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The Language of New Media

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I. What is New Media?

What is new media? We may begin answering this question by listing the categories which are commonly discussed under this topic in popular press: Internet, Web sites, computer multimedia, computer games, CD-ROMs and DVD, virtual reality. Is this all new media is? For instance, what about television programs which are shot on digital video and edited on computer workstations? Or what about feature films which use 3D animation and digital compositing? Shall we count these as new media? In this case, what about all images and text-image compositions — photographs, illustrations, layouts, ads — which are also created on computers and then printed on paper? Where shall we stop?

As can be seen from these examples, the popular definition of new media identifies it with the use of a computer for distribution and exhibition, rather than with production. Therefore, texts distributed on a computer (Web sites and electronic books) are considered to be new media; texts distributed on paper are not. Similarly, photographs which are put on a CD-ROM and require a computer to view them are considered new media; the same photographs printed as a book are not.

Shall we accept this definition? If we want to understand the effects of computerization on culture as a whole, I think it is too limiting. There is no reason to privilege computer in the role of media exhibition and distribution machine over a computer used as a tool for media production or as a media storage device. All have the same potential to change existing cultural languages. And all have the same potential to leave culture as it is.

The last scenario is unlikely, however. What is more likely is that just as the printing press in the fourteenth century and photography in the nineteenth century had a revolutionary impact on the development of modern society and culture, today we are in the middle of a new media revolution -- the shift of all of our culture to computer-mediated forms of production, distribution and communication. This new revolution is arguably more profound than the previous ones and we are just beginning to sense its initial effects. Indeed, the introduction of printing press affected only one stage of cultural communication -- the distribution of media. In the case of photography, its introduction affected only one type of cultural communication -- still images. In contrast, computer media revolution affects all stages of communication, including acquisition, manipulating, storage and distribution; it also affects all types of media -- text, still images, moving images, sound, and spatial constructions.

How shall we begin to map out the effects of this fundamental shift? What are the ways in which the use of computers to record, store, create and distribute media makes it “new”?

In section “Media and Computation” I show that new media represents a convergence of two separate historical trajectories: computing and media technologies. Both begin in the 1830's with Babbage's Analytical Engine and Daguerre's daguerreotype. Eventually, in the middle of the twentieth century, a modern digital computer is developed to perform calculations on numerical data more efficiently; it takes over from numerous mechanical tabulators and calculators already widely employed by companies and governments since the turn of the century. In parallel, we witness the rise of modern media technologies which allow the storage of images, image sequences, sounds and text using different material forms: a photographic plate, a film stock, a gramophone record, etc. The synthesis of these two histories? The translation of all existing media into numerical data accessible for computers. The result is new media: graphics, moving images, sounds, shapes, spaces and text which become computable, i.e. simply another set of computer data. In “Principles of New Media” I look at the key consequences of this new status of media. Rather than focusing on familiar categories such as interactivity or hypermedia, I suggest a different list. This list reduces all principles of new media to five: numerical representation, modularity, automation, variability and cultural transcoding. In the last section, “What New Media is Not,” I address other principles which are often attributed to new media. I show that these principles can already be found at work in older cultural forms and media technologies such as cinema, and therefore they are by themselves are not sufficient to distinguish new media from the old.

How Media Became New

On August 19, 1839, the Palace of the Institute in Paris was completely full with curious Parisians who came to hear the formal description of the new reproduction process invented by Louis Daguerre. Daguerre, already well-known for his Diorama, called the new process daguerreotype. According to a contemporary, "a few days later, opticians' shops were crowded with amateurs panting for daguerreotype apparatus, and everywhere cameras were trained on buildings. Everyone wanted to record the view from his window, and he was lucky who at first trial got a silhouette of roof tops against the sky."¹⁰ The media frenzy has begun. Within five months more than thirty different descriptions of the techniques were published all around the world: Barcelona, Edinburg, Halle, Naples, Philadelphia, Saint Petersburg, Stockholm. At first, daguerreotypes of architecture and landscapes dominated the public's imagination; two years later, after various technical improvements to the process, portrait galleries were opened everywhere — and everybody rushed in to have their picture taken by a new media machine.¹¹

In 1833 Charles Babbage started the design for a device he called the Analytical Engine. The Engine contained most of the key features of the modern digital computer. The punch cards were used to enter both data and instructions. This information was stored in the Engine's memory. A processing unit, which Babbage referred to as a "mill," performed operations on the data and wrote the results to memory; final results were to be printed out on a printer. The Engine was designed to be capable of doing any mathematical operation; not only would it follow the program fed into it by cards, but it would also decide which instructions to execute next, based upon intermediate results. However, in contrast to the daguerreotype, not even a single copy of the Engine was completed. So while the invention of this modern media tool for the reproduction of reality impacted society right away, the impact of the computer was yet to be measured.

Interestingly, Babbage borrowed the idea of using punch cards to store information from an earlier programmed machine. Around 1800, J.M. Jacquard invented a loom which was automatically controlled by punched paper cards. The loom was used to weave intricate figurative images, including Jacquard's portrait. This specialized graphics computer, so to speak, inspired Babbage in his work on the Analytical Engine, a general computer for numerical calculations. As Ada Augusta, Babbage's supporter and the first computer programmer, put it, "the Analytical Engine weaves algebraical patterns just as the Jacquard loom weaves flowers and leaves."¹² Thus, a programmed machine was already synthesizing images even before it was put to process numbers. The connection between the Jacquard loom and the Analytical Engine is not something historians of

computers make much of, since for them computer image synthesis represents just one application of the modern digital computer among thousands of others; but for a historian of new media it is full of significance.

We should not be surprised that both trajectories — the development of modern media, and the development of computers — begin around the same time. Both media machines and computing machines were absolutely necessary for the functioning of modern mass societies. The ability to disseminate the same texts, images and sounds to millions of citizens thus assuring that they will have the same ideological beliefs was as essential as the ability to keep track of their birth records, employment records, medical records, and police records. Photography, film, the offset printing press, radio and television made the former possible while computers made possible the latter. Mass media and data processing are the complimentary technologies of a modern mass society; they appear together and develop side by side, making this society possible.

For a long time the two trajectories run in parallel without ever crossing paths. Throughout the nineteenth and the early twentieth century, numerous mechanical and electrical tabulators and calculators were developed; they were gradually getting faster and their use was became more wide spread. In parallel, we witness the rise of modern media which allows the storage of images, image sequences, sounds and text in different material forms: a photographic plate, film stock, a gramophone record, etc.

Let us continue tracing this joint history. In the 1890s modern media took another step forward as still photographs were put in motion. In January of 1893, the first movie studio — Edison's "Black Maria" — started producing twenty seconds shorts which were shown in special Kinetoscope parlors. Two years later the Lumière brothers showed their new Cinématographie camera/projection hybrid first to a scientific audience, and, later, in December of 1895, to the paying public. Within a year, the audiences in Johannesburg, Bombay, Rio de Janeiro, Melbourne, Mexico City, and Osaka were subjected to the new media machine, and they found it irresistible.¹³ Gradually the scenes grew longer, the staging of reality before the camera and the subsequent editing of its samples became more intricate, and the copies multiplied. They would be sent to Chicago and Calcutta, to London and St. Petersburg, to Tokyo and Berlin and thousands and thousands of smaller places. Film images would soothe movie audiences, who were too eager to escape the reality outside, the reality which no longer could be adequately handled by their own sampling and data processing systems (i.e., their brains). Periodic trips into the dark relaxation chambers of movie theaters became a routine survival technique for the subjects of modern society.

The 1890s was the crucial decade, not only for the development of media, but also for computing. If individuals' brains were overwhelmed by the amounts of information they had to process, the same was true of corporations and of government. In 1887, the U.S. Census office was still interpreting the figures from

the 1880 census. For the next 1890 census, the Census Office adopted electric tabulating machines designed by Herman Hollerith. The data collected for every person was punched into cards; 46, 804 enumerators completed forms for a total population of 62,979,766. The Hollerith tabulator opened the door for the adoption of calculating machines by business; during the next decade electric tabulators became standard equipment in insurance companies, public utilities companies, railroads and accounting departments. In 1911, Hollerith's Tabulating Machine company was merged with three other companies to form the Computing-Tabulating-Recording Company; in 1914 Thomas J. Watson was chosen as its head. Ten years later its business tripled and Watson renamed the company the International Business Machines Corporation, or IBM.¹⁴

We are now in the new century. The year is 1936. This year the British mathematician Alan Turing wrote a seminal paper entitled "On Computable Numbers." In it he provided a theoretical description of a general-purpose computer later named after its inventor the Universal Turing Machine. Even though it was only capable of four operations, the machine could perform any calculation which can be done by a human and could also imitate any other computing machine. The machine operated by reading and writing numbers on an endless tape. At every step the tape would be advanced to retrieve the next command, to read the data or to write the result. Its diagram looks suspiciously like a film projector. Is this a coincidence?

