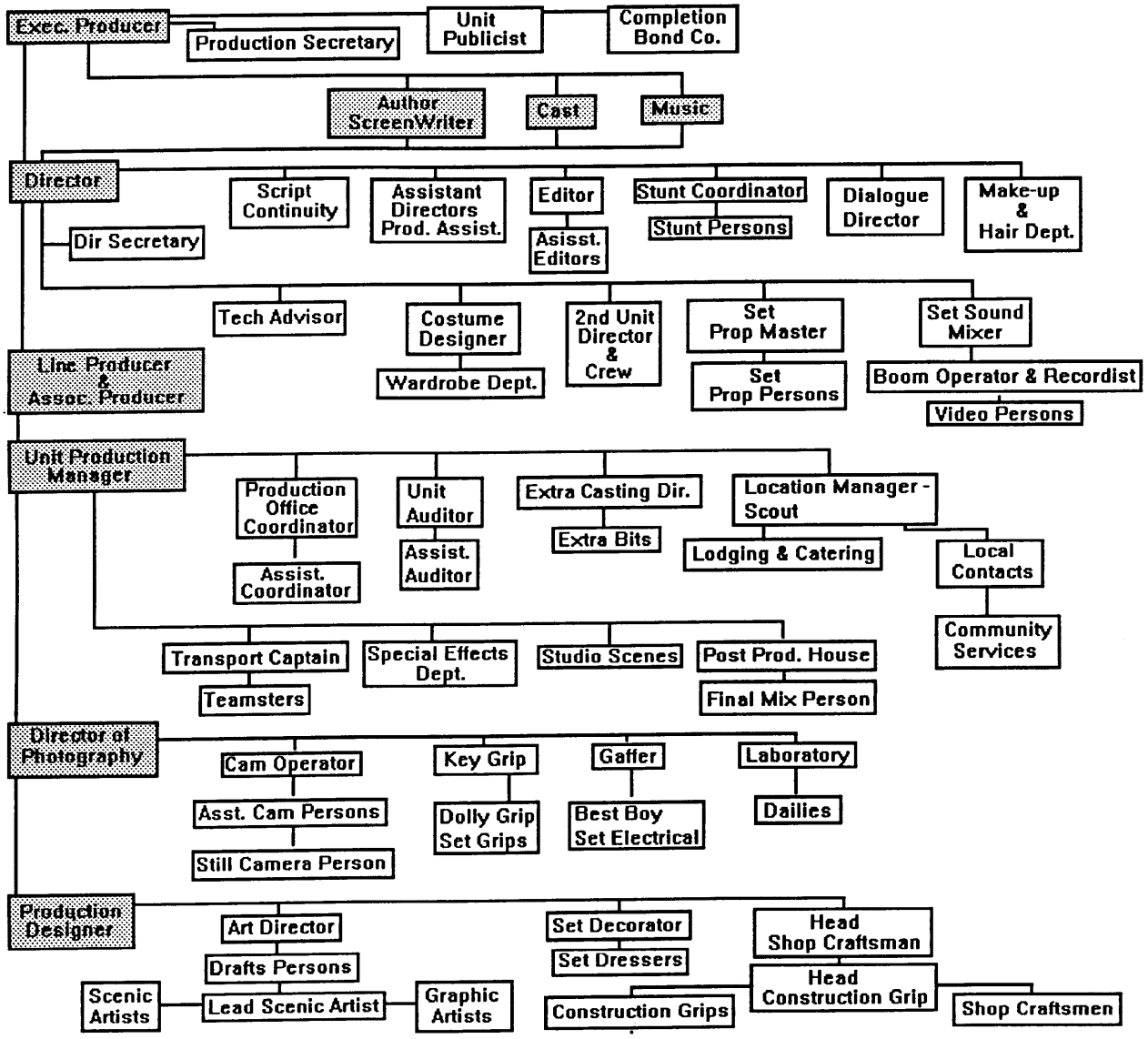


Fig 4, The Production Chart

In this context Cinema Server suggests integration of many partial tools. It integrates tools for the producer by incorporating a budgeting program. It integrates tools for the director by incorporating storyboarding and music programs. In addition it could be used to assist the editor, script

supervisor/continuity, director of photography and sound mixer by providing access to shot logs, non-linear editing software and sound design tools. The *Cinema Server* system eventually should incorporate educational video tips to assist gaffers and grips in rigging lights or provide the director of photography with a real-time lighting previsualization rendering tool.

From the diagram you can see that the flow of information on the shoot must pass to several departments at once and can be altered at any given point by the director. For instance, if according to the log, the next shot to be filmed is Shot 28A, pp62, but for some reason the Director wants to scrub that shot and shoot Shot 30, everyone down the chain of command must realize this immediately, if the actor is in the trailer being prepped by makeup for Shot 28A and arrives on the set in the wrong wardrobe and with the wrong makeup, thousands of dollars have just been wasted. Mistakes are costly, but in film they are almost impossible to avoid. The communication network is a dense web, but until it becomes electronic it is slow and subject to human oversight. Most of the new tools being developed are focused on tracking the data stream and assisting the director with the task of accurately recording the movie during the shoot. These tools do not for the most part deal with the communication issues which are handled by director and production assistants. The following applications are a few of the tools developed to assist the director and departments during the shoot and to forward the data gathered during the shoot to post-production processes such as editing. Clearly, many of these tools are too sophisticated to be present on an exterior location shoot. Slipstream is an exception to most of the tools which aid in the shoot process as it attempts to streamline several departments through one system.

Movie-making is largely an industry of egos. Some directors are described as screamers and are upsetting to be around. Directors with a reputation for being calm, are able to acquire the sought after vision from the actors and crew, and can bring the film on or under budget are worth their weight in gold in Hollywood. Bob Zemeckis, from *Back to the Future* fame has a reputation as being one of the sanest directors in Hollywood. Meryl Streep after working with him on *Death Becomes Her* described him as being "clear and decisive." The producer, Starkey attributes this 'clarity' to Zemeckis's ability to previsualize scenes so that they can be shot exactly as they were committed to storyboards. "Working from precise blueprints, all departments know when they come to work in the morning exactly what props and equipment will be required."

Slipstream

"Slipstream," Alan Lasky's Master's thesis (September, 1990) in the Interactive Cinema Group, streamlined production tools for the shoot by integrating video-tap, storyboards, and continuity processes to assist the director. Slipstream brought together the different elements of cinematic information in a dynamic digital platform. The linking of multi-media elements created a data-rich production pipeline that passed data between pre-production, shooting, and post production. Lasky envisioned an expanded 'on-line' system in which departments such as props, sets, continuity, location scouting, etc. would be linked on a digital network.

Industrial Light and Magic

Lucasfilm and its subsidiary Industrial Light and Magic (ILM) have established themselves as exalted manufacturers of special effects. ILM often uses scanned film footage for not only previsualization but also for production. Using

workstations and mainframes they can take scanned images and manipulate, matte, and composite elements into a new digital synthesized image. In recent years ILM has added the processing power of a mainframe to track all the production data for every shot of every in-house production.

The Digital Muppet

Muppet creator Jim Henson is well known for mixing live puppet performances with both film and video. A company called Pacific Data Images (PDI) of Sunnyvale, California, put together a computer graphics system for the production process. By linking a customized version of Visual Programming Language Research's (VPL's) Body-Electric program to PDI's high-end 3-D systems (VPL is best known as the creator of the DataGlove and Body Suit input devices). The DataGlove technology was adapted to an armature equipped with sensors to capture real-time motion data. As the Muppet puppeteer moves the armature, the movements are translated in the puppet reactions. Armature movements are displayed as a wire-frame version of the character. VPL customized the BodyElectric package to enable it to interface with a Silicon Graphics computer since the MAC, used as the interface, cannot do real-time animations. The Silicon Graphics machine is fed motion parameters from the Mac and renders a puppet character software model which corresponds to the armature movements. The puppeteers use the rendered animation as they perform and the data from the selected takes are brought back to PDI in Sunnyvale where the character, along with the required mattes, is fully rendered. The new fully rendered images are sent back to the production facility where an Ultimatte system combines the images with the video layer.[5]

[5] Stuart Cudlitz, MacWorld, June 1989

Post-Production - From Continuity to Editing

The *post-production* process deals with everything from dialogue replacement and music scoring to negative cutting (editing is often seen as a post-production activity, but is often being done as the film is being shot and once sufficient footage has been recorded). It essentially deals with assembling all the screen elements into a linear (or non-linear) story. In the analog world of filmmaking it means obtaining a *release print.* In the digital movie environment such as the one proposed by the *Cinema Server,* post production entails developing a structured database story engine capable of delivering real-time alterable content within the parameters of the producer's vision. In some real sense, this process will parallel and expand what today is called random access editing or non-linear editing.

The vision for the *Cinema Server* prototype is to incorporate non-linear editing so that while the movie is being shot a video tap data stream is being sent to the server, allowing the system to replace storyboards with video. In the following pages we will look at the some of the applications and implementations for dealing with post production including non-linear editing systems and digital audio. The fulfillment of the vision for the *Cinema Server* requires that the server play an integral part of the *shoot* so that it may carry the data into the post-production process seamlessly. Clearly the resolution of digitized video is not suitable for distribution. While the *Cinema Server* today presumes a film-to-digital transfer process, it ultimately assumes the invention of a high-resolution digital movie camera where the difference between the look of film and a digitally compressed image is negligible.

The editing process starts with logging the first film shot and ends with the marriage of the final mixed master sound track and the final cut picture. The job of tracking every scene, shot, and take in a picture (as well as the corresponding sound tracks) is labor-intensive. During a shoot several people on the set are directly engaged in tracking part of the overall data. Most of the essential information is logged and monitored by the continuity/script supervisor. To help track these processes film is manufactured with film edge numbers printed at 1-foot intervals alongside the picture area. When film is transferred to video there is the additional problem of keeping track of where each film image appears on the videotape. This problem is complicated by the need to resolve 24fps film with 30fps video. The accuracy of the film-to-tape alliance is important and personal computers moving into this arena will help to improve and safeguard the translation. The *Cinema Server* prototype as described in this thesis is a thought experiment; if implemented it would be present on the set in some capacity and directly engaged in the logging process, assisting in audio and film synchronization as well as other processes. It is the vision of the server to integrate all the cinematic elements into a tracking database. The following describes some of the computer-based tools recently developed to assist in this labor-intensive post-production process.

EdgeWriter

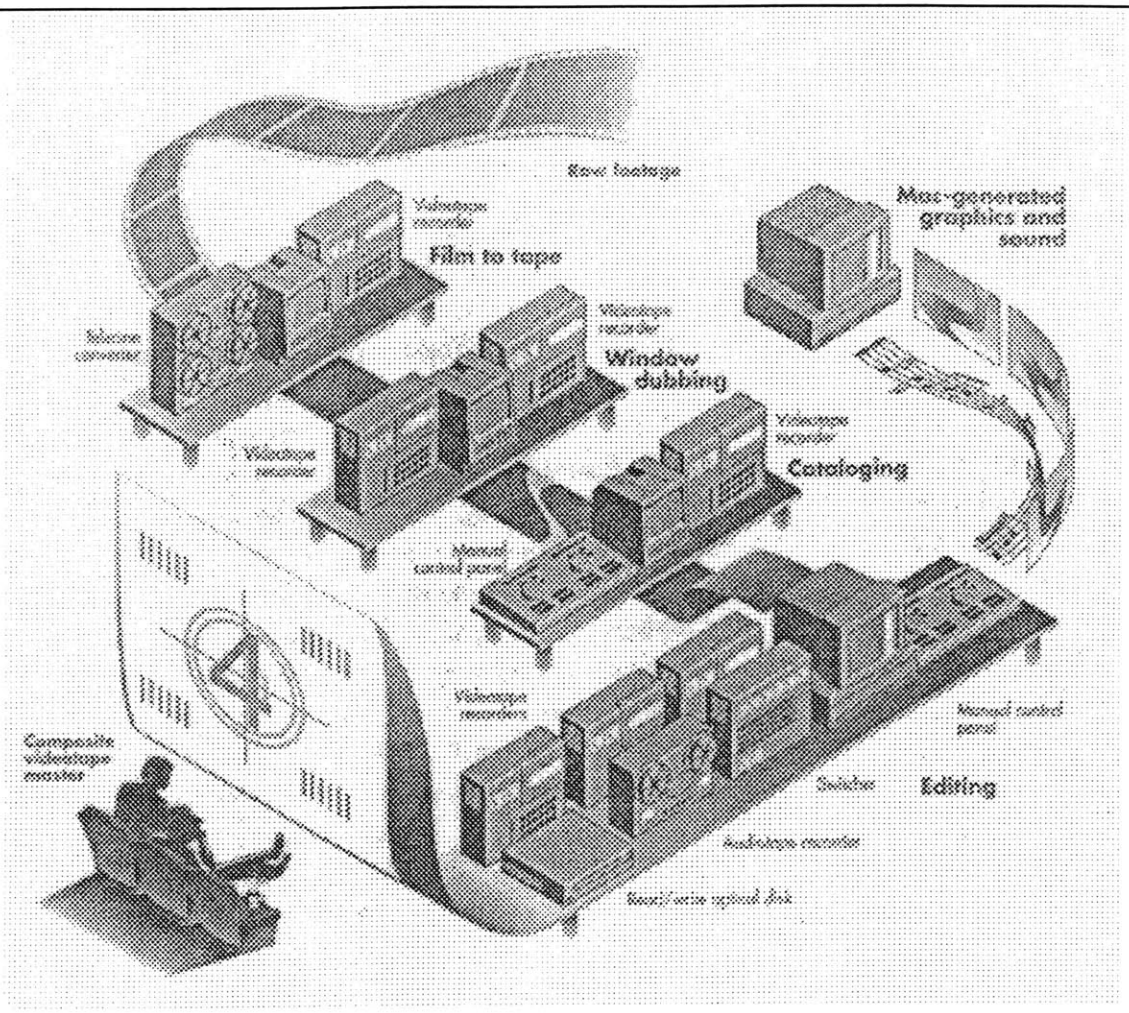
EdgeWriter is a film-transfer and edit-management system that evolved from the designs and engineering skills of Clark Higgins when he worked for Francis Coppola in development of an airstream mobile home, office, conference room, and an on-location film-and-video editing suite called Silver Fish. Higgins and his partner Roger Davis have since developed the technology into a Mac-based platform to control the transfer of film to video. In addition to being able to

control the hardware for the film-to-tape transfer, EdgeWriter eases the process of logging scenes, takes, and shots. Once the film transfer is complete, an Excel log is created for each reel of film. EdgeWriter uses a HyperCard database to manage the individual logs. The resulting shot list are entered into a computer-controlled video-editing system. The EdgeWriter system is part of an integrated system which incorporates VideoMaker (as a video-edit controller), Screenplay Systems software, and Larry Seehorn's Edit Worx.

Edit Worx

Larry Seehorn, of Sunnyvale, realized that when film editors speak fondly of the feel of cutting film, what they're describing is "the immediacy of the thing - make the edit, put it back in the sprockets, and view it." Seehorn's system is designed to provide this flexibility on a video-editing system, offering a single station that controls a video special-effects system (video switcher); audio tape recorders (ATRs); videotape recorders (VTR's); and videodisks, with the input from a high-end frame grabber and EdgeWriter (see fig. 5).[6] The system is Mac-based platform which uses a database program called "4th Dimension." Every sequence logged in the database is referenced by one or more screen icons (PICONS) made from the shots of that sequence.

[6] Stuart Cudlitz, MacWorld, June 1989



A basic Mac-based editing network using Edit Worx. At the first station, film is transferred to tape for a video edit. At the window-dubbing station, SMPTE Time code numbers are added to each frame. Cataloging is the process of assigning labels corresponding to shots and scenes to film sequences. At the final editing station, Edit Worx is used to control source machines and to build a final cut.

Fig. 5, Edit Worx Data Flow
MacWorld - June 1989 pp. 122

"The workstation is a group of tools that ties the script, editing, and catalog together. So, when shooting, one can see what shots are related to what part of the script, and in editing, what shots or script section are related."

Larry Seehorn, (interviewed by Stuart Cudlitz)
MacWorld, June 1989

Before coming to the Media Laboratory, I was engaged in a startup company dedicated to creating an on-line desktop production system. When I visited Larry Seehorn in California I was impressed with his vision of a non-linear editing production system which allowed filmmakers to randomly access and test out editing/story scenarios of their works in progress. Essentially, several computer-based editing companies have made progress in this direction, but without conviction or vision for the potential of the multi-threaded narrative or the potential of digital descriptive story engine interface agents.

Until a real-time image synthesis engine is developed we are forced to discuss the delivery of the multi-threaded narrative in terms of random access editing. Video editing systems as described above were inspired by word processing systems, where cutting and pasting has been possible for a long time. In the context of motion picture post production, the history of computational electronic (non-linear random access) editing has been brief. The following excerpt from the August, 1989 issue of Videography magazine succinctly lays out its history:

An Eclectic History of Nonlinear Video Editing

1822 - First known optical recording (precursor of photography)
1888 - First known proposal for magnetic recording (of sound)
1946 - First known all-electronic memory (vacuum tube)
1948 - First digital tape recording (computer data)
1961 - First digital disk recording (computer data)
1956 - First videotape recorder sold (2"quadruplex)
1957 - First videotape editing by mechanical tape splicing(sound edits determined using ironoxide which illuminated signal amplitude on tape)
1958 - First known proposal for thermo-magnetic recording (precursor of magneto optical recording); CBS airs first full-length edited program, *The Red Mill*, a 90-minute videotape with more than 100 tape splices in it.

1960 - First laser (solid-state -- ruby rod)

1961 - First electronic videotape editor sold; first helical videotape recorder sold -- allows pictures to be seen at other than normal play speed

1965 - RCA introduces a "random-access" video player (2" quadruplex cartridges); first videodisc recorder (magnetic) used

1968 - Ampex introduces videotape synchronizers, utilizing a cue tone

1969 - Ampex RA-4000 random-access programmer utilizes time code (SMPTE standardized time code comes later)

1971 - First true nonlinear video editing system (CMX 600); first 3/4" videocassettes sold

1972 - MCA & Philips demonstrate prototypes of optical videodiscs

1974 - TRI introduces "reel-rocking" videotape editing, allowing frames to be found visually; Sony introduces first 3/4"editing deck; BASF announces plans for a 28-track longitudinal video recorder

1975 - Convergence introduces "joy-stick" editing, bringing reel-rocking to cassettes; Sony introduces Betamax

1976 - JVC introduces VHS; Ampex introduces the EDM-I, an editing system that can "learn" edits and video and audio manipulations and play them back without ever recording anything

1977 - SMPTE begins standardization of the Type C videotape recorder, which, except for its price, might be considered the best offline machine

1978 - First optical videodisc player sold

1979 - Toshiba announces plans for a 300-track longitudinal video recorder

1981 - CBS tells about its random-access multicassette Betamax editor, the first virtual/actual multi-recorder system

1983 - Asaca introduces multi-image viewing for edit point selection; Mitomo introduces a multi-frame video printer and a 100 laser disc changer; Picture Element Limited (PEL) introduces the short-lived Video Sequence Processor including, among other features, random-access editing of short sequences

1984 - At a single NAB show: Montage introduces its videocassette based Picture Processor; Convergence and Lucasfilm introduce their videodisc and videotape-based EditDroid; Ampex, Optical Disc Corporation, and Spectra-Image introduce the heart of the dual-headed, videodisc-based Spectra-System; Quantel introduces the digital disk-based Henry (precursor of Harry) -- all nonlinear editing systems and Apert-Herzog

introduces Step, a multi-frame edit viewer; 3M and Pioneer announce24-hour optical videodisc mastering; Panasonic introduces a desktop full-motion optical videodisc recorder; Spectra-Image offers 24 frame-per-second discs and players for film editing; Videoplex introduces an image combiner for up to16 different moving video images in one screen

1986 - Using Asaca's multi-image viewing system, the Film/Video section from the MIT Media Laboratory demonstrated a non-linear editing system at NAB

1987 - NEC shows a 34 second no-moving-parts all-electronic video memory; Asaca shows a 10 minute erasable magneto-optical disc

1988 - Editing Machines Corporation introduces a magneto-optical disc-based nonlinear editing system at Video Expo New York; Seehorn Technologies introduces Midas desktop production system at SMPTE, adopted by other companies by 1989 NAB

1989 - Videophonics introduces nonlinear editing system based on NEC's solid-state video recorder; of 24 exhibitors of editing systems at NAB, 15 offer nonlinear systems.

Videography Magazine, pp.29, August 1989[7]

While the paradigm we have selected for the *Cinema Server* browser is familiar it has never been exploited in digital format. Although the idea of visual browsing has become an essential feature of random access editing and multimedia systems. Early work at the the MIT Film/Video Section focused on the integration of visual browsing into random access video editors. The interactive documentary, New Orleans in Transition[8] allowed users to draw up browsing windows of picons or keyframes on a query to a relational database, Ingres. However the recent potential for large scale digital storage of motion picture elements makes *Cinema Server* practical. Cinema Server can be distant from non-linear random access editing in its

[7]Mark Schubin, The Rise of Random Access, Videography Magazine, PSN Publication, August 1989

[8]Wendy MacKay and Glorianna Davenport, Virtual Video Editing in Interactive Multimedia Applications, Communications of the ACM, July 1989 Vol 32, No 7

relation to content and its relation to the participant viewer. The following are two examples which used videodisk technology with random access editing techniques to deliver configurable movies.

Elastic Charles

Micons (short for Moving Icons) were introduced as a visual representation for a dynamic movie link. These micons are similar to the scenes which will be digitized and displayed on the video box graphic in the interactive browser. In some stories of the Elastic Charles many micons appear on the screen at the same time. This suggest a complex browsing state which has some parallels to the one we are designing.

Interactive Narratives

Many interactve video programs have been developed in recent years. However, few look to entertainment as their prime market. *"Murder Anyone?"* attempted to address this audience. Unfortunately, the drawing room vote is too contrived an interaction for the reverie which we relate to narrative viewing. *"Interactive Dallas"* was a project developed as a thought experiment by Diana Gagnon at the Audience Research Group directed by Russ Neuman. Material for this project was drawn from scenes which were originally disigned for the linear soap "Dallas." This experiment revealed that although the episodic television soap opera "Dallas" contains many characters interacting in a rapid fire plot, the action is, in fact so intertwined that the story quickly loses coherence when sequences are deleted or reconfigured.

Post Production - Digital Audio

Assuming that the movie has been gathered and assembled within the story engine parameters, the next phase of the post-production process is to put in sound, or build sound tracks and perform the music score(s) to the movie. Since we want to provide the participant-viewer with alterable soundtracks in a digital configurable surround sound environment the producers must establish the parameters for the audio controls which will be made available to the

viewer. The *Cinema Server* environment as described later in this thesis incorporates this vision and maintains a digital audio workstation (AudioFrame) as a integral part of the design so that this vision can be met. The process of using digital tools for sound design and music scoring is relatively new to filmmaking and the recent introduction of digital audio into theaters has demonstrated new possibilities for expression on part of the makers. The following describes the digital audio process.

Cinema Digital Sound

> *Even before the first image was projected, the audience, consisting of some 600 industry insiders, was surrounded by the ambiance of sound so realistic that they, in effect, became part of the story the film was telling.*
>
> Stuart Allan, Film & Video, August 1990

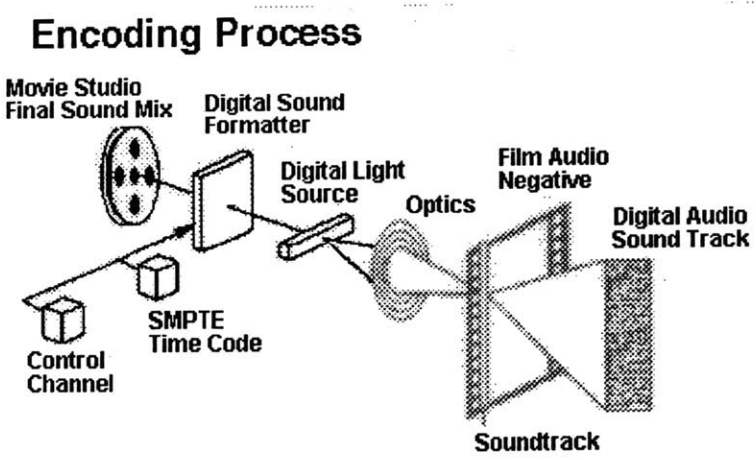
Before Digital Sound, a 70mm analog format movie would have its sound recorded on a magentic track which is coated on the edge of the film after the print is made. The print must wait a day before it can be cured and have sound recorded on it. Recordings are generally made two at a time in real-time, and the audiotrack for each release print must be listened to in order to ensure a quality print for the distributors.

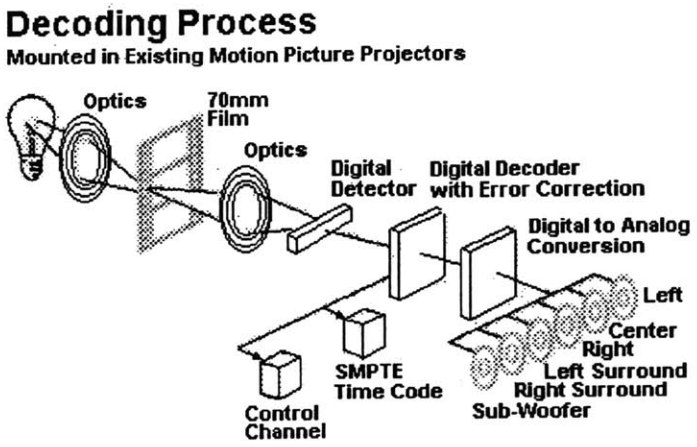
In October of 1988 Kodak and Optical Radiation Corporation joined forced in developing Cinema Digital Sound. As Kodak had been demonstrating a serious commitment in bridging the gap between film and digital technology, their vision for audio was regarded as somewhat less than adequate. Optical Radiation Corporation however, was deeply committed to exploring the audio end of the cinematic experience and it became quickly apparent to Kodak that their R&D efforts should be brought together. The Digital Sound playback system operates

through the installation of a digital head on theater projectors. The digital head reads the data from the print and sends the information stream to a digital-to-analog decoder. The decoder translates the information back to analog signals. An onboard error detection and correction system ensures audio integrity.

> *"Artistically, one of the more interesting developments made possible by the new digital system is the ability it gives filmmakers to localize and move sound anywhere they want it in the theater in tandem with the images on the screen." "...if you give the creative community that tool, some people are going to experiment and stretch the art form by finding effective ways to use it."*
>
> Jerry Kramer (interviewed by Stuart Allan)
> Film & Video August 1990

To demonstrate the technology to the filmmaking community, *Visualize*, a Santa Monica-based production company headed by Alan Kozlowski, was selected to produce a film, entitled "Sounds Like the Reel World." Jerry Kramer (Michael Jackson's "Thriller" and "Moonwalker") was asked to host and direct the film. The relationship between sound and picture has been seriously under-estimated by many makers. Where this new release format does not reinvent the process of recording and mixing movies, it does suggest new possibilities for experimentation and creative expression with the designing, recording and mixing of soundtracks. By controlling the placement, movement, quality and amplification of sound, audio has the potential to become an interactive and integral part of the cinematic experience, and the director can imagine and realize new ways of communicating both powerful and subtle statements to his/her audience. The new technology presents some interesting opportunities for interactive theater environments as well.





