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Rochester Institute of Technology

A thesis submitted to the faculty of
the College of Imaging Arts and Sciences
in candidacy for the degree of Master of Fine Arts

Interactive Multimedia: Defining A Place in History

by: Erika Sears
1997

Thesis Approval

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Table of Contents

Introduction

" To be present at the birth of a new medium is a rare privilege filled with boundless possibilities...." author, Bob Cotton from *Understanding Hypermedia; Multimedia to Virtual Reality*

As the 21st century approaches, we are witnessing the "birth" of interactive multimedia. This unique media was formed out of a combination of old and new technologies. Although many people use it regularly in the form of the Internet and CD-rom products, most users only have a vague idea of its power.

Through my thesis, an interactive educational CD-rom, I will demonstrate that interactive multimedia is a new and unique form of media unlike any before it. I will provide the user with the definition, general history and fundamental components of interactive multimedia. I also make a comparison with other media (print, radio & television) to demonstrate the benefits of interactive multimedia. With a 1940's detective genre and a selective use of color, the interface design is based on the theme of "investigation".

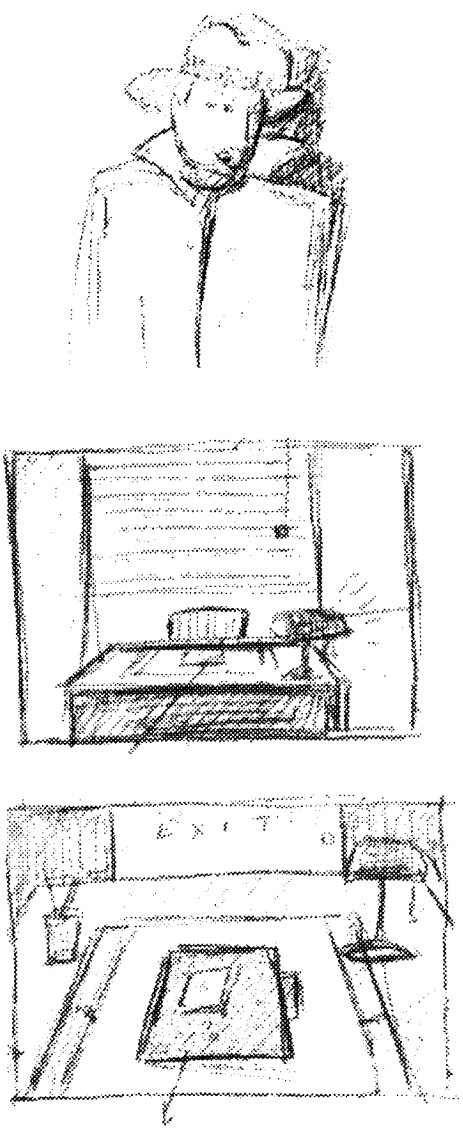
My intended audience is individuals who use interactive multimedia in some form but who have little or no prior knowledge of its underlying theory & principles. Through the dynamic use of text, graphics, audio, video and animation, I hope to provide all levels of computer-literate users with a solid understanding of interactive multimedia. The importance of interactive multimedia is growing steadily as society experiences a convergence of all media towards the 21st century. Understanding the philosophies and goals of this new media is crucial to our appropriate use of it. It has the potential "as an expressive medium unlike any other we have experienced before: an expressive and ubiquitous medium giving sensory form and human meaning to the ever growing, invisible world of digital electronics which increasingly permeates every aspect of our lives" (Cotton, 8). The most unique aspect of interactive multimedia has been its shift of power from author to user; it has changed the fundamental relationship between messenger and audience in a new and dynamic way. Hypermedia is a dialogue that provides the user with non-linear information linked by association through a variety of synchronized media, where users can organize and access information according to their needs. Earlier forms of twentieth century media such as print, radio and television, all required their audiences to simply absorb a one-way flow information. However, interactive multimedia "has the capacity to be more 'democratic' and 'personal' than these, which were all mass media, largely defining their success in terms of audiences counted in millions" (Cotton, 35). This new media provides a more personal form of communication for the masses; one in which self–guided exploration and navigation are encouraged. Now, the user–not the messenger, has control.

Goals & Ideation

I began my thesis with several goals in mind. My first intention was to embark on a project that involved outside research and a reasonable amount of content. After studying Human Computer Interaction (HCI) fall quarter, I was intrigued by its principles and theories and wanted to use this information as content for my thesis.

This material was my starting point in deciding to create an educational CD-rom that would inform a variety of computer-literate users about interactive multimedia. Although many people use the Internet or CD-roms regularly, they may not be aware of this underlying media. After studying HCI, I gained an understanding of the fundamental differences between interactive multimedia and previous media. These key differences formed a central point around which I could educate users about this new media.

My central goals involve several key points. First, this CD-rom will provide a user with a broad understanding of interactive multimedia through the use of a visual, auditory and hands-on experience. Secondly, it will demonstrate the power and potential of interactive multimedia through the unique design of the information, navigation and interface. Thirdly, it will demonstrate the advantages of this new media through a comparison with



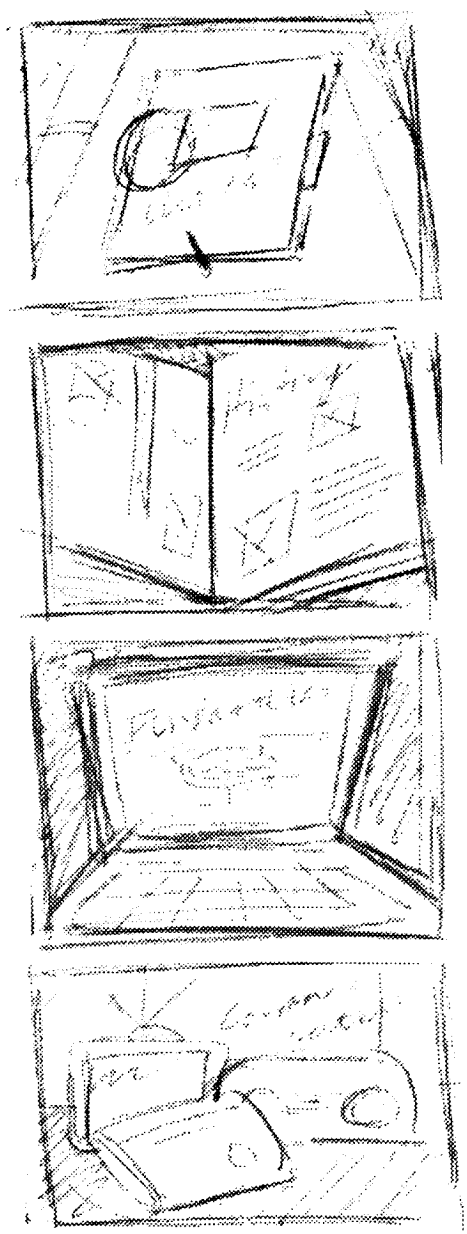
Above: Original screen design ideation for opening sequences

Goals & Ideation

several other forms of media. After establishing the idea of an educational CD-rom about interactive multimedia that would appeal to a variety of computer literate individuals, I chose an interface metaphor. In the early stages, I realized that I wanted to emphasize several key issues in the look and feel of this interface. The first, was to graphically stretch the limitations of interactive multimedia. This meant eliminating the traditional "icons" and cliche computer interface. I wanted to demonstrate how an interface resembling the natural world could not only help a user to navigate this new and unfamiliar domain, but it would create more interest and improve learning.

Secondly, I wanted to emphasize the "investigation" and "exploration" involved in interactive multimedia. I thought of a variety of different metaphors that could do this, however, the components of my project began to feel disjointed. I began to explore overall themes that could tie the entire project (which had a variety of different components) into one unified, consistent and clear presentation. Because of my personal interest in retro American culture, I eventually decided upon a 1940's detective genre.

As I further explored this theme, I began to see a variety of possibilities for coding information. First,



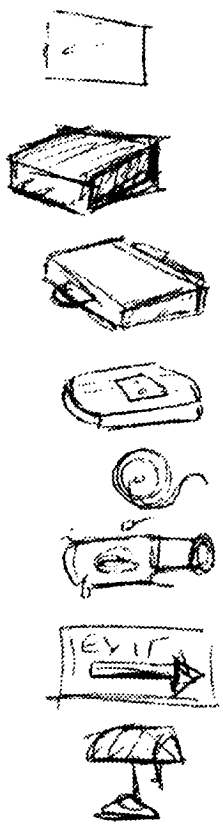
Above: Original screen design ideation for the four interactive rooms

Goals & Ideation

this metaphor supported my desire to interactively demonstrate interactive multimedia. The user could take on the role of the "investigator/detective" and begin to better understand how to operate and interact with this new media. Secondly, it offered me a variety of graphic possibilities. Smaller metaphors within the larger detective genre also offered many interface possibilities. Additionally, it seemed a natural choice to deal with a black and white interface (resembling film noir). This allowed me to use color selectively to highlight various portions and provided a non-traditional and unique interface solution.

Thirdly, the black and white interface allowed me to emphasize the differences between interactive multimedia and "older" traditional forms of media. Although everything appeared old in mostly black and white, the material was being used within this new digital realm.

Ultimately, this CD-rom should be both an entertaining and educational experience. It will provide the user with an understanding of interactive multimedia, its history and growth, various components and forms of distribution, and its benefits compared to previous media.



Above: Sketches from icon development

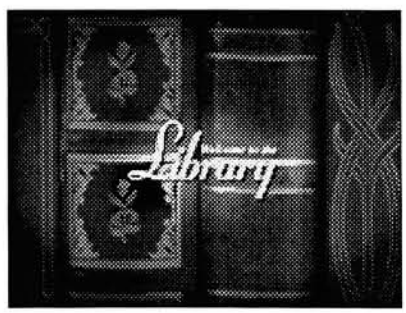
Process & Materials

After I formalized my concept, audience and goals, I decided on presenting the information in four major sections which included, the **definition, history, components** and **advantages** of interactive multimedia. One of my goals was to eliminate the computer interface metaphor as much as possible and have the user interact with their in environment in a natural way. I therefore developed metaphors or metaphorical situations that could communicate the information in these sections.

I developed four unique settings which included a basement, library, office, and media center. Each of these rooms included an optional video briefing by a detective who gives the user an overview of the material contained within the section. These rooms and the information they contain are highly interactive and the user must actively manipulate items to get to this information.

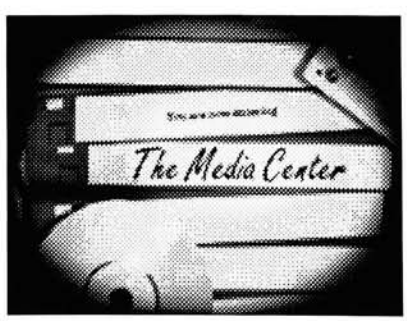
The definition portion entitled "What is Interactive Multimedia?" is contained within the basement. First, the user finds Lead #1 that suggests there is a file containing information in the basement. To keep the program moving interactively, the file contains mostly text, but also images, animation, and audio. Here they are given an explanation of interactive multimedia, the Internet and CD-rom products.

The basement contains "What is Interactive Multimedia?"



The library contains "The History of Interactive Multimedia"

The office contains "Fundamental Components of Interactive Multimedia"



The media center contains "Advantages of Interactive Multimedia"

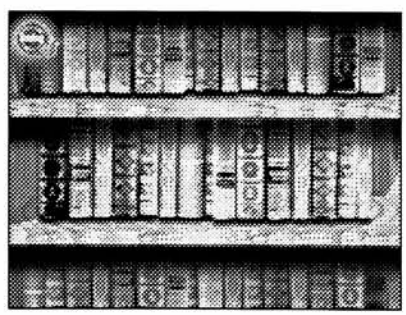
Process & Materials

Lead #2 asks the user to find a book in the library containing the history of interactive multimedia. Here they find three subsections. Section one contains contributions from other forms of media such as telegraphy, radio, film, and tv. Section two discusses individuals responsible for technical contributions. Section three is a timeline of important events related to this new media. Again, this book is not just full of text, but it is filled with multiple video clips related to these areas. The pictures in this book are moving.

Lead #3 explains that there is information about the fundamental components of interactive multimedia contained on a laptop that must be downloaded. Within this computer, there are four sections that include; *what is an interface*, *design of an interface*, *types of interfaces* and *input and output devices*. These areas explain interfaces, interface design, types of interfaces including command line, graphical, virtual reality, and ubiquitous, and discuss the wide variety of input and output devices. They are all highly interactive and include, text, images, animation, audio and video.

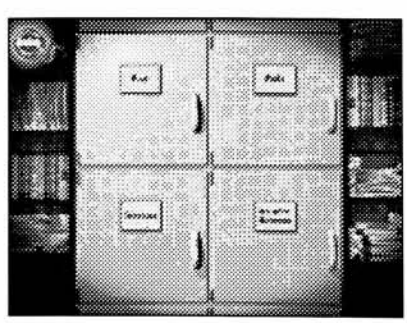
Lead #4 asks the user to go to the media center to find the advantages of interactive multimedia. Here there are four cabinets each containing a different form

In the basement, a file folder contains an explanation of interactive multimedia, the Internet and CD ROM products as distribution mechanisms.



In the library, a book contains information on various media, individuals and events that contributed to the birth of interactive multimedia.

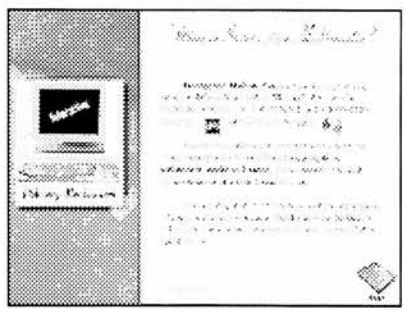
In the office a laptop computer contains information on interfaces including a definition, design theories, types and input and output devices.



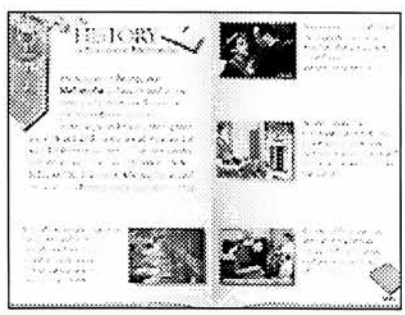
In the media center cabinets contain information on print, radio, tv and interactive multimedia to provide a comparison.

Process & Materials

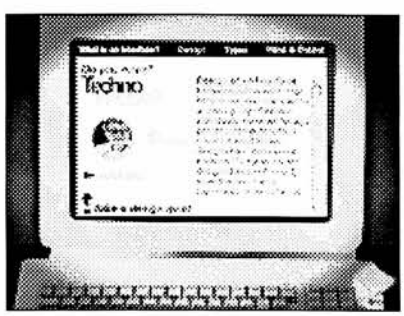
of media. Cabinet one contains a printed piece of material that explains through the simple use of text, how print communicates its advantages and disadvantages. Cabinet two contains an old fashioned radio. The user must turn it on and tune the dials. Through the use of audio, they hear an explanation of how radio communicates and its advantages and disadvantages. They can also continue to tune the dials and hear a variety of radio channels that include Glenn Miller and a V8 commercial. Cabinet three contains an old fashioned tv set. The user must tune the dials again. Through the use of audio and video, they will see and hear an explanation of how tv communicates and its advantages and disadvantages. They can also continue to tune the dials and see a variety of tv shows that include a skit from the George Burns and Gracie Allen Show and a Vitalis commercial. Finally, in cabinet four, the user encounters another computer. Here they will find four links to text, audio, video and animation. Each of these sections discusses how interactive multimedia uses previous media in a new way. Hypertext has changed our idea of text, animation has changed and expanded our expectations of imagery, audio and video may be used in a wide variety of supportive ways. All of these previous media can now be combined and accessed



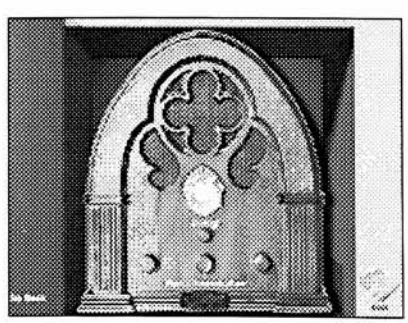
The file folder contains, text, images, animation and audio.



The library book contains text, audio and moving images in the form of video.



The laptop computer contains information in the form of text, images, audio, video and animation.



The various file cabinets contain information in the form of text, images, audio, video and animation.

Process & Materials

interactively by the user. A user navigates this CD-rom by holding down on a "tools" briefcase that opens to reveal a pop up menu containing navigational tools and a volume control. When they eventually exit, the case is "closed" and credits appear.