If we believe the word cinematograph, which means "writing movement," the essence of cinema is recording and storing visible data in a material form. A film camera records data on film; a film projector reads it off. This cinematic apparatus is similar to a computer in one key respect: a computer's program and data also have to be stored in some medium. This is why the Universal Turing Machine looks like a film projector. It is a kind of film camera and film projector at once: reading instructions and data stored on endless tape and writing them in other locations on this tape. In fact, the development of a suitable storage medium and a method for coding data represent important parts of both cinema and computer pre-histories. As we know, the inventors of cinema eventually settled on using discrete images recorded on a strip of celluloid; the inventors of a computer — which needed much greater speed of access as well as the ability to quickly read and write data — came to store it electronically in a binary code.

In the same year, 1936, the two trajectories came even closer together. Starting this year, and continuing into the Second World War, German engineer Konrad Zuse had been building a computer in the living room of his parents' apartment in Berlin. Zuse's computer was the first working digital computer. One of his innovations was program control by punched tape. The tape Zuse used was actually discarded 35 mm movie film.¹⁵

One of these surviving pieces of this film shows binary code punched over the original frames of an interior shot. A typical movie scene — two people in a

room involved in some action — becomes a support for a set of computer commands. Whatever meaning and emotion was contained in this movie scene has been wiped out by its new function as a data carrier. The pretense of modern media to create simulation of sensible reality is similarly canceled; media is reduced to its original condition as information carrier, nothing else, nothing more. In a technological remake of the Oedipal complex, a son murders his father. The iconic code of cinema is discarded in favor of the more efficient binary one. Cinema becomes a slave to the computer.

But this is not yet the end of the story. Our story has a new twist — a happy one. Zuse's film, with its strange superimposition of the binary code over the iconic code anticipates the convergence which gets underway half a century later. The two separate historical trajectories finally meet. Media and computer — Daguerre's daguerreotype and Babbage's Analytical Engine, the Lumière Cinématographie and Hollerith's tabulator — merge into one. All existing media are translated into numerical data accessible for the computers. The result: graphics, moving images, sounds, shapes, spaces and text become computable, i.e. simply another set of computer data. In short, media becomes new media.

This meeting changes both the identity of media and of the computer itself. No longer just a calculator, a control mechanism or a communication device, a computer becomes a media processor. Before the computer could read a row of numbers outputting a statistical result or a gun trajectory. Now it can read pixel values, blurring the image, adjusting its contrast or checking whether it contains an outline of an object. Building upon these lower-level operations, it can also perform more ambitious ones: searching image databases for images similar in composition or content to an input image; detecting shot changes in a movie; or synthesizing the movie shot itself, complete with setting and the actors. In a historical loop, a computer returned to its origins. No longer just an Analytical Engine, suitable only to crunch numbers, the computer became Jacquard's loom — a media synthesizer and manipulator.

Principles of New Media

The identity of media has changed even more dramatically. Below I summarize some of the key differences between old and new media. In compiling this list of differences I tried to arrange them in a logical order. That is, the principles 3-5 are dependent on the principles 1-2. This is not dissimilar to axiomatic logic where certain axioms are taken as starting points and further theorems are proved on their basis.

Not every new media object obeys these principles. They should be considered not as some absolute laws but rather as general tendencies of a culture undergoing computerization. As the computerization affects deeper and deeper layers of culture, these tendencies will manifest themselves more and more.

1. Numerical Representation

All new media objects, whether they are created from scratch on computers or converted from analog media sources, are composed of digital code; they are numerical representations. This has two key consequences:

1.1. New media object can be described formally (mathematically). For instance, an image or a shape can be described using a mathematical function.

1.2. New media object is a subject to algorithmic manipulation. For instance, by applying appropriate algorithms, we can automatically remove "noise" from a photograph, improve its contrast, locate the edges of the shapes, or change its proportions. In short, media becomes programmable.

When new media objects are created on computers, they originate in numerical form. But many new media objects are converted from various forms of old media. Although most readers understand the difference between analog and digital media, few notes should be added on the terminology and the conversion process itself. This process assumes that data is originally continuous, i.e. "the axis or dimension that is measured has no apparent indivisible unit from which it is composed."¹⁶ Converting continuous data into a numerical representation is called digitization. Digitization consists from two steps: sampling and quantization. First, data is sampled, most often at regular intervals, such as the grid of pixels used to represent a digital image. Technically, a sample is defined as "a measurement made at a particular instant in space and time, according to a specified procedure." The frequency of sampling is referred to as resolution. Sampling turns continuous data into discrete data. This is data occurring in distinct units: people, pages of a book, pixels. Second, each sample is quantified, i.e.

assigned a numerical value drawn from a defined range (such as 0-255 in the case of a 8-bit greyscale image).¹⁷

While some old media such as photography and sculpture is truly continuous, most involve the combination of continuous and discrete coding. One example is motion picture film: each frame is a continuous photograph, but time is broken into a number of samples (frames). Video goes one step further by sampling the frame along the vertical dimension (scan lines). Similarly, a photograph printed using a halftone process combine discrete and continuous representations. Such photograph consist from a number of orderly dots (i.e., samples), however the diameters and areas of dots vary continuously.

As the last example demonstrates, while old media contains level(s) of discrete representation, the samples were never quantified. This quantification of samples is the crucial step accomplished by digitization. But why, we may ask, modern media technologies were often in part discrete? The key assumption of modern semiotics is that communication requires discrete units. Without discrete units, there is no language. As Roland Barthes has put it, “language is, as it were, that which divides reality (for instance the continuous spectrum of the colors is verbally reduced to a series of discontinuous terms).”¹⁸ In postulating this, semioticians took human language as a prototypical example of a communication system. A human language is discrete on most scales: we speak in sentences; a sentence is made from words; a word consists from morphemes, and so on. If we are to follow the assumption that any form of communication requires discrete representation, we may expect that media used in cultural communication will have discrete levels. At first this explanation seems to work. Indeed, a film samples continuous time of human existence into discrete frames; a drawing samples visible reality into discrete lines; and a printed photograph samples it into discrete dots. This assumption does not universally work, however: photographs, for instance, do not have any apparent units. (Indeed, in the 1970s semiotics was criticized for its linguistic bias, and most semioticians came to recognize that language-based model of distinct units of meaning can’t be applied to many kinds of cultural communication.) More importantly, the discrete units of modern media are usually not the units of meanings, the way morphemes are. Neither film frames nor the halftone dots have any relation to how film or a photographs affect the viewer (except in modern art and avant-garde film — think of paintings by Roy Lichtenstein and films of Paul Sharits — which often make the “material” units of media into the units of meaning.)

The more likely reason why modern media has discrete levels is because it emerges during Industrial Revolution. In the nineteenth century, a new organization of production known as factory system gradually replaced artisan labor. It reached its classical form when Henry Ford installed first assembly line in his factory in 1913. The assembly line relied on two principles. The first was standardization of parts, already employed in the production of military uniforms

in the nineteenth century. The second, never principle, was the separation of the production process into a set of repetitive, sequential, and simple activities that could be executed by workers who did not have to master the entire process and could be easily replaced.

Not surprisingly, modern media follows the factory logic, not only in terms of division of labor as witnessed in Hollywood film studios, animation studios or television production, but also on the level of its material organization. The invention of typesetting machines in the 1880s industrialized publishing while leading to standardization of both type design and a number and types of fonts used. In the 1890s cinema combined automatically produced images (via photography) with a mechanical projector. This required standardization of both image dimensions (size, frame ratio, contrast) and of sampling rate of time (see “Digital Cinema” section for more detail). Even earlier, in the 1880s, first television systems already involved standardization of sampling both in time and in space. These modern media systems also followed the factory logic in that once a new “model” (a film, a photograph, an audio recording) was introduced, numerous identical media copies would be produced from this master. As I will show below, new media follows, or actually, runs ahead of a quite a different logic of post-industrial society — that of individual customization, rather that of mass standardization.