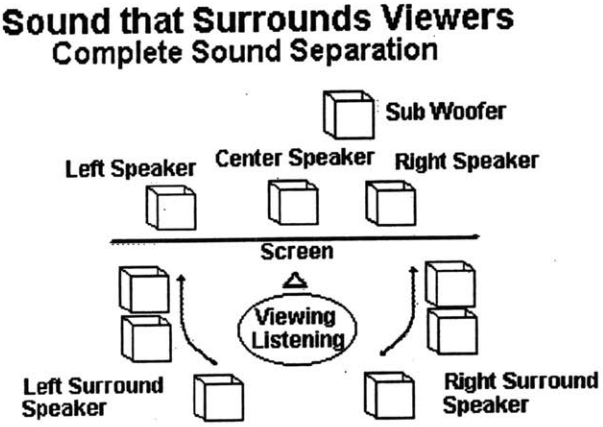


Fig 6, Film & Video, August 1990 pp.33

Since there is a control track on the film designed to work with industry standard digital equipment, it is possible to synchronize in-theater special effects with instructions programmed on prints and for the audio theater to be customizable to its audience size and particularly to their interactions during the film.

> *"With one of the tracks being a MIDI control channel, you now have the ability to sync a piece of motion picture film to a computer to control any number of effects whether it is seats moving in response to a rolling ocean, or lasers firing out above the audience. You could integrate holography and have a spaceship float our over the audience. You now have a tremendous capacity for the creative community to take and say 'wow, what can I do with this.'"*
>
> David Harney, Kodak (interviewed by Allan Varela)
> Post Magazine, September 1990

The first two movies to be released with Cinema Digital Sound were "Days of Thunder" and "Dick Tracy." After a successful debut of two showings of "Days of Thunder" at the National theater in Westwood a processor blew a fuse and the system went down. Paramount pulled the digital prints out of distribution and replaced them with standard 70mm magnetic six-track prints. "Dick Tracy" which was also debuting the new system, did not suffer any mishaps and was well received. Over the course of the next two years most of the theaters here in the US will be retrofitted for Digital Sound including 35mm projection systems. This demonstrates a commitment on the part of the studios to invest in audio and may encourage experimentation in interactive cinema. In addition to digital multi-track audio, Digital Audio Workstations such as WaveFrame Corporation's AudioFrame are receiving increasing acceptance as a post production tool for film. According to my sources at WaveFrame Corp. there is research and development currently underway, in part due to the efforts of this thesis, which will allow the AudioFrame to respond to MIDI signals, enabling them, for the first time, to provide interactive multi-track audio in sync with random access storytelling systems.

Distribution

The final step of getting movies to the theaters is called "distribution" and though it is very much a part of the process it is not often viewed as a production process as much as it is a logistic problem. It involves packaging, advertising, scheduling, shipping and negotiating with theater managers, television executives, school teachers, and film festival committees. In the *Cinema Server* paradigm the distribution channel is easily defined as a "hard disk" attached to a computer which stores movies, hopefully providing a Bulletin Board Service (BBS). The *Cinema Server* specifically recognizes that the distribution channel for digital movies is different than for linear films and is dedicated to providing itself as the mechanism for distribution of these new digital works. Later in this thesis (Section 4.0, Making Multi-Threaded Narratives) I discuss distribution and the importance of having a 2-way system linked to the home, not only to provide feedback from the viewer to the system, but to allow the system to act a Bulletin Board for the viewers own digital movies so that they may be distributed as well. There are several issues which need to be ironed out in order to provide such a two-way service. Most of them are legal issues which pertain directly to such services as Prodigy and CompuServe. However, in essence the *Cinema Server* model removes much of the mayhem of getting titles viewed and provides a browsing channel which can generate revenue. Clearly in the digital domain movies will be removed from the distribution network as it stands today. The *Cinema Server* prototype must act as suitable surrogate to these new digital films in place of that system and generate revenue to the owners of the distribution channel through a new approach in billing. Currently the analog movie must go through some serious logistical issues in order to be widely viewed. The following describes such a process:

Distributing the Linear Movie

The relationship between the filmmaker and his distributor is much like the relationship between the author and his publisher. Often the filmmaker will get a small advance before the film is completed. A filmmaker will also receive a royalty which is a percentage of the profits after the distributor has deducted the advance. Royalties vary depending on the contract, they are not simply based on box office returns or total film rentals. Distributors deduct advertising and print expenses as well as the producer's royalty. In the end, a filmmaker may make as little as 15% of the movie's take. For independent filmmakers the issues of distribution are often dealt with in the pre-production stage. It is much harder for an Independent to get backing for a production without such an agreement. The major studios are tied directly into the distribution network and have no problems getting their films distributed. It is clear among the independents that they must negotiate with the commercial distributor if they want their movie seen. Often, distributors will ask for influence over production decisions in exchange for distribution and/or the size of the advance. A filmmaker who doesn't want to go to a commercial distributor may do self-distribution or work directly with a distribution cooperative. Just about anybody who puts up money for a production wants to have a say in the "look and feel" of the final product, if not for the passion of storytelling then to see a return on their investment. In the case of "Fatal Attraction," where a new ending was shot after audience reaction to a test screening, the concern was the bottom line and not the story. Incidentally, Jeffrey Katzenberg spoke on the issue of Marketing and Testing in his memo; surprisingly, he called for it to cease. "Testing has an aura of science about it. And there is nothing scientific about the movie business."

Audience Participation/Interactive Systems

> *"The more significant distinction between the big screen and the little screen isn't the screen at all. It's the audience. Television is an individual experience. The theater is a communal one and there's something about seeing a film with several hundred strangers that makes a comedy funnier, a horror film scarier and a tearjerker more heart wrenching. The entire range of emotions registers with greater force in the theater."*
>
> Jeffrey Katzenberg, Disney Head

One of the newest results of expanded cinema in relation to technology has been the incorporation of audience participation into the delivery mechanism. Most of the energy put into early experiments has been in the direction of simulation rides. However, at least one large scale experiment now exists where joystick controlls have been installed in a theater providing the audience with direct engagement over story branching or plot directions. The *Cinema Server* model directly supports audience intervention and tools to aid in the development of such productions. It was not my intention to build a movie presentation system that takes the story to a critical point and then asks the viewer to vote for its next direction, but rather to supply the viewer with several cinematic options in the beginning of the movie and allow the viewer to alter the content. It is my feeling that disruption of the story is detrimental to the viewer's experience of it in spite of the alleged benefits of audience intervention. This is not to say engaging movies can not be made within this paradigm, only that a passive intervention is more interesting to this author. It was the intention of the *Cinema Server* prototype to allow the viewer-participant direct real-time control over the sound and sound tracks as well as story branching without having the audience wait. The following describes some of the directions audience intervention has taken in recent cinematic history:

Controlled Entropy

More of an introduction to the technology than a film. Under the vision of Bob Bejan and his partner Bill Franzblau, their company called "Controlled Entropy" premiered an interactive movie entitled "I'm Your Man" on December 16th, 1992 at Loews 19th Street Theatre in Manhattan. Each seat was outfitted with a pistol grip with three buttons that allowed the viewers to vote on plot directions and character actions, ultimately allowing them to alter the movies outcome. It was a 20 minute film, produced for $370,000, shot on super 16mm film and transferred to laser disk. Using a series of disks with duplicate information they could seamlessly make jumps in the story. The movies were projected through two converged hi-resolution video projectors from Sony. Loews theaters, which are owned by Sony and Sony Pictures (New Technologies Group) co-sponsored Controlled Entropy in this effort. Audiences were encouraged to press the buttons on pistol grips attached to empty seats, thereby getting to "stuff the ballot box" in their favor. At the time I saw this laserdisk movie, kids were running around the chairs like ninja commandos controlling the film. They even pushed my hand away from pistol grips to obtain the movie they wanted (I wanted to belt them). I would hate to be in the audience of an interactive "street gang movie" opening in Times Square, New York with this kind of audience intervention encouraged. Not one critic has reviewed the film on its cinematic merit, in part because it has very little, and partly because: How does a critic go about rating an interactive film such as this? Which version do they rate and what is the competence standard?

SIGGRAPH 1991

At the 1991 SIGGRAPH conference an Audience Participation system was tested where the attendees of the conference answered questions and played

games by lifting a wand made up of colored reflective material. One end of the wand was green the other red. Projected on the large screen was a dynamic image made up of red and green dots which represented each seat in the theater. An audience member could identify their location on the grid by lifting their wand and watching the projection screen. Not everyone was successful at this, and some people in the audience asked people around them to flip wands between red and green in unison so that they could find where they were. The red and green reflection were picked up by four three-chip video cameras which were positioned in the back of the room above the catwalk. The cameras were evenly spaced across the back of the room. The two in the center were aimed forward to cover the front audience while the two on the sides covered the back. Next to each camera was a 1,000 watt lamp. When the lamps turned on, the cameras saw a bright red or green spot created by the highly reflective material, called retroreflectors (Reflexite), on the end of each wand.

A geometric model of the room was built in the computer for each of the four cameras. The transformation matrix of the room to the camera image was determined for each camera before the show. There was a program which assigned each seat to a particular camera. This program also told which seats were not visible to any camera.

The image processing software (IPS) for each camera reported the state of each seat for which it was responsible. The IPS code ran on the TI 34010's in 2 Truevision ATVista boards. Each ATVista board handled two cameras taking in only the red and green signals.

The host computer, a Northgate 486PC, ran the games, the setup software and the development environment. It read the state of the seats from the IPS which it used to drive the games. An SGI IrisVision board generated the unencoded NTSC video signal which was fed to the main light valve projector for viewing by the audience. All the signals were synced to the AV master control for switching purposes. The audience was divided in half for a version of the videogame pong. Displaying the green side of the wand moved their paddle up, red moved it down. The audience practiced its controlling skills on a rotating cube, then went on to the flight simulator game.[9]

> *"For most of us, this was our first experience of what might be called a 'group mind,' I am curious as to whether, and under what conditions, such a 'group mind' may be more 'intelligent,' 'creative,' 'wise,' or whatever, than an individual mind. Many people automatically, and dogmatically, take a position affirming or denying any or all of these speculations. They are, in fact open scientific questions, and now we have a tool for exploring them."*
>
> Audience Participation designer, Loren Carpenter
> (interviewed by Computer Graphics),
> a publication of ACM SIGGRAPH

Simulation Rides

> *"Nearly 200 people will be jostled around in sync with the film, running on six Showscan screens, sometimes projected 360 degrees. Six showscan projectors are running all the time in frame-accurate sync to the motion platform. The film and the ride platform are programmed to complement one another, so when the camera goes over the edge the audience will feel an elevator effect. The ride is so sophisticated that those who choose to sit in the center will feel less movement than those who choose to sit on the edge of the platform."*
>
> Boss Studio's President, Richard Edlund
> (as quoted in Film & Video) by Peter Caranicas, April 1991

[9]Computer Graphics, Vol 25 Number 5, October 1991, A publication of ACM SIGGRAPH

In the 1970's Douglass Trumbull and his associates began exploring the potential for higher resolution film technology and came up with Showscan. Showscan is essentially 70mm film shot and projected at 60fps, as much detail as the human eye can see. In 1987, after Showscan went public, Trumbull left the company and started another special effects company called Berkshire Motion Pictures where he has been doing pioneering work in simulation rides. Although simulation rides do not receive feedback from the audience which effects a story path, it engages the audience as a group to share an experience of feeling of motion and remarkable film resolution. These rides are based on a combination of technologies, incorporating film special effects, computer-generated images, high resolution cinematography and aviation flight simulation. The integration of these technologies are spawning a whole new industry for Hollywood and indicate a lucrative future in the area of virtual spaces and interactive movie environments.

4.0 MAKING THE MULTI-THREADED NARRATIVE

> *"Digital post is really another medium. The potential is incredible; it affects every decision you make on the shoot. You don't have to wait three days for the right sky; you don't have to wait for clouds. If you need 40,000 extras for a shot, you only have to shoot 40. And it's all first-generation..." "Screenwriters should just close their eyes and write,...it used to be a sign of inexperience if a writer wrote, '2,000 Indians come over a hill.' But now that's a sign you understand the new potential of film."*
>
> John Clive (interviewed in Millimeter, May 1991, pp25)

Whether the movie is a multi-threaded narrative or a linear film, any good film requires a good story foundation. There are a lot of theories about what makes a good story and I will not get into that. In film school, for better or worse, we learn that the story must serve the Cinematic medium in some respect. We are told "show - don't tell" and forced to find visual means of relating expositional details. Often you'll hear a filmmaker criticize a friends script, "it's a good story, but it's not cinematic." If this were always the case we would never see movies such as "My Dinner With Andre" or "Swimming to Cambodia" which received much recognition for being good films and were, as some would argue, not cinematic. A producer friend of mine once boasted that he wanted a watch with a light switch so that when he was watching a movie in a theater he could check to see if the story setup arrived in the first ten minutes of the film. If not, he would predict its failure. This is actually not uncommon thinking in Hollywood. In just about every Screenwriting book on sale at your local bookstore the formula is the same.

"The next time you go to a movie, find out how long it takes you to make a decision about whether you like the film or not. It takes about ten minutes. That's ten pages of your screenplay. You've got to hook your reader immediately. You have approximately ten pages to let the reader know WHO your MAIN CHARACTER is, WHAT the premise of the story is, and WHAT the situation is."

Syd Field, The Foundations of Screenwriting

If an unusual script crosses a producer's desk which does not conform to the formula, in general, a rewrite takes place and inevitably the square peg will fit into the round hole. It is no surprise that everyone from a 6 year-old to a senior citizen can predict the ending to an American film and why studios have begun to look at the successes of foreign films for ideas and themes which will often contradict the formula. Of course, if there is a remake of a "le Femme Nakita" we can bet someone sitting around the production table has discussed giving the movie an upbeat ending. Examining the formula:

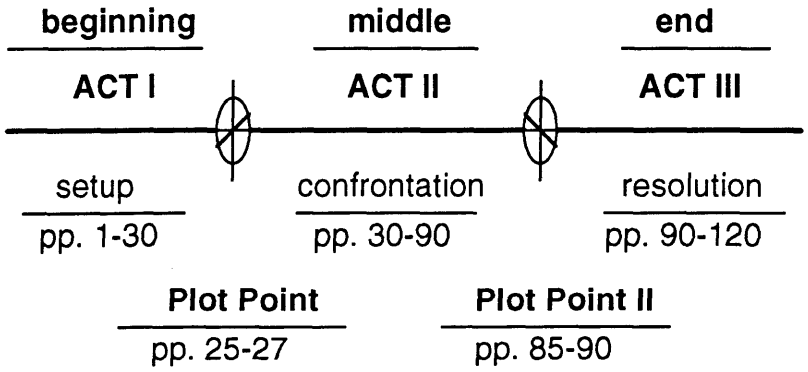


Fig 7, From Syd Fields, "Screenplay, the Foundations of Screenwriting"

Although I could continue with a description of each of the elements in the diagram above I believe it is self evident. Syd Field defines dramatic structure as: "A linear arrangement of related incidents, episodes, or events leading to a dramatic resolution."

This is, in essence, the Formula - however, within this formula exists rules which will often limit the number of "main" characters and force the existing ones into stereotyped performances. Once in a great while unusual scripts get created out of this Hollywood movie engine, almost by fluke. In general, it is the independent filmmaker who creates the movies which become noted for their cinematic style and interesting plots. Take Joel and Ethan Coens film, *Miller's Crossing* as a case in point. Here the characters are not stereotypical: each has some unusual twist to their personality. The story doesn't have a happy ending and yet the protagonist survives an almost certain death. It is the sub-plot which makes the movie great and what is not being said that makes the story interesting. There is no formula in Hollywood for the development of the sub-plot, which is why in most films it is non-existent. Instead, the sub-plot becomes part of a typically underdeveloped character back-story which might explain the characters reason for disliking cops (or, as in the case of *Batman*, why he becomes the Masked Avenger,) but is not directly related to the story itself or the movie's outcome. Although Syd Field is not the only authority on screenwriting, they all conform to this same principal. Syd has gone through the extra effort to make diagrams to explain the theory and for this reason he is fun to pick on, but it is fair to mention that his model for story development is not all bad: it was meant to be a simple model and not the bible on which the religion of screenwriting has become.

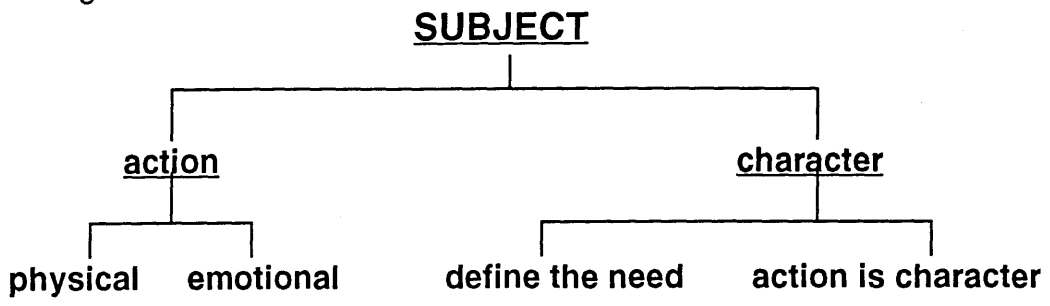


Fig 8, Syd Field, Screenwriting - The Foundations of Screenwriting, pp19

In this diagram we are shown how to deal with story development, essentially the subject of the script. It is explained to us that stories have two kinds of action, one which is driven by some physical effort on the part of the character and one which is driven by the characters emotional need. Most stories are a combination of both; for instance, in *"Dog Day Afternoon"* the character physically robs the bank, but is driven to do it by an emotional center of drama. What is explained to us in story development makes sense, the character should be put in a role and situation which supports the theme and serves the *Story Purpose.* Syd explains that it should be made clear to the audience what the character wants. I disagree with this, because after all, in life, most of us are just faking our way through. In the movie *"When Harry Met Sally"* Billy Crystal's character doesn't know what he wants until the end. Finding out what the character wants is, in fact, the driving force of Harry and Sally's relationship.

The Multi-threaded narrative. Multi-Character\Multi-situational

The formula for linear films, to a large degree, will limit possibilities in story development for multi-threaded narratives. Characters may have more than one emotional need and can find themselves performing a variety of physical efforts which continue to serve the story purpose. If it is the character's action which defines the character and not what he says, then where does this leave us with talkinghead movies and documentaries? It is clear that this is not completely true, and may be why our Hollywood heroes have nothing interesting to say other than "I'll be back" and "Make my day." This theory does serve the "show don't tell" preaching we learn in film school and what we understand as a basic rule of cinema.

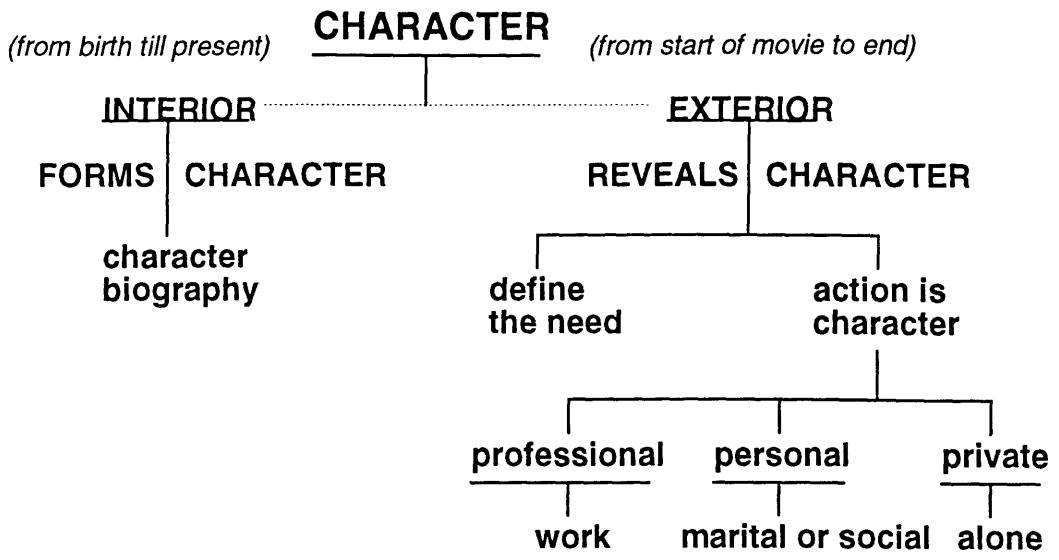


Fig 9, Syd Field, "Screenwriting The Foundations of Screenwriting" pp. 27

Without question, whether the movie is a multi-threaded narrative or a linear movie we must know the subject matter. This means research. The slightest slip in knowing how a character would behave in a given situation can destroy that character's credibility and lose an audience. In developing multi-threaded narratives it is imperative that character actions are defined and tracked in relation to their goals and history. Where this is straightforward in the linear movie, these things become more difficult to establish in the multi-threaded narrative. Multiplying characters or increasing time span of story are two suggested premises which may offer more straight thinking.

Plot Points, Plants, Gimmicks, and the Running Gag

The plot point is an essential device of storytelling. It is the plot point which reveals to the audience the crisis and complications of a character. When plot points are revealed they must be resolved. There may be several plot points embedded in the storyline and each, in some way, should intensify the conflict of

the character or build to a resolution. There is often confusion between *plot points* and *plants*. In bad films the tendency is to not pay-off the plant and/or to unsatisfactorily resolve the plot point. In Batman, plants and plot points are played out one on top of the other in very much a comic book fashion. For instance, when we are introduced to Jack Nicholson's character, it is done using a sound/dissolve transition from a live broadcast of a benefit where the new police commissioner has just been introduced and is speaking about crime. The audience is being informed on the situation in Gotham and is introduced to the mayor. We dissolve into a close-up of a radio playing the broadcast, the radio is in Jack Nicholson's apartment. We see Jack being fondled by a beautiful blonde. It is his boss' girlfriend - Grisoms', Gotham's mafia kingpin. From the dialogue we realize that Jack is nonchalant about getting caught. In fact when the woman comments about what would happen if Grisom knew, Jack replies, "Grisom is an old man...besides he doesn't know." This whole scene is a plot point which is played out in two steps, three if you count the ambush. First, we see Jack arriving at the scene of a crime, where he pays off a crooked cop. Jack doesn't like the cop and bullys him around. As Jack walks away the cop mumbles to himself (the audience), "where have you been spending your nights?" The second step in the payoff of this plot point is the setup by Grisom, filmed very nicely. Basically Jack sits in a chair playing with a deck of cards when the mobster Grisom requests ideas for solving an impending injunction on their chemical plant. Jack shoots his mouth off with a solution and Grisom put's Jack in charge. When Jack tries to weasel out of it, Grisom replies, "...I need you...you're my number one guy." This line is a *plant* which is played out later in the movie when Jack, as the Joker, gives an instruction to his right hand man. For the most part the plot point is paid off in this scene. Logistically, the actual pay-off should be when Jack is ambushed; however it is diminished because the

audience already knows that he's been set up. The ambush scene does, however, pay off Jack's "...think about the future" line when he shoots the cop that told Grisom he was sleeping with his girl. Does this sound complicated? Well, it is. If you haven't seen the movie, rent it and look at these scenes. Imagine now having to develop plot points and plants in a multi-threaded narrative. The scripting system must expand the formula and track the devices. As a development tool for digital movies *Cinema Server* gears itself towards resolving the issues of this premise.

Now that we've stepped through that synopsis, imagine tracking plot points and plants in a multi-threaded narrative which provides the audience interaction with the story line. The database engine which builds the story must have a knowledge base of these plot points and plants so that they are resolved. This also applies to gimmicks, comedy relief, sub plots and running gags as well as other story devices. The database engine and issues are discussed at length later in this section (See The Database and Multi-threaded Narratives). The levels of interaction are many and the medium lends itself to an engaging storytelling system provided that the foundation for the multi-threaded narrative is solid. To backstep a bit, a plot point is an incident or event that hooks into the action and moves the story forward or off into another direction. When a plot point is established, it usually builds across other plot points and the usage of plants to some resolution. Each sequence in any given movie is generally dealing with a plot point, plant or some other device which lends itself to the story by building dramatic action towards a climax and the story resolution.

The plot plant is generally an item of information, either through dialogue, screen action or both. The plant can be easily misused and often there are only one or

two of them in a movie. In Batman there are many, but the dominant one is when Michael Keaton realizes that Jack Nicholson is the robber who killed his parents. He learns this when Jack proclaims, "did you ever dance with the devil by the pale moonlight?" just before firing into Keaton's chest. Keaton remembers this line as the line the robber spoke before shooting his parents.

> *"In Hitchcock's "The 39 Steps"...the fact that the master spy had an amputated little finger was introduced in the first act in the two-shot between the dying female spy and Donat. In the second act the fact was brought out again so that it remained in the audience's subconscious. Then at the end of the second act, as Donat was discussing with a presumed pillar of British society his search for the man with the amputated little finger, the pillar calmly asked, 'you mean this one?' as he raised his hand and showed Donat a hand with a portion of the little finger missing."*
>
> Lewis Herman, "A practical manual of Screen playwriting"

The *gimmick* is another device of the screenplay which is commonly used in Hollywood productions. Its primary use is to create shock. It is used in mystery movies when a new corpse is discovered falling out of a closet, and is often used in suspense/thrillers where a murderer approaches his female victim from the back only to discover just before he strikes that it is a cop in drag. It is the 6th bullet in Clint Eastwoods 45, and it is Madonna revealed as the male criminal at the end of the Dick Tracy movie. Once a gimmick is set up, it must be resolved. If it is used arbitrarily and not integrated into the story it will overshadow the main story line and inevitably disappoint the audience.

The *running gag* is a type of plot plant which is repeated throughout the movie and paid off in the end. Usually the running gag is used as a character developer or as comedy relief as opposed to advancing or serving the plot. In the movie *Silverado*, Brian Dehney constantly teased Kevin Kline about 'the dog"

and his teasing became a running gag in the film. When we finally discover that "the dog" comment was an inside joke about Kevin Kline getting caught robbing a bank because he went back for a dog he loved, we don't even care. Here the running gag was a character developer for Kline: we were to see that Kevin was a bad guy with a heart and that is heart gets him in trouble. This was something we already knew and so the pay-off of this running gag was meaningless.

I could continue with a description of other literary devices which contribute to the storyline. There are many; subplots, minor characters, telegraphing, etc. and all of these require integration into storyline to serve the story purpose through the building of dramatic action, crisis, conflict and complications.[10] In making a multi-threaded narrative many of these devices offer themselves as departure points in the storyline. Where a device such as a plot plant and plot point is established it is clear that they must be resolved no matter how the story moves along this virtual path. Therefore, once a viewer-participant commits to a number of these devices they will in effect reach a "point of no return" where their paths will become limited. The common mistake in early experiments with branching techniques is to only allow the viewer interaction with story possibilities. This is clearly the case with the recent release of the movie "I'm Your Man" directed by Bob Bejan through his production company, Controlled Entropy. The claim that the movie offers 68 plot lines is absurd, in reality there are only about seven. Essentially the only interaction the audience has with the picture is through voting on what action an actor should take in a given situation. The movie design does not allow the viewer any real time processing of image or audio although the technology is in place to perform such a task. Nor does it

[10]Ben Rubin, for his Master's thesis, created under the supervision of Prof. Glorianna Davenport created a constraint-based movie engine. It became apparent that in order to provide a compressable storyline it was necessary to understand story structure.

provide the viewer with levels of violence or sex or alternative ratings. Finally, it offers no transitional effects so the moments of possible interaction are both forced and cinematically abrupt. Overall "I'm Your Man" tossed out many cinematic devices in favor of a story branching system. This does not represent an expanded cinema, rather it can be critiqued as taking two steps forward and then two steps back.