I used a wide variety of software and informational materials to create this project. Most of the scenes where first created through 3D modeling and rendering in Strata StudioPro. These were then manipulated in Photoshop and the final layouts where developed. Any additional imagery that was added in Photoshop such as the media devices (radio, tv's etc) came from the Photodisc clip series. The imagery of famous people and their inventions came from the Internet (via Netscape) and a book called "Understanding Hypermedia" by Bob Cotton. The video clips of the detective were developed and shot by myself, and the historical clips came from a variety of sources that included the Internet, VHS, and CD-rom products. Sound also included narrations I developed, Internet resources, and music CDs manipulated in SoundEdit. Animations were done through the use of Strata and Photoshop. This CD-rom was developed in Director and has been created as a cross platform product. All research resources appear in section 7.

Review of Literature

An Introduction to Interactive Multimedia

The invention of the personal desktop computer has heralded the birth of a new form of media called ***interactive multimedia.*** Although the act of using a computer to manipulate information would seem *interactive*, computers are now being used for activities that were never previously considered interactive-such as reading, acquiring news and experiencing entertainment. Suddenly it seems that interactive multimedia is blurring the lines between media and the reason may be in its format; the presentation of information in a non-linear associative format, where the user must interact and control both their topic and pace. It is not only an interactive dialogue between the user and computer, this non-linear media has the ability to incorporate and utilize many other traditional media such as audio and video. "The computer can simulate a world in which the representations of all related ideas are in the "same place", hyperlinked, even though this is not directly possible in the 3-dimensional world in which we live. Moreover, there can be many ways to view and compare the ideas simultaneously. And finally, the ideas can be in the form of dynamic and interactive simulations" (Kay, online).

In addition to the use of a display, storage device, and controller, this new media is composed of several basic elements which include the non-linear presentation of information, user control over both topic and pace, and the utilization of multiple forms of media. It is like "a collection of elastic messages that can stretch and shrink in accordance with the reader's actions. Ideas can be opened and analyzed at multiple levels of detail" (Negreponte, online). Interactive multimedia has exploded as one of the fastest growing forms of media today. Characterized by more than its output device, it is signified by its communication qualities or the way it delivers information and the way the user interacts with this information. Although this new media may occupy a variety of formats, the average user encounters it most frequently on the Internet or on CD-rom products. As with the emergence and growth of other forms of media throughout history, interactive multimedia needs to be evaluated as a new and unique form of media. Through defining and evaluating its various components and comparing their effectiveness to previous forms, the advantages of this new media will become clear.

Defining Interactive Multimedia

Media can be defined as a variety of technologies involved in the communication and storage of information, received by people through the use of their senses.

Review of Literature

"The mass media consists of a series of diverse elements with two common characteristics: each medium within the mass media reaches a great number of people; each medium gets to these people through a mechanism" (Lovell, 4). Although it may involve such things as language, music, and film, media may also include the way information is presented and the materials on which it is stored (Woodhead,1). Throughout the course of history, mass media has developed into several diverse forms, most of which we still utilize today such as the print, radio and television. Now, with the invention of personal computers, we are witnessing the emergence of a new and unique form of communication known as ***interactive multimedia.*** Interacting with a computer is much different than with other mediums. A newspaper, radio or television requires minimal interaction between medium and user such as flipping a page, pushing a button or turning a dial. The only requirement is that the user listen or watch the steady stream of information being presented. However, interactive multimedia demands much more interaction between user and system. The user must be an active participant, navigating not only the computer, but guiding themselves through the information.

Interactive multimedia is composed of two distinct parts; the "interactive" or "hypermedia" part and the multimedia part. Hypermedia first came about when people wanted to link pieces of information by association. "The prefix hyper' suggests notions of branching and decision making, as in hypertext, a collection of non-linear, text based nodes that are linked together. When different media such as video, sound and animation, are included as well as text in a branching structure, the system is known as hypermedia" (Preece, 320). The term *hypermedia* signifies both the content of the information presented and its delivery platform, however, it also signifies a new model of interaction between user and system. Hypermedia allows a great amount of flexibility with the presentation of information where, "space is by no means limited to three dimensions. An expression of an idea or train of thought can include a multidimensional network of pointers to further elaborations or arguments, which can be invoked or ignored. The structure of the text should be imagined like a complex molecular model. Chunks of information can be reordered, sentences expanded, and words given definitions on the spot .... These linkages can be embedded either by the author at "publishing" time or later by readers over time" (Negreponte, online). Essentially, "'hyper-" is the "interactive" portion of interactive multimedia. It presents the user with a number of options or links in a branching structure

Review of Literature

that encourages non-linear interactive exploration with the information. "Hypermedia, combining publishing, television, audio and computers with a common access through a computer terminal, is also characterized by many links and access points so that the user can move around easily in a multimedia information environment" (Severin, 9).

The second half of interactive multimedia is the "multimedia" portion which can incorporate a wide variety of media including text, audio, video and animation. The relationship between hypermedia and multimedia is simple; "multimedia are synchronized media, such as moving images with sound. Hypermedia is interactive or linked multimedia" (Rada, 11). Essentially, multimedia involves the synchronization of a variety of media and hypermedia signifies the links between these various media which allow the user to organize and access information. Most interactive multimedia applications involve the use of a computer to deliver several of the following five media: sound, text, graphics, animation or video. This media is available interactively and is meaningfully linked (Colombo, online). Although there are other devices capable of delivering multimedia, the two most widely used formats are CD-roms (Compact Disk Read Only Memory) which often hold commercial products, and the Internet through computers that are properly wired.

Interactive multimedia is a relatively new form of media being widely used today. Its main output device is a computer in the form of the Internet and CD-rom products. The "interactive" or "hyper" part of this media presents information through a series of non-linear links in a branching structure that allows the user to pursue topics of their choice at an independent pace. The "multimedia" end is defined by the incorporation of a variety of synchronized media, all of which present information in several ways. Interactive multimedia facilitates a user's access and organization of information. It "has no physical beginning, middle or end. It is this combination of random access with multiple media that opens up such exciting possibilities for radically new ways to communicate ideas, information and entertainment" (Cotton, 8).

History of Interactive Multimedia

Although the history of interactive multimedia is directly tied to the history of computers, it has also grown out of advancements in other fields such as art, film, television, telecommunications, digital and optical storage, psychology and computer science. Because it is a "new media", it is difficult to find a place for interactive multimedia in the history of media. "Eventually, a history of digital

Review of Literature

media will develop and we will see organized developments. For now, we don't even know how to preserve and collect these pieces....The definition of a future requires a past....New media are only new until they are no longer new–and old in this context always means accepted and established" (ed. Velthoven,19). Although its history is woven into that of computers, interactive multimedia itself has several distinct milestones in its unique development as a media. "The computer—especially the personal computer—has served as an important step towards a unified communication paradigm, but it was never conceived of as a communication technology, nor, even more importantly, as a platform to convey ideas. We therefore had to take considerable effort to turn the calculating machine first into a typewriter, and then into a communication device" (ed. Velthoven, 17). Although previous media have paved the way for its introduction, several individuals were responsible for major developments leading towards its birth. These scientists and thinkers explored how to combine various media into one singular form that could be controlled by natural language and gesture. (Cotton,11)

Previous advancements in technology and media throughout the 19th and 20th century, made it possible for the eventual development of interactive multimedia. As far back as the 1830's, the electronic telegraph began to carry signals through networks of wires via a simple code. Initiating the age of electronic communications, telegraphy was soon followed by the telephone which provided the average person with voice communication across continents from the comfort of their own home. Next, came the first" storage and delivery" (Cotton, 12) medium known as *film*, extending visual experiences to enormous audiences. Sound capabilities led to the advent of radio in the 1920's and was further expanded by the invention of television which became widely popular by the 1950's. The television brought film home but it was controlled by the user who could choose what and when they wanted to watch. More than movies, TV could bring home messages as instantly as radio but with sight and sound, and early television required viewer participation with all the dials, buttons, and low resolution images. After WWII, television began to incorporate other forms of media such as radio, film, theater, the novel, magazine, advertisement, newspaper, and comic strip. It was becoming a multiple-medium media (Cotton, 13). Finally, the fusion of these media, leading directly to the development of interactive multimedia began to occur in the late 1940's and early 50's, when digital computer technologies were developed. Work in the areas of information theory,

Review of Literature

cybernetics, digital computing, the transistor, electromagnetic memory and programming led to the development of the transistor in 1948, integrated circuit in 1959 and microprocessor in 1971. These advances made the creation of interactive multimedia possible. Ten years later, personal computers with interactive multimedia software became available.

The work of several unique individuals led to the direct development of hypermedia systems. *Vannevar Bush*, a computer scientist, was the first to envision a primitive interactive multimedia system. From as early as 1912, Bush developed several devices that would lead to the development of the modern computer. Appointed by Roosevelt in 1941, Bush was asked to coordinate the scientific research administration. In 1945, he wrote an article describing a system he envisioned called "Memex" or "memory extension" which allowed the user to input such things as text and drawings into a microfiche system. Among other capabilities, *Memex* could simultaneously display information and link that information to other related files. Other early ideas involved compression of data, information exchange with other users, voice recognition, and character recognition. The basis of the Memex system was 'associative indexing' or the ability to link the microfilm information together in a meaningful way for the user (Cotton, 22). Although the Memex system was never actually produced, the idea of an interactive desktop continued to inspire others.

In 1965 *Ted Nelson*, a writer, coined the term "hypermedia" to describe a new form of media that involved information display and retrieval involving a variety of media via the computer. Nelson used "hyper" to describe non-sequential writing such as "hypertext". His project *Xanadu,* was an attempt to integrate the entire library collections of the world into a seamless electronic database system. Through a series of writings, Nelson fleshed out many of the theories that guided the development of interactive multimedia.

The next great innovation in the development of interactive multimedia, came in 1968 when *Douglas Engelbert*, a pioneer in office automation, produced the NLS (oN Line System). The NLS involved features that are common in today's hypermedia systems such as a mouse, windows electronic mail, word processing and hypertext. His goal was to create an "augmented" system that would combine user activities such as the ability to organize, use of procedures, customs, methods, language and much more with a computer tool system. His ideas also foreshadowed communicating with others via a computer, traveling

Review of Literature

through a cyberspace, and the use of a variety of media. Engelbert believed that such a system would create a "synergy" between the user and the computer that can amplify the user's intellectual capabilities (Cotton, 24). By the late 1960's when the first desktop computers were being developed, most of the research and theories concerning hypermedia were already layed out. However, Englebert's theory was based on large mainframe systems, and the advent of personal desktop computers required a new generation of hypermedia theory.

In 1968, *Alan Kay* invented the Dynabook, the next revolution in hypermedia technology. His prototype was designed to have a flat screen display (a technology then in its early stages) a graphic interface, and would be able to handle large amounts of text (Cotton, 24). Kay continued and expanded his work when he went to work at Xerox Palo Alto Research Centre (PARC), where he designed several important additions to the Dynabook. These included a graphical user interface with icons and menus that Apple later incorporated into their Macintosh computers. Also, he created a new kind of programming language, *Smalltalk*, a precursor to Apple's *Hypertalk*, the first popular hypermedia scripting language. His 'Dynabook' (a portable, personal hypermedia computer) still inspires developers who are creating portable, easy-to-use notepad computers that incorporate telecoms with hypermedia access to information sources (Cotton, 25). The Dynabook concept has inspired the current laptop systems, opening up the future for smaller and more compact environments.

Major Developments in the History of Interactive Multimedia

1945: Vannevar Bush proposes MEMEX, a conceptual machine that can store vast amounts of information, in which users have the ability to create information trails, links of related texts and illustrations, which can be stored and used for future reference.

1951: UNIVAC, 1st commercial mainframe computer

1951: Computer flight simulation/air traffic control

1965: Ted Nelson coins the word *"hypertext"*

1967: H*ypertext Editing System* is built

1968: Xerox Alto Personal Computer developed

1968: Doug Engelbart demonstrates *"Augmented" NLS, a hypertext system*

1972: Nolan Bushnell creates first videogame

1975: Microsoft Corporation is founded

1975: ZOG, a distributed hypermedia system, debuts at Carnegie-Mellon

Review of Literature

1977: Apple II Computer debuts

1978: T*he Aspen Movie Map:* the first hypermedia videodisc, shown at MIT

1981: Ted Nelson conceptualizes "Xanadu"

1981: IBM Personal Computer debuts

1984: Apple Macintosh debuts

1984: Telos introduces Filevision, a hypermedia database for the Macintosh

1985: Janet Walker creates the *Symbolics Document Examiner*

1985: Philips/Sony develops CD ROM

1985: *Intermedia,* a hypermedia system, is conceived at Brown University

1986: GUIDE, a hypermedia document browser

1987: Apple Computers introduces *HyperCard,* the first widely available hypermedia authoring system

1987: Hypertext '87 Workshop

1989: Autodesk, a major CAD software manufacturer, takes on Xanadu as a project.

1989: Tim Berners-Lee proposes World-Wide Web project

1990: ECHT (European Conference on Hypertext)

1990: Desktop Video (DTV) debuts

1991: "Multimedia" PC introduced

1992: Autodesk drops the Xanadu project

1992: Microsoft: Multimedia Windows introduced

1992: CERN releases WWWeb

1993: International Workshop on Hypermedia and Hypertext Standards, Amsterdam

1993: Mosaic 1.0 for X windows released by the National Center for Supercomputing Applications

1993: First World-Wide Web developers' conference in Cambridge,Massachussettes

1993: Hypertext Conference in Seattle, Washington

1993: World Conference on EducationalMultimedia and Hypermedia in Vancouver, Canada.

1993: NCSA Mosaic 1.0 for X Windows (June)

1994: Confs: Geneva, Intl WWW; Vancvr, Ed Multimedia; Edinburgh, Hypermedia Tech

1994: Clark & Andreessen form Mosaic (Netscape), release 1st beta

1995: Lycos WWWeb search engine; Yahoo WWWeb category index

1995: DEC's Altavista search engine word-indexes 15 million pages (Dec)

1996: 24 Hours in Cyberspace documentary project (Feb 8?)

1996: US telecom bill outlaws indecency on Net, immediate court challenges

Review of Literature

Fundamentals of Interactive Multimedia

In the early days of computers, most systems were large, hard to use, and operated by a select group of highly-trained individuals. Today, however, the invention of personal desktop computers has caused a need for well-designed and easy-to-use systems. If designed appropriately, interactive multimedia, can effectively provide information for the user. Ultimately, multimedia needs to accommodate the needs and capabilities of its intended audience; "users should not even have to think about the intricacies of how to use a computer" (Preece, 5). Among other areas, the field of *Human-Computer Interaction* (HCI) deals with issues of good interactive multimedia design; media that is appropriate and effective for its end user. Through the study of HCI, researchers have learned that successful interactive multimedia is composed of several fundamental components. In order to understand how interactive multimedia works, one should understand its general philosophies and goals, its effects on a user's cognition, perception, attention and learning, the various interfaces and interaction styles being used and the input and output devices.

What is an Interface and How Does It Work?

A computer **"interface"** provides a way for a user to interact with a system. It is a metaphor that presents the computer's new and unfamiliar domain with ideas and terms the user is already familiar with. "A human interface is the sum of all communication between the computer and the user. It's what presents information to the user and accepts information from the user. Its what actually puts the computer's power into the user's hands" (Apple,xi). Interfaces allow a two way dialogue between user and machine where the user is able to enter input (information) into the computer which interprets the information and subsequently responds in terms the user understands. Currently, there are several different *types of interfaces* being used, each requiring different *interaction styles* and methods ranging from command entry to 3D direct manipulation of elements. Each type of interface provides a vehicle for interaction and allows the user to develop a mental model of the system. In using computer systems, "the user's primary form of interaction is navigating through the content" and the interface should "help people understand where they are, where they can go, and how they get there" (Kristof, 42). As interface design evolves and moves into the future, these interfaces and interaction styles have both advantages and disadvantages associated with their use and must be utilized according to their appropriateness in a particular application.

Review of Literature

Interfaces are made up of "metaphors"; traditionally associated with language usage, metaphors have become one of the most important parts of computer interface design. Interface designers often take advantage of a user's prior experiences by the use of metaphors that help relate computer processes to the everyday world that people are familiar with (Apple,3). "When we consider how the system interfaces have been designed, we can also see how metaphors play an important role. The objects on the screen, the types of user interactions we perform, the way the system responds, the names given to command names, tend to be based on familiar terms" (Preece, 142). There are three types of metaphors that relate to interfaces: *verbal, virtual,* and *composite.*

Verbal metaphors allow the user to mentally compare this new and unfamiliar computer domain and its functionality with prior systems they have encountered. These metaphorical comparisons may provide the user with a foundation to understand the computer system. "The classic example is of people who use a word processor for the first time; it occurs to them how similar it is to a typewriter. Having activated the typewriter schema, they are able to interpret and predict more readily how the word processor functions" (Preece, 142).