2. Modularity

This principle can be called “fractal structure of new media.” Just as a fractal has the same structure on different scales, a new media object has the same modular structure throughout. Media elements, be it images, sounds, shapes, or behaviors, are represented as collections of discrete samples (pixels, polygons, voxels, characters, scripts). These elements are assembled into larger-scale objects but they continue to maintain their separate identity. The objects themselves can be combined into even larger objects -- again, without losing their independence. For example, a multimedia “movie” authored in popular Macromedia Director software may consist from hundreds of still images, QuickTime movies, and sounds which are all stored separately and are loaded at run time. Because all elements are stored independently, they can be modified at any time without having to change Director movie itself. These movies can be assembled into a larger “movie,” and so on. Another example of modularity is the concept of “object” used in Microsoft Office applications. When an object is inserted into a document (for instance, a media clip inserted into a Word document), it continues to maintain its independence and can always be edited with the program used originally to create it. Yet another example of modularity is the structure of a HTML document: with the exemption of text, it consists from a number of

separate objects — GIF and JPEG images, media clips, VRML scenes, Shockwave and Flash movies -- which are all stored independently locally and/or on a network. In short, a new media object consists from independent parts which, in their turn, consist from smaller independent parts, and so on, up to the level of smallest “atoms” such as pixels, 3D points or characters.

World Wide Web as a whole is also completely modular. It consists from numerous Web pages, each in its turn consisting from separate media elements. Every element can be always accessed on its own. Normally we think of elements as belonging to their corresponding Web sites, but this just a convention, reinforced by commercial Web browsers. Netomat browser which extract elements of a particular media type from different Web pages (for instance, only images) and display them together without identifying the Web sites they come from, highlights for us this fundamentally discrete and non-hierarchical organization of the Web (see introduction to “Interface” chapter for more on this browser.)

In addition to using the metaphor of a fractal, we can also make an analogy between modularity of new media and the structured computer programming. Structural computer programming which became standard in the 1970s involves writing small and self-sufficient modules (called in different computer languages subroutines, functions, procedures, scripts) which are assembled into larger programs. Many new media objects are in fact computer programs which follow structural programming style. For example, most interactive multimedia applications are programs written in Macromedia Director’s Lingo. A Lingo program defines scripts which control various repeated actions, such as clicking on a button; these scripts are assembled into larger scripts. In the case of new media objects which are not computer programs, an analogy with structural programming still can be made because their parts can be accessed, modified or substituted without affecting the overall structure of an object. This analogy, however, has its limits. If a particular module of a computer program is deleted, the program would not run. In contrast, just as it is the case with traditional media, deleting parts of a new media object does not render its meaningless. In fact, the modular structure of new media makes such deletion and substitution of parts particularly easy. For example, since a HTML document consists from a number of separate objects each represented by a line of HTML code, it is very easy to delete, substitute or add new objects. Similarly, since in Photoshop the parts a digital image are usually placed on separate layers, these parts can be deleted and substituted with a click of a button.

3. Automation

Numerical coding of media (principle 1) and modular structure of a media object (principle 2) allow to automate many operations involved in media creation, manipulation and access. Thus human intentionally can be removed from the creative process, at least in part.¹⁹

The following are some of the examples of what can be called “low-level” automation of media creation, in which the computer user modifies or creates from scratch a media object using templates or simple algorithms. These techniques are robust enough so that they are included in most commercial software for image editing, 3D graphics, word processing, graphic layout, and so on. Image editing programs such as Photoshop can automatically correct scanned images, improving contrast range and removing noise. They also come with filters which can automatically modify an image, from creating simple variations of color to changing the whole image as though it was painted by Van Gog, Seurat or other brand-name artist. Other computer programs can automatically generate 3D objects such as trees, landscapes, human figures and detailed ready-to-use animations of complex natural phenomena such as fire and waterfalls. In Hollywood films, flocks of birds, ant colonies and crowds of people are automatically created by AL (artificial life) software. Word processing, page layout, presentation and Web creation programs come with “agents” which can automatically create the layout of a document. Writing software helps the user to create literary narratives using formalized highly conventions genre convention. Finally, in what maybe the most familiar experience of automation of media generation to most computer users, many Web sites automatically generate Web pages on the fly when the user reaches the site. They assemble the information from the databases and format it using generic templates and scripts.

The researchers are also working on what can be called “high-level” automation of media creation which requires a computer to understand, to a certain degree, the meanings embedded in the objects being generated, i.e. their semantics. This research can be seen as a part of a larger initiative of artificial intelligence (AI). As it is well known, AI project achieved only very limited success since its beginnings in the 1950s. Correspondingly, work on media generation which requires understanding of semantics is also in the research stage and is rarely included in commercial software. Beginning in the 1970s, computers were often used to generate poetry and fiction. In the 1990s, the users of Internet chat rooms became familiar with bots -- the computer programs which simulate human conversation. The researchers at New York University showed a “virtual theater” composed of a few “virtual actors” which adjust their behavior in real-time in response to user’s actions.²⁰ The MIT Media Lab developed a number of different projects devoted to “high-level” automation of media creation and use: a “smart camera” which can automatically follow the action and frame the shots given a script;²¹ ALIVE, a virtual environment where the user interacted with

animated characters;²² a new kind of human-computer interface where the computer presents itself to a user as an animated talking character. The character, generated by a computer in real-time, communicates with user using natural language; it also tries to guess user's emotional state and to adjust the style of interaction accordingly.²³

The area of new media where the average computer user encountered AI in the 1990s was not, however, human-computer interface, but computer games. Almost every commercial game includes a component called AI engine. It stands for part of the game's computer code which controls its characters: car drivers in a car race simulation, the enemy forces in a strategy game such as Command and Conquer, the single enemies which keep attacking the user in first-person shooters such as Quake. AI engines use a variety of approaches to simulate human intelligence, from rule-based systems to neural networks. Like AI expert systems, these characters have expertise in some well-defined but narrow area such as attacking the user. But because computer games are highly codified and rule-based, these characters function very effectively. That is, they effectively respond to whatever few things the user are allowed to ask them to do: run forward, shoot, pick up an object. They can't do anything else, but then the game does not provide the opportunity for the user to test this. For instance, in a martial arts fighting game, I can't ask questions of my opponent, nor do I expect him or her to start a conversation with me. All I can do is to "attack" my opponent by pressing a few buttons; and within this highly codified situation the computer can "fight" me back very effectively. In short, computer characters can display intelligence and skills only because the programs put severe limits on our possible interactions with them. Put differently, the computers can pretend to be intelligent only by tricking us into using a very small part of who we are when we communicate with them. So, to use another example, at 1997 SIGGRAPH convention I was playing against both human and computer-controlled characters in a VR simulation of some non-existent sport game. All my opponents appeared as simple blobs covering a few pixels of my VR display; at this resolution, it made absolutely no difference who was human and who was not.

Along with "low-level" and "high-level" automation of media creation, another area of media use which is being subjected to increasing automation is media access. The switch to computers as means to store and access enormous amount of media material, exemplified by the by "media assets" stored in the databases of stock agencies and global entertainment conglomerates, as well as by the public "media assets" distributed across numerous Web sites, created the need to find more efficient ways to classify and search media objects. Word processors and other text management software for a long time provided the abilities to search for specific strings of text and automatically index documents. UNIX operating system also always included powerful commands to search and filter text files. In the 1990s software designers started to provide media users with

similar abilities. Virage introduced Virage VIR Image Engine which allows to search for visually similar image content among millions of images as well as a set of video search tools to allow indexing and searching video files.²⁴ By the end of the 1990s, the key Web search engines already included the options to search the Internet by specific media such as images, video and audio.