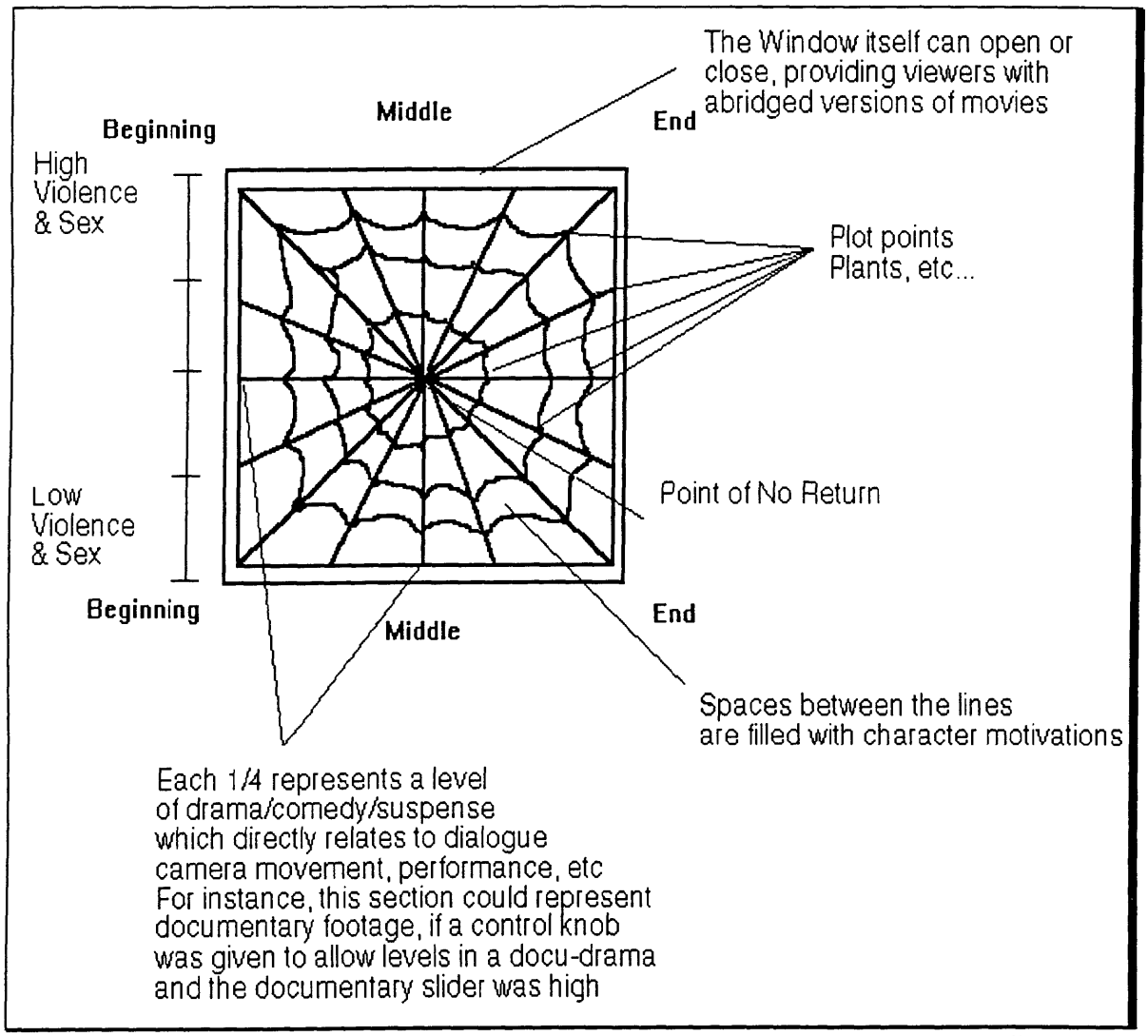


Fig 10, Multi-threaded 3-D approximation story diagram

It is important to develop a new template for building interactive movies, I like the idea of using the spider's web in a window as visual model of how that story

diagram might look. However, in reality we need to think of it as a three dimensional model that cannot be displayed on paper. Figure 10, on the previous page is an approximation.

In addition to providing methods of interaction with story through branching, we must recognize that cinema, the dense language that it is, offers many other methods and devices for audience engagement. Some of these, such as digital sound, can easily be mapped to real-time computer processes. It is very easy, for instance to allow the viewer-participant to control the levels of documentary and drama in a docu-drama or levels of suspense in a suspense/thriller. How these films use special literary devices and stylized camera movements defines the way in which the film is classified; many of the differences in style between a suspense film and a noir detective or a mystery are transparent. When Arachnophobia was released it was advertised as a "thrill-omedy." Upon watching the film it was apparent that the two styles were interchangeable and it was easy to imagine what would have to be done to make the movie more of a thriller and less of a comedy or vice versa. It is important to think about how an interior scene changes when performed outside and about the impact of a scene revealed in daylight rather than at night. What is the difference between having the murderer use a knife on his victim or his bare hands? What is the result of showing the violence off-screen as opposed to a close-up? What happens if the main character is dressed in flamboyant clothes and big hats: will this make him comical or interesting? What is the impact of set design? What influence does a transitional effect has on my experience of a story? The director can extract several performances from the actors with a wide range of results, s/he can do this with the film production crew as well. The results can bring forth a very textured multi-structured cinematic experience, worthy of watching several times

for the cover price of a movie ticket. The following is an incomplete list of cinematic devices which would allow departure points and interaction on the part of the viewer with their experience of the movie.

CINEMATIC LANGUAGE DEFINED BY:

Camera Movement

Handheld
Dolly
Crane
Pan
Tilt
Steady Cam
Static

Camera Angle

Close-up
Extreme Close-up
Med Close-up
Extreme Long Shot
Long Shot
Wide Angle
Reverse Angle
POV
Insert
High Angle
Low Angle
Over the Shoulder
Sequence
Montage
Establishing Shot
Freeze Frame
Stock Shot
Off Axis
Super Imposition
Compositing

VOICE/PERSPECTIVE:

Fly on the Wall
Main Character
Narrator
Author/Director

POSSIBLE SPRINGBOARDS:

Sound
Narration/Music
Dialogue
Internal Thoughts (Subconscious & Memory)
Flashback & Flash Forward

MUSIC:

Rock
Classic
Folk
Country
R & B, etc...

FRAME DIRECTION:

Zoom in /out
Tilt up/down
Pull Focus

SETTINGS:

Interior
Exterior
Day
Night, etc.

EDITING:

- Cutting on Beats
- Cutting for Suspense
- Cutting for Comedy
- Cutting for Action, etc.

Deciding on Beats
Creating Beats

1. Dramatic Action
2. Story Purpose

Cutting on movement
Cutting on Sound (see Sound Cutting)

SOUND CUTTING:
Create Sound links
Create Beats
Creating Ambiance
Creating Climate

ACTING STYLE:
Performance
Method
Ego - Human Element

ART DIRECTION:
Creating Sets
Choosing Colors
Creating Language
Prop Selection
1. Prop appearance
2. How prop is used
3. Interface Design

CINEMATOGRAPHY
(Based on type of film)
Hi contrast
Soft
Hard
Colors

WRITING STYLE:
Defines Type immediately
Defines Dialogue

TRANSITIONAL EFFECTS:
Fades
Dissolves
Intercut
Match Cut
Jump Cut
Wipes
Pan (possible with Digital effects tools)

WARDROBE:
Costume choices
(Authenticity)

DIRECTING:
Human Element
Choices reflect the Directors Vision

COLOR TIMING:
Director's choice

SOUND DIRECTION:
Off Screen (O.S.)
Voice Over (V.0.)
Up
Over
Out
Under

Each section in the above columns represents a point of interaction for the audience or the viewer-participant. When creating a linear film the Director is confined to making a single choice in each of these departments which will ultimately determine the look and sound of the movie. In the digital domain, that is no longer necessary. A director can now make numerous choices and map those choices to movie versions which the audience selects. Therefore we can now have 'The Director's Cut' and 'The Producer's Cut' and four different music scores accessible to the public. We can have the MPAA's X-rated version and

the PG-rated version all on the same system and/or distributed over cable channels simultaneously.

When we project the image of desktop video as an environment where a single creator writes, directs, shoots and assembles a movie on a personal computer, we are asking for everything. We ask that the maker understand scripting and story development in the manner which has been summarized in this thesis. We also ask that they know how to shoot, direct and manipulate images and sound. We also ask that they understand how to program a story on a computer. However we have not yet been able to produce tools which allow them to effectively generate this content. Available tools such as Adobe Premiere, Quicktime (Video Compression & Sound Boards), Morph software, etc... allow us to manipulate images and perform effects on them on the desktop but do not address the problem of getting it there. When we propose the development of multi-threaded narratives we essentially are inviting a production nightmare unless our previsualization and production tools are robust. If we address these issues through further development of the *Cinema Server*, it may be feasible to generate a template whereby the layperson can learn to create their own movies, be they linear or non-linear multi-threaded narratives. Given the movie industries apprehension about spending money and moving forward in this uncharted cinematic direction, it will be largely up to the academic and private sector to perform the necessary research and development to see that these tools are made. The following describes a new software product by a company called Screenplay Systems, the makers of the industry preferred production tool, Movie Magic, mentioned earlier. In essence it reflects an AI program which tracks story devices and assists the writer in resolving plants, plot points, etc. It also brings story development closer to a science than an art form and, although

it demonstrates potential as a development tool for multi-threaded narratives, at this time it does not incorporate hooks into a non-linear form of story development.

Dramatica

From the makers of Movie Magic's Scriptor, Budgeting and Scheduling program; Dramatica (in development) boasts as being a revolutionary new theory of Story that explains WHAT stories are and WHY they work. Dramatica is the first non-dogmatic, content-independent, objectified view of story. Specifically it defines what elements are present in all well-structured stories, how these elements are related, and how they interact. Dramatica sees every character, conflict, action or decision as aspects of "a single mind trying to solve a problem". This mind, the Story Mind, is not the mind of the author, the audience, nor any of the characters but of the Story itself.

The Database and Multi-threaded narratives

> *...aesthetic strategies invented 100 years ago in photography and cinema - scaling, perspective, positive/negative reversals, wipes, mattes - have now become machine elements whose operations are trivially invoked through the preset button. It is a question of primitives. The code is a metamedium: through it, high-level aesthetic constructs from previous media become the primitives of the new medium. This influences which aesthetic strategies will be emphasized. When a strategy that was possible but difficult in film becomes a preset button in video or a command in computer graphics, it tends to be used more frequently. But that does not make it more meaningful. The challenge is to turn 'effects' into expressions, into syntactical units of meaning.*
>
> Gene Youngblood - Cinema and the Code

When sophisticated neural networking software (expert system kernels) become an integral part of operating systems and can track movie production processes over time, we may discover that the knowledge they acquire is useful in creating sophisticated AI narrative engines. The database is the key to the process. The type of database and the design of its logic will determine the success of the first prototypes of these multi-threaded narratives. Where some AI researchers working in the field of narrative intelligence feel that meaning in cinema is derived almost solely from the montage or the juxtaposition of images (frames), filmmakers with a broader understanding of the language conclude that this philosophy reflects a short-sightedness in directed research.

> *The second level of the image as object is achieved through digital image synthesis. Here, because it is a three dimensional database, we can control not only the location of the image-object with the frame, but also its perspective, its angle of view, its geometry. As a result, the synthesized image becomes truly an object, the witness becomes a 'user', and the relation between them becomes not observation but interaction.*
>
> Gene Youngblood - Cinema and the Code

It is important in developing multi-threaded narratives, to keep cinema, as much as possible, in the sum of its parts. In the same way as our genetic code can be considered the database to our existence, and where in each living cell all the genetic information is retained, there must also exist a database for the multi-threaded narrative which is frame-based. Interaction with the database at any given frame represents more than a departure point in story: it creates a new genetic offspring, performing a biological splice which fundamentally alters the viewers experience by generating an entirely different film. What is the frame? In digital media the pixel and the viewing screen become the frame and Cinema becomes a virtual space contained within the boundaries of the viewing screen

which allows the compositing and transformation of images and sound to unfold. This means that every object (including actors) must be considered the result of ever-changing pixel configurations. Pixels are not bound by a 24fps or 30fps speed, but by the speed of the driving engine which is the computational power of the server and the resolution of the viewing screen. Each pixel can be considered as similar to a biological cell. As our cells make us into our physical form, the pixel makes the movie into the physical frame of the viewing screen. Where cinema is the result of the evolution of painting and technology (the lens/camera) it has always been clear to the filmmaker/artist how to design or create within the easily defined boundaries of the frame/canvas. To some extent the frame as the viewing screen remains a tangible canvas for narratives; however, it is no longer clear to the filmmaker how to design for it. Until this is understood, the filmmaking industry will continue to create narratives using the current analog devices and substances (film), digitizing them as necessary for post production or distribution. As long as our scripts are linear and continue to read with screen directions such as "CUT TO:" and "ANGLE ON," then interaction with cinema will be limited, at its most extensive, to story branching. It is imperative, therefore, that the language of cinema be redefined with the realization that the frame has undergone a digital transformation and that this presents new opportunities to the maker and the participant-viewer. The idea of transformation will fundamentally change cinema as an art form. Film schools must embrace this challenge and encourage the exploration of the new cinematic frame. In doing so, the tools required for development of tomorrow's movies will become apparent, and will be shaped by the makers as well as by the software programmers.

In speaking of the frame I am not only referring to the potential of digital images, but also to the potential of digital audio synthesis. The database should consist of sub-programs with links to smaller databases, one for sound, another for props, another for dialogue, etc.... We can imagine that a particular viewer, with interest in audio, may access the database nodes for the soundtracks and do in-depth reprogramming or a re-mix. On a networked system, such as *Cinema Server,* access to any node would require an additional fee on the part of the subscriber. If this subscriber were a talented sound designer and performed a remix which is better than the one released, they could post their remix to the database node offering an alternative viewing experience which another subscriber may select. When their node is accessed, both the sound designer and the original movie makers get a residual payment. For high-concept movies such as *Lawnmower Man*, a subscriber could access the computer graphics files to touch-up and/or replace some of the cheesier computer graphics in the film with their own better graphics. Again, the subscriber would be charged for access to these low-level cinema files, but for each subscriber who accesses the new resynthesized graphic version there would be a capital kickback to the original filmmaker as well as the subscriber who made the new node. If the industry explores these directions in film and networked distribution by acknowledging the financial rewards in leaving cinema in the sum of its parts, this vision will be more quickly realized. Progress in the development of new tools and applications for filmmaking and motion picture distribution will be imminent and new stories will be told in new ways to a growing mass audience of Nintendo groupies entering adulthood.

Non-linear Information Presentation

On the computer we have already seen these directions explored through Hypercard and hypertext programs on the PC and the MAC. Hypertext programs are becoming more sophisticated with added navigational and multi-media hooks. On the PC side hypertext applications are entering Microsoft's Windows domain where multi-tasking is an added benefit. These programs contain two parts: a reading run-time program and an authoring program. Users in navigating through a hypertext document or program can browse or jump around through large volumes of data by 'clicking' on (accessing) links in documents and applications.[11]

It is possible to perform associative linking or "non-linear" writing and reading in many ways, where links between applications and information can be accomplished instantly, seamlessly and transparently to the user. It is also possible for the viewer to trace the navigational path using visual cues.[12] At XEROX's Palo Alto Research Center (PARC) developers George Robertson, Stuart Card, and John Mackinlay have developed an advanced 3-D Information Visualizer. Using methods of human memory enhancement where abstract ideas are fused with three dimensional space, they have developed a prototype of a system which presents data as 3-D interactive objects. XEROX PARC is known for its pioneering work in Graphical User Interfaces and Object-oriented programming systems. Philosopher Robert Fludd of the English Renaissance wrote a treatise entitled, "Art of memory in the Technical History of the Microcosm," which was influenced by Hermetic-Cabalist concepts and was created to hold the entire domain of human knowledge. It has been argued that

[11]Henry Fersko-Weiss, PC Magazine, May 28, 1991 3-D Reading with the HYPERTEXT EDGE
[12]Brondmo/Davenport, "Creating and Viewing the Elastic Charles"

Shakespeare's Globe Theater was based on Fludd's blueprint for 3-D memory visualization. The developers of the Information Visualizer at XEROX use the ideology from this "house of memory" as a foundation on which they built their prototype. They use virtual workspaces called "rooms" and they use "doors" to connect the rooms to each other.[13] Each room and door pathway creates a cluster of related information, each room has a "window" and "objects" which are relevant to a specific task. From any given room another room's "objects" can be viewed through a "window" without having to pass through a "door." This model demonstrates a process of navigation which is beneficial to creating multi-threaded narratives and for browsing through the massive amounts cinematic data accumulated during a movies production process. If we construct a *Cinema Server* database which operates along these lines, where a 3-D database information visualizer and "interface agent" is linked to the viewer-participant or subscriber, we could provide the viewer with an intuitive visual map of their navigation through the material. Networked multiple users might share their maps to create MUD-like interaction. This tracking or memory management system is not only relevant to the subscriber as a record of navigation but also to the field of AI. Integration of this 3-D information visualizer with a neural networking engine would be an ideal program for tracking the movie making processes of the various production departments and could be vital in assuring the success of intelligent cinematic story engines of the future.

[13]Dan Ochiva, Millimeter April '91, Virtual Rooms and the Art of Memory

4.1 DISTRIBUTION - PERSONAL CINEMA

Edison, Muybridge and the Lumiere brothers generated a wave of interest in moving images through their innovation of a motion picture camera. At the time, the purpose of recording motion images was regarded as being one of social utility. The idea of making things visible to humans which had previously been unseen, was offered to a technological incredulous society in the context of a device which could be used to create mass communication and to record historical events. Artists saw within it the ability to seek intellectual, emotional and technological means of altering the ways in which the world could be viewed. Cinema had an unspoken promise of improving and transforming the quality and nature of humanity.

When Edison marketed the 8mm and 16mm cameras and projectors to the public in the 1920's *Personal Cinema* was *still* born. Its purpose was not so much to serve as a social utility or for profitable enterprises, but rather for expressions of personal creativity. The vision was that films could be conceived, recorded, developed, assembled and printed by a single creator. People bought the cameras in herds and began recording personal events and making movies, but when it came time to share these movies with the public the vision ran into a brick wall. Edison owned the theaters and had put in place a distribution system for Hollywood's feature films. Unfortunately, it excluded the films made by the public. Whatever the vision was for *personal cinema* as a form of mass communication, it died struggling for its voice.

Today we have Hi-8 cameras and the ability to record fair quality images with ease and little expense. We can take these recordings to the computer and digitize them where the quality is even further depleted. In exchange for the

poor quality we fool ourselves into believing we have something of value, because we can assemble them and perform transitional effects and mix limited tracks of poor quality audio in pseudo sync. We want to call these trivial digital compositions "movies." Apple calls theirs QuickTime, Microsoft calls theirs AVI (Audio Video Interactive), Intel calls theirs DVI (Digital Video Interactive). I can be as critical as I want with these efforts regardless of their promise because there seems to be a gross lack of understanding from these developers of how short they come to the promise of Cinema, to "improve the quality of life and transform the nature of human life." The public is armed with cameras, (the Rodney King incident is testament to that), as well as the ability to manipulate and assemble the digital stream into syntactical sequences of meaning; but, there exists a failure on the part of the technologists, researchers and prophets to recognize the need for a distribution system for these visions and for the *code* itself to be as transmutable and accessible to them as a sketch pad and a pencil.

It was the experimental filmmakers who moved cinematic language forward. The Trance Films of the 1950's and the Mythopoeic Films which followed gave way to emerging styles such as the Structural Films of Warhol and the movies of Bresson, Renoir, Godard of the French New Wave. Today we witness ingredients from their styles as cinematic devices of the traditional Hollywood narrative. What was once taboo and experimental eventually becomes mainstream. Digital media offers us the power to replace the spoken language as a central method of communication, to expand consciousness and to express the full potential of the human mind. The code is not in the hands of the filmmaking industry, however, and in general there is opposition from filmmakers to welcome it into their lives - much in the same way as Chaplin resisted sound in the golden days of Hollywood. The film schools are not teaching these things

either. I know, because I graduated from one of the best of them. So whether this new promise for personal movies is to suffer the same fate as it did in the 1920's for lack of a distribution system only time will tell. Although digital movies can be played over networks and shared with others in this limited capacity, these stories are not flowing freely through a distribution system which allows me to share them easily with others. We cannot consider networks as a free-flowing distribution system for personal movies until there is a widely available 2-way signal accessible to the public. In all fairness, there is an effort being made in this area of technology. The issues of personal cinema, distribution, and interactive TV, as it relates to cable, satellite, fiber, networks, database management, and intelligent user interfaces (AI - interface agents) seems to be only vaguely understood in the private sector of R&D departments and academic circles. It is time to address cinema as a new art-form which speaks directly to the issues of filmmaking and distribution as it relates to *audience participation* and the creation of *content* for these channels. In the following diagram we see an example of media distribution systems.

THE POLITICAL AND ECONOMIC RELATIONSHIPS OF MEDIA

	MEDIA ECONOMICS		MEDIA POLITICS				
MEDIUM	*Nexus*	*Sales Orientation*	*Channels*	*Access*	*Interaction*	*Distribution Flow*	*Consumer Control*
BOOKS	distribution	object	open	good	unidirectional	discrete	yes
NEWSPAPERS & MAGAZINES	prod./dist.	object, ad space, audience	open	good	unidirectional	semidiscrete mosaic	yes
FILM	distribution	entertainment	open	limited	unidirectional	discrete	some
RADIO	prod./dist.	ad time, audience	limited	limited	mainly unidirect.	continuous	no
CB	manufacture	equipment	limited	execellent	interactive	continuous	no
AUDIO DISCS	prod./dist.	object	open	fair	unidirectional	discrete	yes
AUDIO TAPES	production	object	open	good	unidirectional	discrete	yes
TELEVISION	dist. (prod.)	ad time, audience	closed	none	unidirectional	continuous	no
CABLE	distribution	entertainment	limited	some	mainly unidirect.	continuous	no
VIDEODISC	manufacture	equipment	open	limited	unidirectional	discrete	yes
VIDEOTAPE	production	equipment	open	good	unidirectional	discrete	yes

Nexus: Where does the concentration of economic power lie? *Sales Orientation:* What is the primary product being sold? *Channels:* Are there a limited number of distribution channels? *Access:* How easy is it for someone to gain access to the medium? *Interaction:* Is the medium unidirectional or interactive? *Distribution Flow:* Are the items distributed singly or continuously? *Consumer Control:* Must the consumer/spectator/reader/listener adjust his schedule to the medium's, or can he control the time and location of the experience?

Fig 11 James Monaco, "How to Read a Film" pp.362

The discussion of DATV (Digital Advanced Televsion) almost exclusively deals with the issues of providing delivery of information to the subscriber and providing theories for new technological industry.

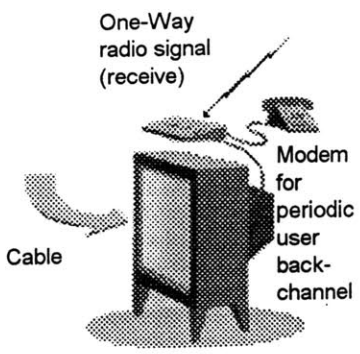
> *"Right now, film suppliers are able to spin millions of dollars from prepackaged product. They have not been, and most likely will not be, willing to gamble those millions on a new technology unless they are certain they can reap more revenue from it than they can from packaged goods. So for the videostore to continue to be the purveyor of packaged-goods entertainment, the studios will need to keep the pipeline open to them exclusively to support the huge business they're doing. The programming question also exposes the major obstacles in the road to Lippman's world of video. The technology may be able to accommodate 500 or 600 different entertainment choices, but what will all those channels play?"*
>
> John Gaffney, VSM Magazine, August 1992,
> Digital Doomsday

A solution to the issue of what to show on 500 channels becomes clear in view of the willingness the public has to produce movies and to the availability of tools which can be provided to them. I predict that the post production houses will generate their own shows, as will advertisers, public access television stations and educational institutions. If we are imagining a home entertainment system with a computer attached to our television monitors, and we are already providing digital tools on the desktop and the ability to manipulate video and multi-track audio, then why not include the public as providers of content in the distribution channel? The crux of the problem comes from the management of all that information. Who's going to do it? Who's going to be liable if a pornographic movie reaches the portable watchman in 9-year-old Johnny's lunchbox? The system will either have to be real-time or administered by

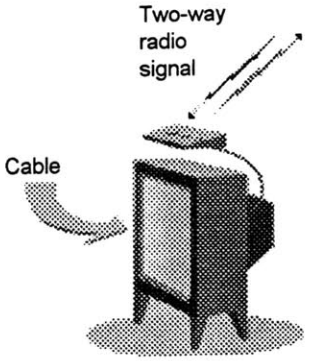
someone. How in a money driven industry will a buck be made, and who will reap the rewards?

> *"Television dominates the social imagination of democracy in the United States: 98 percent of all homes have a TV set, and the average person watches more than four hours per day. If an issue or concern does not appear on television, then, for all practical purposes, it does not exist in the mass social consciousness. Television determines which issues will dominate the public agenda, which spokespersons will be credible, and which trends will be considered critical...There is a way to obtain rapid and representative feedback, and that is by obtaining responses (via telephone voting) from a preselected, scientific sample of citizens to get a reliable sense of overall community views."*
>
> Don Adams & Arlene Goldbard,
> The Independent Film & Video Monthly, July/August 1990

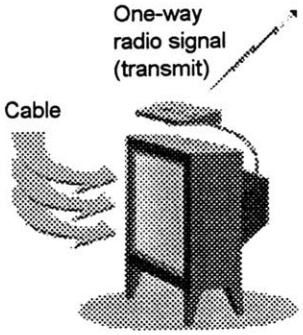
When we realize the massive amounts of video data and stock footage available through special production houses and in libraries, as well as those in foreign countries, the 500 channels begin to fill up rather quickly. Stock footage houses have been making a lot of money providing clients with reels which are later combined with video effects and ultimately transformed into something new. We can imagine these stock footage houses broadcasting their library over some of these channels and allowing filmmakers and the general public access. The public could browse as well as download footage for an additional fee. Providing channels dedicated to movie browsing is an obvious choice and one which serves the position of this thesis (*Cinema Server*). The vision for Interactive Television incorporates several models, some of which are displayed in fig. 12. However, it is imperative that a two-way system be adopted if there will be anything to gain from the owners of the distribution channels. We will not even get into the failure of NBC's 1992 Olympic simulcast.



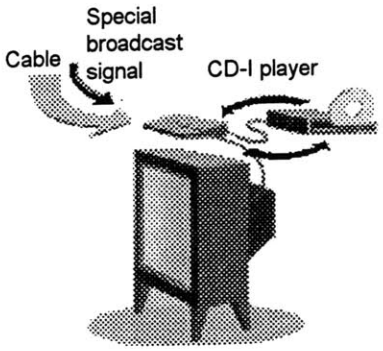
a) One-Way parallel
With systems like Interactive Network, a service provides up-to-date information. For example, questions and and answers related in a format similar to quiz and sports shows may be transmitted completely separate from the television broadcast by using radio. A periodic user back-channel may not be available in the form of a modem link.



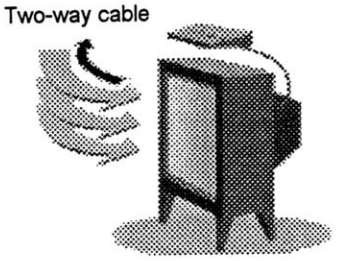
b) Two-way parallel
TV Answer's system is also independent of the broadcast, but users can respond on an on-going basis over radio. In this system, an infrared link handles the communication between a hand-held controller and a device that sits on top of the television; satellites are used on the back end.



c) Customized cable
Primarily used for video on demand, these systems will offer the illusion of interactivity by providing custom programming to individuals. At first, the back channel will be separate, by way of voice, modem, or radio.



d) Local background system
In an upcoming GTE/Phillips experiment, a cable TV station will broadcast a special signal that can activate related background material available locally by CD-ROM. Such a system only works when the programming is set well in advance.



e) Two-way cable or fiber optic
In this ultimate goal of interactive television, the interaction is instant and uses the same medium, whether it's two-way switched cable or fiber-optic cable, using ISDN or another channel switching technology.

Fig 12, New Media, December 1992 pp.29

By providing a two-way signal it is possible for the delivery system itself to retain market information and user knowledge models which in turn may aid the user

with navigation issues. By allowing the viewer interaction, we provide what has been called "Electronic Democracy." If there was ever anything to frighten you about the implementation of digital television technology as it pertains to politics this would be it, nonetheless, it demonstrates a thinking about two-way channel systems used as a feedback mechanism for providing politicians with citizen attitudes.