However, when it comes to understanding and interacting with the interface itself, verbal metaphors are not enough. They must be expanded to develop and describe aspects of the computer's structure and functionality. The expansion of this metaphorical correlation comes through *virtual metaphors.* Virtual metaphors most often consist of icons, buttons, sliders, etc., which directly represent objects in the real world. "A difference between virtual metaphors and verbal metaphors is that the former user part of the interface. Whereas verbal metaphors invite the user to 'see' the similarities and dissimilarities between the system and the familiar domain, interface metaphors combine the system and familiar domain into one entity" (Preece, 146). The virtual interface metaphor allows the user to build a mental model of the system more like the metaphor rather than based on how the system actually works; the metaphor becomes the model.

In turn, a third type of metaphor is created, the *composite metaphor* which allows designers to incorporate additional functionality which is not a part of the interface metaphor. "The desktop metaphor has been combined with other metaphors" (i.e. scrolling, menus, windows, etc.) "to allow users the flexibility of carrying out a range of computer-based actions" (Preece, 147). Composite metaphors help

Review of Literature

users to assimilate and understand multiple mental models. Composite metaphors are often used in GUI interfaces.

Design of an Interface

Well-designed interactive multimedia is governed by a number of factors. One of the most critical of these is understanding how users interact with a system. Issues related to a user's cognitive abilities, perception, attention, and learning skills will directly affect the design of the final product. "Cognition" refers to how user's process information and gain knowledge. Cognitive theories developed by psychologists help designers to understand how knowledge and information is exchanged between the computer and the user. These models also help the designer predict the behavior and performance of the end user. Several cognitive approaches that are used when evaluating users, have come about because of the development of computers and interactive multimedia. The *computational approach* is based on a computer metaphor as a theoretical framework where tasks are analyzed in terms how a user deals with new information rather than the amount of information that is processed. The second approach is the *connectionist approach* based on a brain metaphor in which cognition is represented as a series of neural networks consisting of interconnected nodes; cognition is based on activations of these nodes in a network and the connections between rather than the manipulation and processing of information. Finally, *distributed cognition* creates a cognitive framework based on multiple users in a work situation rather than an individual; cognition is distributed across a group of people in a similar work environment. Cognitive theories help interactive multimedia designers predict a user's behavior and performance with a system and guide designers in creating systems that effectively meet those user's needs.

Similarly, perceptual models are used to help designers create unambiguous and easy to understand applications. Two theories on perception which are commonly referred to in the design of interactive multimedia is the *constructivist* and *ecological* approach. Constructivist theory believes that the process of seeing is an active one in which a user perceives information based on the environment and previously stored knowledge. The ecological approach believes that a user only experiences information in the environment and does not construct or elaborate that information. Designers must take these models into account when designing interactive multimedia applications. Appropriate graphical coding and modeling on the interface level can greatly enhance a user's perception and under-

Review of Literature

standing of the information. There are a variety of aspects that must be addressed when graphically coding or modeling information such as the use of color, size, interposition, contrast, clarity, shadow, texture and depth. The designer must decide which of these and in which combination to use these so that users will properly perceive the information. Three tools that are used when creating perceptually accurate interfaces are *visibility, mapping and affordance.* Like its name, *visibility* means the degree of visibility of a programs' controls. *Mapping* means how well that control's effects are visible from their appearance; how well the control's effects are mapped. *Affordance* is how well the control (affords) or suggests its functionality; manipulations to a particular object. If designed appropriately, these three elements will help to coordinate the user's goals and needs to the functions available. The relationships between the user's goals, required actions and the results should be sensible and meaningful.

A user's attention and memory constraints are also fundamental in understanding how interactive multimedia operates. Designers use attention models to design systems that are easy to navigate. Interfaces are structured so that the user does not view too much information on one screen or too little information on numerous screens. Additionally, data is grouped and ordered in meaningful ways. Attention models may deal with how a user focuses or divides attention, approaches tasks or processes information. "By capitalizing on the perceptual laws of grouping, information can be meaningfully structured so that it is easier to perceive and able to guide attention readily to the appropriate information" (Preece, 102). Some tools that designers use to guide a user's attention include spatial and temporal cues, color, commands, alerting techniques (like flashing), windows, menus and icons. Meaningfulness of these elements is determined by their context, task, representation and underlying concept. (Preece, 113). Interfaces based on attention theories help designers create applications that are intuitive. Users do not have to think about their actions because the interface does most of the remembering. A user only needs to know where to find things and how to interact with these simulated objects.

While it is important to understand cognitive, perceptual, and attention theories in the design of interactive multimedia, one must also understand the fundamental principle of *models* in the user's learning process. Mental models are an important part of interface design which help the user to understand their interactions with a system. Designers work with models to create a common base on

Review of Literature

which a user and computer can effectively understand one other and work together. There are three main types which include: *the user model, the design model,* and *the system image.* The "user model" is a mental model developed by the user about how the system works. The user model is the way users conceptualize and understand the functionality of the system. "The primary goal of interface design is to create and support an appropriate and coherent mental model of the operations and organization of the computer system. Graphic user interfaces incorporate visual and functional metaphors drawn from the world of everyday experience to help orient the computer user to the possibilities and functions of the computer system" (Lynch, online). When using a system, people use their prior knowledge to help them develop mental models to understand and predict the computer's behavior. (Preece, 151).

Often designers attempt to work off of the user's prior knowledge when developing the *"design model".* "The problem is to design a system so that, first it follows a consistent coherent conceptualization– a design model– and, second, so that the user can develop a mental model of the system– a user model– consistent with the design model" (Preece, 151). The final interface, should enable the user-model to map onto the design model so that users can fully utilize the system. Donald Norman believes that without a good conceptual model, we function blindly "we do operations as we were told to do them" and cannot fully appreciate why. (D. Norman, online) "The development cycle of computers is now well past the point where the use of computers is exclusively by computer scientists. The general work force and the public-at-large is already using or beginning to use the computer in one form or another. It is at this point that careful consideration must be made of how to lay out the architecture and the building code in each new community of users. Without such forethought, users are likely to become prematurely locked into an arbitrary and archaic structure" (K. Norman, online).

Additionally, users generally come to understand a system through not only its interface metaphor, but also its behavior and documentation. These combine to form the "system image" or model. "Using a modern computer system also involves reading manuals, calling help lines, attending training classes, asking questions of colleagues, and trying to puzzle out how software operates. A successful computer system or software package supports those activities, so that support is part of the user interface too" (Lewis, online). The system image is understood by the user through an interface that helps the user-model map

Review of Literature

onto the design model, and through viewing and interacting with the whole system. The creation of effective models on both the design end and the user end help both the user and system effectively work together.

Types of Interfaces and Interaction Styles

Metaphors and models become extremely important when designers select a particular type of interface and interaction style. Currently, there are several different types of interfaces being used, some more than others. Each type of interface has both advantages and disadvantages, and when a designer chooses a particular type of interface, they must consider its appropriateness in the application. Unlike early interfaces, today "human-computer communication often takes non-verbal form, such as the manipulation of objects and tools, the indication of points, paths and various types of gestures" (Preece, 262). "Interface design does not just concern the look of the control panel (although this obviously determines how effectively the user will suspend disbelief in the metaphor); it also encompasses the ergonomics of the user's control of the program... The interface metaphor may also determine the overall "house style" (Cotton,44) . Each type of interface may employ a particular interaction style or a combination of several. There are four main types of interfaces used today; *Command Line, GUI, Virtual Reality, Ubiquitous.*

Command Line Interface interfaces involve communication between a user and computer system, usually via a keyboard, in which a request is made by the user for an action by inputting a short word or abbreviation (Preece, 710). Entering information can take the form of function keys, single characters, short abbreviations, whole words, or a combination of the above. Command line interfaces were once the most common before graphical interfaces were created, but they are still used in various systems. This interface uses "command entry" as its primary type of interaction style which involves the use of a keyboard to express instructions to the computer and a monitor for the computer to show its response.

There are several advantages and disadvantages to the command line interface and command entry style. First, for highly experienced users, command-driven systems allow speed and flexibility. They are often faster systems without the memory allotment needed for graphical interfaces, and their languages allow the user great flexibility and interactivity with the system. However, the languages required to use command systems are often complex and require a great deal of memorization and retention skills. "In

Review of Literature

fact, unless a person knows the protocol that has to be followed, no dialogue may be possible" (Preece, 263). Ultimately, command driven systems are best utilized by experts but are not very functional for the average user. With the invention of graphical user interface, systems that solely use command entry are not as common.

Graphical User Interfaces (GUI) use a mouse on a flat surface corresponding to a cursor or arrow on the screen to point to options on a displayed menu. This new type of graphic-oriented operating system created a whole new set of interactions styles. Two of the most commonly used are menus/navigation, and direct manipulation, however, often these and others including command entry are used in various combinations. "A menu is a set of options displayed on the screen where the selection and execution of one or more of the options results in a change in the state of the interface" (Preece, 265). There are both pull-down and pop-up menus which are hidden until the user somehow interacts with them. *Direct manipulation* is the most common interaction style for GUIs. It involves the visibility of objects of interest and quick reversible incremental actions. Typically, direct manipulation involves the manipulation and navigation of icons representing objects with the mouse. "Direct manipulation has been much heralded within HCI as the way forward in interface design" (Preece, 271).

There are several advantages and disadvantages to the GUI interface and its menu and direct manipulation interaction styles. Menus are beneficial because "unlike command-driven systems, menus have the advantage that users do not have to remember the item they want, they only need to recognize it" (Preece, 265). Organized in hierarchical structures (i.e. alphabetical), menus often use natural language techniques to describes commands. "Users are presented with a list of options from which they can choose and some mechanism by which to indicate their choice. The characteristics of menu selection are that (a) the interaction is, in part, guided by the computer; (b) the user does not have to recall commands from memory, and (c) user response input is generally straight forward" (Norman, online). However, one disadvantage is that users must have a basic knowledge of the system. "Users also need some basic knowledge to use this system. They must know that they have to use the mouse to position the cursor on one of the words in the title bar and then click to obtain a menu" (Preece, 264). Also, the overwhelming amount of information presented in these hidden menus may be obscured or hard to locate in the multiple hidden menus.

Direct manipulation can help novices learn quickly,

Review of Literature

experienced users can move around and perform tasks rapidly, error messages are rare, and intermittent users can retain operational concepts, users receive immediate feedback to their actions, the comprehensible interface creates less anxiety in users, and inspires confidence in users who can predict the outcome of their actions (Preece, 271). The disadvantage is that some tasks cannot be described by concrete objects and not all actions can be directly performed.

Virtual Reality interfaces or virtual environments are digital 3D "environments" The interaction style involves direct manipulation by the user on several levels. VR (virtual reality) can be characterized by three main factors which include: a sense of direct physical presence, the use of sensory cues presented in three dimensions, and natural interaction with the environment. In edition to direct manipulation as an interaction style, natural language techniques are becoming widely used also. *Natural language* dialogue includes both type written or verbal commands and interactions with the computer using the user's natural language. The equipment used may vary but generally provides the users with visual, aural, and / or Haptic (force feedback). "VR is the state where the level of interaction, autonomy and feeling of presence is indistinguishable from the real world" (Preece, 343). However real-world use of VR is currently far from this goal because of technological and human-factor limitations.

Virtual reality systems are divided into two separate categories; *desktop and immersion systems. Desktop systems* use a single, large color screen for input and output, a 3D pointer (i.e. mouse) and a keyboard. They are most synonymous with the environments used in computer and video games where the software and controller involved, allow the user to fly or turn around in space. (Preece, 336). Immersion systems on the other hand, include peripherals such as helmets (Head Mounted Displays (HMDs), stereoscopic goggles, and gloves that allow the user to move around easily in a space such as a room. "This computer generated world may be a model of a real-world object, such as a house; it might be an abstract world that does not exist in a real sense but is understood by humans, such as a chemical molecule or a representation of a set of data; or it might be in a completely imaginary science fiction world" (Monnot, online).

There are several advantages and disadvantages to the Virtual Reality interface and direct manipulation interaction style. Virtual reality interfaces are only as good as the graphics and sound effects that make them up. The closer they resemble reality and the user's interactions with real-

Review of Literature

ity, the better they are. "An even greater sense of presence can be achieved if one allows one's own body to become part of the virtual environment. I am convinced that integration of the real world with a virtual world offers the best compromise with today's technology" (Preece, 343). VIrtual reality interfaces and the direct manipulation in 3D environments that they provide, not only have the capacity to imitate reality, but they can take the user into realistically impossible situations for a variety of reasons.

However, there are also some disadvantages with this interface technology. First, the same ability that VR has to take people to different environments can also be a source of problems. "People tend to perform better in a simulator than in a real environment because of the low risk factor" (Preece, 344). Additionally, many VR systems cannot yet respond efficiently to natural language interaction and cannot interpret subtle gestural or non-verbal human communication. Eventually, as technology improves however, the user may have trouble discerning the virtual world from the real one. VR is currently a very expensive interface to adopt and is not a reasonable alternative for most systems.

*Ubiquitous interfaces a*re the most unique of all, and next to VR, seem to be the most promising solutions to the future of interface design. In a ubiquitous system, the interface metaphor is made to appear invisible to the user. Ubiquitous systems claim to invisibly enhance the existing world, but the goal is not a high level of interactivity between user and machine. The goal of this type of interface is to make the interface metaphor invisible to the user, while computers themselves interact with one another invisible to humans. "Virtually every coffee machine now has a microprocessor inside and so do cars. But it's all stand-alone, and the next big step will be to interconnect it all" (Wolkomir, online). For example, "instead of you having to decide that you need to buy some milk, or that the heating needs turning up or the trash needs emptying, a 'society of objects' in the form of virtual butlers, secretaries and housekeepers will organize and manage everything for you" (Preece, 151). There is no particular interaction style as with the other types of interfaces because the interface metaphor itself is invisible. This system is intended to provide effortless results when the user interacts with these 'invisible' computer systems. "Technology can not truly be helpful unless it can provide the information that you need where you want it, when you want it, and without you needing to manage it" (Negreponte, online).

There are several advantages and disadvantages to the ubiquitous interface. Because the user is distanced from

Review of Literature

the complexities of how the system works, a ubiquitous computing system may have a smaller learning curve to use and people may be less fearful towards it than towards a traditional interface metaphor. Ubiquitous computers are in objects that people utilize everyday and they allow the user to enhance their environment rather than having to change to fit into the computer environment. Nicholas Negreponte believes that there should be more capable devices, pervasively embedded into the environment. When these are linked widely into large distributed networks, computers and interfaces can filly be less obtrusive to humans.

However, because ubiquitous computing systems are easy and effortless to use, they can cause users to take them for granted. Without an interface metaphor to relate to, the user is so far removed from the design model that they lack any solid understanding of how the system actually works.The design model is presented so "ubiquitously" to the user that if there are no metaphors to help them relate to it, they cannot form an appropriate or correct mental model of how it works. When the computer fails, they have no idea of its underlying system and cannot effectively interact with it to solve the problem. When the user feels that they do not have an understanding of the computer or how it works, they "may assume that the system is more intelligent than it is. When the virtual agents fail to behave as expected, users may get frustrated" (Preece, 151).

Although there are several types of interfaces and interaction styles that are used, two are being highly researched today. Both virtual reality and ubiquitous interfaces are leading the way towards the interface of the future; one in which man and machine are naturally meshed. "Hypermedia...simulators...virtual reality...we are moving further and further along the road towards a physically enveloping, multi-sensual illusion of telematic control. What is now called the "interface" between man and machine will gradually be subsumed within an ever more real illusion that we are actually "inside" the machine itself, interacting at first hand with what Timothy Leary calls 'vast continents of unexplored data'"(Cotton, 45).

Interactive Multimedia Input and Output Devices

Interactive Multimedia may involve a variety of input and output devices depending on the type of application, interface and interaction style, user needs and characteristics, and work or environment conditions. Although these devices may vary, they all allow a user to interact with a variety of media in an interactive multimedia application.