The Internet, which can be thought of as one huge distributed media database, also crystallized the basic condition of the new information society: over-abundance of information of all kind. One response was the popular idea of software “agents” designed to automate searching for relevant information. Some agents act as filters which deliver small amounts of information given user's criteria. Others are allowing users to tap into the expertise of other users, following their selections and choices. For example, MIT Software Agents Group developed such agents as BUZZwatch which “distills and tracks trends, themes, and topics within collections of texts across time” such as Internet discussions and Web pages; Letizia, “a user interface agent that assists a user browsing the World Wide Web by... scouting ahead from the user's current position to find Web pages of possible interest”; and Footprints which “uses information left by other people to help you find your way around.”²⁵

By the end of the twentieth century, the problem became no longer how to create a new media object such as an image; the new problem was how to find the object which already exists somewhere. That is, if you want a particular image, chances are it is already exists -- but it may be easier to create one from scratch when to find the existing one. Beginning in the nineteenth century, modern society developed technologies which automated media creation: a photo camera, a film camera, a tape recorder, a video recorder, etc. These technologies allowed us, over the course of one hundred and fifty years, to accumulate an unprecedented amount of media materials: photo archives, film libraries, audio archives... This led to the next stage in media evolution: the need for new technologies to store, organize and efficiently access these media materials. These new technologies are all computer-based: media databases; hypermedia and other ways of organizing media material such the hierarchical file system itself; text management software; programs for content-based search and retrieval. Thus automation of media access is the next logical stage of the process which was already put into motion when a first photograph was taken. The emergence of new media coincides with this second stage of a media society, now concerned as much with accessing and re-using existing media as with creating new one.²⁶ (See “Database” section for more on databases).

4. Variability

A new media object is not something fixed once and for all but can exist in different, potentially infinite, versions. This is another consequence of numerical coding of media (principle 1) and modular structure of a media object (principle 2). Other terms which are often used in relation to new media and which would be appropriate instead of “variable” is “mutable” and “liquid.”

Old media involved a human creator who manually assembled textual, visual and/or audio elements into a particular composition or a sequence. This sequence was stored in some material, its order determined once and for all. Numerous copies could be run off from the master, and, in perfect correspondence with the logic of an industrial society, they were all identical. New media, in contrast, is characterized by variability. Instead of identical copies a new media object typically gives rise to many different versions. And rather being created completely by a human author, these versions are often in part automatically assembled by a computer. (The already quoted example of Web pages automatically generated from databases using the templates created by Web designers can be invoked here as well.) Thus the principle of variability is closely connected to automation.

Variability would also will not be possible without modularity. Stored digitally, rather than in some fixed medium, media elements maintain their separate identity and can be assembled into numerous sequences under program control. In addition, because the elements themselves are broken into discrete samples (for instance, an image is represented as an array of pixels), they can be also created and customized on the fly.

The logic of new media thus corresponds to the post-industrial logic of "production on demand" and "just in time" delivery which themselves were made possible by the use of computers and computer networks in all stages of manufacturing and distribution. Here "culture industry" (the term was originally coined by Theodor Adorno in the 1930s) is actually ahead of the rest of the industry. The idea that a customer determines the exact features of her car at the showroom, the data is then transmitted to the factory, and hours later the new car is delivered, remains a dream, but in the case of computer media, it is reality. Since the same machine is used as a showroom and a factory, i.e., the same computer generates and displays media -- and since the media exists not as a material object but as data which can be sent through the wires with the speed of light, the customized version created in response to user's input is delivered almost immediately. Thus, to continue with the same example, when you access a Web site, the server immediately assembles a customized Web page.

Here are some particular cases of the variability principle (most of them will be discussed in more detail in later chapters):

4.1. Media elements are stored in a media database; a variety of end-user objects which vary both in resolution, in form and in content can be generated, either beforehand, or on demand, from this database. At first, we may think that this is simply a particular technological implementation of variability principle,

but, as I will show in “Database” section, in a computer age database comes to function as a cultural form of its own. It offers a particular model of the world and of the human experience. It also affects how the user conceives of data which it contains.

4.2. It becomes possible to separate the levels of "content" (data) and interface. A number of different interfaces can be created to the same data. A new media object can be defined as one or more interfaces to a multimedia database (see introduction to “Interface” chapter and “Database” section for more discussion of this principle).²⁷

4.3. The information about the user can be used by a computer program to automatically customize the media composition as well as to create the elements themselves. Examples: Web sites use the information about the type of hardware and browser or user's network address to automatically customize the site which the user will see; interactive computer installations use information about the user's body movements to generate sounds, shapes, and images, or to control behaviors of artificial creatures.

4.4. A particular case of 4.3 is branching-type interactivity (sometimes also called menu-based interactivity.) This term refers to programs in which all the possible objects which the user can visit form a branching tree structure. When the user reaches a particular object, the program presents her with choices and let her pick. Depending on the value chosen, the user advances along a particular branch of the tree. For instance, in *Myst* each screen typically contains a left and a right button, clicking on the button retrieves a new screen, and so on. In this case the information used by a program is the output of user's cognitive process, rather than the network address or body position. (See “Menus, Filters, Plug-ins” for more discussion of this principle.)

4.5. Hypermedia is another popular new media structure, which conceptually is close to branching-type interactivity (because quite often the elements are connected using a branch tree structure). In hypermedia, the multimedia elements making a document are connected through hyperlinks. Thus the elements and the structure are independent of each other --rather than hard-wired together, as in traditional media. World Wide Web is a particular implementation of hypermedia in which the elements are distributed throughout the network . Hypertext is a particular case of hypermedia which uses only one media type — text. How does the principle of variability works in this case? We can conceive of all possible paths through a hypermedia document as being different versions of it. By following the links the user retrieves a particular version of a document.

4.6. Another way in which different versions of the same media objects are commonly generated in computer culture is through periodic updates. Networks allow the content of a new media object to be periodically updating while keeping its structure intact. For instance, modern software applications can

periodically check for updates on the Internet and then download and install these updates, sometimes without any actions from the user. Most Web sites are also periodically updated either manually or automatically, when the data in the databases which drives the sites changes. A particularly interesting case of this “updateability” feature is the sites which update some information, such as such as stock prices or weather, continuously.

4.7. One of the most basic cases of the variability principle is scalability, in which different versions of the same media object can be generated at various sizes or levels of detail. The metaphor of a map is useful in thinking about the scalability principle. If we equate a new media object with a physical territory, different versions of this object are like maps of this territory, generated at different scales. Depending on the scale chosen, a map provides more or less detail about the territory. Indeed, different versions of a new media object may vary strictly quantitatively, i.e. in the amount of detail present: for instance, a full size image and its icon, automatically generated by Photoshop; a full text and its shorter version, generated by “Autosummarize” command in Microsoft Word 97; or the different versions which can be created using “Outline” command in Word. Beginning with version 3 (1997), Apple’s QuickTime format also made possible to imbed a number of different versions which differ in size within a single QuickTime movie; when a Web user accesses the movie, a version is automatically selected depending on connection speed. Conceptually similar technique called “distancing” or “level of detail” is used in interactive virtual worlds such as VRML scenes. A designer creates a number of models of the same object, each with progressively less detail. When the virtual camera is close to the object, a highly detailed model is used; if the object is far away, a lesser detailed version is automatically substituted by a program to save unnecessary computation of detail which can’t be seen anyway.

New media also allows to create versions of the same object which differ from each other in more substantial ways. Here the comparison with maps of different scales no longer works. The examples of commands in commonly used software packages which allow to create such qualitatively different versions are “Variations” and “Adjustment layers” in Photoshop 5 and “writing style” option in Word’s “Spelling and Grammar” command. More examples can be found on the Internet were, beginning in the middle of the 1990s, it become common to create a few different versions of a Web site. The user with a fast connection can choose a rich multimedia version while the user with a slow connection can settle for a more bare-bones version which loads faster.

Among new media artworks, David Blair’s WaxWeb, a Web site which is an “adaptation” of an hour long video narrative, offers a more radical implementation of the scalability principle. While interacting with the narrative, the user at any point can change the scale of representation, going from an image-based outline of the movie to a complete script or a particular shot, or a VRML

scene based on this shot, and so on.²⁸ Another example of how use of scalability principle can create a dramatically new experience of an old media object is Stephen Mamber's database-driven representation of Hitchcock's Birds. Mamber's software generates a still for every shot of the film; it then automatically combines all the stills into a rectangular matrix. Every cell in the matrix corresponds to a particular shot from the film. As a result, time is spatialized, similar to how it was done in Edison's early Kinetoscope cylinders (see "The Myths of New Media.") Spatializing the film allows us to study its different temporal structures which would be hard to observe otherwise. As in WaxWeb, the user can at any point change the scale of representation, going from a complete film to a particular shot.