4.2 OPPOSITION

As with most stories of change, our prediction of future electronic tools and viewing environments is pitted against those who cannot see how change can happen or simply do not want it to happen. Without question, the vision provided by the technologist, scientist, and researchers largely ignore the legal issues and hurdles which will inevitably inhibit swift progress and movement towards the envisioned goals. Pamela Samuelson, professor of law at the University of Pittsburgh School of Law has written many papers and essays on digital media. She outlines the following which has immediate bearing on what is proposed in this thesis:

Ease of Replication:

> "What makes works in digital forms so much more threatening is that the same technology one needs to use the digital work is often the technology that can be used to make multiple copies of the work. Even more frightening, the technology can be used to produce "perfect" copies. Selling computer programs (or for that matter, other works in digital form) has become comparable to selling a customer the Ford automotive plant at the same time as selling him or her a Ford automobile."

Ease of Transmission and Multiple Use:

> "Early efforts to exercise control in the computer software market, through shrinkwrap licenses and copy-protect systems, have not been very successful. Market forces led to the abandonment of copy-protected software because users thought they interfered with legitimate uses of the software. Shrink wrap licenses (which are of questionable legality, anyway) are widely ignored by consumers who continue to use and share software as if they had acquired the software without restriction. Other efforts to control transmission of works in digital form, such as export control regulations, seem doomed to failure in a world in which one can make digital transmissions of protected works to sources abroad through a numberof means. Ease of replication and ease of transmission and multiple use present copyright enforcement challenges of the first order. Together, there will be powerful incentives for the owners of rights in such works to attempt to restrict access and use, and to derive revenue more from uses than from sales of copies. Those who operate computer systems have already developed elaborate systems for restricting access, not only to the computer system itself, but within the system, regulating,

for example, which groups of users have authorization to have access to which parts of the system. Eventually, questions are likely to arise about whether the government should regulate (as it has in the communications market) who has what rights to control what kinds of access to information resources in digital form. "

Plasticity of Digital Media:

"Digital sampling techniques allow one to "chop" a sound recording into sound bites that can be remixed and combined with soundbites from other recordings to produce a new recording which is not recognizable as derived from the original recordings. Photographs can be digitally manipulated to add what was not there, or to remove what was, or to combine photographic elements from many different works (which seem likely to make it much more difficult to use photographs as legal evidence). Computer programs can, by being processed through sophisticated reengineering software or compilers, be transmuted into unrecognizable forms. And these are only a few examples of what is characteristic of all works in digital form: they are all inherently plastic. The plasticity of digital media is not an unmixed blessing. Copyright owners now have more reason to be concerned about what an individual user might do with his or her copy of the work. What if the user now customizes it and resells it to someone else? What if the user changes it in a way that misrepresents what the author meant to say? With a computer program, suppose the user modifies it to correct one error, but in the process of making a correction, inadvertently changes the software in a way that endangers life or property (as might happen with avionics software), thereby affecting the developer's potential warranty liability. U.S. copyright law gives copyright owners the right to control the making of derivative works. The term "derivative work" is defined quite broadly ("any work . . . based upon a preexisting work..."). Thus, the copyright statute would seem to provide some authority for exercising control over what users can do to transform the copies they might have of a copyrighted work in digital form. And yet, much of what a copyright owner might want to control through the reach of the derivative work right is really outside the realm of interests that the U.S. Congress has traditionally meant for copyright to protect. "

Equivalence of Works in Digital Form:

"...copyright has traditionally conceptualized each entity as being only what it is, and not another thing. ...The music and the poem (i.e., the lyrics), if written to go together, are classified together as a musical work. The sound recording, however, is treated as a separate work. Although some works can be made available in different media (music can be written on paper, sung on stage, or recorded on tape), the law still treats each medium somewhat differently. Any work that can be represented in

other media can now be represented in digital form. In this form it can be used in a computer or other data processing unit, whether to be displayed or heard, or to perform some other function. Once in digital form, works protected by copyright are going to become less and less differentiated by type and more and more equivalent to one another because they will now all be in the same medium. This equivalence of works in digital form will make it increasingly easy to create a difficult-to-classify work by combining what have previously been thought of as separate categories of works. (What is an interactive annual report for a company? A literary work? A computer program? An audiovisual work?)

Compactness of Works in Digital Form:

"With works in digital form, users of the work will tend to become much more dependent on user interface systems which will serve as a porthole through which to see the contents of the compact, but nonetheless oceanic, text of the digital work. Unless one can design one's own specialized portholes for viewing the encoded contents of the work, one's ability to access its contents will be constrained by how well or poorly the generalized user interfaces are for accessing these systems. Thus, while compactness is a virtue for users because digital works take up less space than paper, the trade-off for users may be in their greater dependence on user interface systems which will not always have been designed with that particular user's needs in mind. Those who already use computing systems to do everyday tasks will have enough experience with how frustrating it can be to have to deal with an unfriendly user interface to understand how critically important user interfaces will be as access systems in a world dependent on digital libraries and other extensive collections of digital data. "

Nonlinearity:

"It will not help someone, looking through an electronic version of the work for a particular passage once seen in the printed version, to recall that in the book the passage was in the upper right-hand corner on the left side of the page about halfway through. One cannot browse through a book in digital form the way one can browse through a printed book. And yet, there are things one can do with digital versions of text that are, as a practical matter, very difficult or impossible in printed form (such as all instances of the word "glurp" in a long text). ...One group involved in digital library design envisions the creation of "knowbots" to navigate digital spaces to gather what individual users want, maybe even providing users with a synopsis of what it finds. There are a host of new intellectual property law questions raised by the new capacity for searches and linking of works in digitalform. Some of them are copyright questions; some are patent questions. Because works in digital form are processed by machine, it may be possible to patent search and linking techniques

that, applied to works in printed form, would unquestionably not be patentable. ...Among the many copyright questions raised by hypertext forms of works is whether creating a search trail through the digital text is itself a protectable work of authorship -- particularly when one does it within the confines of the copy of the hypertext system copy-righted by somebody else. Another question is whether it is an infringing derivative work to create a program that links a variety of texts and parts of texts together to allow the user of the program to jump from one related part to another but without there being a new, and potentially infringing, copy made of any of these texts. ...Especially for works in digital form, creating links within texts and among texts maybe a kind of intellectual work for which some recompense is appropriate, and copyright law may need to consider taking such links into the fold of protectable expression. "

The Directors Guild of America

On the following page we find a letter and a Summary of the Film Disclosure Act of 1991 which was sent to me from the Directors Guild. It directly opposes everything that my Browsing interface tries to provide. This letter was sent to all members of the University Film/Video Association (UFVA). As the contact person for the Interactive Cinema Group here at the Media Laboratory, this form letter was sent to me, referring to me inappropriately as "Professor."

Filmmakers have the most difficulty with the paradigm of interactive motion pictures, in part because it has for so long been an analog and linear process and there are no examples of such work which are worth watching; and secondly, because much of the teaching and learning about film is directed towards obtaining that single vision.

December 1991

Dear Professor,

Your voice is needed now in the halls of the U.S. Congress. Please join with us in expressing support to members of the United States Senate and House of Representatives for H.R. 3051, The Film Disclosure Act of 1991.

After theatrical release, motion pictures are routinely changed and abused in subsequent exhibition. Grotesque practices like colorization, time-compression, time-expansion, indiscriminate cutting, panning-and-scanning regularly occur without the consent or knowledge of any of the film's creators. The altered version is then marketed as the work of the original artists and the viewers are led to believe that they are seeing that original.

H.R. 3051 would mandate a precise label informing audiences of any alterations made in the original film, and a statement of objection if the changes are made without the consent of the filmmakers.

H.R. 3051 is opposed by those who claim that ownership is equivalent to authorship, that financing is equivalent to creation. They feel an entitlement to deface or destroy the work without notice to the consumers and without regard to the reputations of the true authors. This practice is an irresponsible mistreatment of the national cultural heritage, a damage to the reputation of artists, and a violation of truth in advertising principles.

The Directors Guild of America, along with the rest of the creative community, supports H.R. 3051 as a first step towards protecting the work of film artists and letting the audience know that what they are seeing is not the original, but a desecrated version.

Please take a few minutes right now to write a brief note to your Congressman and Senators on behalf of this important legislation. Your letter can simply be addressed to:

Congressman _____	and	Senator _____
U.S. House of Representatives		United States Senate
Washington, D.C. 20515		Washington, D.C. 20510

Also, please send a copy of your letter to my attention at the Directors Guild ofAmerica, 7920 Sunset Blvd., Los Angeles, CA 90046 as authorization for public use of your name in support of H.R. 3051. Your support can make the difference.

Your support can make the difference.

Sincerely,

Arthur Hiller
President

AH/ls

Summary of The Film Disclosure Act of 1991

American filmmakers -- the directors, screenwriters and cinematographers, the "artistic authors" who create motion pictures seen and admired around the world -- currently have no legal recourse in their native land when their work is colorized, edited and otherwise defaced by technological means. American audiences viewing these materially altered films on television or videocassette mistakenly believe the films they watch accurately reflect the artistic vision of its creative authors. Almost invariably this is not the case. Movie makers believe it is a misrepresentation to imply, as is done in advertisements, that the films shown on television or on videocassette are the same as the films shown as originally released. In order to provide a modest degree of protection to both film audiences and artists, the Film Disclosure Act of 1991 seeks to amend this nation's "truth in labeling" law, Section 43 (a) of the Lanham Act, to require that labels be affixed to films that have been materially altered after their original theatrical release.

The label would require that the nature of the alterations made to a film be spelled out. Also, the artistic authors would have the opportunity to express their objection to these changes. While nothing in the proposed Act would curtail the continued defacement of motion pictures, America's filmmakers would gain a modicum of legal respect as the artistic authors of their work and the American public would get fairer treatment in the marketplace, learning for the first time about the authenticity of the film they are seeing. Despite the simplicity of its objectives, the Act itself is a detailed piece of legislation designed clearly and unambiguously to state the obligations of those who wish to exploit commercially

materially altered versions of motion pictures in America. The following summary highlights the major provisions of the bill: Each public exhibition of a materially altered motion picture and each copy of such motion picture sold or leased to the public (e.g. on videocassette) would contain a label which discloses:

- the fact that the motion picture has been materially altered from Its original version and the nature of that alteration; and

- the fact that the artistic author, i.e. the film's principal director, screenwriterand/or cinematographer, objects to the alteration if he or she, in fact, does so.

The Act protects films which are at least sixty minutes in length and which have been created for public exhibition, performance, sale or lease. Episodic television programs, advertisements, and private commercial or industrial films remain outside its protection. "Material alteration" has been defined to include such changes as colorization, lexiconning, time compression and expansion, panning-and-scanning and editing. Although other changes would also constitute material alterations, these practices are currently the most troubling and widespread, particularly in the television marketplace. The Act would use the "first paid public exhibition of a motion picture" as its reference point for determining when a film has been materially altered.

The bill excludes from the definition of "material alteration" the insertion of commercials into motion pictures, editing for FCC requirements, transferring films to videotape, preparing a film for foreign distribution or engaging in legitimate film preservation activities.

Syndicators, distributors, networks and videocassette manufacturers would make a good faith effort to contact a film's artistic authors prior to exhibiting or distributing the film to determine if the artists object to any of the material alterations made to the motion picture. The artistic authors would also be given the opportunity to object to certain alterations that may be made by exhibitors further down the distribution chain (e.g.television stations). These exhibitors would include their own label if they further alter these motion pictures.

The Act would give standing to artistic authors and their heirs, without regard to nationality or country of domicile, to seek copyright law remedies including injunctions, statutory damages up to $100,000, attorney's fees and, in some cases, punitive damages when the provisions of the Act are flagrantly violated. The Act would also preempt any similar rights created under state statute or the common law. The required labels would identify the artistic author by name, his or her (or their heirs') specific objections to the material alteration and the reason for the objection. The label requirements would be explicit and have been designed so that local exhibitors can easily implement them. Although an important first step, the Act would only provide film artists with a relatively limited right to object to changes in their original works. Consequently, the burden on those who wish to exploit materially altered films would be slight; nothing in the Act would prevent such exploitation or even make it significantly more expensive to do so. This legislation is, ultimately, a recognition that the individual film artist speaks to the public through his or her films as seen. Simply, the Act would give the film artist the opportunity to tell us whether the voice we hear, in fact, belongs to the artists.

E-MAIL Efforts

The following e-mail message captured on net news by one of Interactive Cinema's content cultivators reveals how murky the televsion industry regards its future. The message was forwarded to me on December 18th, 1992 in response to the directed research of this thesis. It tries to mobilize forces in the television industry which would be unnecessary in a digital interactive broadcasting environment. Because it directly points towards creating standards for violence, it is directly related to the violence slider provided on my browsing interface. In my paradigm, the user selects the violence level; in the one proposed in this e-mail message, the networks do. Why would they bother when they could provide three different versions (edits) of any given television show with high, medium and low violence levels and allow the home viewers to watch the one they want? The e-mail message below is printed verbatim from the forwarded message of Brian Bradley to me.

From daemon Fri Dec 18 14:54:56 1992
Received: by media.mit.edu (5.57/DA1.0.4.amt)
id AA27833; Fri, 18 Dec 92 14:54:56 -0500
Date: Fri, 18 Dec 92 14:54:56 -0500
From: Brian E. Bradley <beb@media.mit.edu>
Message-Id: <9212181954.AA27833@media.mit.edu>
To: gmo@media.mit.edu
Subject: VIolence Sliders needed!!
Cc: gid@media.mit.edu
Status: R

Article 1188 of clari.news.tv:
Xref: news.media.mit.edu clari.news.gov.usa:9050 clari.local.los_angeles:928
clari.news.tv:1188 clari.news.top:10467
Path: news.media.mit.edu!enterpoop.mit.edu!eff!world!uunet!looking!clarinews
From: clarinews@clarinet.com (STEVE GERSTEL)
Newsgroups: clari.news.gov.usa,clari.local.los_angeles,clari.news.tv,clari.news.top
Subject: Networks reach agreement on limiting violence
Keywords: usa federal, government, television, media,
general broadcast news, tv & radio

Message-ID: <networksU2DB635pp@clarinet.com>
References: <networksU2DB140pe@clarinet.com>
X-Supersedes: <networksU2DB630pp@clarinet.com>
Date: Fri, 11 Dec 92 18:41:18 PST
Location: los angeles
ACategory: national
Slugword: networks
Priority: major
Format: regular
ANPA: Wc: 378; Id: z6484; Sel: hcngw; Adate: 12-11-635pps; Ver: 1/6; V: ld
Approved: clarinews@clarinet.com
Codes: &ngwrhc., &bivrhc., &etgrhc., xxxxxxxx
Note: MetroWire
(complete writethru -- details, quotes)
Lines: 39

WASHINGTON (UPI) -- The three major networks have agreed on joint standards to limit entertainment violence that should be incorporated into programming by start of next fall's season, Sen. Paul Simon, D-Ill., announced Friday. Simon said that ABC, CBS and NBC have called an industry-wide conference for next spring in Los Angeles. Simon added that he hoped cable television and independents would participate and ``adopt standards prior to the meeting.'' In addition, Simon said that Jack Valenti, representing the motion picture industry, had called to tell he would participate ``and wants to cooperate on this national need.''

The networks were able to consider a joint set of standards through a limited exemption from the antitrust laws proposed by Simon and approved by Congress.

The standards agreed to by the networks would limit:

--Gratuitous, excessive or redundant violence.

--Glamorous depictions of violence.

--Scenes showing excessive gore, pain or physical suffering.

--Scenes depicting uses of force that ``on the whole'' are inappropriate for a home viewing medium.

--Replicable, unique or ``ingenious'' methods of inflicting pain or injury.

--Portrayals of dangerous behavior or weapons that invite imitation by children.

--In children's programs, realistic portrayals of violence (and scenes, images, events) that are unduly frightening to children.

--Gratuitous depiction of animal abuse.

The standards also encourage portrayal of the consequences of violence and the scheduling of programs, including programs depicting violence, with regard to the likely composition of the audience. In addition, the standards urge caution in stories in which children are victims and in themes, plots or scenes which mix sex and violence.

``A free society can solve its problems without government censorship,'' Simon said. ``We are moving toward a solution on this one.'' He said television and the movies have already made an impact by dramatically reducing heroes and heroines who smoke or drinks in excess``and now a second step forward can be taken by deglamourizing violence.''

PART II

IMPLEMENTATION OF THE CINEMA SERVER

5.0 HARDWARE

To develop the *Cinema Server* prototype I decided to use the PC platform configuration. I felt that if I could demonstrate the concept of video browsing through a 3D graphical interface using standard inexpensive hardware the demonstration would have greater impact. Although greater computational power exists on Unix workstations, these machines are somewhat out of reach to the public and do not always demonstrate practical applications which are easily realized in the common market. Not only did I feel that the PC Clone could be pushed to deliver some extraordinary results, but I knew that there was an abundance of off-the-shelf software and competitive hardware add-on boards which could deliver a quality thought experiment in a short time frame. It also allowed me to participate and influence software and hardware manufacturers through development stages of their products. But I quickly realized that PCs and MACs were not the platform on which multi-media/interactive cinema experiments could achieve their greatest potential.

The DVI Board

From the many available video compression boards on the market for the PC, I opted for the DVI ActionMediaII Boardset from Intel. Reason's for this are outlined later in the Hardware section of this thesis. The ActionMedia II DVI (Digital Video Interactive) board did not function to my needs, however. It revealed a short-sightedness in R&D which exists across all platforms and all video compression board manufacturers. Perhaps one of the most aggravating drawbacks to the DVI ActionMedia II boardset was its inability to operate at higher resolutions than 640x480. The lack of generating a SMPTE index number for each digital frame is another significant drawback. Furthermore,

there seems to be a general ignorance as to what purpose such an external/internal sync feature might be used for. In general it is not clear to these manufacturers why we need to have multi-track digital audio in sync with a reliable and syncable video stream. Working with the DVI board, I was able to emphasize this need to Intel and have been able to promote realization of this feature with some of the new MPEG boards appearing on the market. I have also stressed that the DVI board needs to allow the compositing of animation layers with a DVI stream. The significance of this is two-fold. First, if we wish to allow the viewer-participant/subscriber to specify the language of the subtitles for a given movie, then we must be able to overlay or composite the text in sync with the DVI stream. Second, if we ever hope to produce movies such as "Who Framed Roger Rabbit?" on the desktop (where live-action and animation are brought together), then we will have to be able to work with the digital video stream on a "frame level" along with our animation: in other words, we will need to composite. This means either the animation software companies such as Autodesk must allow for these "digital video" hooks into their animation programs, or, the video editing software companies, such as D/Vision and Asymetrix DIME programs, must allow the integration of animation into their editing tools. To be sure, hardware imaging boards such as the DVI board must incorporate these capabilities.

The AudioFrame (WaveFrame Corp.)

Where it is does not appear to be clear to the digital video manufacturers of the importance of having multi-track digital audio in sync with a reliable and syncable video stream, the audio people seem to recognize this imperative in their positioning of their Digital Audio Workstations and future products. The multi-track, multichannel systems, like those from WaveFrame and NED (New

England Digital), are focusing on becoming total digital environments for film audio in the future.

> "The future increasingly points to more integrated facilities in which more and more aspects of film audio are done under one roof and in a single digital domain, and, if evolution follows the trends of the past few decades, a limited number of widely used formats."
>
> Dan Daley, Film &Video, April 1991

When I envisioned the design of the Cinema Server I recognized the importance of sound and the need to allow the viewer direct engagement with it in real-time. I chose the AudioFrame as the Workstation to fulfill that need based on discussions with Chuck Grindstaff, then-president of WaveFrame Corporation. It was clear from our conversation that this was a direction in which WaveFrame was focusing.[14] Chuck offered us an extended loan of the AudioFrame in the early summer of 1992, based on our discussions and the directed goals of the *Cinema Server* as a research project .

Digital Video is a truly non-linear medium. In the same way that word-processors have changed the way people edit text, Digital Video will change the way we edit movies. In the same way that Hypertext has changed the way we read text, Hypermovies will change the way we watch movies. Digital video is much richer than digital text in some ways: it contains images and sounds placed strategically somewhere in time. To make interactive audio that is as complex or more complex than a high quality film soundtrack is a goal that we had in mind when we set off in this direction. Some requirements about audio quality needed

[14]WaveFrame Corporation was purchased by Digital F/X in October of 1992. Digital F/X clearly wants to integrate multi-track audio with its video editing workstations. This demonstrates that the predicted direction for both Digital Video and Digital Audio manufacturers is on the mark. The AudioFrame donated to this research effort, according to Chuck's office, may remain here indefinitely.

to be filled for us to be satisfied with the system we would use. The sampling rate would have to be at least 44.1 KHz, and each sample would have to be at least 16 bits wide for the quality to be on a professional level. There would have to be a way to control the audio from computer, and the playback would have to be fast enough to be frame-accurate. It would have to have multiple tracks, 8 or more, so that many layers could be overlaid to create an interesting soundspace, and all 8 tracks would have to be able to play independently of each other. The last requirement was that the system would have to be able to deliver this throughput for long passages, perhaps even a feature length film.

We knew that this list of requirements would be hard to satisfy, but we went searching for this system none-the-less. The RAM-based add-in card solutions were very interactive, and some could even be stacked to provide 8 independent outputs, but they couldn't deliver the storage we needed to score and mix a 5 minute film (approx. 2.1 X 10^8 bytes) let alone 120 minutes. The other possibility was hard-disk recording systems. These are based on the idea that if you have a fast enough hard disk, you can process and record large amounts high quality sound without having to keep it all in memory. Since they could deliver the same number of tracks at the same sound quality, we decided to explore them and see if we could overcome the inherently slow response of hard disks. It seemed that if Digital Video could play and cut between files seamlessly off a hard disk, why not Digital Audio?

After surveying all the possible systems of the hard-disk design, the most promising seemed to be one made by a company called "WaveFrame". Their top of the line digital audio workstation, called the AudioFrame, fit all our criteria. It

had 8 tracks of digital audio, great sound quality, a Widows/PC based interface, and SMPTE synchronization.

The first problem with the Audioframe was getting the software to work. It had been written in an old version of Windows, and could not take advantage of all the advanced features of Windows 3.1, nor of Ethernet technology (it uses token-ring.) It therefore could not coexist on the same PC as our Digital Video delivery system (DVI) or on the same network that the Digital Video PC was on. This made communication between the video and audio servers extremely difficult. We overcame this problem only partially by using SMPTE time code striped on the audio tracks of the digital video to synchronize the two subsystems. This partial solution created new problems. Since we wanted to simulate non-linear video, we created movies with non-sequential SMPTE time code numbers to see how well the access time of the hard drive could be masked. We hoped that the Audioframe would attempt to chase-lock to the new SMPTE time code numbers, as was said in the manual. Unfortunately this only happens if there is a 0.5 sec drop in the SMPTE signal. If there is no loss of time-code, the Audioframe will ignore the nonsequential SMPTE numbers. When we forced the Digital Video streams to pause between edits, we found that the Audioframe did jump to the right places in the mix, but was very sluggish and inaccurate. After lengthy communication with the design teams at Waveframe, we were told in order to turn off the 0,5 sec drop switch we would need access to the source code, but this, for obvious reasons is not truly an option for the folks at WaveFrame. Jim Mercs, Vice President of WaveFrame disclosed to me the direction they're taking to solve our very needs which entails the use of MIDI to trigger events. According to the folks at WaveFrame this would solve our

problem. However, as of January 1992 this new software upgrade is still in early development stages.

At that point, we saw no further way to synchronize audio on the Audioframe with our Digital Video, so we tried to use the synchronization utilities of the DVI drivers themselves to play audio-files on the same PC that was delivering the digital video. This experiment produced results that were also mediocre, with sounds being played at an accuracy of approximately 5 frames. This was also unacceptable.

The conclusions that we drew from these attempts is that although there is some communication and interaction between hardware and software manufacturers towards delivering a minimum of 8 tracks of nonlinear audio synchronized with digital video, the solution has yet to reach production. There is a company in California called Spectral Synthesis which may have a product that suits the purposes of this project, but time has run out. We look forward to a new Digital Audio Workstation, designed rather than modified to provide random access delivery of multiple tracks. Such a system would have to be much more computationally powerful that a PC (Mac or IBM), and would have to have a different philosophy of the way to represent digital audio. Instead of looking at audio as being made up of "tracks" that are burned with a time code, sounds (dialogue, foleys, effects, ambient sounds, etc.) should be viewed as data objects that have "knowledge" of their own purpose. For example, "dialogue" objects would be sounds that know that they are linked with specific frames by default. Sound effects, on the other hand, could be sent a message of the type: "PLAY AT 01:12:32:11", and would load themselves into memory in time to be read from RAM in sync with the video. Objects are a good way to represent

foleys, because many foleys are used more than once, and rather than having multiple copies of a sound, it is much more efficient to reuse a previously defined object over and over again. I think that by learning what the current state of the art could not do, we learned the mistakes that will be made by all on the road to interactive movies. Now that we know what is needed, knowledge from other groups, such as the Media Lab's Speech Group and Music and Cognition Group, should be used to develop robust, object oriented audio severs to provide interactive audio for Digital Video.

Network Cards

The issue of networking cannot be overlooked. Through discussions with the people at Novell and Anthem Technologies (they make Novell's Network Cards) there is a clear commitment on the part of the network industry to provide digital video throughput. Where Apple and Microsoft make their "software compression" digital video programs network-friendly, the quality is not acceptable for real-time, full screen, 30fps near-VHS-quality resolution with digital stereo sound. Anthem technologies donated three network cards: a high-end NE3200 EISA Card, a standard ISA NE2000 and an EISA NE2100. Where these cards could adequately playback DVI streams in PLV format over the network using FTP software, they could not playback the RTV format in real-time. Furthermore, if they played off of the server while no-one else was using it there was no problem; however, if someone else accessed the server even the PLV format would break up. There are several companies, including Anthem Technologies, manufacturing cards specifically to meet the demands of networked digital video.[15] While these cards make digital video networking a

[15]Three companies I know of, "Starlight," "Protocomm" and "Thomas Conrad" in addition to Anthem Technologies are manufacturing special network cards.

reality, they are somewhat non-standard and many of the device drivers needed to fulfill the basic networking issues under Microsoft windows and off of UNIX (FTP based) servers are not supported. Ideally, the Cinema Server would use a fiber optic networking environment to deliver its promise.[16] Recently, Fluent, Inc. demonstrated for the first time that a single Netware file server can deliver high-quality video with synchronized audio to at least 20 concurrent users over a computer network.

Development Environment

The following is a list and an explanation of the computers used for the Cinema Server prototype:

GERONIMO : PC-Clone configuration
486DX 33Mhz w/ Coprocessor w/ 64MB RAM
256k Internal Cache
Mylex EISA SCSI controller capable
of 33MB Throughput
Video 7 VRAMII Board
NE3200 Anthem Technology EISA Ethernet Board
Nanao Flexscan 9500 21" Monitor
Turlte Beach systems MultiSound 16bit audio Card
Maxtor 200 Lx-218 MB SCSI Drive
Maxtor 1GB PO-2s SCSI Drive
TokenRing Card
IBM (loaned) MAU

Summary: Geronimo - named after the Native American Warrior. One of his greatest achievements was the development of a new unifying language, in essence an alphabet, so that all native American tribes could communicate to

[16]The Media Laboratory is in the pre-planning stages for a fiber networked under the directed efforts of Steve Sausville in System Administration

GERONIMO *Summary (cont'd)*

each other. Geronimo felt that this new language would be the key to their survival. The name is given to this machine as it represents the creation and evolution of digital cinematic language, temporarily given the hideous name "multi-media." In essence, the composition of the language of sound, graphics, video, text, animation, and music. Cinema requires new approaches and tools for filmmaking and provokes new industries and technologies to assist in understanding the intricacies of the immensely analog process of filmmaking. Geronimo was the primary computer used for the development of Cinema Server and is the link between the DVI digital stream playback and the multi-track sound system (the AudioFrame) through the token ring connection.