Input devices allow a user to enter data and issue

Review of Literature

instructions to a computer; "a device that, together with appropriate software, transforms information from the user into data that a computer application can process" (Preece, 212). Input devices are determined heavily by the way they help a user work effectively and safely with a system, matching the physical and psychological restrictions of a user. Additionally, input devices should match the task they are used to perform and should be suitable for the environment they are used in. Many systems will use several in combination to achieve an appropriate set of results. *Discrete entry* devices involve touching one of two or more items (buttons, switches, etc.). *Continuous entry devices* include such items as pens with digitizing tablets, joysticks, rollerballs, etc., where a range of continuous contact is required. *Keyboards*, a discrete entry device is generally the most common type of input device and allows command entry using alphabetic or numeric characters. Another common type of input device is the *mouse* which falls in the category of continuous entry along with the *joystick and trackball,* all of which can specify a point or path in one, two, or three dimensional spaces. A third category is called *3D trackers,* include such items as the data glove, which like other such devices, can measure the absolute position and orientation of a sensor in an open space with three dimensions (Preece, 234). These types of devices are most often used in conjunction with virtual reality interfaces or for users that are handicapped. Less common forms of input devices include *touch screens* which allow the user to input information by touching a part of the screen, v*oice recognition systems* which will accept and decode natural language, and input devices that will interpret human handwriting. Currently, the most dramatic developments in input devices involve multi-modal input, or input involving several senses at once. These continual developments will expand the way we interact with computer systems, making interactive multimedia all the more effective and exciting.

Like input devices, output devices provide a means for the user and computer to interact and understand one another. Output devices convert information coming from the internal electronic computer into a form understandable by the user. Visual display of text or images involving a *monitor* or screen is the most common form of output, which leads us back to understanding the importance of a well designed interface. Output in this case often relies on dynamic visualizations such as still graphics, models, or 3D animations. Similarly, *sound output* is available with most computers and may include speech, musical or natural sound output. Additionally, when combined, image and

Review of Literature

sound can be output in the form of video. Finally, output of printed material is possible with the use of a printer. Like input devices, advances in output have directly affected interactive "multimedia". They allow a true hybrid of media in the computer and are heading towards a more multi-modal format.

The Advantages of Interactive Multimedia

As we approach the end of the twentieth century, we are witnessing the growth and power of interactive multimedia. Now that we have defined it, explored its growth, and examined its fundamental components, we must address its relationship to other popular forms of media. Like any media, it shares similar aspects of communication, however, it may be the most beneficial way yet to present and receive information. A comparison of interactive multimedia to print, radio and television will help to demonstrate why this new media is so popular.

A Comparison of Print and Interactive Multimedia

Print has long been a media that has allowed society to store and communicate ideas and knowledge through the visible language of writing and illustration. In the 15th century, print first became a "mass media" when Gutenberg and his colleagues where able to achieve the mass production of books without sacrificing quality (Bolter,2). Just as Gutenberg had changed society's idea of a book, transforming its creation from the handwritten pages of a scribe to an impersonal mechanical process, so too is the computer changing the concept of printed material. "The physical presence of books has been crumbling away for more than five centuries. Since the invention of printing—often falsely seen as the beginning of book culture—the book has been disappearing. Compare the material presence of a medieval manuscript with that of a twentieth-century novel–especially the mass-marketed paperback version. The book's evaporation has seen the growth of the number of books produced while the price declined spectacularly. And the readability and usability of books had increased greatly. The disappearance of the physical book has been a pre-condition for centuries for the growth of book culture" (ed.Velthoven,13). Whether or not the invention of the computer is causing a decline in the appeal of books, one must consider its overall impact on the media of print.

There are several fundamental structure and format differences between print and interactive multimedia. First, the **structure** of information delivery is radically different in both. Print, like other forms of media has the ability to

Review of Literature

express and distribute widespread information in the form of text and images. It requires two major forms of user interaction; the ability to read the language and the ability to understand and visualize the information presented or interpret the images. Printed material generally presents information in a linear format. Chapters, page numbers, columns and paragraphs, all guide us from beginning to end in a logical sequence of ideas or events. "A written text is a structure in space that implies a structure in time: writing turns time into space" (Bolter,107). A book must be read from beginning to end in order to fully understand the information and often resemble a monologue rather than a dialogue. However, a monologue may be appropriate in some circumstances, "The carefully composed linear narration that finds intimate refuge in books corresponds so beautifully to the course of our lives that there will always be a large group of people who identify wholly with them" (ed. Velthoven,12).

The second fundamental difference between print and interactive multimedia is their **formats.** Most people encounter the widespread distribution of printed material in the form of newspapers, magazines or books. The distribution of information in print is often delayed from a period of days to years. Also, printed material may be subject to eventual deterioration or decay, leading to the loss of information. However, it is not an electronic medium, requires no electricity and it is therefore "portable, inexpensive, and easy to read" (Bolter, 4).

However, the advent of computers has expanded our ideas and expectations of print, delivery of printed material and information consumption. "The German media theorist Norbert Bolz is convinced that the *information processing system 'book' is clearly no longer up to the complexity of our social system. The New Media unfold the grey environments of text into spectral colors of sensuous knowledge"* (ed. Velthoven, 19). Although we are familiar with text being displayed off the traditional printed page such as on a TV screen, computer monitor, or even printed from a computer, "hypertext" has taken printed material to a new level. The major **structural** difference between interactive multimedia and print, is that the former incorporates *hypermedia.* As previously discussed, *hypertext or hypermedia* is text or media presented through a series of non-linear linked nodes of information in a branching structure that allows a user to pursue topics of their choice at an independent pace. While printed material requires only two types of interaction—language and visualization, interactive multimedia requires the user to be an active participant, navigating not only the computer, but guiding themselves and interacting

Review of Literature

with the information. Through the use of "hyper" media or nodes of information linked by association, the user can choose to follow a variety of non-linear paths leading to areas of interest. They are no longer restricted to the linear monologue of the author. This new way of dealing with information is also changing our perceptions of both text and imagery.

Interactive multimedia's use of hypertext has dramatically affected our idea of text. Hypertext falls into two categories; *clearly-structured* and *implicitly-structured* text. Clearly-structured has obvious structural links such as a directory, technical manual or catalogue. Implicitly structured hypertext provides little logical structure with no obvious subdivisions such as a novel written as stream of consciousness. Depending on the application, either may be used. However, they are both include nodes of text interconnected and transversed by links. Those links may be in the form of maps, menus, icons, highlighted text, and other interface indications of hypertext. Essentially, hypertext creates a new author/reader relationship. No longer is the reader a passive receptor of the message, but they are free to explore and browse the information presented based on their priorities and needs. "The computer gives the reader the opportunity to touch the text itself, an opportunity never available in print, where the text lies on a plane inaccessible to the reader. Readers of a printed book can write over or deface the text, but they cannot write in it. In the electronic medium readers cannot avoid writing the text itself, since every choice they make is an act of writing" (Bolter 144).

Similarly, imagery has evolved from static printed pictures to a multitude of visual experiences. Interactive multimedia provides the user with multiple media and an opportunity for visual experimentation using 2D or 3D imagery, video or animation. Because imagery no longer needs to be static, the way we look at images has changed. In interactive multimedia, pictures can be used in many ways and "linked together with text and other images to create new kinds of relationships that can be explored interactively by the user. Just as a film poster, a stained glass window or a painting can tell us a 'story' in an iconic, 'all-at-once', non-linear way, so images in hypermedia programmes can be devices for providing a variety of different ways of looking at a particular subject or theme" (Cotton, 48). Images no longer need to be statically observed, but can themselves be menus, icons or links for navigation in an interactive presentation. Images may be used in a linear slide show format, non-linear linked screens of multiple images or complex montages, all of which can help coordi-

Review of Literature

nate a user's physical interaction with their perceptual interaction. "In this way, the user will have access to a wide variety of ways through which to approach the subject matter. It will be possible for users to 'browse' through these approaches, select the most appropriate, and 'fine tune' them to optimize their own understanding" (Cotton, 50).

There are also several differences between the **format** of printed material and interactive multimedia. Most people encounter the widespread distribution of interactive multimedia in two ways; via the Internet or CD-rom products. Although much faster, the speed and type of information retrieval via the Internet resembles information retrieval via a newspaper, where as a CD-rom information retrieval would resemble that of a book. If a user has a properly wired computer and equipment, within a matter of seconds, they can acquire up-to-the-second information using the Internet. Acquiring information from a CD-rom would require purchasing the software and then running it from a computer. However, compared to print, both mediums allow faster and more immediate retrieval and access to relevant information for the user. Additionally, both the Internet and CD-roms with not deteriorate like most printed material. The almost indefinite lifespan of information that is stored and transferred between computers on the Internet or stored on CD-roms, creates a world where information will never be lost due to material defect. "All previous marking and symbol systems can be subsumed by digital representations. The implications of this become really interesting when the second property is added: that stable digital representators can be inexpensively made in astronomical quantities. Third, the representations can be transmitted to everyone in the world very rapidly and at low cost. Finally, the digital representations are active and reflective—they can read and write themselves at great rates of speed" (Kay,online).

However, there may also be several obstacles to the complete utilization of interactive multimedia over print. First, like any electronic device, computers need electricity to run. This means that for some people, access to interactive multimedia may be limited. Additionally, portability problems have existed in the past when computers were very large. This is becoming less of an issue as computers become as small as notepads and even wristwatches—easily the same size as a paperback novel. "Right now it is hard, but not impossible, to compete with the qualities of a printed book. A book has a high-contrast display, is lightweight, easy to "thumb" through, and not very expensive. But getting it to you includes shipping and inventory. In the case of textbooks, 45 percent of the cost is inventory, shipping,

Review of Literature

and returns. Worse, a book can go out of print. Digital books never go out of print. They are always there" (Negreponte, online). Similarly, the newness of these technologies means that computers and hence interactive multimedia is expensive and less accessible to the masses. Today it seems that a paperback or even a hard bound book will always be less expensive than a computer and therefore more accessible. However, "the availability of the material does not define the medium, much as the physical object of paper no longer defines the conceptual category 'book', 'periodical' or even 'daily newspaper' The decision regarding the delivery platform (paper or electronic or both) strongly influences the work, but the medium is defined by the communicative concept in conjunction with the delivery platform" (ed. Velthoven, 17). Finally, like any new media, people must first learn how to operate the technology. The learning curve for using computers and interactive multimedia is higher than for any other form of media today. However, as each subsequent generation grows up using these technologies, that large learning curve will be eliminated.

It is obvious that both the media of *print* and *interactive multimedia* have had a unique and interesting relationship with one another. Print was the earliest form of media and still remains alive-though not as well today. In spite of several obstacles such as expense and skill level associated with the new technologies, interactive multimedia has expanded the audiences idea and expectations of text and imagery. For authors, interactive multimedia is the next step in the written word, allowing them to dynamically connect text, images, sound and much more in a non-linear way. This combination of print with other media, may allow the author to "tighten" their grip on the audience, immersing them ever more deeply in the meaning and message of their writing (ed. Velthoven, 15). "The developments of the aesthetics of hypertext will take generations and will be accompanied by extensive changes of consciousness, comparable to literature's long development, which took place in continual exchange with much broader social developments. However, I would advise no-one to have great expectations for the nearest future. And hyperculture will never replace book culture; hypertext exists by grace of text" (ed. Velthoven, 15).

A Comparison of Radio and Interactive Multimedia

When radio first became a form of mass media, it quickened and expanded widespread information distribution and retrieval. There was no longer a need to wait for

Review of Literature

the daily newspaper or monthly magazine to receive news or even open a book for entertainment; the radio became the most immediate source for information. From the first broadcast in 1910, radio offered news, talk shows, sporting events, concerts, comedy and variety programming. Although television eventually became more popular, today, radio still holds a large piece of the mass media market today. "Radio audiences are considerably smaller than television audiences, but the audience of even a moderately small AM station in a big city will often exceed that of a city's leading newspaper" (Lovell, 280). Today, radios themselves may also include tape or CD players for playing pre-recorded music or entertainment. Although radio first lost much of its patronage to television, what remains is now being threatened by the growth of interactive multimedia.

The **structure** of radio's information delivery is simple; a messenger at one end broadcasts audio information using electronic signals to the user's end. The user has a box with controllers (a radio) that decodes these electronic signals and turns them into sounds or words. The radio has several forms of interaction; a user must be able to operate the machine (turning it on, off, adjusting volume, or switching stations), and they must be able to understand the language or hear the music. Additionally, a user may have the ability to play tapes or CDs of pre-recorded music from the same box. However, unlike print, radio is slightly less linear; a user may choose to switch the channel and listen to something else.

The second aspect of radio is its **format.** Most people encounter the widespread distribution of radio on a stereo, car radio, or portable radio. Although information distribution via radio is much faster than print, there is still a delay. If a user is seeking a particular piece of information or news immediately, they must wait for the broadcaster to announce it. In this way, it is difficult to find a particular piece of information quickly. Rather, a user may have to continually flip channels or wait for the information to be announced. Additionally, radio is just a delivery medium-news, data or information cannot be stored. A radio or stereo may be able to play recorded information if the user has a tape or CD player. Although radio runs on electricity, the technology is older and therefore radio is relatively portable, inexpensive and easy to use.

Although radio is much different than print, it is also at risk from the growth of interactive multimedia. As previously discussed interactive multimedia involves "hypermedia" or linked pieces of non-linear information. This information usually includes audio that is often com-

Review of Literature

bined with additional media in a non-linear linked format. The most apparent threat for radio, seems to be from the Internet. The Internet provides news and entertainment similar to radio but with multiple media support and more user navigation and control. The Internet offers news and information in both visual and auditory formats. Its non-linear structure allows users to find exactly what they are looking for without having to wait for an announcer. For recorded audio such as tapes or CDs, the threat seems to from commercial interactive CD-rom products that offer audio along with multiple media support. These CD-roms can offer full recorded music in addition to supportive images, video, or animation all in one package. Also, interactive audio is "used within the context of a graphical interface that provides special screen buttons or 'icons' on which the user clicks to trigger audio sequences....Such 'audio icons' can be called 'Earcons', and provide a valuable method for accessing audio sequences in the non-linear environment of hypermedia, giving the user the choice of what to listen to and when and how they hear it" (Cotton, 61). Rather than a linear stream of information such as radio, audio can become a truly interactive experience through a variety of formats. A designer may use simple auditory cues or a linear narration that can interrupted by the user when they make another selection or further information. Audio may be presented with visual controls such as dials knobs etc for full control as on a standard radio or stereo. Also, music may play when objects are rolled over with the mouse or as scrolling text for lyrics or sheet music. Interactive multimedia offers the user a greater potential to interact with audio than previously with radio or recorded music.

Again however, interactive multimedia may possess several obstacles that the use of radio does not. Much like print, issues of portability are becoming less and less as computers that are capable of accessing the Internet and playing interactive CD-roms are becoming as small as a laptop or book. Like print, radio is an inexpensive and easy to use media.

A Comparison of Television and Interactive Multimedia

By the early 1950's, television was replacing the radio in homes across the America offering both the auditory experience of radio and the magic of moving pictures. Television cost more to produce than radio and these lavish visual and audio productions quickly lured audiences away from radio. TV programs included news, soap operas, sitcoms, variety shows and eventually made-for-TV movies.

In more recent years, the advent of video cassette

Review of Literature

recorders (VCR) and cable television have expanded audiences viewing choices. Up to this point in history, television has seemed to offer everything; text, video, audio and even some amount of genuine user control. However, interactive multimedia is in the process of achieving what TV could not–the seamless integration of all of these media with full user navigation and control.

Although there are some communication similarities, there are fundamental differences in the structure and format of television and interactive multimedia. Television works much like radio in that the broadcaster (television station) sends out electronic signals that when interpreted by your television set, offer both sight and sound. Similar to radio, television requires only two types of interaction; the ability to watch and listen to information being presented and the ability to manipulate the controls of the TV (on, off, channel and volume). Although television presents information in a linear stream with programs running from beginning to end, the user has the ability to change the channel and move around between programs. However, like radio, the user cannot control the time, topic (of a program) or pace of information presented.

The most common format for viewing TV is with a standard television set. Also, cable television provides a variety of additional special interest channels and video cassette recorders can play recorded video. Like print and radio, information retrieval via television is often delayed. The time and date of TV shows is set by broadcasters and the viewer must wait to see the news or entertainment they want. Even 24-hour a day news channels circulate stories so the viewer must wait to see a particular piece of information. Although video can be recorded on tape, TV, like radio, is not itself a storage medium–just a delivery medium. Much like radio, TV also uses electricity and is relatively portable, inexpensive and easy to use.