As can be seen, the principle of variability is a useful in allowing us to connect many important characteristics of new media which on first sight may appear unrelated. In particular, such popular new media structures as branching (or menu) interactivity and hypermedia can be seen as particular instances of variability principle (4.4 and 4.5, respectively). In the case of branching interactivity, the user plays an active role in determining the order in which the already generated elements are accessed. This is the simplest kind of interactivity; more complex kinds are also possible where both the elements and the structure of the whole object are either modified or generated on the fly in response to user's interaction with a program. We can refer to such implementations as open interactivity to distinguish them from the closed interactivity which uses fixed elements arranged in a fixed branching structure. Open interactivity can be implemented using a variety of approaches, including procedural and object-oriented computer programming, AI, AL, and neural networks.

As long as there exist some kernel, some structure, some prototype which remains unchanged throughout the interaction, open interactivity can be thought of as a subset of variability principle. Here useful analogy can be made with theory of family resemblance by Wittgenstein, later developed into the influential theory of prototypes by cognitive psychologist Eleanor Rosch. In a family, a number of relatives will share some features, although no single family member may possess all of the features. Similarly, according to the theory of prototypes, the meanings of many words in a natural language derive not through a logical definition but through a proximity to certain prototype.

Hypermedia, the other popular structure of new media, can also be seen as a particular case of the more general principle of variability. According to the definition by Halacz and Swartz, hypermedia systems "provide their users with the ability to create, manipulate and/or examine a network of information-containing nodes interconnected by relational links."²⁹ Since in new media the individual media elements (images, pages of text, etc.) always retain their individual identity (the principle of modularity), they can be "wired" together into more than one object. Hyperlinking is a particular way to achieve this wiring. A

hyperlink creates a connection between two elements, for example between two words in two different pages or a sentence on one page and an image in another, or two different places within the same page. The elements connected through hyperlinks can exist on the same computer or on different computers connected on a network, as in the case of World Wide Web.

If in traditional media the elements are "hardwired" into a unique structure and no longer maintain their separate identity, in hypermedia the elements and the structure are separate from each other. The structure of hyperlinks -- typically a branching tree - can be specified independently from the contents of a document. To make an analogy with grammar of a natural language as described in Noam Chomsky's early linguistic theory,³⁰ we can compare a hypermedia structure which specifies the connections between the nodes with a deep structure of a sentence; a particular hypermedia text can be then compared with a particular sentence in a natural language. Another useful analogy is with computer programming. In programming, there is clear separation between algorithms and data. An algorithm specifies the sequence of steps to be performed on any data, just as a hypermedia structure specifies a set of navigation paths (i.e., connections between the nodes) which potentially can be applied to any set of media objects.

The principle of variability also exemplifies how, historically, the changes in media technologies are correlated with changes the social change. If the logic of old media corresponded to the logic of industrial mass society, the logic of new media fits the logic of the post-industrial society which values individuality over conformity. In industrial mass society everybody was supposed to enjoy the same goods -- and to have the same beliefs. This was also the logic of media technology. A media object was assembled in a media factory (such as a Hollywood studio). Millions of identical copies were produced from a master and distributed to all the citizens. Broadcasting, cinema, print media all followed this logic.

In a post-industrial society, every citizen can construct her own custom lifestyle and "select" her ideology from a large (but not infinite) number of choices. Rather than pushing the same objects/information to a mass audience, marketing now tries to target each individual separately. The logic of new media technology reflects this new social logic. Every visitor to a Web site automatically gets her own custom version of the site created on the fly from a database. The language of the text, the contents, the ads displayed — all these can be customized by interpreting the information about where on the network the user is coming from; or, if the user previously registered with the site, her personal profile can be used for this customization. According to a report in USA Today (November 9, 1999), "Unlike ads in magazines or other real-world publications, 'banner' ads on Web pages change wit every page view. And most of the companies that place the ads on the Web site track your movements across the Net, 'remembering' which ads you've seen, exactly when you saw them, whether

you clicked on them, where you were at the time and the site you have visited just before.”³¹

More generally, every hypertext reader gets her own version of the complete text by selecting a particular path through it. Similarly, every user of an interactive installation gets her own version of the work. And so on. In this way new media technology acts as the most perfect realization of the utopia of an ideal society composed from unique individuals. New media objects assure users that their choices — and therefore, their underlying thoughts and desires — are unique, rather than pre-programmed and shared with others. As though trying to compensate for their earlier role in making us all the same, today descendants of the Jacquard's loom, the Hollerith tabulator and Zuse's cinema-computer are now working to convince us that we are all unique.

The principle of variability as it is presented here is not dissimilar to how the artist and curator Jon Ippolito uses the same concept.³² I believe that we differ in how we use the concept of variability in two key respects. First, Ippolito uses variability to describe a characteristic shared by recent conceptual and some digital art, while I see variability as a basic condition of all new media. Second, Ippolito follows the tradition of conceptual art where an artist can vary any dimension of the artwork, even its content; my use of the term aims to reflect the logic of mainstream culture where versions of the object share some well-defined “data.” This “data” which can be a well-known narrative (Psycho), an icon (Coca-Cola sign), a character (Mickey Mouse) or a famous star (Madonna), is referred in media industry as “property.” Thus all cultural projects produced by Madonna will be automatically united by her name. Using the theory of prototypes, we can say that the property acts as a prototype, and different versions are derived from this prototype. Moreover, when a number of versions are being commercially released based on some “property”, usually one of these versions is treated as the source of the “data,” with others positioned as being derived from this source. Typically the version which is in the same media as the original “property” is treated as the source. For instance, when a movie studio releases a new film, along with a computer game based on it, along with products tie-ins, along with music written for the movie, etc., usually the film is presented as the “base” object from which other objects are derived. So when George Lucas releases a new Star Wars movie, it refers back to the original property — the original Star Wars trilogy. This new movie becomes the “base” object and all other media objects which are released along with refer to this object. Conversely, when computer games such as Tomb Rider are re-made into movies, the original computer game is presented as the “base” object.

While I deduced the principle of variability from more basic principles of new media — numerical representation (1) and modularity of information (2) — it can also be seen as a consequence of computer’s way of to represent data and model the world itself: as variables rather than constants. As new media theorist

and architect Marcos Novak notes, a computer — and computer culture in its wake — substitute every constant by a variable.³³ In designing all functions and data structures, a computer programmer tries to always use variables rather than constants. On the level of human-computer interface, this principle means that the user is given many options to modify the performance of a program of a media object, be it a computer game, a Web site, a Web browser, or the operating system itself. The user can change the profile of a game character, modify how the folders appear on the desktop, how files are displayed, what icons are used, etc. If we apply this principle to culture at large, it would mean that every choice responsible for giving a cultural object a unique identity can potentially remain always open. Size, degree of detail, format, color, shape, interactive trajectory, trajectory through space, duration, rhythm, point of view, the presence or absence of particular characters, the development of the plot — to name just a few dimensions of cultural objects in different media — all these can be defined as variables, to be freely modified by a user.

Do we want, or need, such freedom? As the pioneer of interactive filmmaking Graham Weinbren argued in relation to interactive media, making a choice involves a moral responsibility.³⁴ By passing these choices to the user, the author also passes the responsibility to represent the world and the human condition in it. (This is paralleled by the use of phone or Web-based automated menu systems by all big companies to handle their customers; while the companies are doing this in the name of “choice” and “freedom,” one of the effects of this automation is that labor to be done is passed from company’s employees to the customer. If before a customer would get the information or buy the product by interacting with a company employee, now she has to spend her own time and energy in navigating through numerous menus to accomplish the same result.) The moral anxiety which accompanies the shift from constants to variables, from tradition to choices in all areas of life in a contemporary society, and the corresponding anxiety of a writer who has to portray it, is well rendered in this closing passage of a short story written by a contemporary American writer Rick Moody (the story is about the death of his sister):³⁵

I should fictionalize it more, I should conceal myself. I should consider the responsibilities of characterization, I should conflate her two children into one, or reverse their genders, or otherwise alter them, I should make her boyfriend a husband, I should explicate all the tributaries of my extended family (its remarriages, its internecine politics), I should novelize the whole thing, I should make it multigenerational, I should work in my forefathers (stonemasons and newspapermen), I should let artifice create an elegant surface, I should make the events orderly, I should wait and write about it later, I should wait until I’m not angry, I shouldn’t clutter a narrative with fragments, with mere recollections of

good times, or with regrets, I should make Meredith's death shapely and persuasive, not blunt and disjunctive, I shouldn't have to think the unthinkable, I shouldn't have to suffer, I should address her here directly (these are the ways I miss you), I should write only of affection, I should make our travels in this earthy landscape safe and secure, I should have a better ending, I shouldn't say her life was short and often sad, I shouldn't say she had demons, as I do too.