SITTING-BULL: PC-Clone configuration
486DX 50Mhz w/ Coprocessor w/ 32MB RAM
256k Internal Cache
Data Technology EISA SCSI controller
ATI VGA Stereo/FX
    1024x768 Resolution
    8 bit stereo audio MIDI In/out
Music Quest MQ-32 SMPTE to MIDI board
CNET E900 EISA Ethernet Board
NEC Multiscan 21" Monitor
Maxtor 200 Lx-218 MB SCSI Drive
Fujitsu 2GB PO-2s SCSI Drive
DVI ActionMedia II board

SUMMARY: Sitting-Bull was given its name as it represents another native American warrior who fought and died in the struggle to save a dying nation. The nation of filmmakers in the industry of cinema have long been stifled by the decadence of its blockbuster mentality. The language of cinema is being transformed - not in Hollywood, but on the desktop and in the hands of the hi-res digital movie camera about to be born. Sitting-Bull is the primary demonstration development machine. It is used to capture and playback digital movie streams and is the front end to the virtual server. The right audio channel of the ActionMedia II board sends the analog SMPTE signal to the WaveFrame for

multi-track sync playback. The video feed, through the VideoLogic Mediator, is sent to the Sharp LCD video projector for large screen presentation.

CRAZY-HORSE:

33Mhz 386 w/ 20MB RAM
2 Sony Trinitron MultiSync Monitors
Paradise VGA card
Pro Audio card 8 bit Audio
Dual Sony Speakers
1GB SCSI Hard Drive
NE2000 Ethernet Card Anthem Technologies
Adaptec SCSI Controller AHA-154
ActionMedia II DVI Board

SUMMARY: Crazy-Horse is given its name in keeping with the general theme of the platforms' purpose and the efforts behind this thesis. It is a donated machine from Intel Corporation's Educational Grants Group through my effort to bring non-linear editing to the Interactive Cinema Group. Intel granted this request and followed with a full Media-Lab sponsorship. This machine's primary use is for the non-linear editing software (D/Vision) donated by TouchVision Systems, Inc. It is also used as a backup demonstration platform and is sometimes used as a movie server.

WOLFE-ROBE:

IBM MicroChannel 486 33Mhz 95e
IBM MCA Ethernet
XGA Video Graphics Adapter
ActionMedia II MCA DVI Board
32 MB RAM
IBM SCSI Adapter
300MB Harddrive
1 GB Maxtor P0-2s

SUMMARY: Wolf-Robe was a donation by IBM and its primary purpose is to test new operating systems and beta software. It is essentially the first place to test the interface and will be the primary demonstration platform once the

interface design has been finalized on Sitting-Bull. It is a fast machine and contains a DVI boardset so the delivery of digital streams are possible here.

Videologic Mediator

This device is used to convert the 640x480 VGA computer resolution into an NTSC signal which is necessary for the Sharp LCD Video Projector. The VGA card, through its feature connector receives the composite of the digital video stream. This composite is sent directly to the Mediator, which splits it into two signals: one a VGA monitor signal and the other an NTSC signal.

Sharp LCD Video Projector

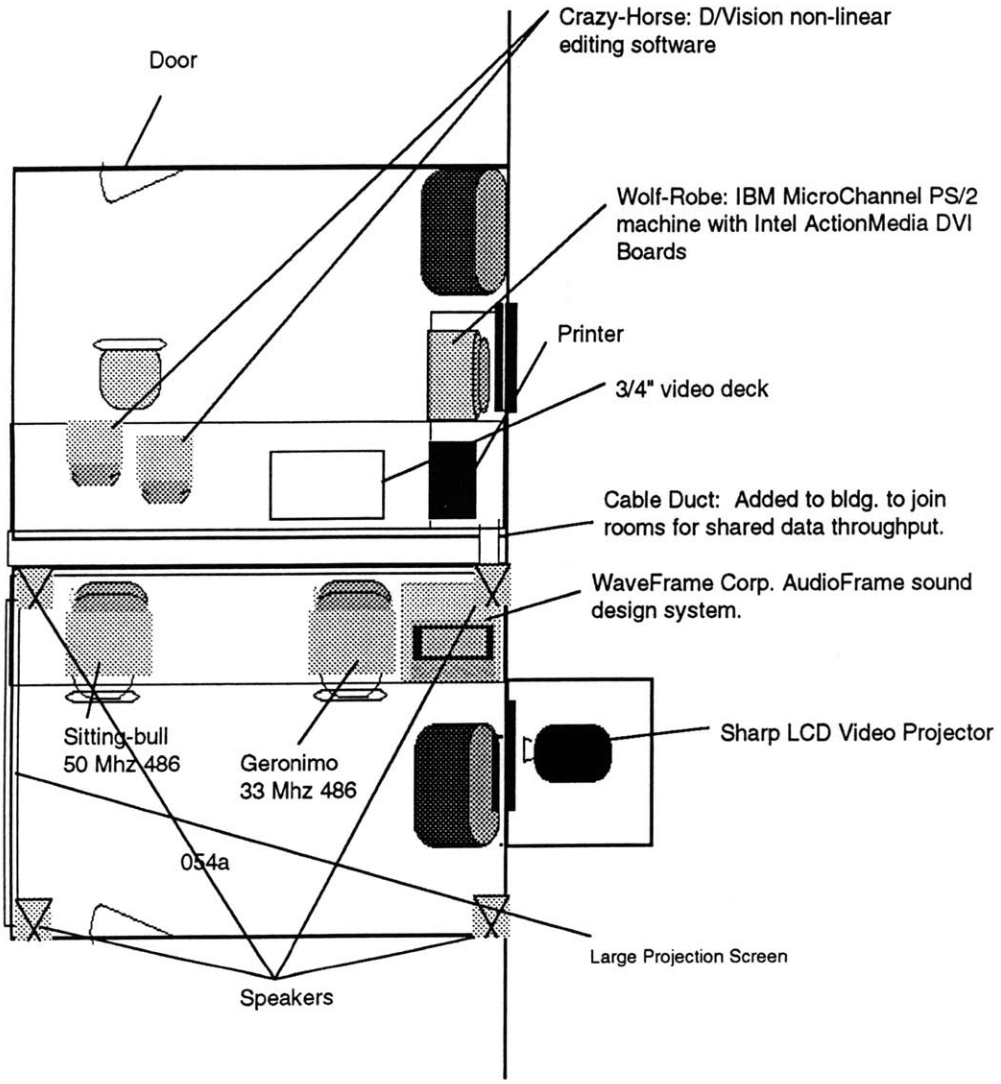
Through my efforts to find a fast way of getting the digital streams on a large screen without having to go through difficult convergence techniques (as is the case with tube video projectors), I promoted interest in my project to Sharp LCD products division and received this LCD projector to demonstrate the Server. Sharp saw this as a way of getting visibility to their products in the context of state-of-the art research projects.

The sharp projector receives the video signal directly from the Mediator (through Sitting-Bull) and Sitting-Bull's Intel ActionMediaII board which passes its streams through the ATI Technologies VGA StereoFX board.

Air-Mouse

Sumantech Technologies. After using an early prototype of their Air-mouse I convinced to send us a newer sleek version (the release product) as I felt that it would showcase their product in a better light. The air-mouse is used to provide direct engagement with the large screen. Placed above the large screen, the airmouse position recognizer, uses infrared to detect the movement of the mouse in the user's hand. It provides a pointer and all "point and click" functions of a regular computer pointing device.

THE ROOM CONFIGURATION:



TOP VIEW

Fig. 13, The Room Configuration

This is the general layout of the environment in which the Cinema Server, the previsualization tools, and the interactive multi-track sound configuration (which

includes dialog replacement, foley placement, and music scoring) was developed. Digital video streams were played off of the hard drive on Sitting-Bull, the VGA signal was split so that the monitor as well as the Sharp Video Projector displayed the streams. When streams were digitized, they were captured with SMPTE on one of the audio tracks. During playback this audio track is sent to Geronimo, which is the interface to the WaveFrame sound design system. The AudioFrame provides interactive high quality audio synchronized to the stream. The user may interface with the browser or previsualization tools, including the database, directly through Sitting-Bull's monitor or by use of Symantech's airmouse directly on the large screen.

5.1 SOFTWARE

The following is a brief description of the primary software tools used in the Cinema Server prototype. Many of the tools which were received in a Beta form and implemented into the Cinema Server configuration helped the manufacturers shape the release product with a clearer view of tomorrow's multi-media environment.

Asymetrix Corporation

MultiMedia Toolbook ver 1.5: Was used as the primary development program for the Cinema Server. I chose this program for the ease of programming and because it did not make sense to spend a lot of time writing a software program for the PC platform - which lacked a true 32bit multi-tasking environment. Multimedia Toolbook is the software construction set for building multimedia application in the MicroSoft 3.0 environment. With Multimedia Toolbook, you can use OpenScript statements or widgets (pre-scripted graphical objects) to control bitmap display, animation, three kinds of audio (waveform, CD audio, and MIDI), laserdisc players and device timers.

DIME software ver. 3.0 (beta): From Asymetrix Corporation, this program is still in beta and is being developed as a non-linear editing system designed specifically for Intel's ActionMedia II Board. Our enrollment into the Beta program came with Intel's donation of Crazy-Horse. DIME's DVI player is used under the Mutlimedia Toolbook and provides the playback of Cinema Server's streams.

Autodesk, Inc.

3D Studio Release 2.0: All animations used in the interface design for the Cinema Server prototype were created using 3D Studio. It is an incredibly powerful animation program and is being imported to the Silicon Graphics workstations and towards the Microsoft NT environment. Having this power in a true networked and multi-tasking environment will generate interesting results on the desktop. 3D Studio is a powerful, high-resolution, 3D-visualization, animation and presentation software package containing more than 500MB of rebuilt 3D objects, textures, animations and text fonts. 3D Studio Release 2 is a

creative and productive graphics tool for three-dimensional design and high-speed rendering on a 386 or 486 DOS system, and is ideal for producing animations and photorealistic still images.

Autodesk Animator Professional: Used in conjunction with 3D Studio this program was used for image enhancement and animation control. Animator Pro is a 2D animation and graphics toolset ideal for creating and producing full-fledged on-screen and video animation. Animator Pro extends the limits of presentation software by providing a repertoire of special effects, paint features, scanned-in images and more.

Animation Player for Windows: Autodesk, realizing that being based in the DOS environment kept it at a distance from multi-media under Windows, supplied an Animation player and MCI (Media Control Interface) driver which allowed animations to be incorporated with Multimedia Toolbook and directly under Microsoft Windows using windows multimedia player.

Microsoft Corporation

Microsoft Windows NT - 32Bit Windows: Microsoft finally answers the prayers of the public by supplying the PC with a true mutli-tasking environment. NT is still in Beta, but upon product release will be the environment under which the Cinema Server, if it is to remain on the PC platform, should be developed using C or C++.

HumanCad Corporation/Biomechanics Corporation

Mannequin: HumanCad's Mannequin program is a PC-based revolutionary software package that integrates human likeness into CAD and graphic software. The innovative program uses an extensive library of ergonomic data that allows users to integrate specific likenesses of men, women, and children of different sizes, shapes, and nationalities into a design. Mannequin allows the user to choose specific body types based on gender, size, nationality, etc. and integrate them into an ergonomic equation that can graphically depict the results in the form of human body likenesses. This program was used in concert with 3D studio, the likeness of the actors in the Coke commercial storyboard system were generated using this software and then imported into 3D studio for rendering.

Macrohard Mirrors Corporation - Dial-A-Movie:

Dial-A-Movie is an integrated Scripting / Storyboarding / Shot Logging / Playback system designed for interactive movie fun! Developed by independent filmmaker and programmer extraordinaire Brian Bradley, this state-of-the-art utility combines the best of Artificial Intelligence and common sense to provide a powerful, easy-to-use, fully-automated movie editor. Dial-A-Movie's customizable control panels allow the adventurous viewer to specify story parameters with ease. Its powerful story-generating engine uses these viewer preferences to evaluate a database of shot contents and continuity constraints, generate all appropriate movie edits, and rank these movies according to "goodness". Any of these movie possibilities can then be selected and played at the push of a button. At any point during playback, the viewer has the option of changing the values set at the control panel: the movie will continue, seamlessly reflecting the updated viewer choices.

6.0 THE BROWSER

The Browsing interface, as described in this thesis, pre-supposes a completely digital environment; movies on demand would be delivered into a digital system in the home via digital channels such as fiber optics, satellite or cable. The environment in which these movies are displayed approximates a "*living-room of the future*"[17] where narratives and info-tainment are generally viewed on large screens through projection or on some other flat panel hi-resolution wall mounted display. There are several issues which confront the filmmaker who decides to develop interactive multi-threaded narratives for such a browser described in this thesis. For such narratives the browser offers navigational and experiential controls for the viewer/subscriber.

To discuss a movie browser which also allows a viewer-participant control over the medium itself brings forth the issues which deal very specifically with the process of filmmaking and its transformation into the software domain. A filmmaker of a digital multi-threaded narrative must learn new techniques for scripting as well as develop new tools for previsualization. It is imperative that the movie is delivered as the sum of its parts, rather than as a hard copy of single vision. This means that all the stages that a release print of a traditional linear narrative goes through before it reaches BlockBuster or the local theater must now remain as vast chunks of data, synchronized with its audio, video and story counterparts; and, it must provide hooks to the viewer-participant's control panel. All sound tracks which were mixed down to the single digital stripe of the release print must become available (in the context of the makers intentions) for the viewers to be capable of altering it. The color timing of the print, the music

[17]Neuman, W. Russell and Teresa Cader. Interactive Video; A Research Report. 1985

score, all the footage, the edit, the theme and the story itself must be flexible, providing expanded possibilities of viewership and experiences of the original vision. There are hurdles to jump: there exists a shortage of filmmakers and producers with adequate knowledge of the technology and a willingness to open up their visions to the dirty hands of its audience. There also exist some hardware/computational limitations which cannot yet provide the real time intervention which in-depth manipulation of the interactive medium requires. This thesis has attempted to come to practical terms with the issues of making and delivery of not only multi-threaded but multi-experiential content. I designed the interface using Asymetrix Corporation's Multimedia Toolbook program under MicroSoft Windows version 3.1, Autodesk's 3D Studio and Animator Professional package, and HumanCad Corp's Mannequin software program. Macrohard Mirrors Corp's Dial-A-Movie program in alpha release was incorporated into the server paradigm in the late stage of development as an extension of a low-end database story-engine thought process. The following description of the *Cinema Server* is a prototype which suggests how it should function if it became a viable service.

Logging In

In a real system, when the viewer decides to watch a digital movie, they must first log on to the movie server supplied by a licensee or the owner of the distribution channel (*Cinema Server*). We envision browsing in three layers, each layer allowing substantially more interaction. We imagine such a server would have a database of subscribers, each with a unique account number for billing purposes. When the viewer dials up to Cinema Sever they are greeted by the Cinema Server logo and theme music (see fig 14).

Fig 14, "Welcome Logo"

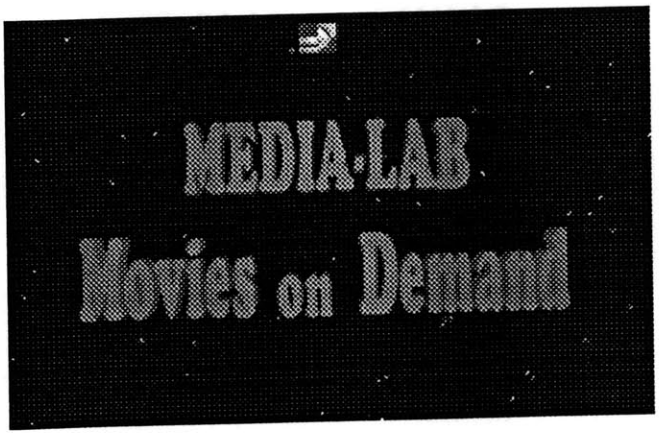


Fig 15, "Media-Lab Logo"

The animation proceeds to bring up a crane and camera mount, the viewer is zoomed into the lens of the camera. The lens explodes and the subscriber is asked to "please login" (fig.16-17).

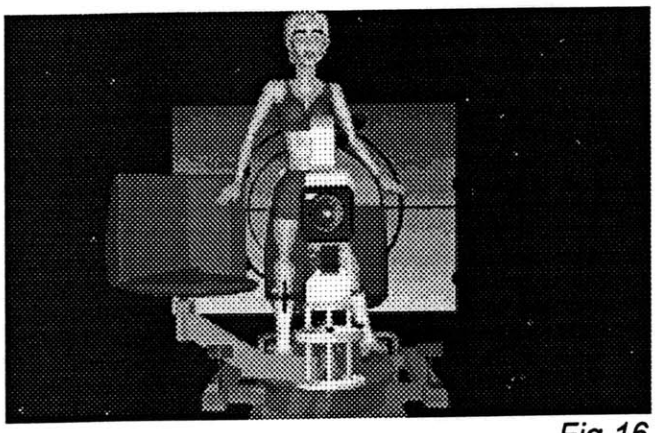


Fig 16, "Hello Dolly In..."

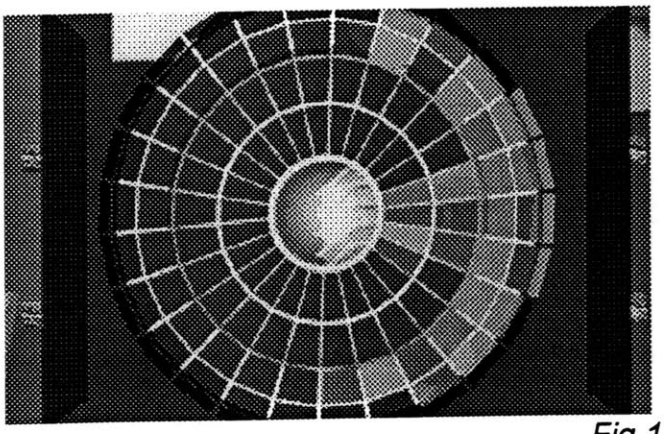


Fig 17, "Into the Lens"

The viewer is given three tries to login correctly. If they fail, they are disconnected from the server. If the login succeeds, their view proceeds through the lens where they are acknowledged by a clapping slate which morphs into the movie palette of digital titles. This movie palette offers the viewer the initial browsing interface, *level 1* of the three browsing and control levels for the digital movie title. Each level offers the viewer varying degrees of database access and control over searches and intervention of a digital movie title. With the first level of the browsing interface, a sub-menu, which is another instance of the Toolbook application, is opened and made available to the viewer. Each of the three aforementioned levels are described in full in the following sections.

Level 1

The browser for the digital interface has three levels. The first level provides a *point-only* level of interaction. From a palette of movie titles displayed as video-boxes suspended in space, the viewer points to a video-box and information is immediately displayed on a Marquis in the center of the movie palette. It reveals to the viewer: Title, director, producer, actors, length of title, rating, and any comments such as academy awards, or special credits which may further entice the viewer to make that selection (see fig 18).

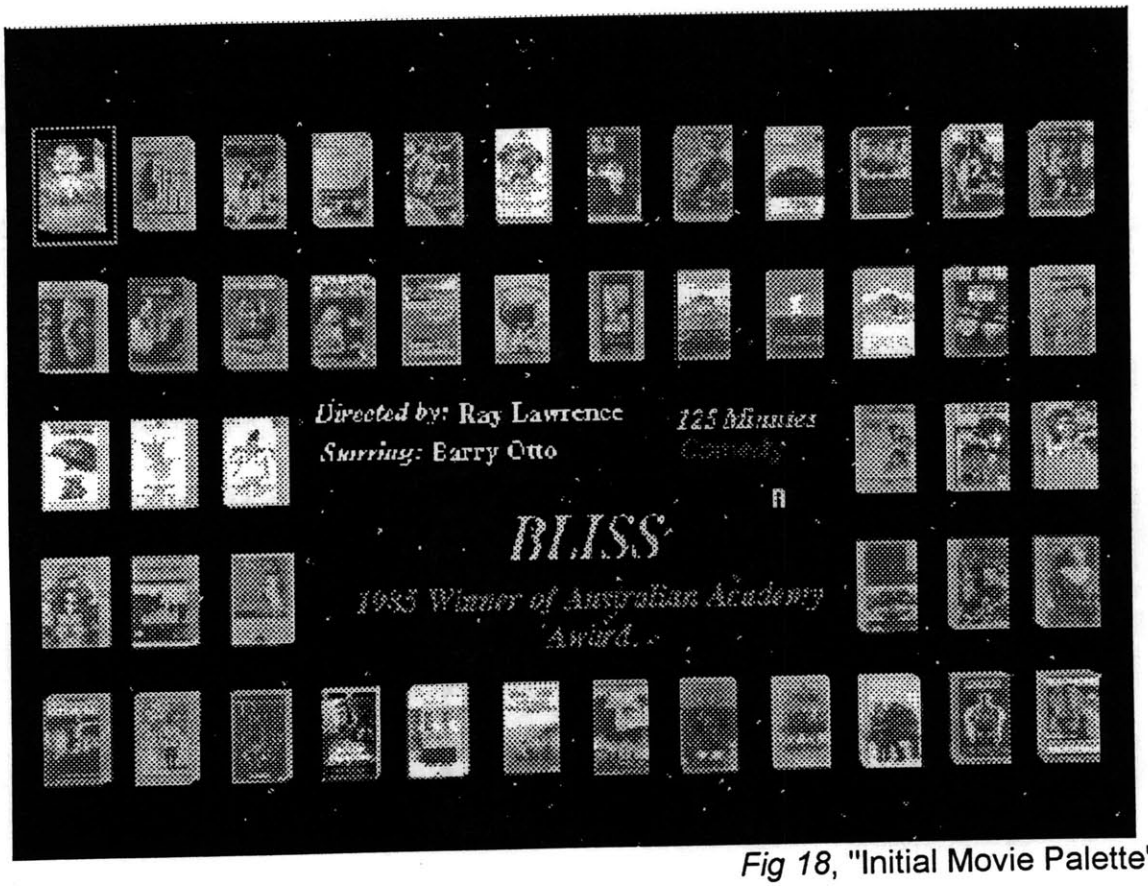


Fig 18, "Initial Movie Palette"

The Submenu of Level 1

If the viewer is not satisfied with the default movie palette, the submenu of the Level 1 interface allows the viewer the opportunity to perform a search based on a number of movie criteria, and to create a new movie palette based on the results of their search. Criteria include a search by: Director, Year Made, Actors, Producers, Awards Won, Budget of Production, Box Office Dollars, Controversy, etc.

When fully loaded, it would be possible for the viewer to read newspaper and magazine reviews, view a digital preview or movie trailer of a selected title, and view digital video television reviews such as Siskel and Ebert, or local news broadcast reviews. There may also exist talk show interviews with actors and filmmakers as well as info-tainment programs such as Entertainment Tonight and "Behind the Scenes & Making Of" specials (See fig. 19). Viewers may spend a lot of time in just this first level of the browser, being charged a fee associated with low level data searches and digital stream processing. At this level they are not allowed control over the selected title, such as altering the rating or changing the music score among other controls.

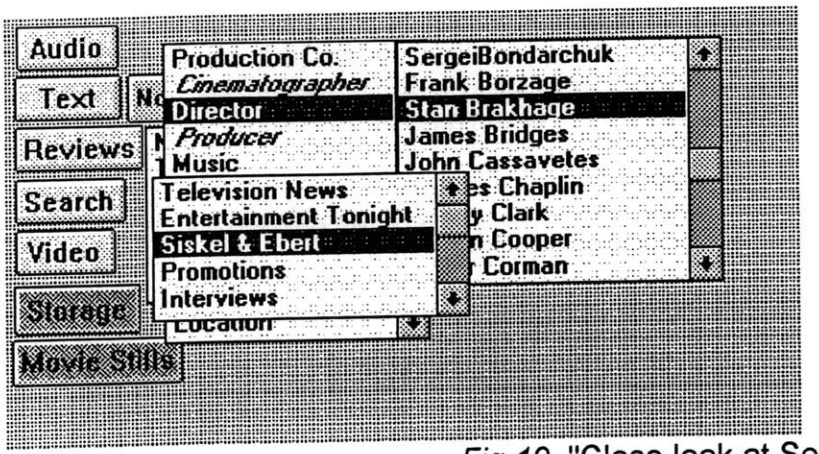


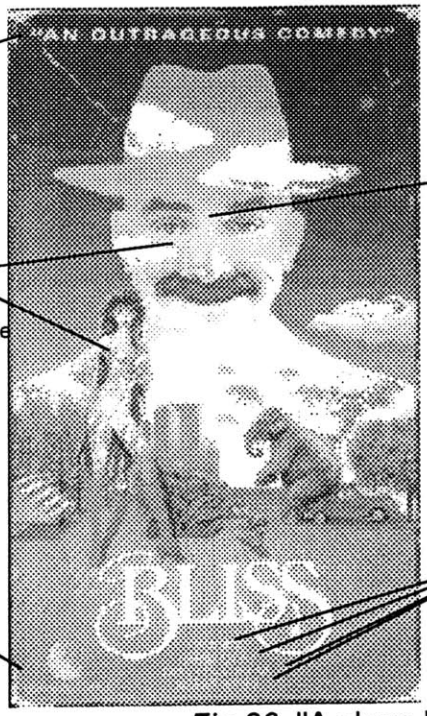
Fig.19, "Close look at Search Panel"

A click on the storage button shows a "popcorn-maker" icon which allows the subscriber to drag and drop movie boxes into the icon for safe-keeping. This will allow the subscriber to vary their selection process according to individual style and mood of the instant. Often a subscriber may wish to glance over more than one title before making a selection. Or, if they wish to view more than one title they may specify the time they wish to view them. When the popcorn-maker icon is accessed, it displays a command-level protocol which speaks directly to the *Cinema Server*, allowing the subscriber programming/scheduling features and to dump the specified titles into the Server's buffer.

Level 2

The second level of the prototype provides the viewer with a point-and-click method of interaction. From the palette of movies a viewer can decide to have a closer look at a particular selection and must remove it from the shelf to do so. By clicking on the selection, the video-box title flips and spins into the center of the marquis lights. Immediately, an actual size hi-resolution bitmap of the front of the box is displayed, the MCI (Media Control Interface) software driver for Intel's ActionmediaII DVI (Digital Video Interactive) board is initialized (transparent to the viewer), and a digital preview of the film is displayed.[18] The hi-res bitmap of the videobox front cover displays the title, further production credits, audio specifications, and the distribution company among other information (information varies from box to box, see fig 20).

[18]We imagine a system which could automatically compile a trailer from the raw digital data, using autonomous agents in an artifical intelligent sub-program (intelligent editor).



A "click" here gives the viewer immediate access to other reviews.

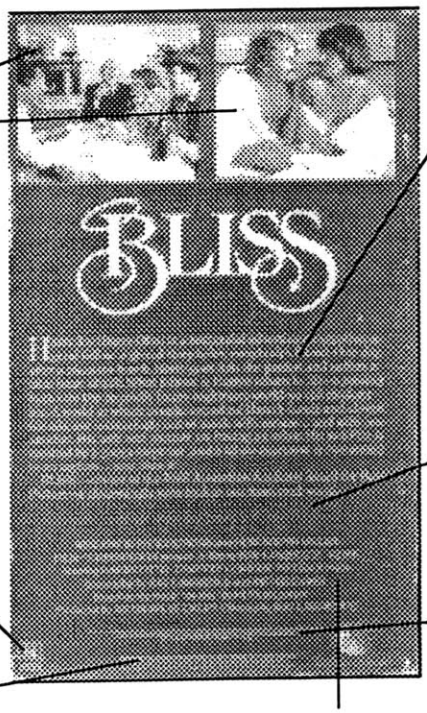
Box covers often are the same as the official movie poster. A "click" here may allow the viewer to order the poster.