Up to this point, television has been the most immediate, interactive, and informative media yet, for the distribution and retrieval of information. However, interactive multimedia has been able to use much of the same technology in a new and unique way. As discussed previously, multimedia can incorporate text, video, sound and animation, all of which television can provide. However, the fundamental structural difference is that interactive multimedia provides full user navigation and control over both topic and pace. User control, easy access, and the non-linear nature of this new media is responsible for its enormous popularity.

Currently, interactive multimedia is not replacing television, but it is competing for audiences who want infor-

Review of Literature

mation and entertainment immediately. The format that seems to be directly competing with television on a daily basis, is the Internet, offering immediate, up-to-the-second information on nearly any topic. Although the technology is still in progress, the Internet, like CD-roms, offer video, but unlike television, this video can operate upon user demand, in a non-linear multiple-media supported environment. Although users can flip the TV channel, interactive multimedia allows them to be the program director. "Common to these 'linear' media developments is the notion of the audience as passive consumers. Hypermedia, however, offers a return to the idea of an audience of active participators. It challenges the whole notion of the author-reader relationship that we have grown used to, and creates the opportunity for another form of dialogue" (Cotton,64). Currently, interactive multimedia is finding some new and unique relationships with television such as "Web TV", access to the Internet on your TV, and broadcasting television on the Internet. Like television however, computers still operate on electricity which may limit access to some users. The portability of TV and computers seems to be leveling off, but the expense and learning curve for using computers-hence interactive multimedia is still large.

Conclusion

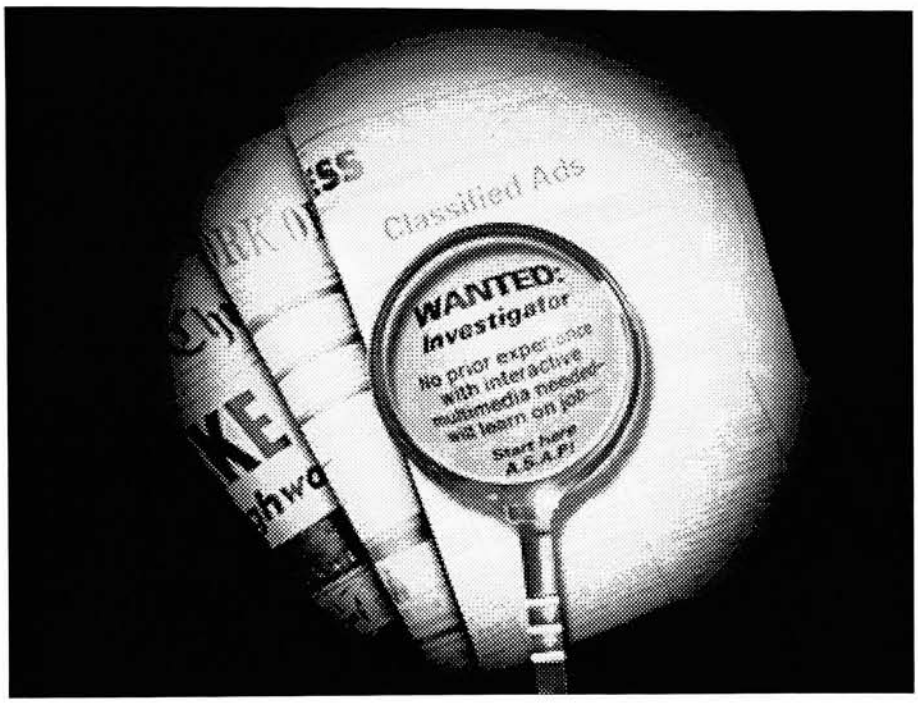
Through my thesis, I have provided several valuable insights into the power and potential of this new media. My first goal was to create an easy-to-understand educational CD-rom on the topic of interactive multimedia. While my research provided the content for the piece, the interface techniques I explored helped to solidify and enforce the concepts presented. The user is able to experience first hand these concepts.

I also discovered several new things through both the research and development of this interactive piece. Based on my research, I believe that while interactive multimedia may be classified as a new media, its roots and composition are found in previous media. These previous forms of media provide users with a reference point that often helps them to understand this new format. Print, radio and television are not disappearing but their form and functions are changing. While each form of media can provide users with a variety of information, their limitations and benefits will determine their success in the future.

For the interface, I chose to make the computer metaphor invisible and allow the user to manipulate and interact with the objects and environment naturally. With a 1940's detective genre and a selective use of color, the interface design is based on the theme of "investigation". My intended audience is individuals who use interactive multimedia in some form but who have little or no prior knowledge of its underlying theory & principles. Through the dynamic use of text, graphics, audio, video and animation, I hope to provide all levels of computer-literate users with a solid understanding of interactive multimedia.

My thesis is a hands-on learning experience directed at all levels of computer literate users, that demonstrates and explains the concept of interactive multimedia in an entertaining new way.

Appendix/Screen



Introduction to presentation

The magnifying glass moves according to the user's mouse movement.

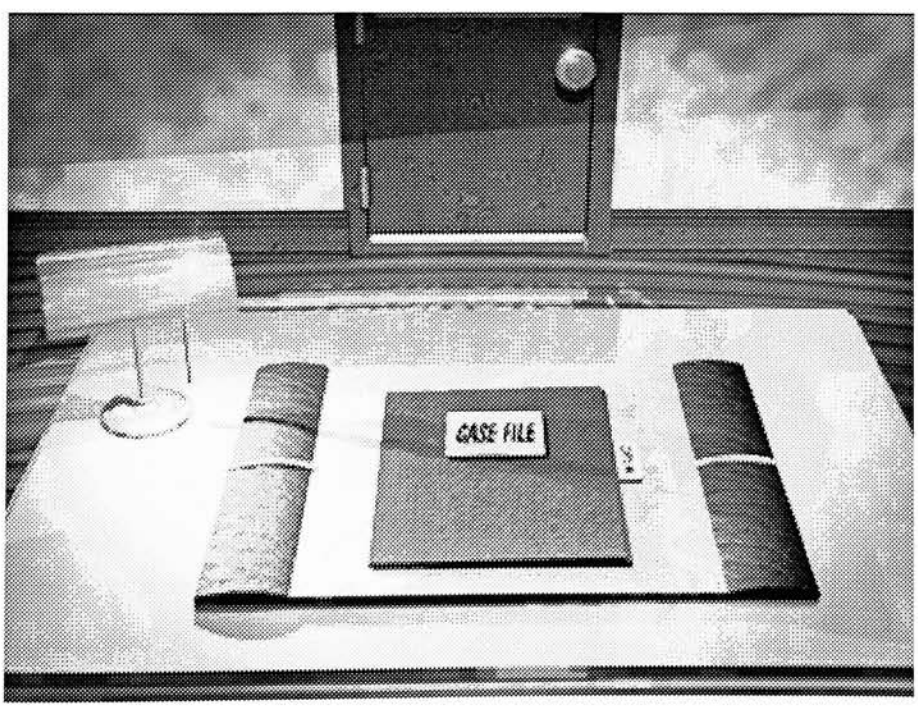
Introduction to presentation

Detective behind the door walks back and forth as floor creaks. He asks the user to come in.

Appendix/Screen

Introduction to presentation

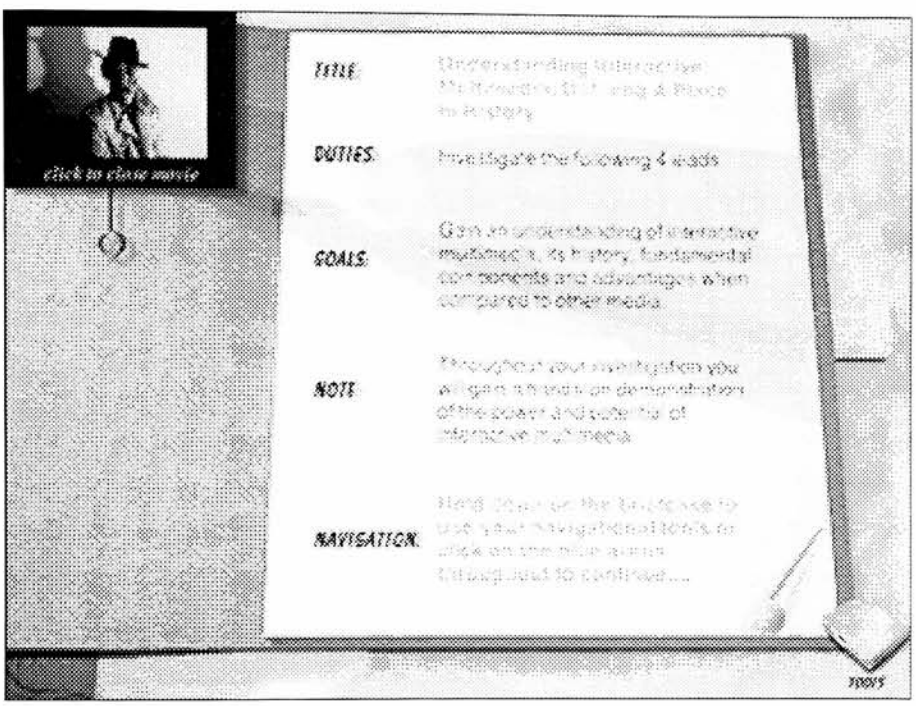
Detective shows user the office and explains there is a case file that needs to be reviewed on the desk.



Introduction to presentation

User clicks to open file folder.

Appendix/Screen

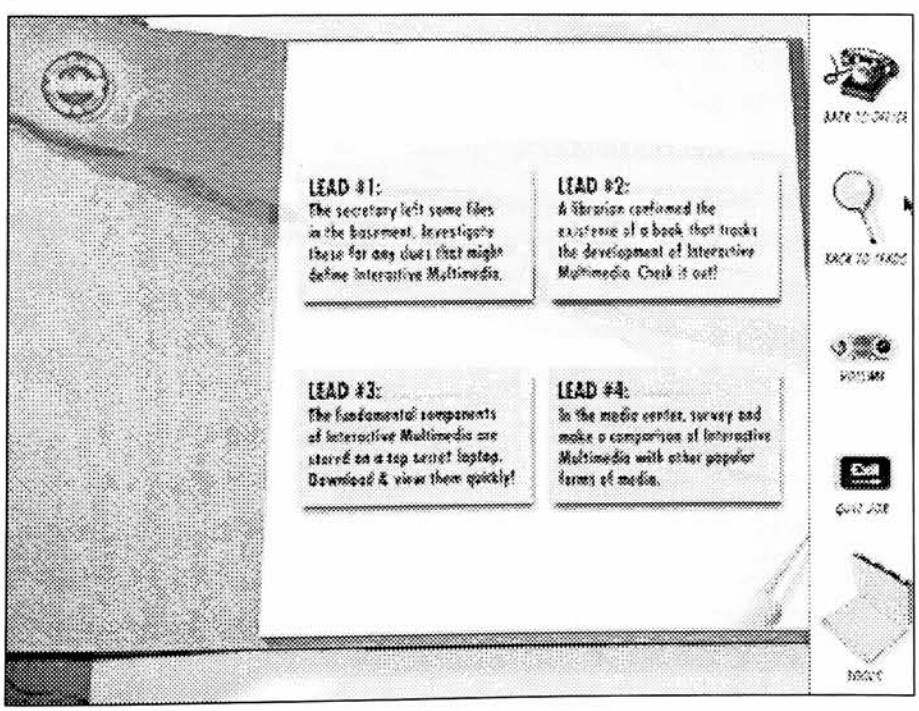


Introduction to presentation

Here the user finds an explanation of the case and directions on what to do.

Wherever there is a "briefing" sign

A small video will appear and a detective explains information contained in the section.



Introduction to presentation

Here are the four leads to explore.

Navigation

A user holds down on the "tools" briefcase to find navigational tools throughout presentation.

Appendix/Screen

Lead #1: What is Interactive Multimedia?

Enter basement.

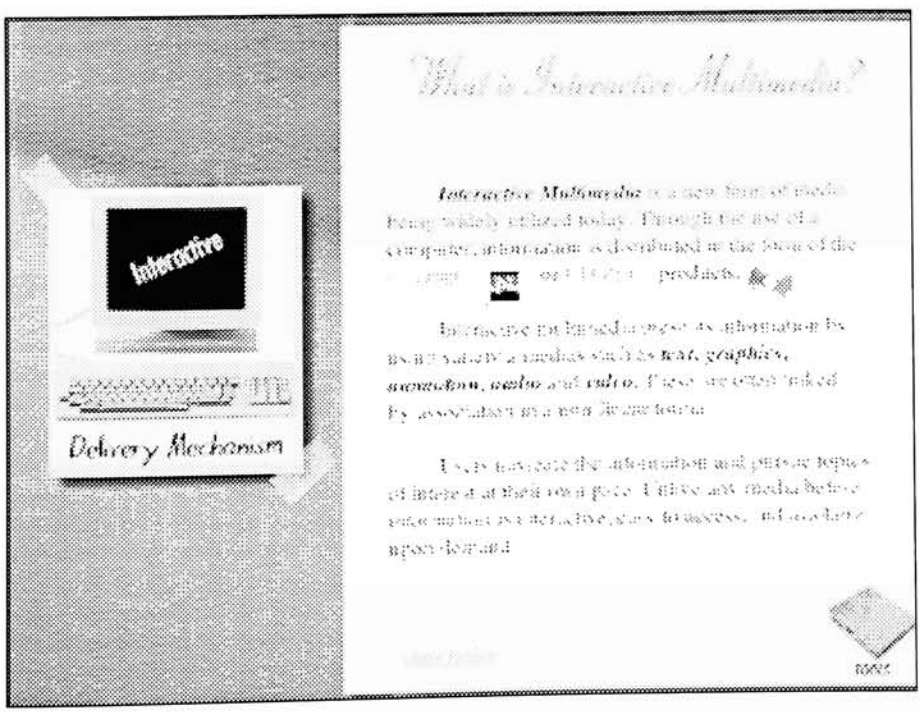
Lead #1: What is Interactive Multimedia?

Open file cabinet.

Appendix/Screen

Lead #1: What is Interactive Multimedia?

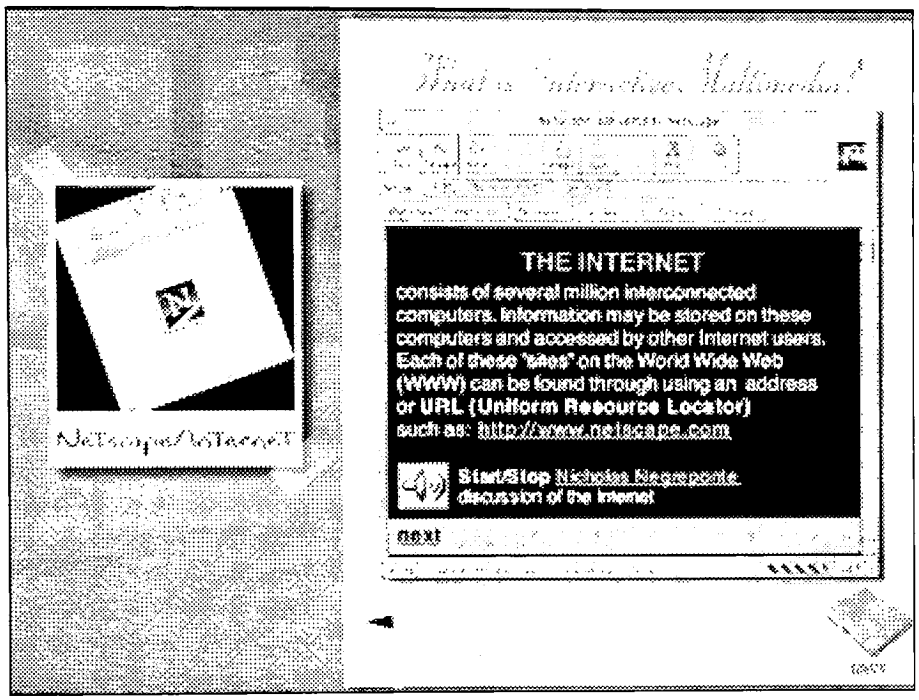
A user can select briefing or folder.



Lead #1: What is Interactive Multimedia?