5. Transcoding

Beginning with the basic, "material" principles of new media — numeric coding and modular organization — we moved to more "deep" and far reaching ones — automation and variability. The last, fifth principle of cultural transcoding aims to describe what in my view is the most substantial consequence of media's computerization. As I have suggested, computerization turns media into computer data. While from one point of view computerized media still displays structural organization which makes sense to its human users — images feature recognizable objects; text files consist from grammatical sentences; virtual spaces are defined along the familiar Cartesian coordinate system; and so on — from another point of view, its structure now follows the established conventions of computer's organization of data. The examples of these conventions are different data structures such as lists, records and arrays; the already mentioned substitution of all constants by variables; the separation between algorithms and data structures; and modularity.

The structure of a computer image is a case in point. On the level of representation, it belongs to the side of human culture, automatically entering in dialog with other images, other cultural "sems" and "mythemes." But on another level, it is a computer file which consist from a machine-readable header, followed by numbers representing RGB values of its pixels. On this level it enters into a dialog with other computer files. The dimensions of this dialog are not the image's content, meanings or formal qualities, but file size, file type, type of compression used, file format and so on. In short, these dimensions are that of computer's own cosmogony rather than of human culture.

Similarly, new media in general can be thought of as consisting from two distinct layers: the "cultural layer" and the "computer layer." The examples of categories on the cultural layer are encyclopedia and a short story; story and plot; composition and point of view; mimesis and catharsis, comedy and tragedy. The examples of categories on the computer layer are process and packet (as in data packets transmitted through the network); sorting and matching; function and variable; a computer language and a data structure.

Since new media is created on computers, distributed via computers, stored and archived on computers, the logic of a computer can be expected to

significant influence on the traditional cultural logic of media. That is, we may expect that the computer layer will affect the cultural layer. The ways in which computer models the world, represents data and allows us to operate on it; the key operations behind all computer programs (such as search, match, sort, filter); the conventions of HCI — in short, what can be called computer's ontology, epistemology and pragmatics — influence the cultural layer of new media: its organization, its emerging genres, its contents.

Of course what I called a computer layer is not itself fixed but is changing in time. As hardware and software keep evolving and as the computer is used for new tasks and in new ways, this layer is undergoing continuous transformation. The new use of computer as a media machine is the case in point. This use is having an effect on computer's hardware and software, especially on the level of the human-computer interface which looks more and more like the interfaces of older media machines and cultural technologies: VCR, tape player, photo camera.

In summary, the computer layer and media/culture layer influence each other. To use another concept from new media, we can say that they are being composited together. The result of this composite is the new computer culture: a blend of human and computer meanings, of traditional ways human culture modeled the world and computer's own ways to represent it.

Throughout the book, we will encounter many examples of the principle of transcoding at work. For instance, "The Language of Cultural Interfaces" section will look at how conventions of printed page, cinema and traditional HCI interact together in the interfaces of Web sites, CD-ROMs, virtual spaces and computer games.

"Database" section will discuss how a database, originally a computer technology to organize and access data, is becoming a new cultural form of its own. But we can also reinterpret some of the principles of new media already discussed above as consequences of the transcoding principle. For instance, hypermedia can be understood as one cultural effect of the separation between an algorithm and a data structure, essential to computer programming. Just as in programming algorithms and data structures exist independently of each other, in hypermedia data is separated from the navigation structure. (For another example of the cultural effect of algorithm—data structure dichotomy see "Database" section.) Similarly, the modular structure of new media can be seen as an effect of the modularity in structural computer programming. Just as a structural computer program consists from smaller modules which in their turn consist from even smaller modules, a new media object as a modular structure, as I explained in my discussion of modularity above.

In new media lingo, to "transcode" something is to translate it into another format. The computerization of culture gradually accomplishes similar transcoding in relation to all cultural categories and concepts. That is, cultural categories and concepts are substituted, on the level of meaning and/or the language, by new ones which derive from computer's ontology, epistemology and

pragmatics. New media thus acts as a forerunner of this more general process of cultural re-conceptualization.

Given the process of “conceptual transfer” from computer world to culture at large, and given the new status of media as computer data, what theoretical framework can we use to understand it? Since on one level new media is an old media which has been digitized, it seems appropriate to look at new media using the perspective of media studies. We may compare new media and old media, such as print, photography, or television. We may also ask about the conditions of distribution and reception and the patterns of use. We may also ask about similarities and differences in the material properties of each medium and how these affect their aesthetic possibilities.

This perspective is important, and I am using it frequently in this book; but it is not sufficient. It can't address the most fundamental new quality of new media which has no historical precedent — programmability. Comparing new media to print, photography, or television will never tell us the whole story. For while from one point of view new media is indeed another media, from another is simply a particular type of computer data, something which is stored in files and databases, retrieved and sorted, run through algorithms and written to the output device. That the data represents pixels and that this device happened to be an output screen is besides the point. The computer may perform perfectly the role of the Jacquard loom, but underneath it is fundamentally Babbage's Analytical Engine - after all, this was its identity for one hundred and fifty years. New media may look like media, but this is only the surface.

New media calls for a new stage in media theory whose beginnings can be traced back to the revolutionary works of Robert Innis and Marshall McLuhan of the 1950s. To understand the logic of new media we need to turn to computer science. It is there that we may expect to find the new terms, categories and operations which characterize media which became programmable. From media studies, we move to something which can be called software studies; from media theory — to software theory. The principle of transcoding is one way to start thinking about software theory. Another way which this book experiments with is using concepts from computer science as categories of new media theory. The examples here are “interface” and “database.” And, last but not least, I follow the analysis of “material” and logical principles of computer hardware and software in this chapter with two chapters on human-computer interface and the interfaces of software applications use to author and access new media objects.

What New Media is Not

Having proposed a list of the key differences between new and old media, I now would like to address other potential candidates, which I have omitted. The following are some of the popularly held notions about the difference between new and old media which this section will subject to scrutiny:

1. New media is analog media converted to a digital representation. In contrast to analog media which is continuous, digitally encoded media is discrete.
2. All digital media (text, still images, visual or audio time data, shapes, 3D spaces) share the same the same digital code. This allows different media types to be displayed using one machine, i.e., a computer, which acts as a multimedia display device.
3. New media allows for random access. In contrast to film or videotape which store data sequentially, computer storage devices make possible to access any data element equally fast.
4. Digitization involves inevitable loss of information. In contrast to an analog representation, a digitally encoded representation contains a fixed amount of information.
5. In contrast to analog media where each successive copy loses quality, digitally encoded media can be copied endlessly without degradation.
6. New media is interactive. In contrast to traditional media where the order of presentation was fixed, the user can now interact with a media object. In the process of interaction the user can choose which elements to display or which paths to follow, thus generating a unique work. Thus the user becomes the co-author of the work.

Cinema as New Media

If we place new media within a longer historical perspective, we will see that many of these principles are not unique to new media and can be already found in older media technologies. I will illustrate this by using the example of the technology of cinema.

(1). “New media is analog media converted to a digital representation. In contrast to analog media which is continuous, digitally encoded media is discrete.”

Indeed, any digital representation consists from a limited number of samples. For example, a digital still image is a matrix of pixels — a 2D sampling of space. However, as I already noted, cinema was already based on sampling — the sampling of time. Cinema sampled time twenty four times a second. So we

can say that cinema already prepared us for new media. All that remained was to take this already discrete representation and to quantify it. But this is simply a mechanical step; what cinema accomplished was a much more difficult conceptual break from the continuous to the discrete.