Where actors appear in box cover a "click" on the actor's image gives immediate access to other films they appear in as well as a short bio and/or resume if it is on file.

New World Video
The Distribution company - a "click" here gives the viewer access to other movies from this Co.

The Actor's names: this would be the same as clicking on their image.

Fig 20, "A close look at the Videobox cover"



Digtial video previews/trailers are texture mapped directly on the box and play in these windows. Viewers may also access movie stills from these windows as well, photo's can be ordered for the viewer's private collection

Synopsis of the movie can be viewed in hi-resolution window. The viewer can read it or by pressing the audio button which appears with it have it read to them in a preferred language.

By directly clicking on the rating button, a viewer may toggle through different ratings and previews/trailers will adapt to the selected rating.

Movie runtime is displayed here. It can be altered by the viewer where they can select an abridged viewing of the selected film.

A viewer can have access to audio database and select/alter soundtracks and music scores.

FBI Warning

All production credits can be "clicked" allowing the viewer access to production crew profiles. By clicking on the Director for instance, the viewer may view a list and select another movie by this Duirector. A click on the Screenwriter can not only provide the viewer access to the writers bio, including other titles, but allow the viewer access to the screenplay.

Fig 21, "A close look at the Videobox Back"

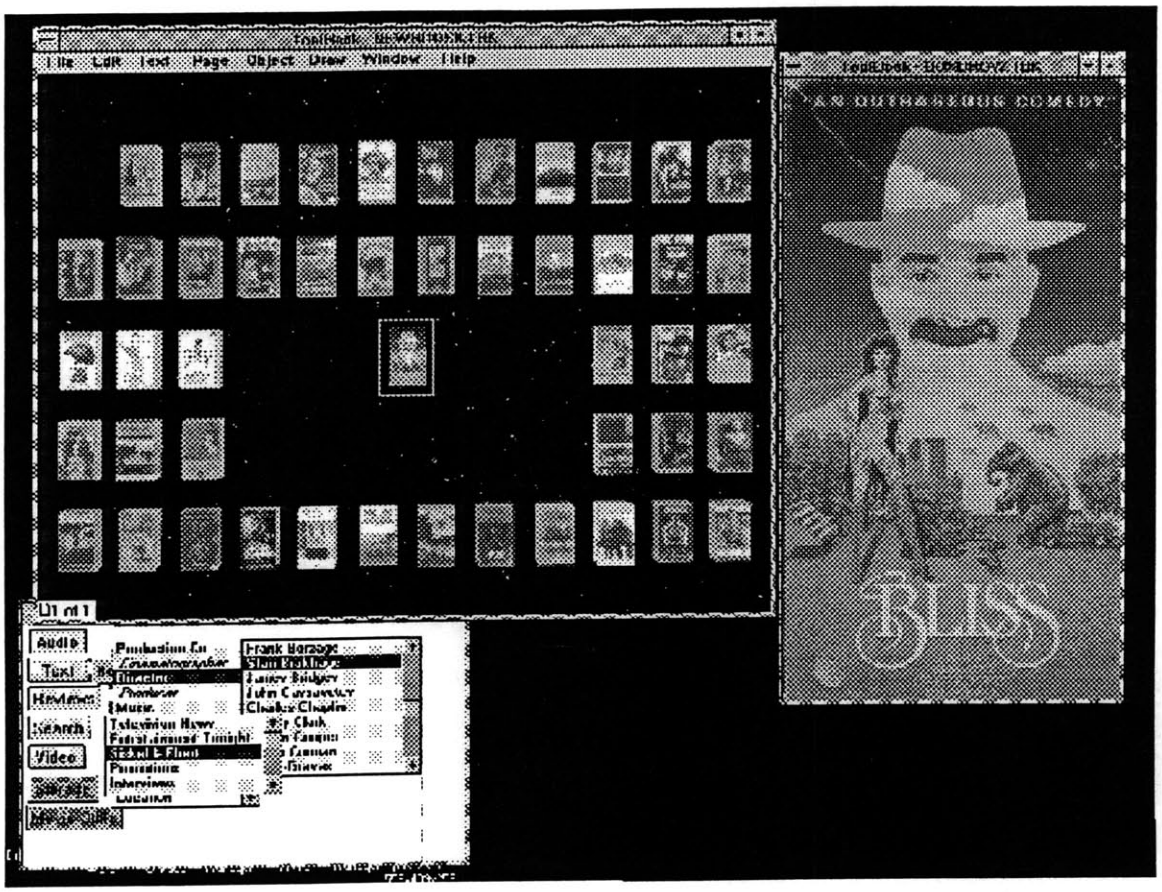


Fig 22, "A View of the Level 2 Screen"

A point-click on the front cover of the bitmap causes a wipe effect across the box and displays the back of the box (see fig. 21, previous page). The back of the video-box provides the viewer with access to movie stills, rating, length of film, and a synopsis of the film in text. A click on any field of data will bring up a sub-menu allowing the viewer deeper data searches: for instance, a click on the "Screenwriter" may bring up background on the writer, other credits, a look at any of the scripts with the possibility for download or printing with an associated fee, a photograph of the writer, an address, a resume? Clicking on the synopsis will bring the text into sharper resolution or a zoomed hilight of the text (text may also appear in different languages). At the same time an audio button appears, providing the viewer with a reading of the synopsis and a choice of languages to

hear the reading in. It is also possible for the viewer to turn on or off the subtitle feature and to specify what language they desire to see the subtitles in (See Section 6.0 "Making the Automatic Trailer" and Section 4.0 "The DVI Board" for more information). By clicking on movie stills, the viewer can access the full printing of all stills taken by the set photographer, as well as access to his/her background and resume. From here a viewer can order copies of stills or request a printing of the poster. From the editor, the viewer has access to editor's logs, script supervisor's notes, Polaroids, etc. From the director's field, the viewer can access the director's notes (audio/text/graphics), storyboards, the director's copy of the script, etc.

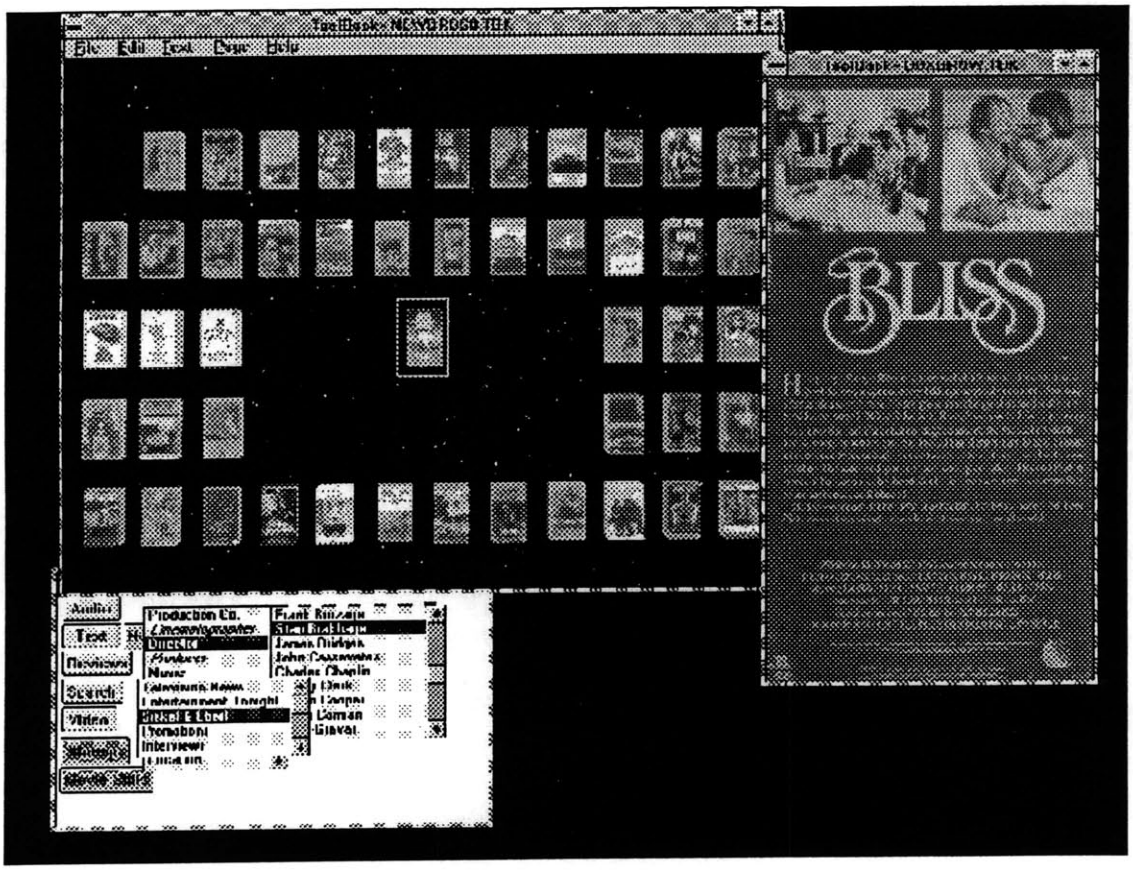


Fig 23, "A View of the level 2 - Box Wipe Screen"

Level 3

When the user is engaged in a selection and has decided to retrieve a particular title from the archive they in effect are requesting access to the higher level deliverables of the Browsing interface. To reach level 3 from the level 2 interface the user is required to "click" on the box displayed in the center of the marquis. Immediately the box begins to spin forward and then unfold into a fully opened videobox. A control panel appears with Violence, Sex, Comedy, Drama and Length of Movie slider knobs as well as a rating control knob. The videobox itself becomes an interactive interface for direct audience engagement (see fig 24-27). The features in this third level of the browser interface provides the user with controls over the content of the selected title. Users may alter length or runtime of a title as well as increase or decrease levels of Comedy or Drama and Sex and Violence. Users may alter these variables in three ways: by moving the slider pods displayed on the control panel, by directly changing the rating using the rating button on the control panel, or by direct engagement with the box itself. For instance, where the rating is displayed on the box, the user may simply click on the hotfield and toggle through to the rating they desire. Where the length of film is displayed they may simply point to the hotfield and they are given a control knob which allows them to alter the length. Where the film "type" is displayed a "point and click" brings up a Comedy/Drama slider which may allow them to increase or decrease the comedy or drama level (see fig 28). If the movie is an action/adventure, they may increase the level of action; and, where adventure implies drama, they may decrease those levels. When a user has made conclusive decisions with these various slider positions they may preview a trailer which best reflects their preferences. Trailers are displayed as digital video clips texture mapped directly onto the box. (See Section 6.0, Automatic Trailers).

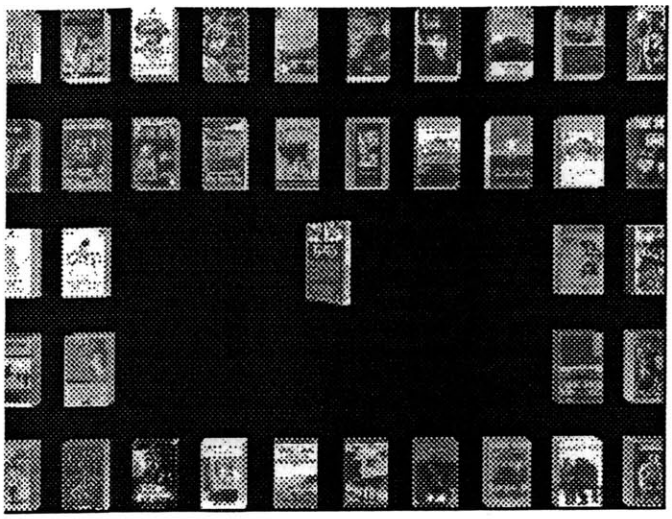


Fig. 24

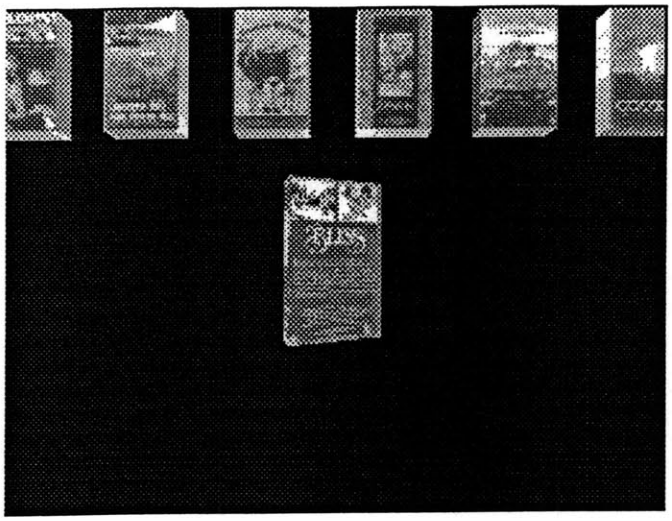


Fig. 25

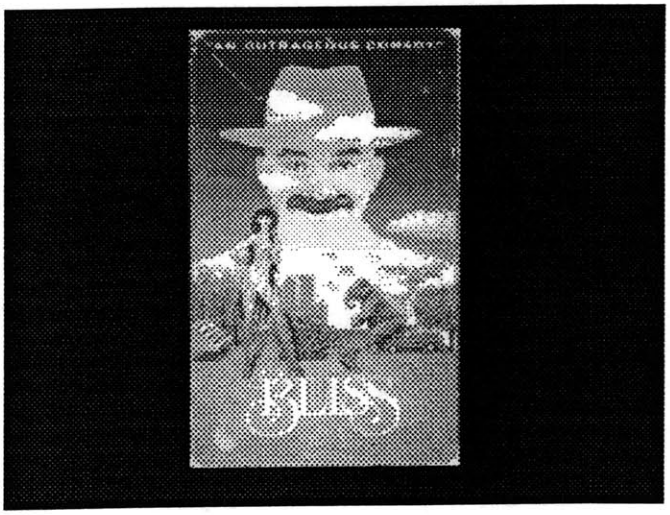


Fig. 26

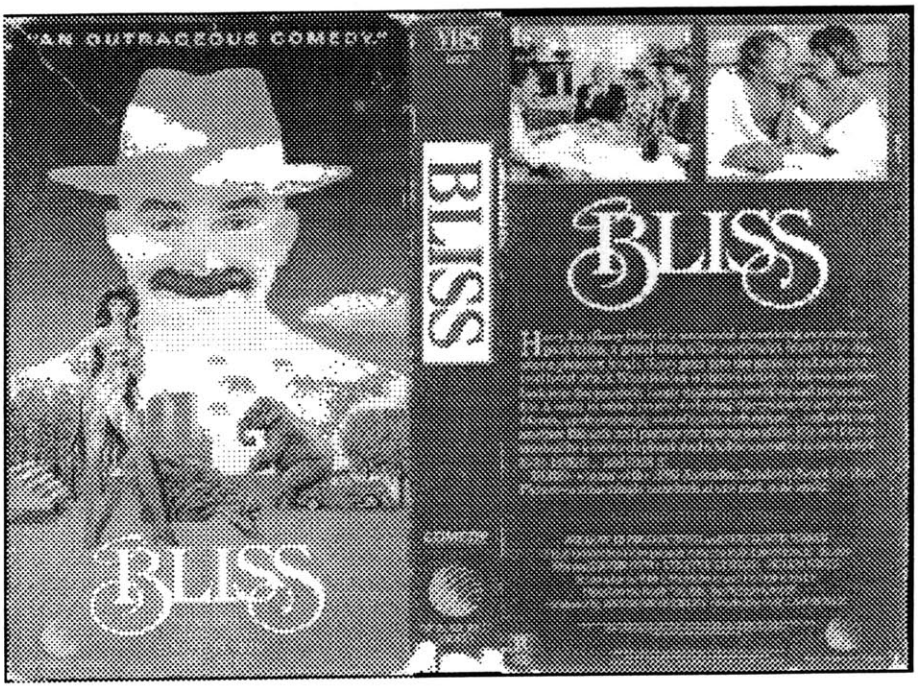


Fig. 27, "The open box interface of level 3"

When the user reaches this 3rd level of interaction they are given a new control panel in addition to the search control panel. This control panel is delivered as a separate instance of Toolbook and has a direct link to the database program in the same way as the slider knobs on the box itself.

There are six control panel slider knobs included with this interface. The Comedy slider has direct result on a general story theme through a loose edit overall digital footage. As *comedy values* increase *drama values* decrease and vice-versa. The control panel provides a subscriber with a twist or slant in scenes which can be more or less comedic. The panel may also provide the viewer with a happy or sad ending. This slider, as well as the Drama slider, has direct engagement with the sound mix and sound design of the digital movie composition. Music scores and incidental music will be altered directly through

these slider positions. The Sex slider has direct results on the delivery of particular scenes or the shots within scenes and the use of profanity in context to sex or violence within all shots.

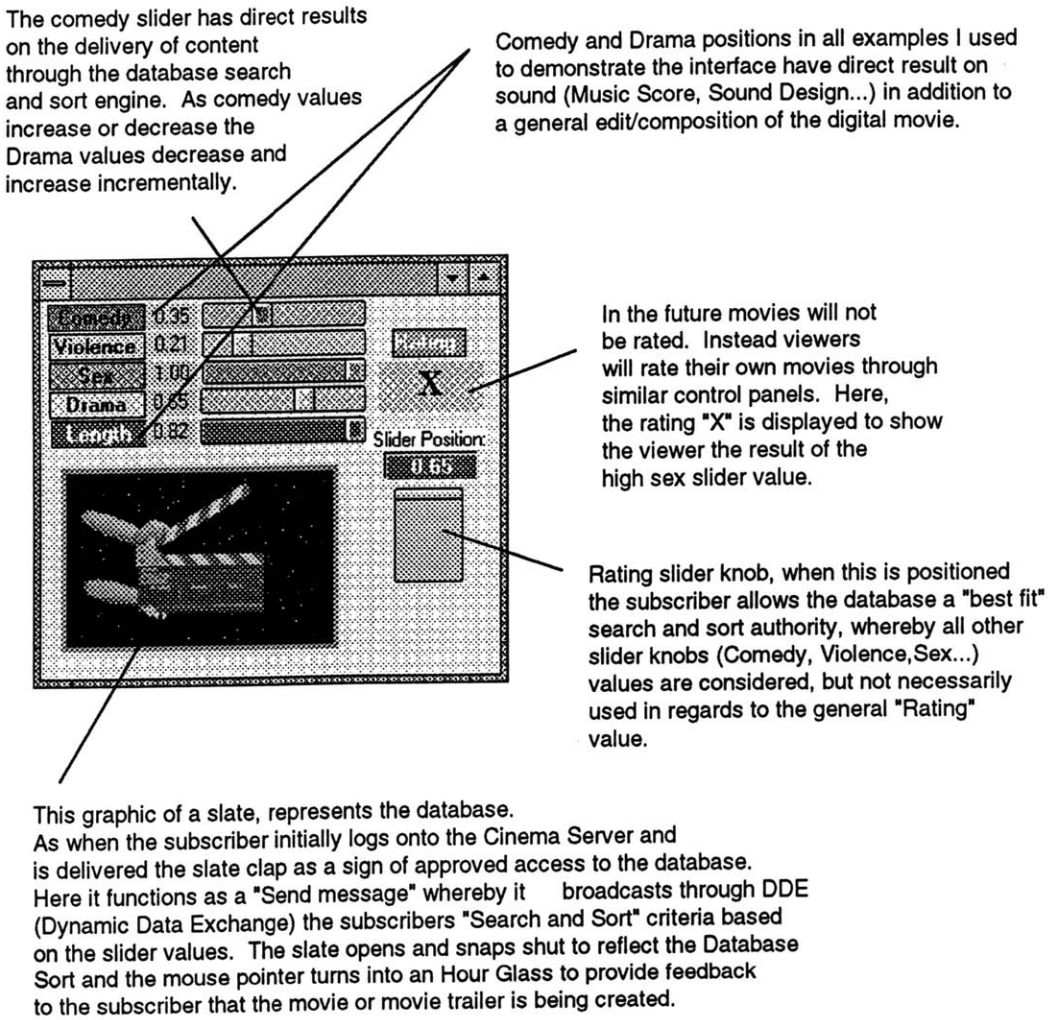


Fig 28, "A close look at the slider control panel"

The values associated with what I consider profanity or high in sexual content may differ greatly between individuals. It is therefore essential that an artificial intelligent interface agent application be developed to learn about the user's preferences. Once a user profile has been obtained, the interface should structure a search and sort database logic based on this knowledge.

The Violence slider operates in the same fashion as the Sex slider only it directly engages the database on a context *search and sort* based on the level (value) of violence within scenes or shots. To give the subscriber a notion of the violence contained within the digital title without revealing an essential story element, the database will call up previously annotated or system set photos (bitmaps) which reflect violence and the value of the violence slider knob. Again, these photos may be replaced by the movie clips from previously viewed titles which had been annotated by the subscriber. The Length slider is self-evident as it provides the subscriber with an abridged or extended version of the film. This could remove non-essential scenes or add lost footage to a digital title. The Rating slider knob is yet another control interface to the digital stream. When the Rating slider knob is positioned the subscriber defers the slider value preferences from all other control sliders to itself, whereby the other settings are considered, but not necessarily used in regards to the general rating value. Therefore, a subscriber may set the "Sex" slider to a high rating which classifies the movie as an ***"X"***, however if they select a rating of ***"PG-13"*** through the rating slider, the value given by the sex slider is ignored and sexual content submits to the general rating of ***"PG-13."*** A subscriber may provide a lock-out feature on the control knobs so that parents or guardians may have control over what their children watch. The general rating of the movie qualifies as a filter, much like the manual edit filter used to provide movies on airlines.

7.0 THE STORYBOARDER / PREVISUALIZATION TOOLS

Previsualization Tools - My Storyboard System

It is clear that the flow of information on the set is dense and errors which may occur during a shoot can be costly. For this reason previsualization tools exist and there is a dedication among some makers and studios to carefully track the flow of information and production processes. Pre-production is a key element in getting a picture shot on time and on or under budget. In proposing a future cinema in which an audience can intervene and modify the presentation of a motion picture, we are substantially increasing the risk of costly errors in production. The previsualization tools, scripting program, budget and scheduling program, and the database engine for the delivery of multi-threaded content must be in place before production begins. The first question to ask oneself before deciding to go into any production are: Why? - Why do I want to tell this story? What? - What is my story and What makes this story interesting to tell? How? - How will I tell this story? Who? - Who will want to hear this story and Who (with money) would be enthusiastic about joining me in this endeavor? When proposing to create a multi-threaded narrative these questions are even more difficult to answer, because we are no longer are talking about creating one story but possibly several through one production. The previsualization tools therefore are to previsualize all the possibilities a viewer-participant would have access to.

The range of experiences available to a viewer depends on how well the story is developed and to what end or ends is the story dedicated to serving. In screenwriting we learn that stories are driven by a "story-purpose" through a "theme" - thus, when someone asks what is your movie about, we do not say, "its

about a man who is abducted by aliens and falls in love with another abductee - and when given an opportunity to return to earth he must choose between true love and what might be his only chance back home." Instead, we say "it is a story about finding happiness in the strangest places," or "it is a story about choosing between living and loving." The theme, we might say, is "loneliness sucks." We begin from here - the story is told with this theme and story-purpose in mind. The variations on the theme and story-purpose - including the ending(s) and how the protagonist gets there - will depend on the interface we provide and the database engine of the story delivery system. If they are doing their job correctly, the writers will unfold the story in such a way that on every page the story purpose and theme is kept in mind. We may provide everything from a G-rated movie with a soft-rock music score to an NC17-rated movie with a classical score, it can range from a high-drama romance to a hi-jinx comedy depending on who we cast and the performances of our talent. The script, which is the foundation, must support these variations, and the storyboarding system must reflect to the producers all of the several story scenarios. This brings us to the new tools for directors - particularly the previsualization multi-threaded storyboard system I developed for this thesis.

The Coke Commercial

It is apparent that this thesis tries to cover a broad base of problems which deal with multi-threaded narratives in the context of cinema. Where the Browser is developed as an interface for selecting these movies, the first problem we have in testing the browsing interface is that we have no movies which are multi-threaded to which the Browsing interface can communicate. In an attempt to solve this problem I developed a short multi-threaded narrative in the form of a Coke commercial. The script, at first glance has no dialogue, but the actions within the script reveal several possible scenarios for our protagonist. The theme, "Woman vs. machine." The story-purpose, "Coke is the Real Thing." Here's one version of the script:

Version 1 (No comedy, High Drama, Moderate Sex, No Violence)

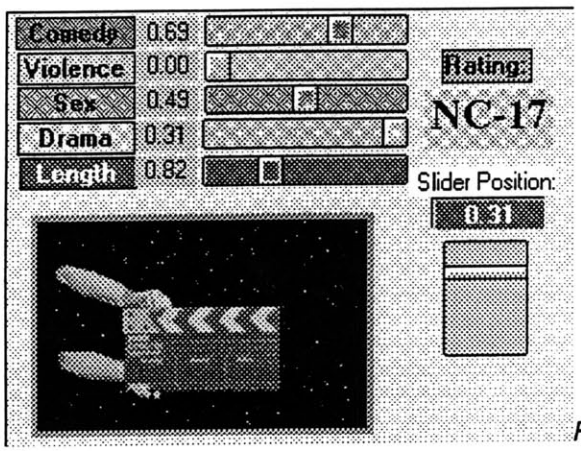


Fig. 29, Version 1 Control Panel Setting

INT. - MEDIA-LAB BASEMENT HALLWAY - AFTERNOON

Karen, after working long hours on a top-secret experiment, can't quell her thirst for Coke any longer and proceeds down the hallway for a quick break to the Soda Machine. The HALLWAY IS POORLY LIT and we HEAR the HUMMING of all the machinery in nearby equipment rooms, including the HYDRAULIC ELEVATOR.

Karen approaches the machine and proceeds to take out THE CORRECT CHANGE to place into the COIN SLOT of the machine. She reaches into her pocket and withdraws the CHANGE. One by one she drops the COINS into the machine until the correct amount has been reached. She pushes COKE. The machine HUMS and we HEAR a CAN FALLING into the Can Dispenser. Karen bends over and retrieves the COKE. She turns and exits down the hallway - back to work. Coke its the real thing.