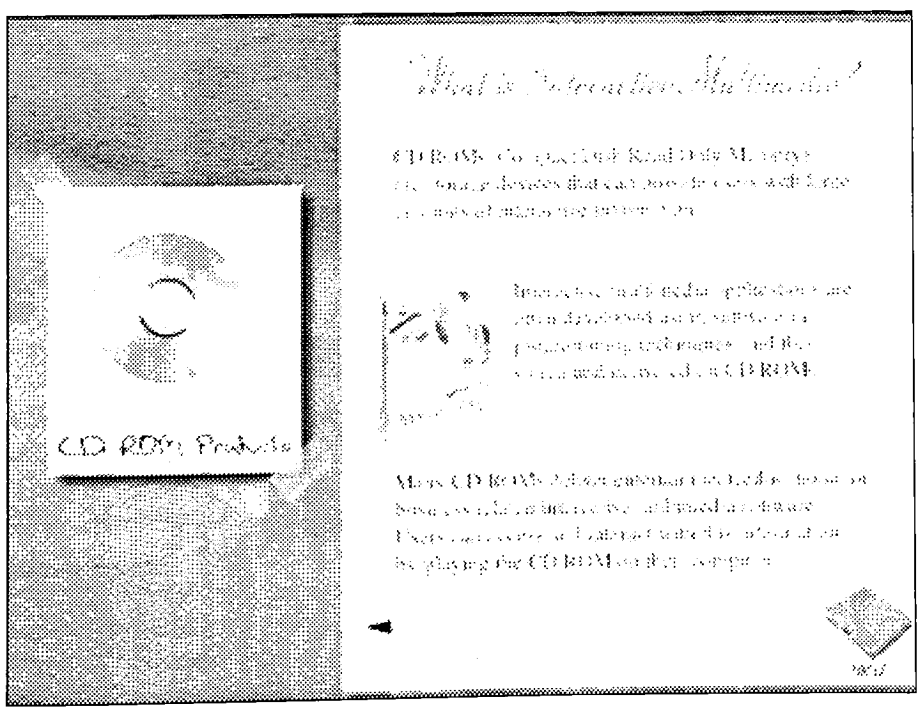
User finds explanation of interactive multimedia.

Appendix/Screen



Lead #1: What is Interactive Multimedia?

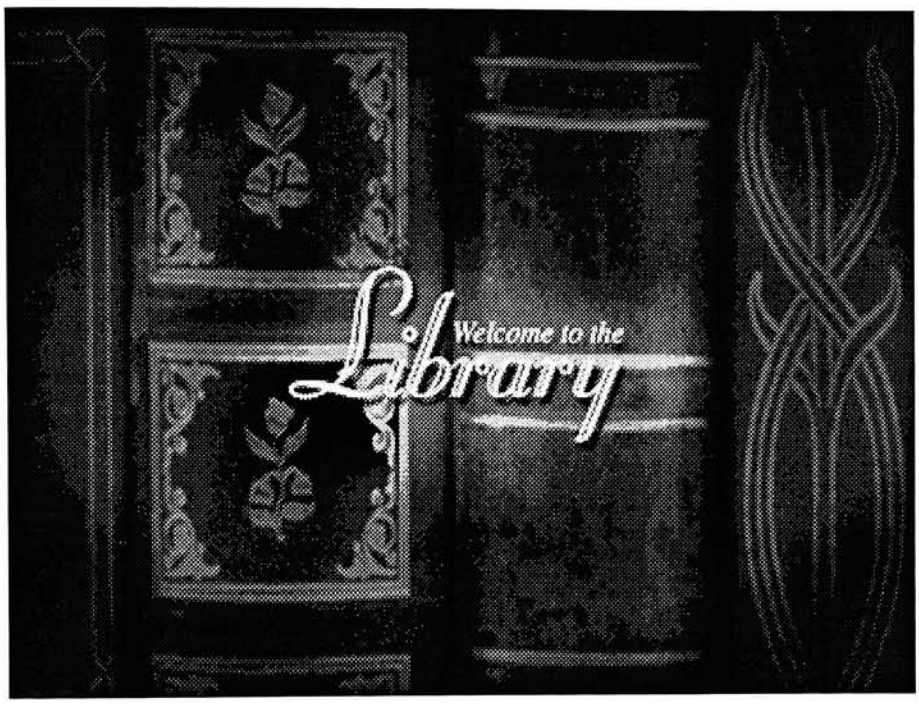
Explanation of Internet.



Lead #1: What is Interactive Multimedia?

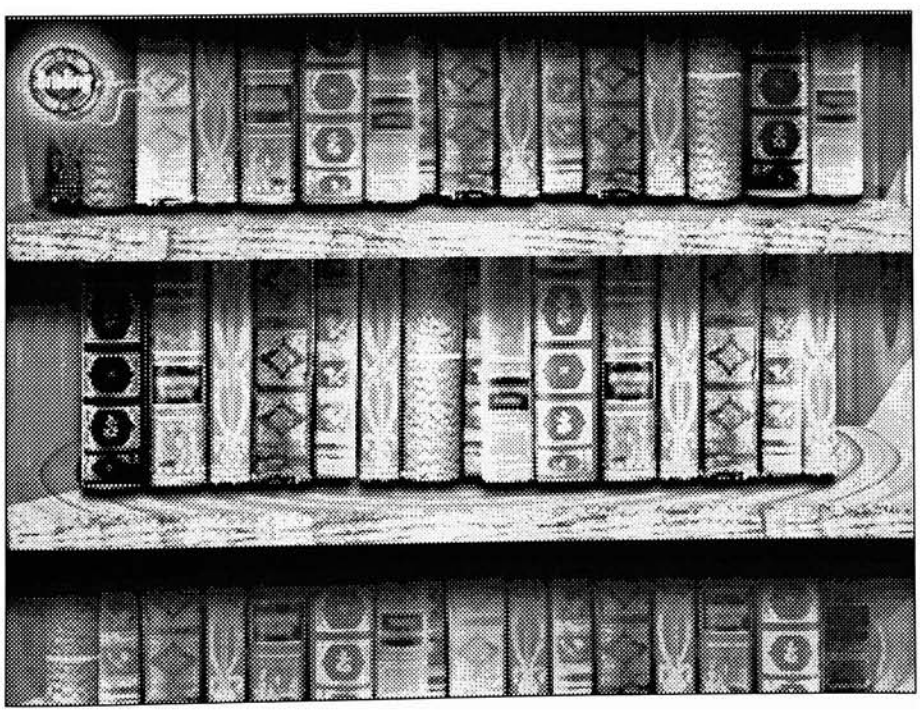
Explanation of CD-rom products.

Appendix/Screen



Lead #2: History of Interactive Multimedia

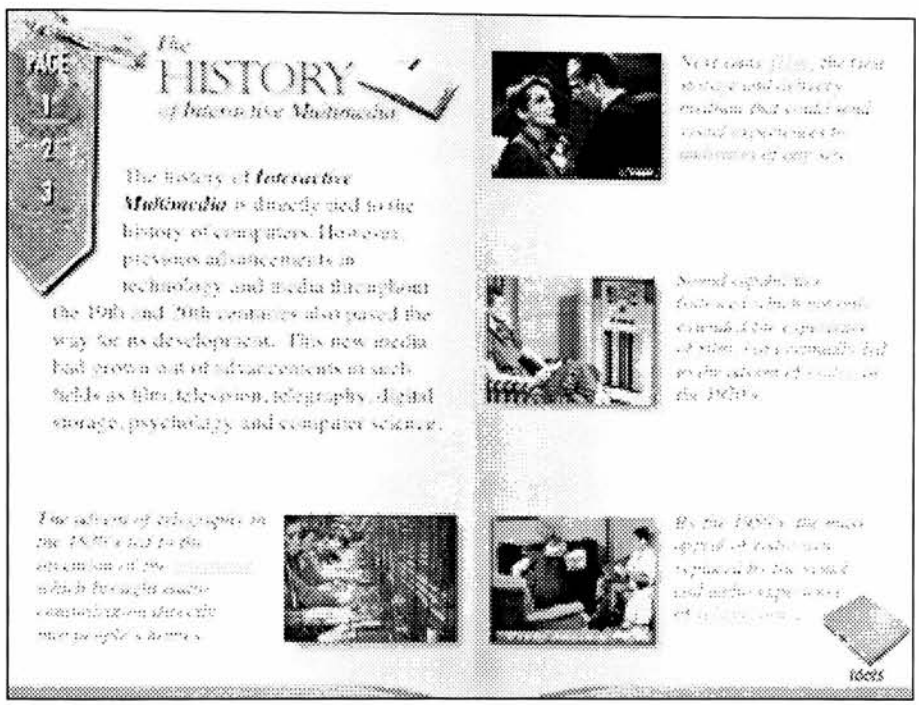
User enters library.



Lead #2: History of Interactive Multimedia

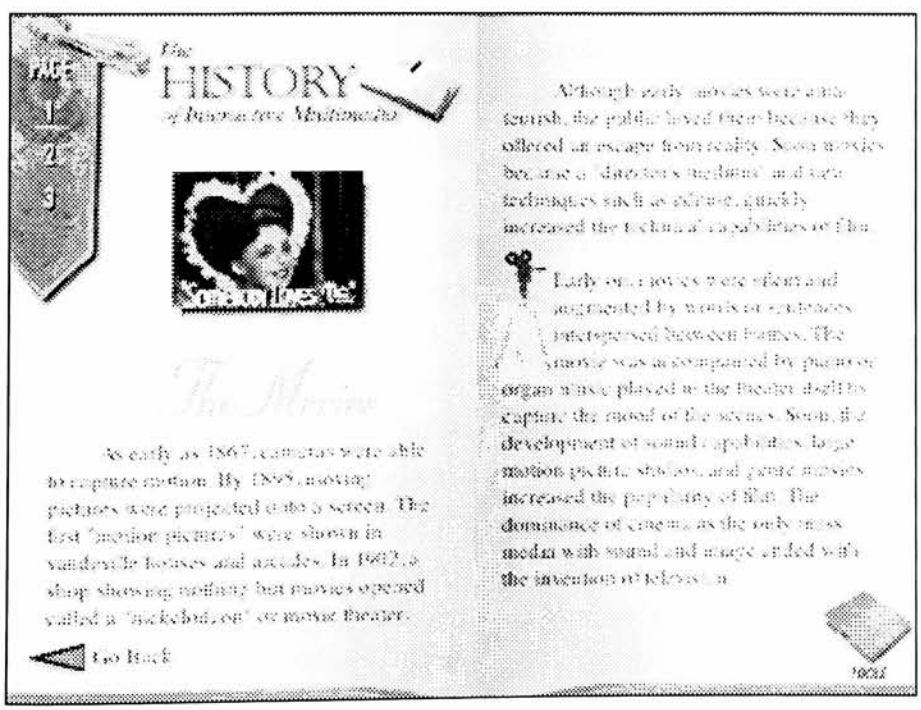
A user can choose briefing or book.

Appendix/Screen



Lead #2: History of Interactive Multimedia

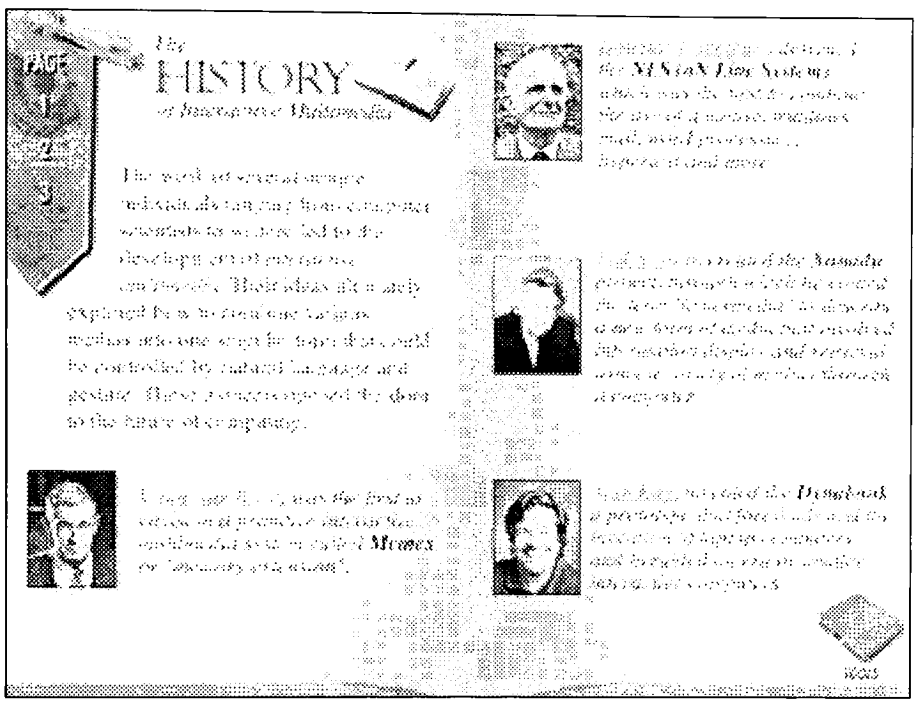
A user can choose from 3 areas on bookmark or view telephone, film, radio or tv in depth.



Lead #2: History of Interactive Multimedia

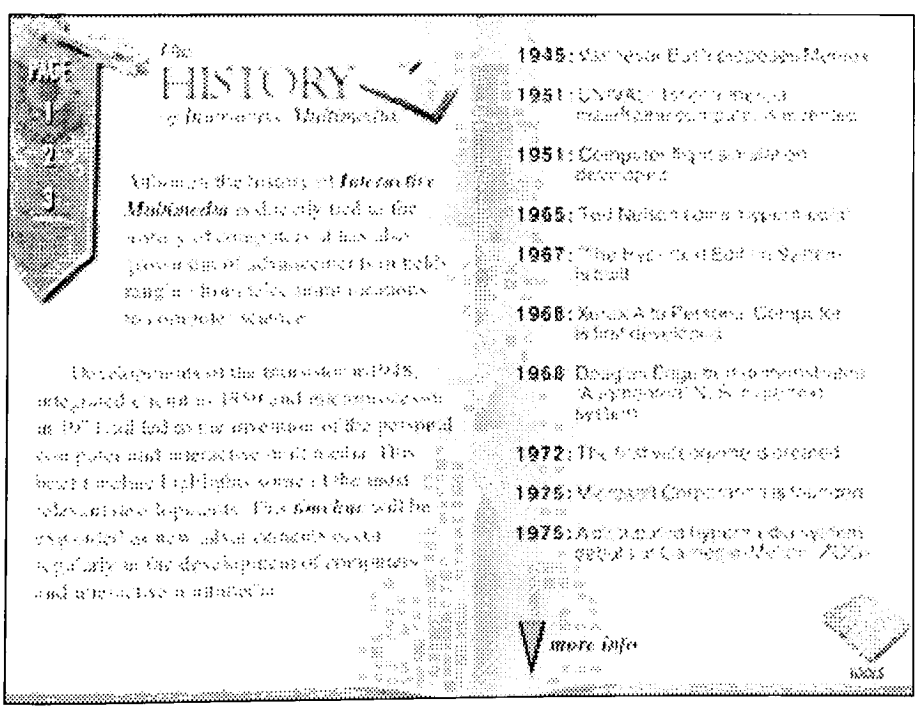
Film in depth.

Appendix/Screen



Lead #2: History of Interactive Multimedia

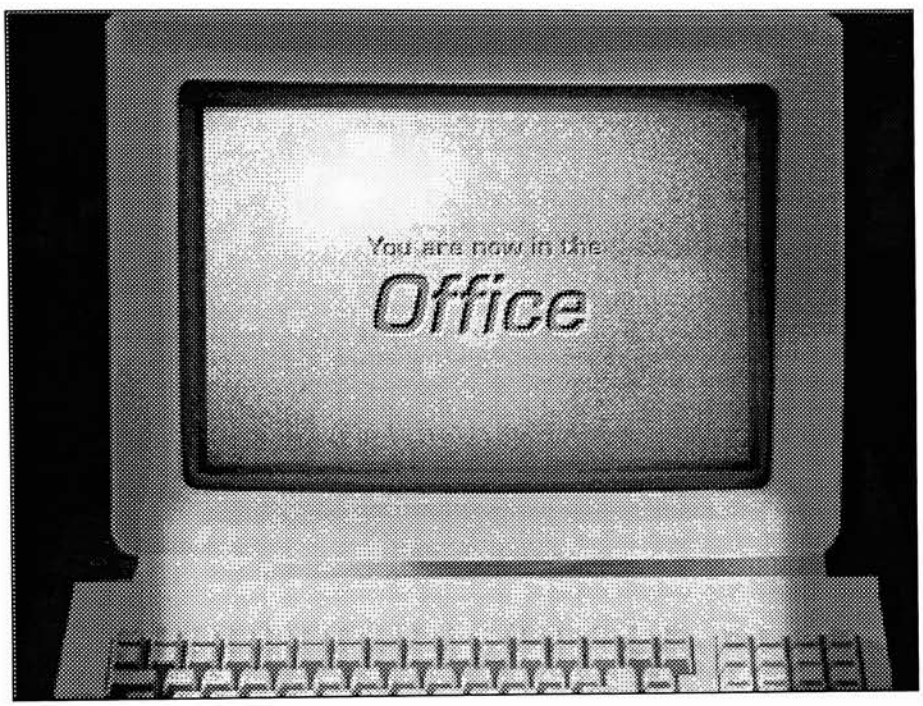
A user can choose from 3 areas on bookmark or view important individuals in depth.