Cinema is not the only media technology which, emerging towards the end of the nineteenth century, employed a discrete representation. If cinema sampled time, fax transmission of images, starting in 1907, sampled a 2D space; even earlier, first television experiments (Carey, 1875; Nipkow, 1884) already involved sampling of both time and space.³⁶ However, reaching mass popularity much earlier than these other technologies, cinema is the first to make the principle of a discrete representation of the visual a public knowledge.

(2). "All digital media (text, still images, visual or audio time data, shapes, 3D spaces) share the same the same digital code. This allows different media types to be displayed using one machine, i.e., a computer, which acts as a multimedia display device."

Before computer multimedia became commonplace around 1990, filmmakers were already combining moving images, sound and text (be it intertitles of the silent era or the title sequences of the later period) for a whole century. Cinema thus was the original modern "multimedia." We can also much earlier examples of multiple-media displays, such as Medieval illuminated manuscripts which combined text, graphics and representational images.

(3). "New media allows for random access. In contrast to film or videotape which store data sequentially, computer storage devices make possible to access any data element equally fast."

For example, once a film is digitized and loaded in the computer memory, any frame can be accessed with equal ease. Therefore, if cinema sampled time but still preserved its linear ordering (subsequent moments of time become subsequent frames), new media abandons this "human-centered" representation altogether — in order to put represented time fully under human control. Time is mapped onto two-dimensional space, where it can be managed, analyzed and manipulated more easily.

Such mapping was already widely used in the nineteenth century cinema machines. The Phenakisticope, the Zootrope, the Zoopraxiscope, the Tachyscope, and Marey's photographic gun were all based on the same principle -- placing a number of slightly different images around the perimeter of a circle. Even more striking is the case of Thomas Edison's first cinema apparatus. In 1887 Edison and his assistant, William Dickson, began experiments to adopt the already proven technology of a phonograph record for recording and displaying of motion pictures. Using a special picture-recording camera, tiny pinpoint-size photographs were placed in spirals on a cylindrical cell similar in size to the phonography

cylinder. A cylinder was to hold 42,000 images, each so small (1/32 inch wide) that a viewer would have to look at them through a microscope.³⁷ The storage capacity of this medium was twenty-eight minutes -- twenty-eight minutes of continuous time taken apart, flattened on a surface and mapped into a two-dimensional grid. (In short, time was prepared to be manipulated and re-ordered, something which was soon to be accomplished by film editors.)

The Myth of the Digital

Discrete representation, random access, multimedia -- cinema already contained these principles. So they cannot help us to separate new media from old media. Let us continue interrogating these principles. If many principles of new media turn out to be not so new, what about the idea of digital representation? Surely, this is the one idea which radically redefines media? The answer is not so strait forward. This idea acts as an umbrella for three unrelated concepts: analog-to-digital conversion (digitization), a common representational code, and numerical representation. Whenever we claim that some quality of new media is due to its digital status, we need to specify which out of these three concepts is at work. For example, the fact that different media can be combined into a single digital file is due to the use of a common representational code; whereas the ability to copy media without introducing degradation is an effect of numerical representation.

Because of this ambiguity, I try to avoid using the word “digital” in this book. “Principles of New Media” focused on the concept of numerical representation as being the really crucial one out of these three. Numerical representation turns media into computer data thus making it programmable. And this indeed radically changes what media is.

In contrast, as I will show below, the alleged principles of new media which are often deduced from the concept of digitization — that analog-to-digital conversion inevitably results in a loss of information and that digital copies are identical to the original — turn out not to hold under closer examination. That is, although these principles are indeed logical consequence of digitization, they do not apply to concrete computer technologies the way they are currently used.

(4). “Digitization involves inevitable loss of information. In contrast to an analog representation, a digitally encoded representation contains a fixed amount of information.”

In his important study of digital photography *The Reconfigured Eye*, William Mitchell explains this as follows: "There is an indefinite amount of information in a continuous-tone photograph, so enlargement usually reveals more detail but yields a fuzzier and grainier picture... A digital image, on the other hand, has precisely limited spatial and tonal resolution and contains a fixed

amount of information."³⁸ From a logical point of view, this principle is a correct deduction from the idea of digital representation. A digital image consists of a finite number of pixels, each having a distinct color or a tonal value, and this number determines the amount of detail an image can represent. Yet in reality this difference does not matter. By the end of the 1990s, even cheap consumer scanners were capable of scanning images at resolutions of 1200 or 2400 pixels per inch. So while a digitally stored image is still comprised of a finite number of pixels, at such resolution it can contain much finer detail than it was ever possible with traditional photography. This nullifies the whole distinction between an "indefinite amount of information in a continuous-tone photograph" and a fixed amount of detail in a digital image. The more relevant question is how much information in an image can be useful to the viewer. By the end of new media first decade, technology has already reached the point where a digital image can easily contain much more information than anybody would ever want.

But even the pixel-based representation, which appears to be the very essence of digital imaging, cannot be taken for granted. Some computer graphics software have bypassed the main limitation of the traditional pixel grid -- fixed resolution. Live Picture, an image editing program, converts a pixel-based image into a set of mathematical equations. This allows the user to work with an image of virtually unlimited resolution. Another paint program Matador makes possible painting on a tiny image which may consist of just a few pixels as though it were a high-resolution image (it achieves this by breaking each pixel into a number of smaller sub-pixels). In both programs, the pixel is no longer a "final frontier"; as far as the user is concerned, it simply does not exist. Texture mapping algorithms make the notion of a fixed resolution meaningless in a different way. They often store the same image at a number of different resolution. During rendering the texture map of arbitrary resolution is produced by interpolating between two images which are closest to this resolution. (The similar technique is used by virtual world software which stores the number of versions of a singular object at different degree of detail.) Finally, certain compression techniques eliminate pixel-based representation altogether, instead representing an image via different mathematical constructs (such as transforms.)

(5). "In contrast to analog media where each successive copy loses quality, digitally encoded media can be copied endlessly without degradation."

Mitchell summarizes this as follows: "The continuous spatial and tonal variation of analog pictures is not exactly replicable, so such images cannot be transmitted or copied without degradation... But discrete states can be replicated precisely, so a digital image that is a thousand generations away from the original is indistinguishable in quality from any one of its progenitors."³⁹ Therefore, in digital culture, "an image file can be copied endlessly, and the copy is

distinguishable from the original by its date since there is no loss of quality."⁴⁰ This is all true -- in principle. However, in reality, there is actually much more degradation and loss of information between copies of digital images than between copies of traditional photographs. A single digital image consists of millions of pixels. All of this data requires considerable storage space in a computer; it also takes a long time (in contrast to a text file) to transmit over a network. Because of this, the software and hardware used to acquire, store, manipulate, and transmit digital images uniformly rely on lossy compression -- the technique of making image files smaller by deleting some information. The example of lossy compression technique is JPEG format used to store still images and MPEG, used to store digital video on DVD. The technique involves a compromise between image quality and file size -- the smaller the size of a compressed file, the more visible are the visual artifacts introduced in deleting information. Depending on the level of compression, these artifacts range from barely noticeable to quite pronounced.

One may argue that this situation is temporary and once cheaper computer storage and faster networks become commonplace, lossy compression will disappear. However, presently the trend is quite the reverse with lossy compression becoming more and more the norm for representing visual information. If a single digital image already contains a lot of data, this amount increases dramatically if we want to produce and distribute moving images in a digital form (one second of video, for instance, consists of 30 still images). Digital television with its hundreds of channels and video on-demand services, the distribution of full-length films on DVD or over Internet, fully digital post-production of feature films -- all of these developments are made possible by lossy compression. It will be a number of years before the advances in storage media and communication bandwidth will eliminate the need to compress audio-visual data. So rather than being an aberration, a flaw in the otherwise pure and perfect world of the digital, where even a single bit of information is never lost, lossy compression is the very foundation of computer culture, at least for now. Therefore, while in theory computer technology entails the flawless replication of data, its actual use in contemporary society is characterized by the loss of data, degradation, and noise; the noise which is often even stronger than that of traditional analog media.