Typically in a script PROPS and AUDIO CUES are formatted in Caps as well as any other cues which may be relevant and/or important to one of the production departments or to the director. Here, we see that in addition to these cues the action cues are also in caps indicating a parallel event or action. These cues can be viewed using Hyperlinks and 3-D scripting tools which allow the reader to view the parallel pages where these events occur. The slider control panel which is linked to both the Browsing Interface as well as the Previsualization tools can display these versions by moving the sliders and "clicking" on the slate graphic. The following is the storyboard which reflects the above version (Version 1) of the commercial narrative:

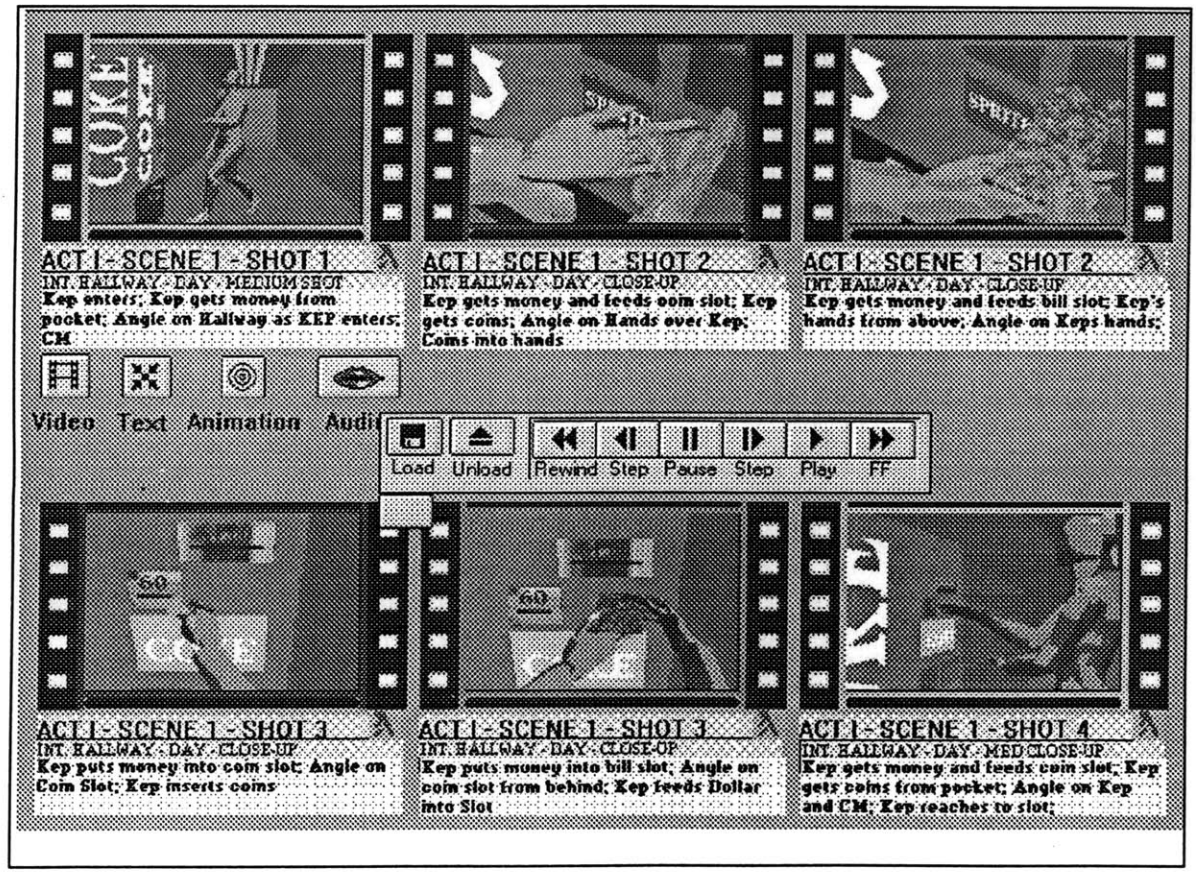


Fig 30 "Storyboard depicting shots 1-4" per Control Panel Setting (Version 1)

The storyboard system was designed to display the sequences of shots in two ways: first, as a complete layout of all shots whereby the viewer can see all possible replacements for a specific shot at one time; or secondly, where only the sequence of shots which relate to the slider position is displayed. The border around the storyboard window indicates that another possibility is behind the one being displayed. A mouse click on the border will display alternate shots selected by the database and will indicate the sex, violence, drama/comedy values. The viewer may select a new shot to replace the one the database offers; immediately, a message window opens informing the viewer the result of changing that shot. Messages might include continuity errors in terms of props, wardrobe, camera position, or character position, etc. It may also have an effect on the selected violence, sex, drama, or movie rating. If the viewer accepts the change the control panel is altered to reflect the substitution of that particular shot. The viewer may wish to play out the sequence to view the storyboard as an animatic movie. To do this the viewer accesses the movie player through a "double right click" on the control panel slate graphic. The database then builds the movie out of the sequence of shots and displays it in a separate window. This allows the viewer to previsualize the sequence as a movie. The control panel is linked to the database which holds all the details of the movie including the possible music scores. Therefore, soundtracks can also be experimented with at this previsualization level. In figure 31 we see what this storyboarding system may look like. By clicking on the reference icon a series of buttons appears providing the viewer access to the script, budget, scheduling program, director's notes (Text) etc., as well as video sequences captured during pre-shoot tests.

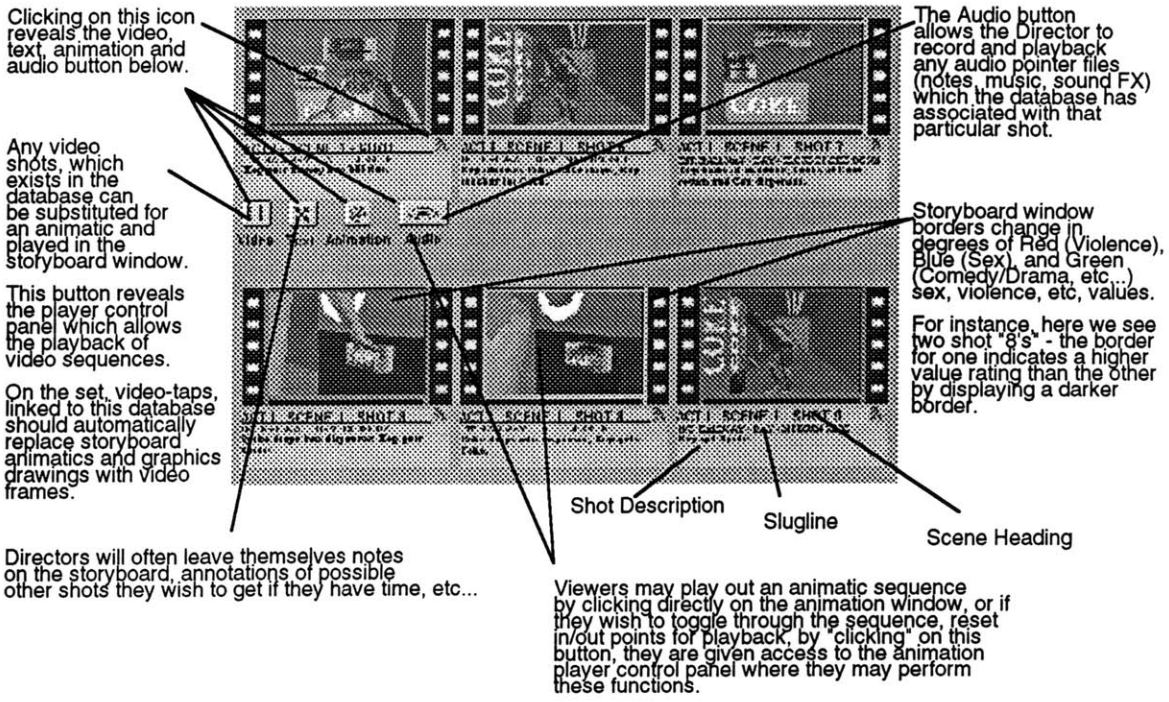


Fig. 31, "Storyboard Description"

It will also display location (video-tap) sequences, animatics (Animation), and audio files, such as directors annotations, actors readings, music scores, etc. On the following page (fig. 32) is an example of what a typical previsualization (storyboard) computer screen might look like. In figure 32, we see the interactive storyboard, the slider control panel, the animation/video player control panel, and the shotlog display. The shotlog display is created in runtime using Asymetrix's Toolbook database reader. Essentially, the fields for shot description, context, shot number, sluglines, camera angles, shot value ratings, etc. are created on one background page of the Toolbook application. The database reader then pastes all the information from the corresponding database field names and creates an index of all the shots into this shotlog display.

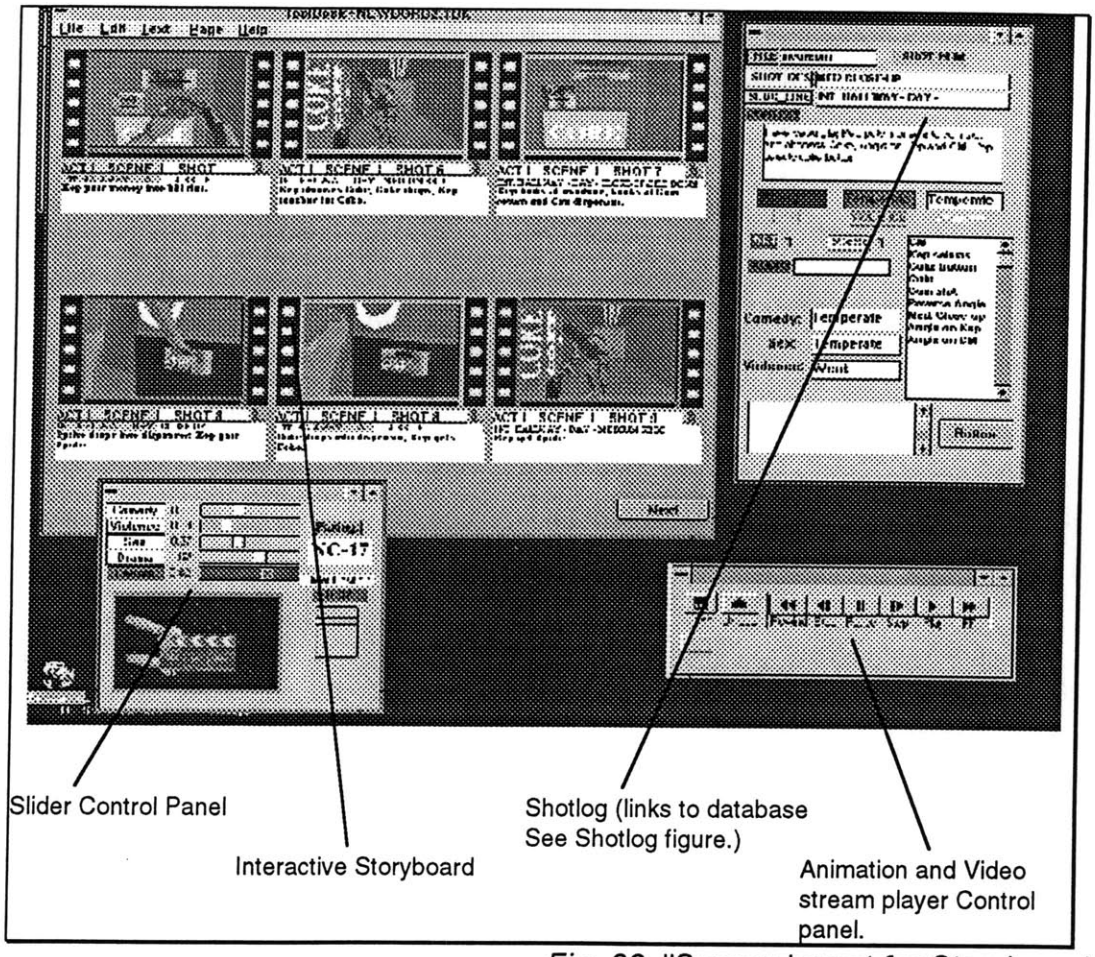


Fig. 32, "Screen layout for Storyboard System" linked to Database(shotlog) and Control Panel.

When the database performs a crunch based on slider values and begins to load the corresponding animations into the storyboard windows we can see the shotlog flip through its indexes and load its data into the storyboard fields. Figure 33 on the following page gives us a closer look at the shotlog display. Having developed an infrastructure for a database search and sort logic it was apparent that we needed a database management approach which could take logged descriptions, search and sort them relative to the composite narrative indicated by the sliders. One such program written by Cambridge independent, Brain Bradley contributed to this project with his "Dial-A-Movie" story engine.

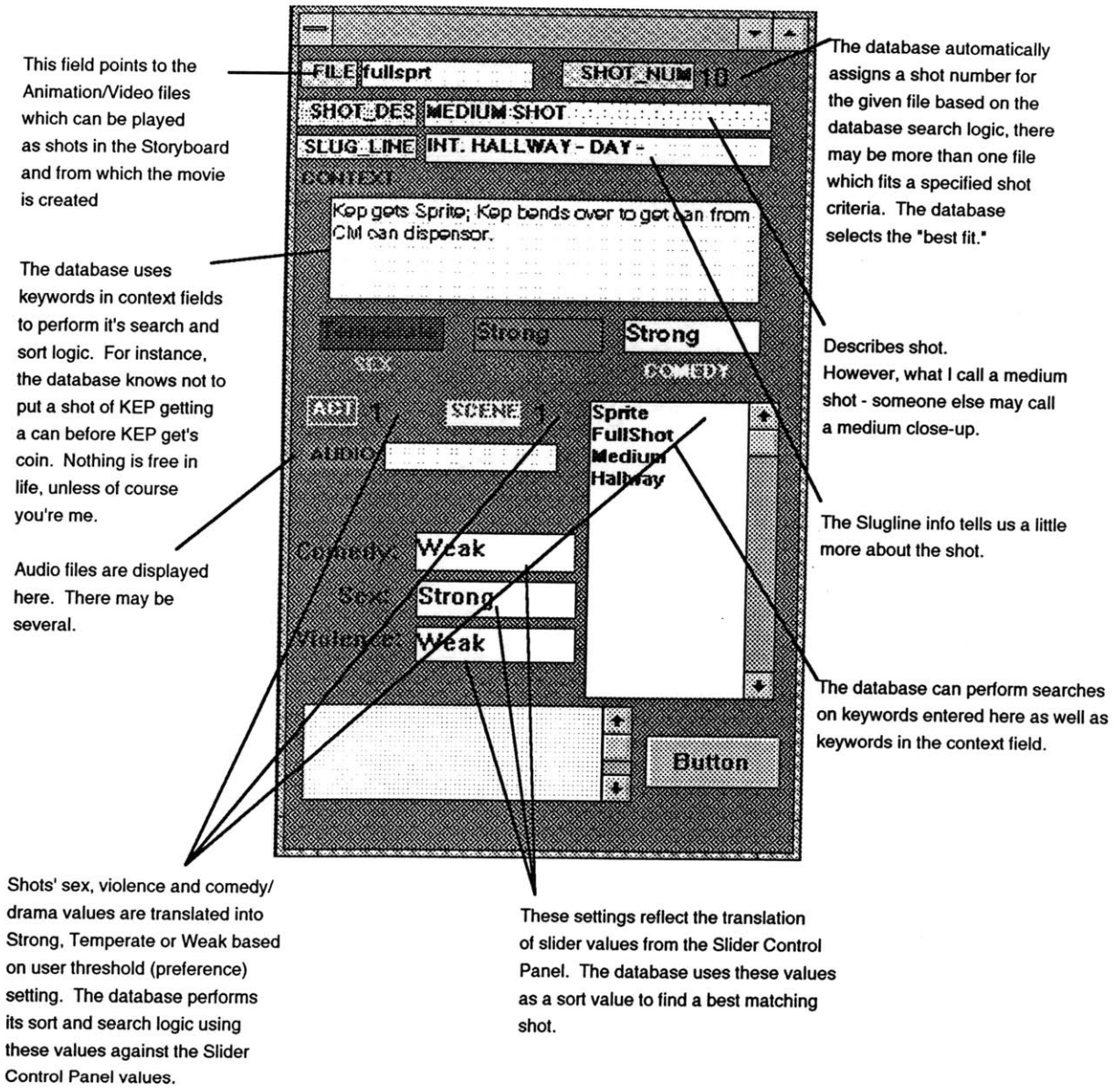


Fig. 33, "A close look at the Shotlog" which is the direct link to the database.

8.0 THE COKE COMMERCIAL

To test the Cinema Server as a viable interface for accessing digital movies (multi-threaded narratives), for automatic trailer generation and configurable advertisement, I decided to shoot a short sequence in the form of a Coke commercial. Karen Pfautz and Cyrus Shaoul were assisting these research efforts under my supervision and contributed to the "quick" shoot. Karen performed as actor, and although we had intentions of having Cyrus perform a 'male' version of the movie as well, we did not have time to do it. Cyrus acted as grip and assistant camera. The movie was shot in the basement hallway of the media laboratory and shot entirely on hi-8 video. The location was confining and to a great extent limited our camera movement. In a couple of instances I would have preferred to use a tracking or dolly shot, but could not since the Interactive Cinema Group does not have a dolly in its equipment inventory. There was a close-up shot I needed of Karen which was not obtainable without attempting to "cheat" the lens (See Fig 35). These reaction shots or cut-aways are essential in creating both configurable advertisements and multi-threaded narratives. It is often these kinds of shots that a continuity person or script supervisor will recommend to a director when shooting a tight sequence. There is not always time to get these shots, but without them the editors' options diminish. In providing multi-threaded narratives where length as well as sexual content and degrees of violence are offered as user controls these shots gain significance and are not simply "pick-ups" but become, to some degree, the punctuation of the interactive movie. For instance the two close-up shots of the Coke machine dispenser which shows us the can of soda which the machine delivers (Coke or Sprite) is directly related to the drama/comedy values.

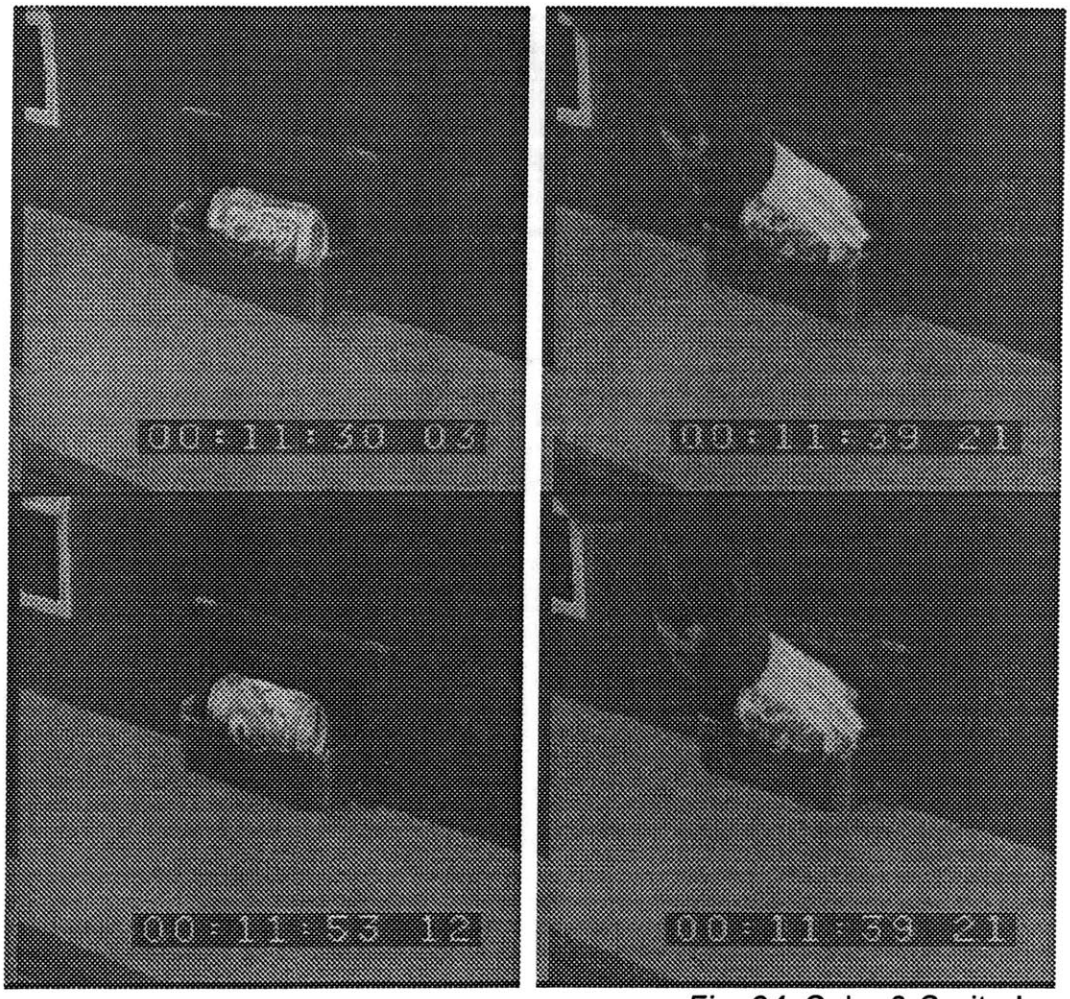


Fig. 34, Coke & Sprite Inserts

If the drama value is higher than the comedy value, the shot with the Sprite can followed by a close-up of her face being disappointed is inserted into the story model. However if comedy is high, she may walk away from the machine thinking that it stole the last of her change; but, as she walks away, the coke falls down into the dispenser. In this instance, we would not see her picking up the Coke. If Violence is high, when the Sprite can falls she may unleash an ungodly vengeance on the machine with kicks and punches. In this case a close-up of an angry face is inserted along with a series of shots showing her punching and kicking the machine. If the Violence slider was high we could edit in close-ups of her face as she angrily and repeatedly punched the machine. These could be easily cross cut with either a reverse-angle full shot of her kicking or a medium

close-up of her hands punching. If the drama setting was high, we could use dissolves between the shots to imply time.

Fig. 35, Close-up Inserts / Reaction shots

We were able to configure several movies from the shots we obtained, some with coins getting stuck, some with dollars being spit out repeatedly and including one where she beats the machine till it relinquishes its possession of her money and Coke. Karen is a natural actor and if she wanted to make a career move in the business she'd be great. Cyrus is a "jack of all trades." He could do anything if he dedicated his mind to it. He is extremely motivated, responsible, and sincere. He was very good at rigging the lights and assisting me in the shoot.

The Automatic Movie Trailer

Earlier in the Browser (section 5.0) of this thesis we discussed how the system could generate a customized trailer based on the slider positions (values) in the control panel. Automatic trailers are amazingly easy to make **IF** the makers design them to be alterable. This means tagging sequences for maximum action content, comedy, one-liners, etc. and providing a basic film editing logic (filter) into the story engine database. It is important that the system have a pool of incidental music and canned rock, classical, blues, etc. as well as canned voice-overs (narration) from both a male and female reader. Ideally you would want the computer to generate a realistic voice print of any sex, nationality, or age of character to read the text with all human intonations and inflections, but speech research has not yet created that system component. In any case it would not be hard to have several compressed digital audio files for each of the different movie versions. This would make it simple for a machine such as a Silicon Graphics computer to mix the streams and generate an automatic trailer in real time.

9.0 THE DATABASE SEARCH AND SORT INTERFACE

Access to the database program interface is provided through a "right-click" on the slate board graphic on the slider control panel.

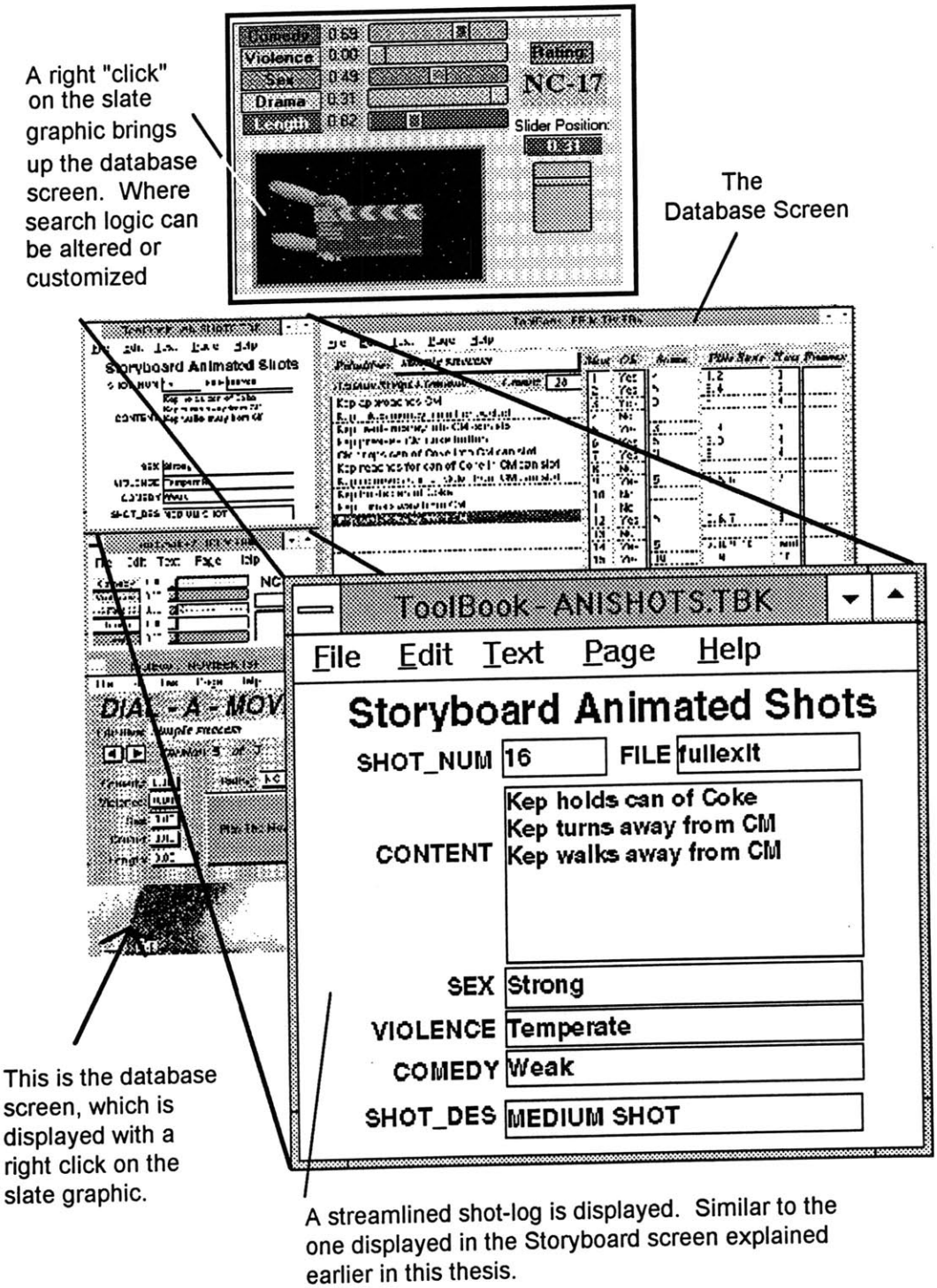


Fig. 36, "The Database Screen w/ Close Look at Shotlog"

We are familiar with the "slate-board" from both the level 3 browsing interface and the storyboard/previsualization interface where it is present on the slider knob control panel. (See Fig. 36) When the database interface is accessed, the computer screen is resized to include all database sort and search details. The database screen is broken down on each of these following pages.