Lead #2: History of Interactive Multimedia

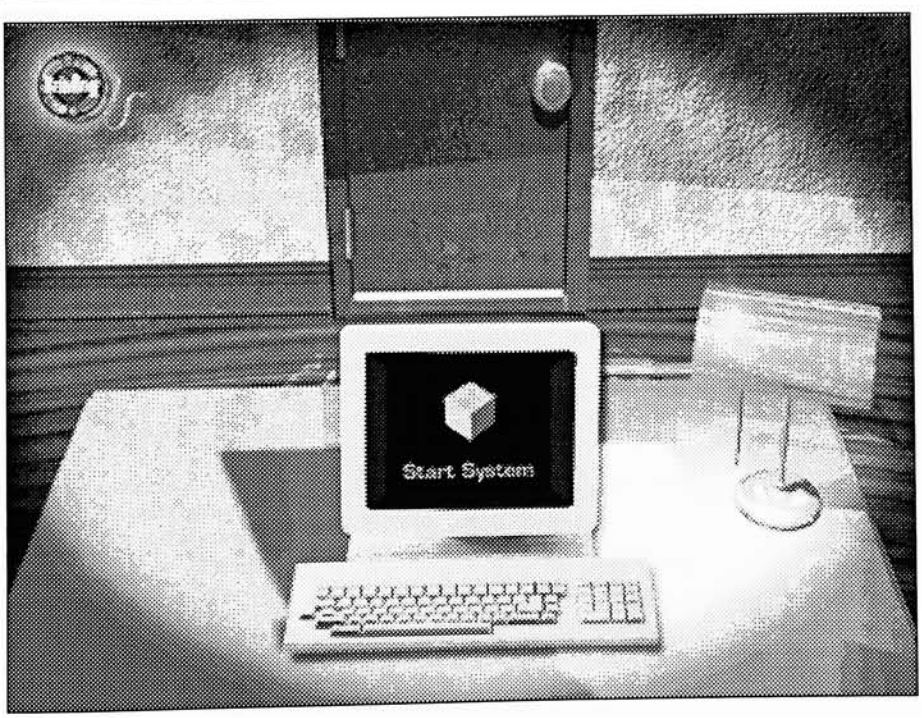
A user can choose from 3 areas on bookmark or view timeline.

Appendix/Screen



Lead #3: Fundamental Components of Interactive Multimedia

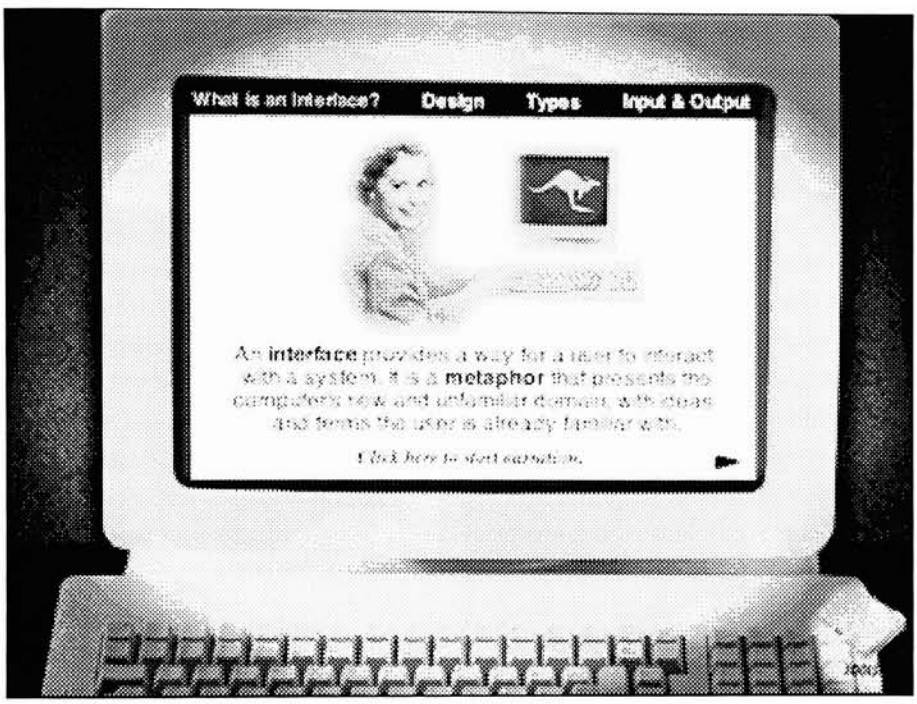
User enters office.



Lead #3: Fundamental Components of Interactive Multimedia

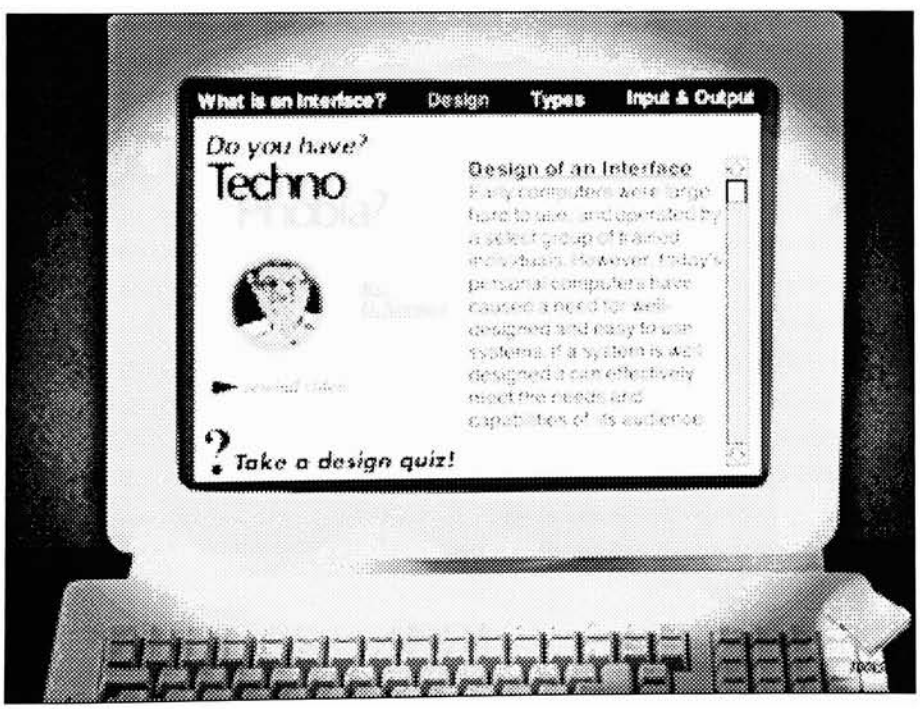
A user can see briefing or start the computer.

Appendix/Screen



Lead #3: Fundamental Components of Interactive Multimedia

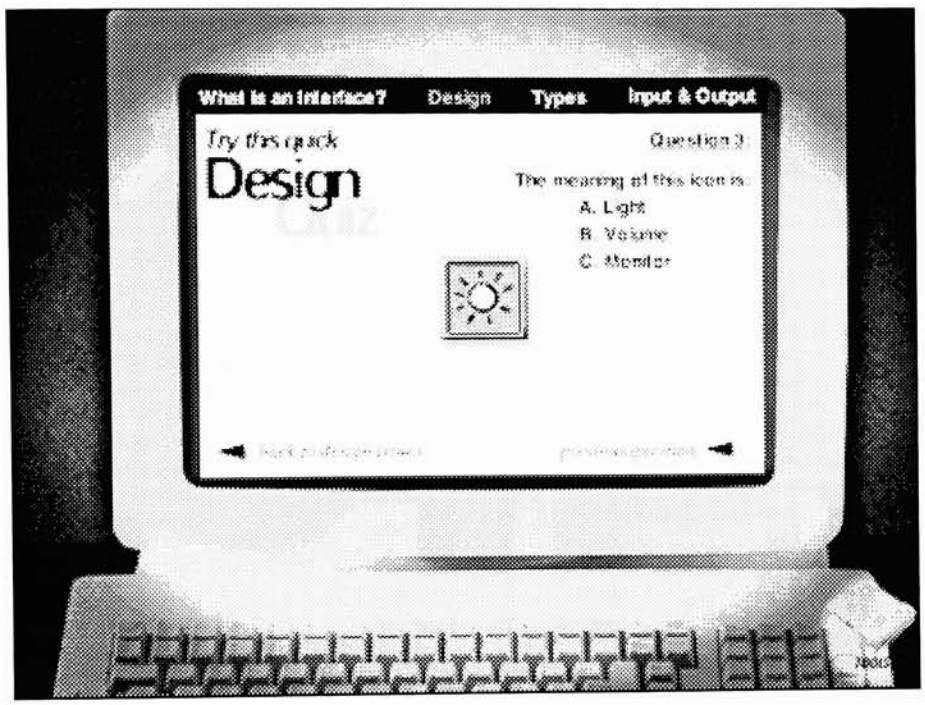
1st screen of "What is an Interface?"



Lead #3: Fundamental Components of Interactive Multimedia

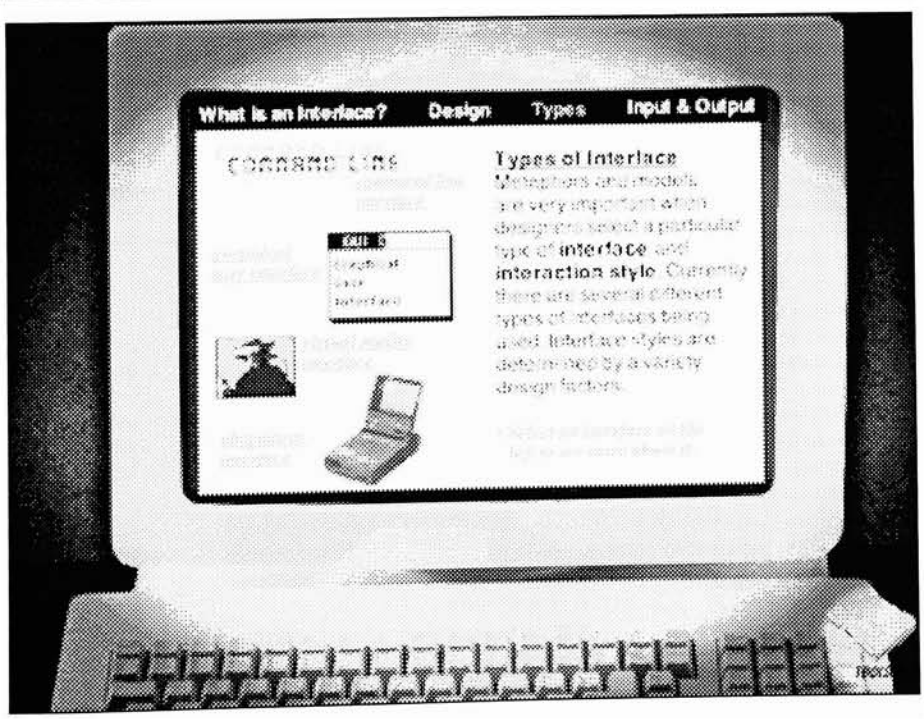
1st screen of "Design of Interfaces"

Appendix/Screen



Lead #3: Fundamental Components of Interactive Multimedia

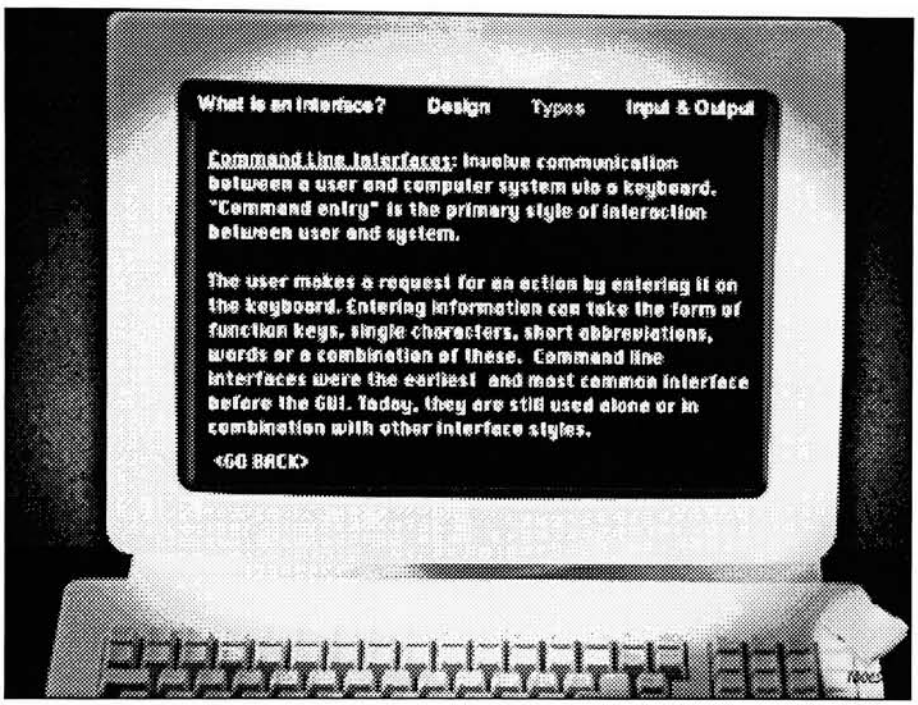
Design quiz from "Design of Interfaces"



Lead #3: Fundamental Components of Interactive Multimedia

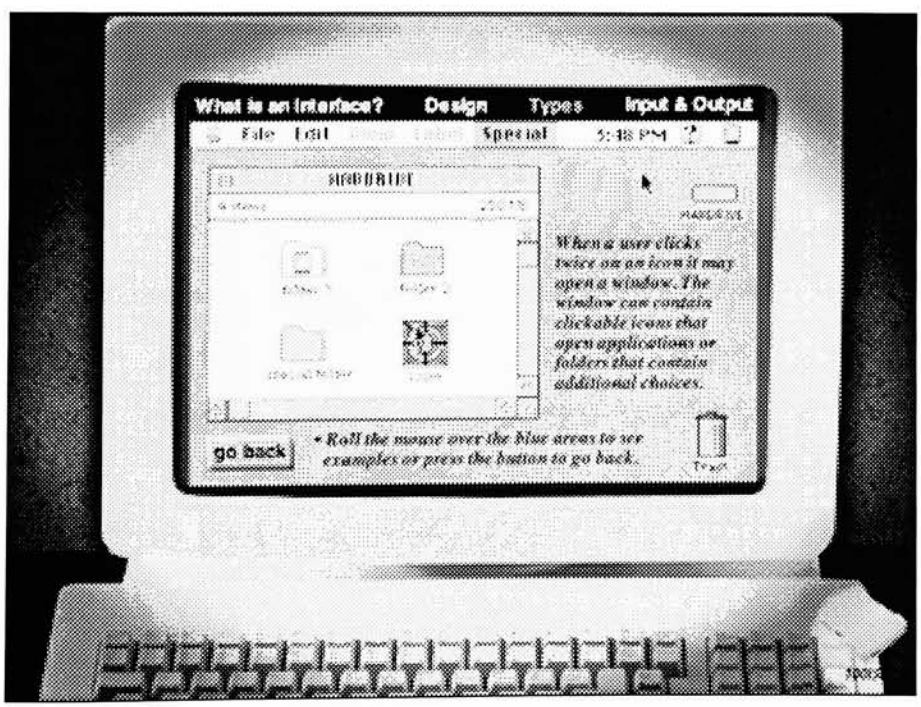
1st screen of "Types of Interfaces"