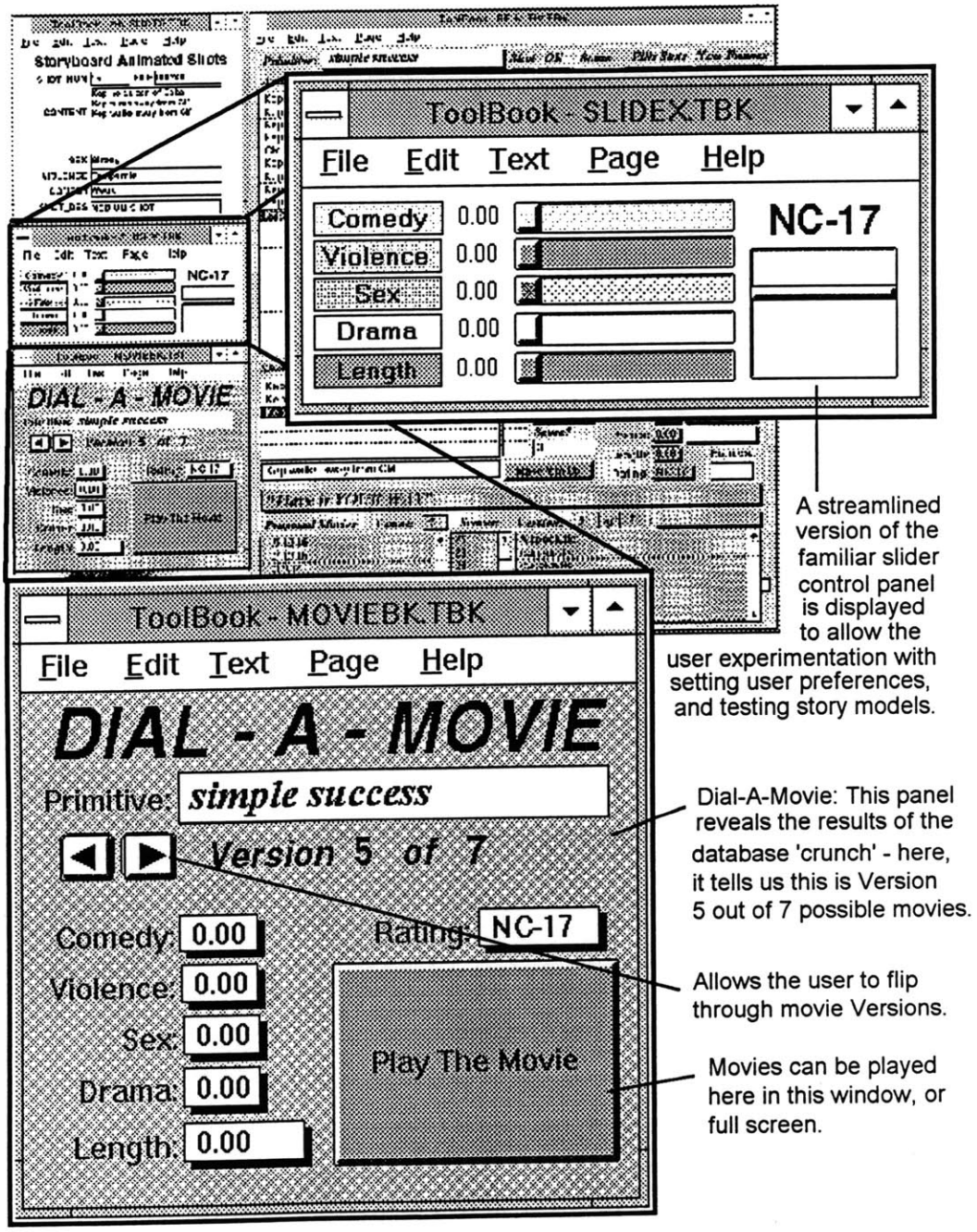


Fig. 37, "The Database Screen w/ Close Look at Dial-A-Movie & Slider"

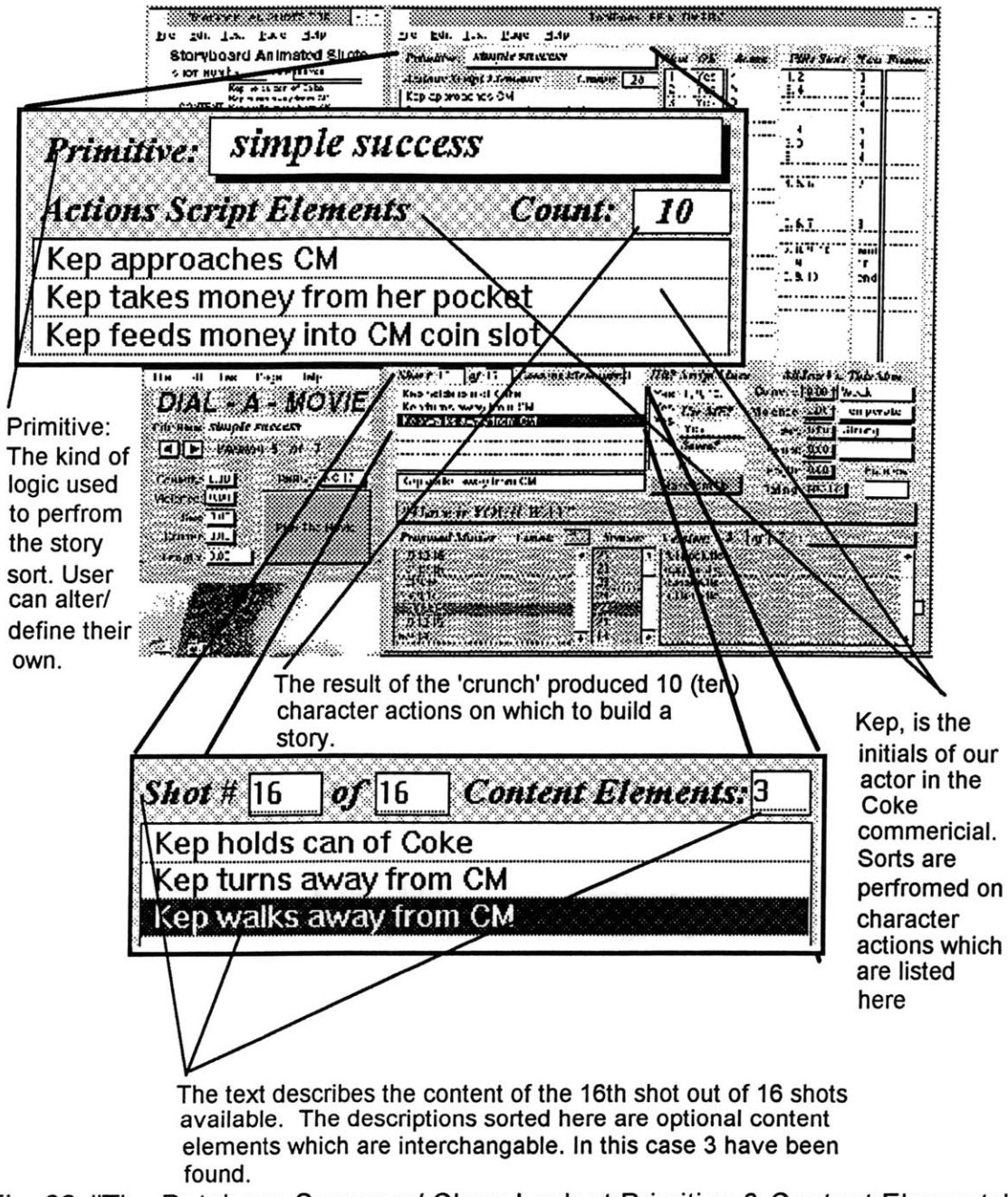


Fig. 38, "The Database Screen w/ Close Look at Primitive & Content Elements"

The database supplies all the information from which the story engine derives possible scenarios or movie versions. The story engine logic is programmed by the filmmaker. This means that the filmmaker still remains in control of the vision for the story. The difficulty ahead with the transformation of film into a digital domain is represented here, because we are no longer just asking the creators

to write a script, but to write a "story logic program" and therefore thoroughly grasp the concept of non-linear narratives and database programming. Databases are still primarily engineered for MBA's and lack an intuitive quality which is imperative to the creative film community which is very much alien to this world of software.

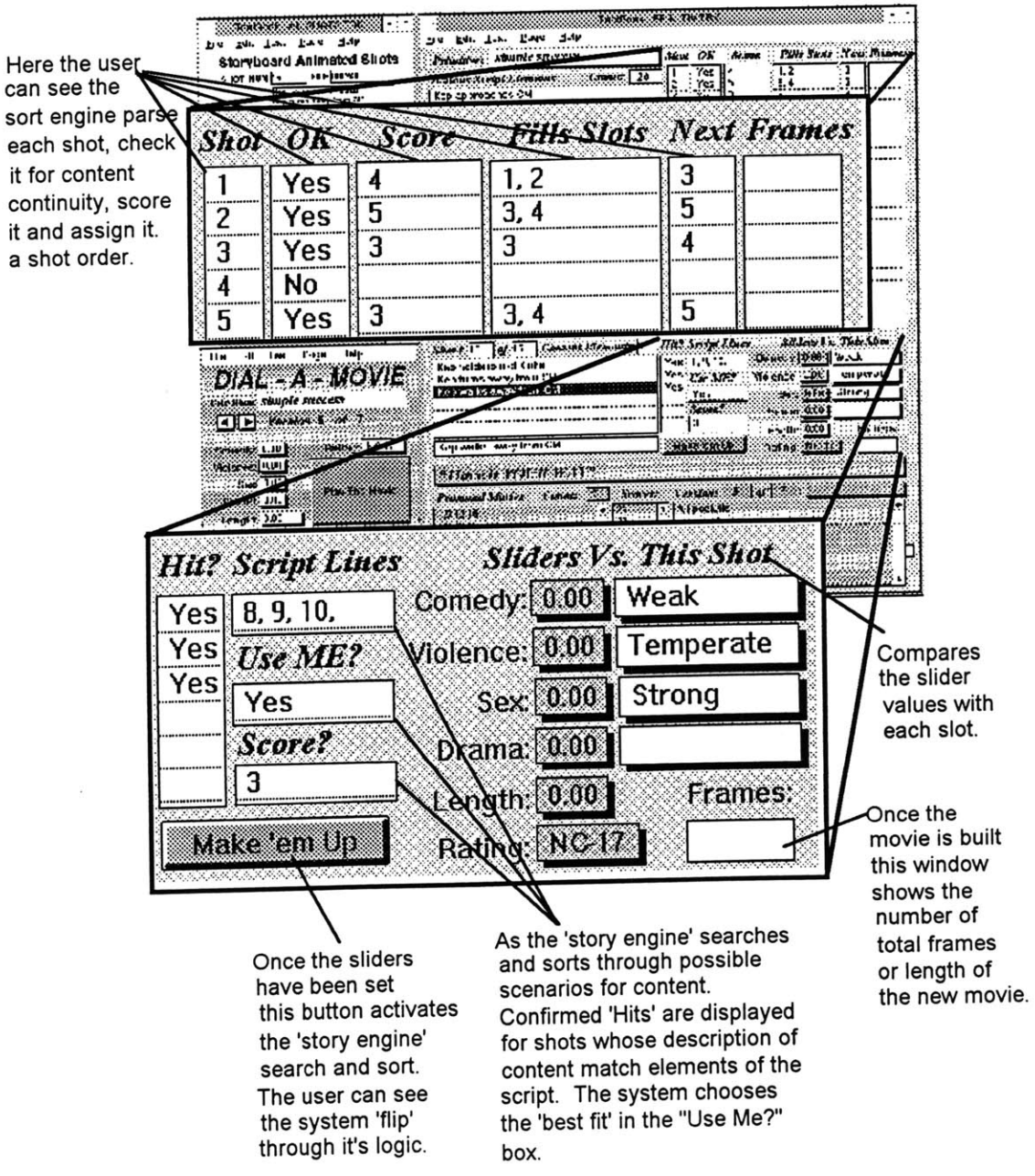


Fig. 39, "The Database Screen w/ Close Look at Sort Parse"

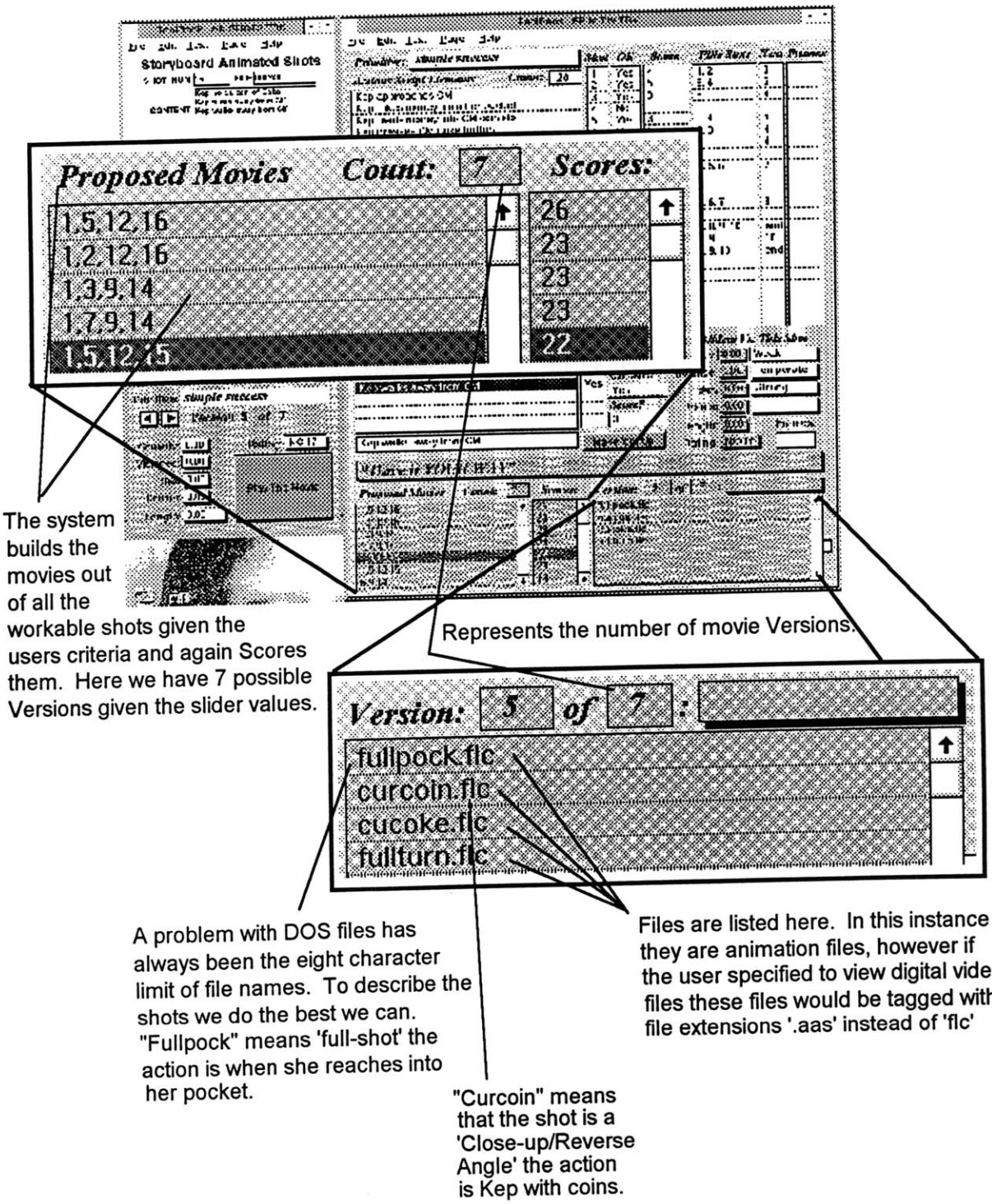


Fig. 40, "The Database Screen w/ Close Look at Sort Results"

When the "story engine" completes a search and sort. It calculates how many versions have been acquired and then proceeds to parse the different versions

and score them based on the user's specified slider values. Each version can be played as an animation file or as a digital video stream - provided it has been captured. The "story engine" theory described it the aforementioned text and illustrations used for the Cinema Server demonstration prototype is an application of only one theory from many which may be used to provide a subscriber with direct engagement over story/time lines in multi-threaded narratives. The Database for both the catalogue aspect of the browser and the prototype multi-threaded narrative was implemented for a minimal demonstration. We are very familiar with relational databases and techniques for cataloging (See menu). The challenge of the multi-threaded narrative is more interesting. Independent filmmaker Brian Bradley tested his theory by building a small weighted database for the Coke commercial animatics which appears to work well. The important point to realize and the main thrust of this thesis involves how a filmmaker scripts for extremely interactive narrative concepts. All the previous diagrams (figures 36-40) reflect Brian Bradley's interface to the database and represent his approach to providing a narrative story engine.

In addition to viewing the database performing a movie crunch, the subscriber may set their user preferences upon which the database performs that parse. In this prototype thought experiment, we envision that the subscriber may set the Sex slider knob to the highest level and with a "right-click" on that particular slider button, view an image (photograph) which the database regards as a photo reflecting that value. Movie shots can also be used, but not shots or scenes from the selected movie, any available movie on the server or any title which has received theatrical release and which the subscriber has not previously viewed. This is done because it would be detrimental to the

subscriber's experience of the movie if the database were to reveal story elements. This would also apply to any titles which the viewer has not previously viewed. Providing a database which retains user knowledge would be beneficial in this regard and points to future directions for browsing paradigms. If such a feature were present in this prototype, it could extract scenes or shots from previously viewed titles which had been annotated by the subscriber to model a similar sex slider value or movie rating and display these digital streams to the viewer to give them an example of what they may be in for. As we mentioned earlier, most movie renters and film-goers shop blindly for their theatrical experiences, or follow the guidance of critics and advertisers. This run-time trailer generator would be one solution to help resolve this issue.

Included in this database engine interface is the ability to hardwire the sound design preferences of the movie. A multi-track sound panel can be presented to allow the subscriber full manipulation of all available tracks and music scores provided the maker has made these tracks accessible. Where a demonstration interface for multi-track audio manipulation is easily provided, actual implementation of the hardware could not be solved within the time frame of this thesis (see WaveFrame in Hardware section 5.0 for details). In the future, when the cable and/or fiber optic delivery systems are integrated into home entertainment systems, the subscriber's system may inform the Cinema Server of its audio configuration, such as the location/position of the speakers, the tuner make and functionality (i.e. front or rear projection, monitor size, hi-def or NTSC...). This should motivate manufacturers of these electronic entertainment components to integrate computer processing technology into their products. With this technology the subscriber will be allowed to customize the digital movie

title to best suit the environment in which it will presented in.[19] The advanced features of the database interface also provide the subscriber, through the processing power of their delivery systems, direct engagement over color timing and transitional effects. Though this should be achievable through the Server itself, the actual processing will be done on the subscriber's end of the delivery system, allowing it to be manually or system determined.

[19]Cheops, (Open Architecture Television) designed by Mike Bove, John Wadington, Andy Lippman of the Media Laboratory is a high speed modular video processign system, can encode or decode several video signals at once, displaying the output in a window system at a variety of resolutions, and can communicate with a variety of host computers via standard SCSI connection.

10.0 CONCLUSION AND FUTURE DIRECTIONS

The future looks very promising in terms of the technology which is becoming accessible to the public. Companies like Autodesk with its 3D-Studio and Animator Professional software packages are putting enormous power on the desktop and soon into 32-bit multi-tasking environments such as Windows NT. On a software level, intuitive relational databases with real-time object embedding and hooks to dynamic engineered operating systems are required. These databases must integrate neural network kernels and customizable interfaces. Perhaps one of the most simple and yet intriguing parts of the Cinema Sever prototype was its use of 3-D animation in the interface. This is not common on personal computers such as the MAC and PC, but is somewhat commonplace on machines such as the Silicon Graphics workstations. Much of the promising research in interactive cinema will require migration from the limited capability of MACs and PC platforms to faster parallel processing computers. Ideas are very much limited by the technology when it comes to processing power. I believe this is why IBM and Apple have joined forces to build a new machine, and Quicktime and Autodesk programs are being imported into the Silicon Graphics/ Risc-based domain. Parallel processing computers in turn must come down drastically in price if it is to take hold in the mainstream creative community - the term "starving artist" didn't come from nowhere.

Many of the issues concerning future directions for browsing interfaces (as they pertain to digital movies and interactive television) are suggested in this thesis. It is important to have a two-way channel to the viewer at home, and the specific issues of providing the public with a way to post "their movies" back into the system (like a bulletin board service) should be understood and recognized for

its value and potential revenue. It is important that the viewers/subscribers have both visual and audio contact with other subscribers as they browse through movie titles. This would make browsing fun and socially engaging, not unlike the phone sex lines and the MUD's (Multi User Dungeons) described earlier. The network environment for browsing should incorporate this feel with the added ability of the subscriber to present themselves as an alter ego. This kind of browsing interaction with other subscribers, will become more like a game, and in many respects surpass the interactions in the newsstand paradigm. This is feasible with the fiberoptic networking environments surfacing today.

In regards to multi-threaded narratives, it is important that film schools begin to define the potential for digital cinema on present-day cinematic terms. This means bringing computers into the editing suites, screenwriting courses, directing, cinematography, acting, sound design classes, producing courses, and ultimately on *the shoot*. Efforts in research need to integrate ideas between multi-media specialist, software programmers, and filmmakers. A software programmer should become a crew member and work with the director and producers from pre-production to release print. Process tracking is critical, but will still be somewhat wasted without building an expert system. I believe that it is important for the film schools to wake-up and make a strong commitment to exploring the future of cinema, we must provide the students with a broad outlook of cinema's directions and transformation.

I think the first step in process tracking should be to have a computer assemble a rough cut on the set during the shoot. This would be a major advancement in streamlining the production process and I believe that it is "do-able" with the

current technology. Grid pads (LCD writing tablets) should take the place of clip boards, transmitting in real-time the script supervisor's notes, the digital slate readout, the sound log and the digitzed video-tap (SMPTE indexed) into the set computer, which then performs a rough cut. All of this should be linked across all departments including those in post. During the shoot, communication (audio/video) should be switched through the system to those department heads with access.

Companies will soon be providing 500 channels of interactive television: for the browsing interface. On some of these channels they could cover the live shoot of any given movie and broadcast it on their service. People are fascinated by the process of movie making. Most of us have witnessed crowds of people standing around to get a glimpse of an actor during a shoot. Why not make some money off of it and provide it as a feature on the server network?

Distribution will radically change. It is my hope that the public will have access for the first time to this distribution channel. Much as people now post files on bulletin board services such as Compuserve and Prodigy, it would be great to allow the public to post their digital movies on a cable server. When we have as many channels as we propose and television and movie production costs are high, why not let the public produce its own entertainment? Its free and you still can charge them for it.

The Thesis

Writing a thesis within the constraints of an analog medium is difficult in this day and age. The limitations of the format should be recognized. How can we pontificate future directions and technologies with such attitudes when we

cannot embed digital movies, audio, animation and color graphics into these critical documents? I propose that we start at this institute, with a replacement of this ancient thesis format with a contemporary one which reflects the ideas we so adamantly preach.

11.0 ACKNOWLEDGMENTS

The author would like to thank the following individuals and corporations:

Julia Kohlas, Jan Bella Berkowitz, Martin Berkowitz, Glorianna Davenport, Brian Bradley, Cyrus Shaoul, Karen Pfautz, Saf Yaboa, Shahrokh David Yadegari, Thomas Smith, Teo, The Waveframe Corp., Maxtor Corporation, Sharp Corporation, Spea Technologies, Asymetrix Corporation, Microsoft Corporation, Eddie Elliot, Autodesk, HumanCAD Corporation, Screenplay Systems (Steven Greenfield), Adobe (Sue Spenser), Sharp LCD Products Division, Sony Corporation (Hiro Uchida), Toshiba Corp., Michael Peyser, Russell Neuman, Truevision Inc., Anthem Technologies, Quarterdeck Corp., Fujitsu Corp., Novell Systems, Fotovix, D/Vision (Bruce Rady), Intel Corporation, Bellcore Labs, Movies of the Future, Claudio Migliore, ATI Technologies, Michael Johnson (a.k.a. Wave), Pattie Maes, Cris Dolan, Stuart Cody, Greg Tucker, Ben Lowengard, Martin Friedmann, Barry Brown, Sarah Sears, Amelia and Simone, Turtle Beach Systems, Netergaid, Magni Systems, Betsy Brown, Mom & Dad, David Boor, IBM Corporation, John Watlington, Mathew Perry

12.0 BIBLIOGRAPHY

Adams, Don and Goldberg, Arlene. *Steal this TV: How Media Literacy Can Change the World.* The Independent Film & Video Monthly, Utne Reader, FIVF, New York July/Aug. 1990

Allan, Stuart. *Digital Sound for Feature Films.* Film & Video Magazine Optic Music, Inc. Los Angeles, August 1990

Bazin, Andre'. *What is Cinema?*, vol. 1, selected and translated by Hugh Gray, University of California Press, Berkely, Los Angeles, and London - 1967.

Bobrow, Daniel G. *Dimensions of Interaction.* AAAI-90 Presidential Address

Brady, John. *The Craft of the Screenwriter.* A Touchstone Book, Simon & Schuster, New York, 1982

Brakhage, Stan. *Film at Wits End.* McPherson & Company, New York 1989

Brondmo, Hans Peter and Davenport, Glorianna. *Creating and Viewing the Elastic Charles - a Hypermedia Journal.* Hypertext II Conference proceedings, York England July, 1989.

Bruckman, Amy. "Identity Workshop, Emergent Social and Psychological Phenomena in Text-Based Virtual Reality." April 1992, unpublished.

Caranicas, Peter. *The New Business of Creating Simulation Rides.* Film & Video Magazine, Optic Music, Inc. Los Angeles, April 1991

Carpenter, Loren. SIGGRAPH; Audience Particpation. Computer Graphics Magazine, vo. 25, No. 5, ACM SIGGRAPH, Oct. 1991

Carpenter, Teresa. *Hope I Die Before I Get Old*, Premiere Magazine K-III Magazine Corporation, New York, September 1992

Clive, John. Director Pushes Digital Post; Creative Eye. Millimeter Magazine, May 1991, pp.25

Cudlitz, Stuart. Move It!. MacWorld Magazine, June 1989

Daley, Dan. *Film Audio Heads into the Digital Domain*, Film & Video Magazine Optic Music, Inc. Los Angeles, April 1991

Davenport, Glorianna. "(in draft) *Future messages; future movie forms"*

Davenport, Glorianna and MacKay, Wendy. *Virtual Video Editing in Interactive Multimedia Applications.* Communication of the ACM, vol. 32 no. 7, July 1989

Fantasy and the Cinema, edited by James Donald, BFI Publishing 1989

Field, Syd. *Screenplay, The Foundations of Screenwriting, A Step by Step Guide from Concept to finished script.* Dell Publishing Co, Inc. 1982

Gaffney, John. *Digital Doomsday?*, Video Software Magazine (VSM) August 1992

Gagnon, Diana. *Interactive Versus Observational Media: the Influence of User Control and Cognitive Styles on Spatial Learning.* Unpublished

Gagnon, Diana, Neuman, Russell, McKnight, Lee and Frying, ann. Interactive Entertainment Television: A Study Series. Paper presented to the 1986 International communications Association. 1986

Garfinkle, Simson. "Picking up the Narrative Thread with MIts Glorianna Davenport." NewMedia Age, vol. 1, no. 4, June 1991, p. 14-16.

Katzenberg, Jeffrey. Internal Memo - reprinted in Dailey Variety Newspaper. A Cahners Business Newspaper, Vo. 230, No. 36, Jan 30, 1991

Metz, Christian. *The Imaginary Signifier, Psychoanalyses and the Cinema.* Translated by Celia Britton,Annwyl Williams, Ben Brewster and Alfred Guzzetti, Indiana University Press, 1982

Meyers, Brad A. and Buxton, William. *Creating Highly-Interactive and Graphical User Interfaces by Demonstration.* Dallas, August 18-22 vo; 20, No. 4 - 1986

Monaco, James. *How to Read a Film.* New York, Oxford University Press, 1981

Negroponte, Nicholas. The Impact of Optical videodisks on Filmmaking. Unpublished paper. June 1979.

Neuman, W. Russell and Teresa Cader. Interactive Video; A Research Report. 1985

Ochiva, Dan. NewMedia; Virtual Rooms and the Art of Memory. Millimeter Magazine, New York, April 1991

Pincus, Edward and Ascher, Steven. *The Filmmaker's Handbook.* Signet, Signet Classic, Mentor, Plume, Meridian and Nal Books, NY - 1984

Rosenthal, Steve. The Gold Rush Is On. New Media Magazine, vo; 2, No. 12; Hypermedia Communications Inc. (HCI) San Mateo, CA, Dec. 1992

Samuelson, Pamela. *Digital Media and the Law; Legally Speaking.* Communications of the ACM, October 1991, vo. 34, No.10

Schank, Roger C.and Abelson, Robert P. Yale University, Lawrence Erlbaum Associates, Publishers. Hillsdale, NJ - 1977

Sitney, P. Adams. *Visionary Film. The American Avant-Garde 1943-1978:* Second Edition. University of Oxford Press, New York 1974, 1979

Schubin, Mark. The Rise of Random Access, Videography Magazine Technology Section, PSN Publications, NY, August 1989

Stone, Dave. *Cinema Digital Sound; New System Swings and Misses Goes for Two.* MovieSound Newsletter, vo.I,#14; ISSN 1043-7304, Aug. 1990

Varela, Allan. *They Mix for Flicks; Film Sound Goes Digital.* Post Magazine, Post Pro Publishing, New York, September 21, 1990

Weiss-Fersko, Henry. 3-D Reading with the Hypertext Edge. PC Magazine, May 28, 1991

Youngblood, Gene. *Cinema and the Code.* Leondardo, Computer Art in Context, Supplemental Issue. Pergamon Press plc. - 1989