Appendix/Screen



Lead #3: Fundamental Components of Interactive Multimedia

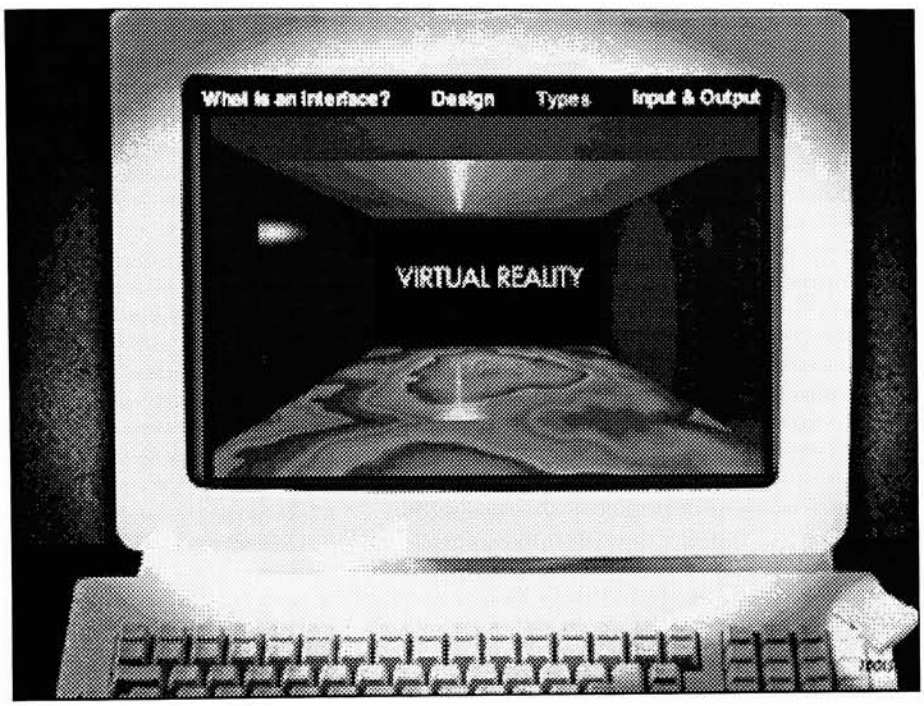
Command Line from "Types of Interfaces"



Lead #3: Fundamental Components of Interactive Multimedia

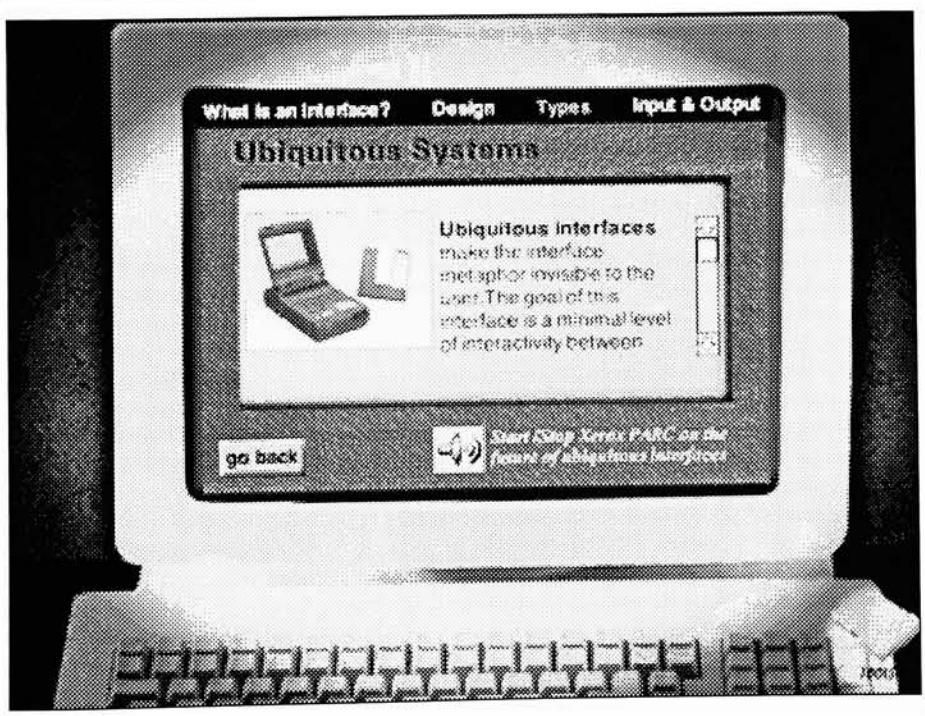
GUI from "Types of Interfaces"

Appendix/Screen



Lead #3: Fundamental Components of Interactive Multimedia

Virtual Reality from "Types of Interfaces"



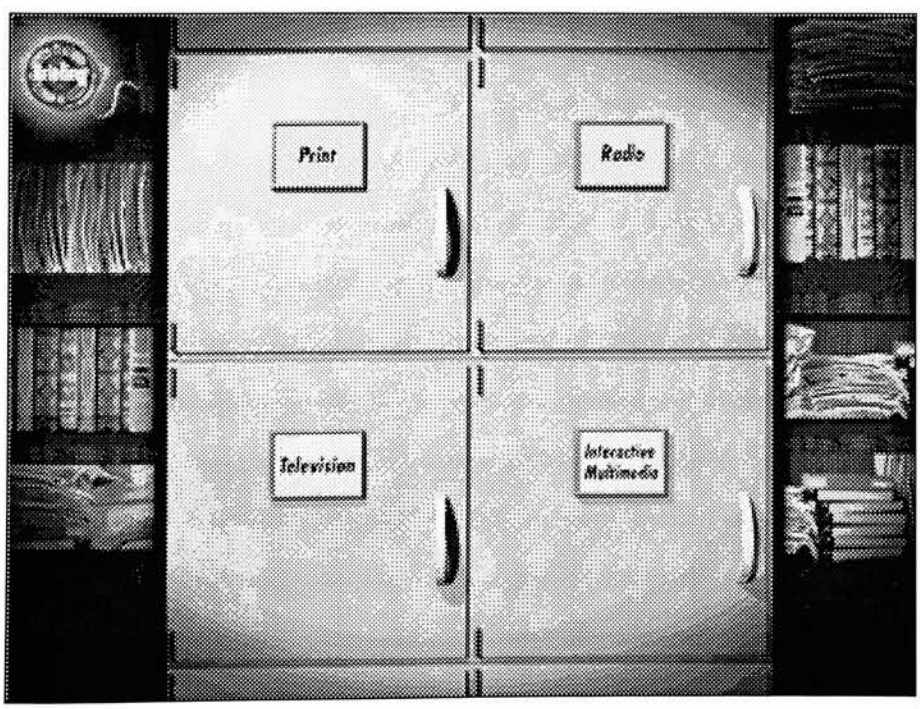
Lead #3: Fundamental Components of Interactive Multimedia

Ubiquitous from "Types of Interfaces"

Appendix/Screen

Lead #4: Advantages of Interactive Multimedia

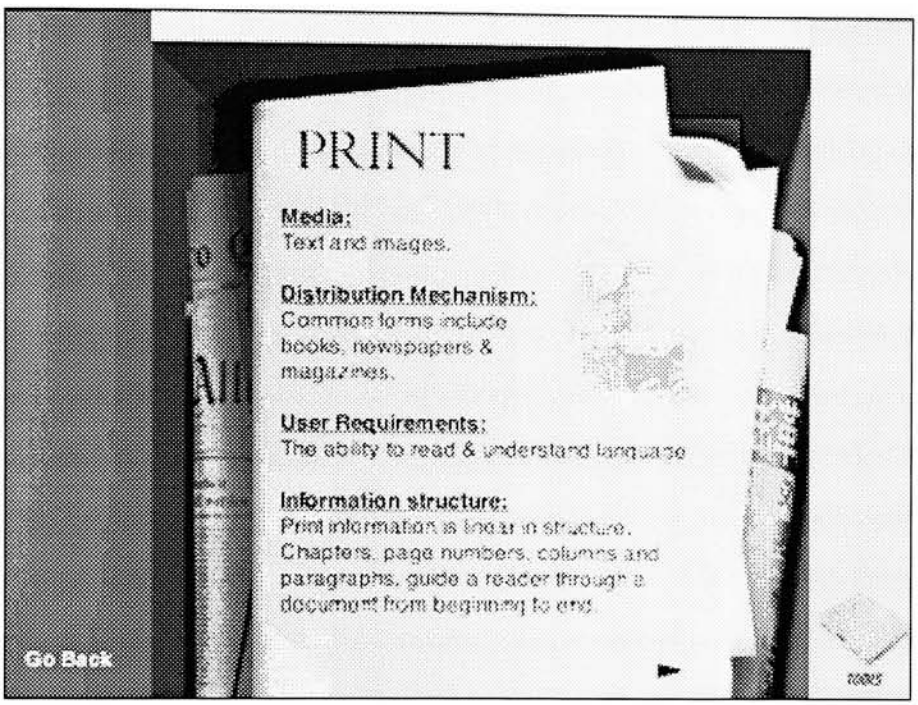
Enter media center.



Lead #4: Advantages of Interactive Multimedia

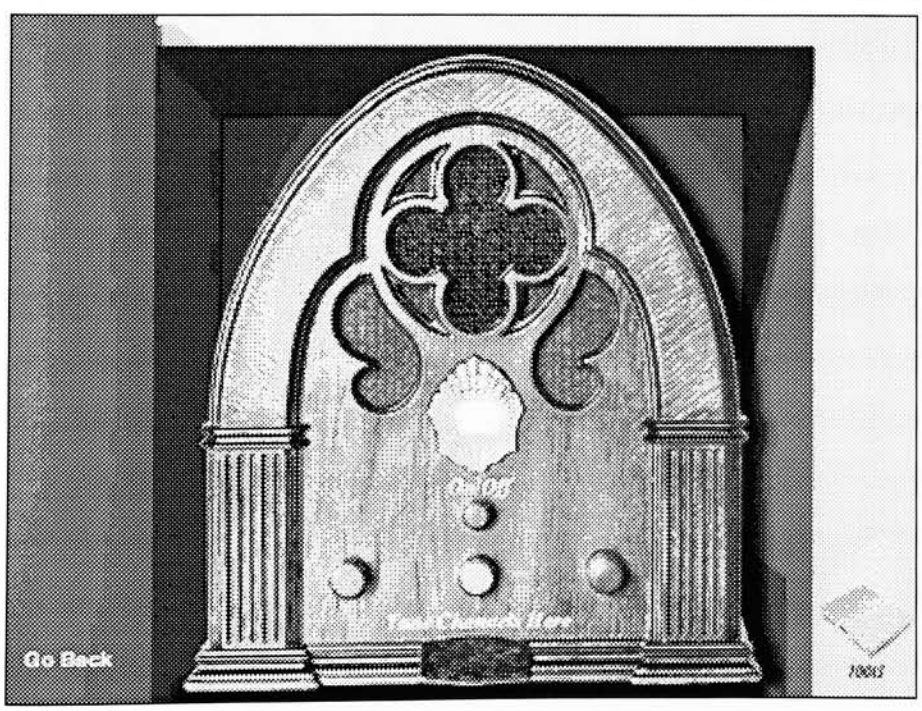
A user may choose to see a briefing or explore print, radio, tv or interactive multimedia.

Appendix/Screen



Lead #4: Advantages of Interactive Multimedia

Exploring print.



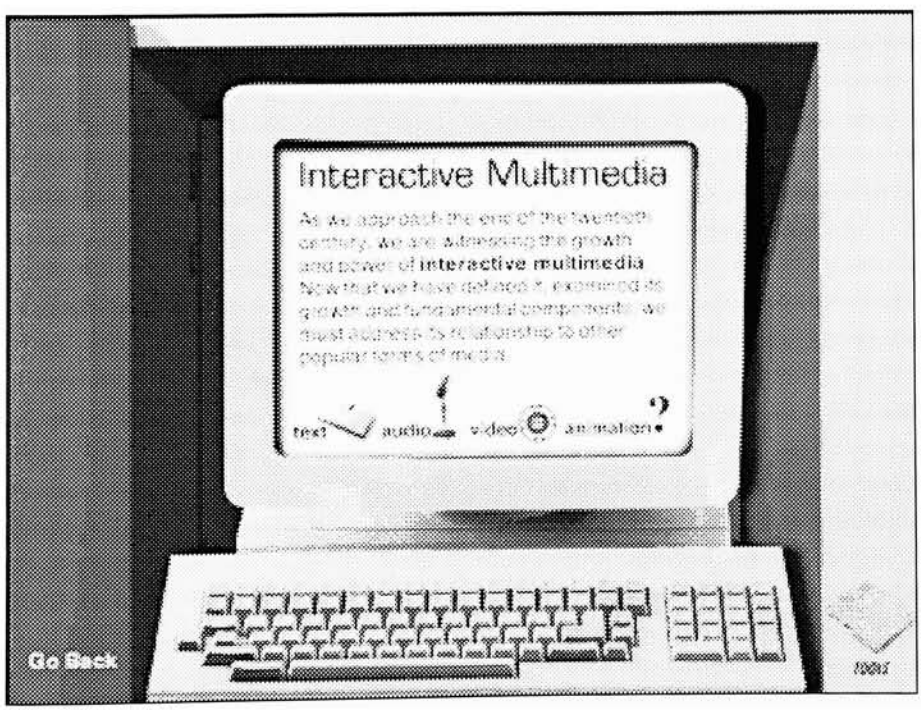
Lead #4: Advantages of Interactive Multimedia

Exploring radio.

Appendix/Screen

Lead #4: Advantages of Interactive Multimedia

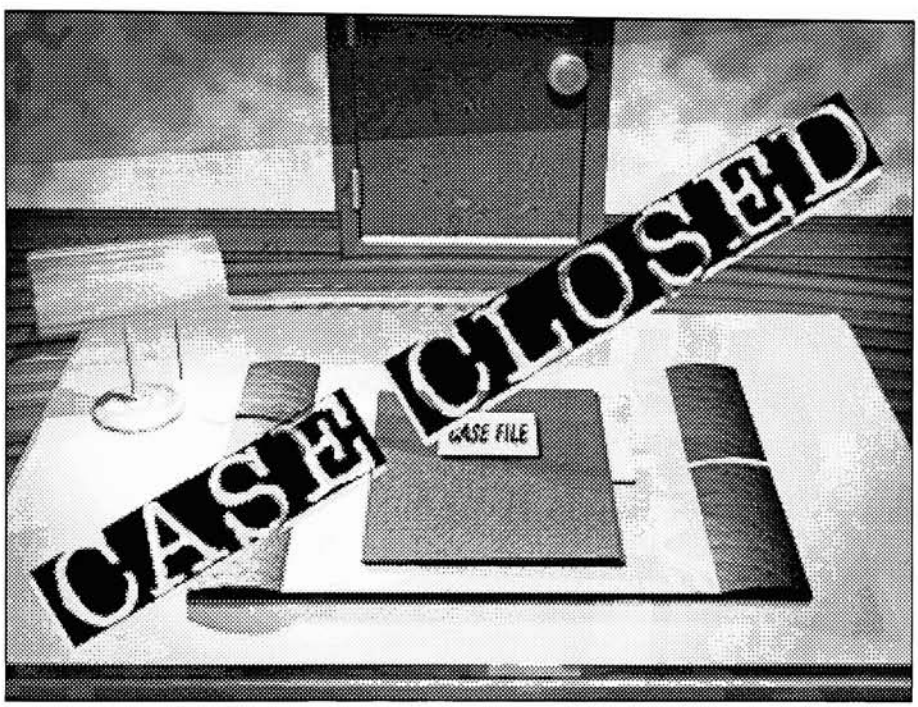
Exploring television.



Lead #4: Advantages of Interactive Multimedia

Exploring interactive multimedia.

Appendix/Screen



Exiting program

Resources

Music Resources:
Blue Light, Red Light by: Harry Connick Jr.,
© Sony Music Entertainment 1991

Benny Goodman Live at Carnegie Hall
© Columbia Records/CBS Inc. recorded 1/16/38

Sentimental Journey Vol 2. (1947-1950)
© Rhino Records Inc. 1993

Woody Herman and His Big Band 50th Anniversary Tour
© Concord Jazz Inc. 1986

Always Say Goodbye by Charlie Haden Quartet West
© Gitanes Jazz Productions 1993

Glen Miller Lost Recordings
© BMG Music 1996

Best of Radio Comedy (Fred Allen & Jack Benny)
© Delta Music Inc. 1995

http://www.ubiq.com/hypertext/weiser/quicktime/UbiCompIntro.qt

http://www.randomhouse.com/knopf/digital.html

http://www.naples.net/~arzone/mach_age.wav

Video Resources
Narrator Detective: Hal Soucier

TV Commercials of the 50's and 60's
© Chestnut New Media 1994

The George Burns and Gracie Allen Show
© TV Classics Collection Golden Age of Television 1992

http://www.FOOTAGE.net/directory/

http://members.aol.com/flypba/index.html (Digital Cinema)

http://www.atg.apple.com/Norman/DNcd.html

http://www.filmbank.com

Text Resources:
Apple Computer. (1987)- Apple: Human Interface Guidelines. Melno Park, CA: Addison-Wesley Publishing Company, Inc.

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