The Myth of Interactivity

We have only one principle still remaining from the original list: interactivity. As with "digital," I avoid using the word "interactive" in this book without qualifying it, for the same reason -- I find the concept to be too broad to be truly useful.

Used in relation to computer-based media, the concept of interactivity is a tautology. Modern human-computer interface (HCI) is by its very definition interactive. In contrast to earlier interfaces such as batch processing, modern HCI allows the user to control the computer in real-time by manipulating information displayed on the screen. Once an object is represented in a computer, it automatically becomes interactive. Therefore, to call computer media interactive is meaningless -- it simply means stating the most basic fact about computers.

Rather than evoking this concept by itself, in this book I use a number of other concepts, such as menu-based interactivity, salability, simulation, image-interface, and image-instrument, to describe different kinds of interactive structures and operations. The already used distinction between “closed” and “open” interactivity is just one example of this approach.

While it is relatively easy to specify different interactive structures used in new media object, it is much more difficult to theoretically deal with user experiences of these structures. This remains to be one of the most difficult theoretical questions raised by new media. Without pretending to have a complete answer, I would like to address some aspects of this question here.

All classical, and even more so modern art, was already "interactive" in a number of ways. Ellipses in literary narration, missing details of objects in visual art and other representational "shortcuts" required the user to fill-in the missing information.⁴¹ Theater, painting and cinema also relied on the techniques of staging, composition and cinematography to orchestrate viewer's attention over time, requiring her to focus on different parts of the display. With sculpture and architecture, the viewer had to move her whole body to experience the spatial structure.

Modern media and art pushed each of these techniques further, putting new cognitive and physical demands on the viewer. Beginning in the 1920s new narrative techniques such as film montage forced the audiences to quickly bridge mental gaps between unrelated images. New representational style of semi-abstraction which, along with photography, became the “international style” of modern visual culture, required the viewer to reconstruct the represented objects from the bare minimum -- a contour, few patches of color, shadows cast by the objects not represented directly. Finally, in the 1960s, continuing where Futurism and Dada left of, new forms of art such as happenings, performance and installation turned art explicitly participational. This, according to some new media theorists, prepared the ground for interactive computer installations which appeared in the 1980s.⁴²

When we use the concept of “interactive media” exclusively in relation to computer-based media, there is danger that we interpret "interaction" literally, equating it with physical interaction between a user and a media object (pressing a button, choosing a link, moving the body), at the sake of psychological interaction. The psychological processes of filling-in, hypothesis forming, recall

and identification, which are required for us to comprehend any text or image at all, are mistakenly identified with an objectively existing structure of interactive links.⁴³

This mistake is not new; on the contrary, it is a structural feature of history of modern media. The literal interpretation of interactivity is just the latest example of a larger modern trend to externalize of mental life, the process in which media technologies -- photography, film, VR -- have played a key role.⁴⁴ Beginning in the nineteenth century, we witness recurrent claims by the users and theorists of new media technologies, from Francis Galton (the inventor of composite photography in the 1870s) to Hugo Münsterberg, Sergei Eisenstein and, recently, Jaron Lanier, that these technologies externalize and objectify the mind. Galton not only claimed that "the ideal faces obtained by the method of composite portraiture appear to have a great deal in common with...so-called abstract ideas" but in fact he proposed to rename abstract ideas "cumulative ideas."⁴⁵ According to Münsterberg, who was a Professor of Psychology at Harvard University and an author of one of the earliest theoretical treatments of cinema entitled The Film: A Psychological Study (1916), the essence of films lies in its ability to reproduce, or "objectify" various mental functions on the screen: "The photoplay obeys the laws of the mind rather than those of the outer world."⁴⁶ In the 1920s Eisenstein was speculating about how film can be used to externalize — and control — thinking. As an experiment in this direction, he boldly conceived a screen adaptation of Marx's Capital. "The content of CAPITAL (its aim) is now formulated: to teach the worker to think dialectically," Eisenstein writes enthusiastically in April of 1928.⁴⁷ In accordance with the principles of "Marxist dialectics" as canonized by the official Soviet philosophy, Eisenstein planned to present the viewer with the visual equivalents of thesis and anti-thesis so that the viewer can then proceed to arrive at synthesis, i.e. the correct conclusion, pre-programmed by Eisenstein.

In the 1980s, Jaron Lanier, a California guru of VR, similarly saw VR technology as capable of completely objectifying, better yet, transparently merging with mental processes. His descriptions of its capabilities did not distinguish between internal mental functions, events and processes, and externally presented images. This is how, according to Lanier, VR can take over human memory: "You can play back your memory through time and classify your memories in various ways. You'd be able to run back through the experiential places you've been in order to be able to find people, tools."⁴⁸ Lanier also claimed that VR will lead to the age of "post-symbolic communication," communication without language or any other symbols. Indeed, why should there be any need for linguistic symbols, if everybody, rather than being locked into a "prison-house of language" (Fredric Jameson⁴⁹), will happily live in the ultimate nightmare of

democracy -- the single mental space which is shared by everybody, and where every communicative act is always ideal (Jurgen Habermas⁵⁰). This is Lanier's example of how post-symbolic communication will function: "you can make a cup that someone else can pick when there wasn't a cup before, without having to use a picture of the word "cup."⁵¹ Here, as with the earlier technology of film, the fantasy of objectifying and augmenting consciousness, extending the powers of reason, goes hand in hand with the desire to see in technology a return to the primitive happy age of pre-language, pre-misunderstanding. Locked in virtual reality caves, with language taken away, we will communicate through gestures, body movements, and grimaces, like our primitive ancestors...

The recurrent claims that new media technologies externalize and objectify reasoning, and that they can be used to augment or control it, are based on the assumption of the isomorphism of mental representations and operations with external visual effects such as dissolves, composite images, and edited sequences. This assumption is shared not just by modern media inventors, artists and critics but also by modern psychologists. Modern psychological theories of the mind, from Freud to cognitive psychology, repeatedly equate mental processes with external, technologically generated visual forms. Thus Freud in The Interpretation of Dreams (1900) compared the process of condensation with one of Francis Galton's procedures which became especially famous: making family portraits by overlaying a different negative image for each member of the family and then making a single print.⁵² Writing in the same decade, the American psychologist Edward Titchener opened the discussion of the nature of abstract ideas in his textbook of psychology by noting that "the suggestion has been made that an abstract idea is a sort of composite photograph, a mental picture which results from the superimposition of many particular perceptions or ideas, and which therefore shows the common elements distinct and the individual elements blurred."⁵³ He then proceeds to consider the pros and cons of this view. We should not wonder why Titchener, Freud and other psychologists take the comparison for granted rather than presenting it as a simple metaphor -- contemporary cognitive psychologists also do not question why their models of the mind are so similar to the computer workstations on which they are constructed. The linguist George Lakoff asserted that "natural reasoning makes use of at least some unconscious and automatic image-based processes such as superimposing images, scanning them, focusing on part of them"⁵⁴ while the psychologist Philip Johnson-Laird proposed that logical reasoning is a matter of scanning visual models.⁵⁵ Such notions would have been impossible before the emergence of television and computer graphics. These visual technologies made operations on images such as scanning, focusing, and superimposition seem natural.

What to make of this modern desire to externalize the mind? It can be related to the demand of modern mass society for standardization. The subjects have to be standardized, and the means by which they are standardized need to be standardized as well. Hence the objectification of internal, private mental processes, and their equation with external visual forms which can be easily manipulated, mass produced, and standardized on its own. The private and individual is translated into the public and becomes regulated.

What before was a mental process, a uniquely individual state, now became part of a public sphere. Unobservable and interior processes and representations were taken out of individual heads and put outside -- as drawings, photographs and other visual forms. Now they could be discussed in public, employed in teaching and propaganda, standardized, and mass-distributed. What was private became public. What was unique became mass-produced. What was hidden in an individual's mind became shared.

Interactive computer media perfectly fits this trend to externalize and objectify mind's operations. The very principle of hyperlinking, which forms the basis of much of interactive media, objectifies the process of association often taken to be central to human thinking. Mental processes of reflection, problem solving, recall and association are externalized, equated with following a link, moving to a new page, choosing a new image, or a new scene. Before we would look at an image and mentally follow our own private associations to other images. Now interactive computer media asks us instead to click on an image in order to go to another image. Before we would read a sentence of a story or a line of a poem and think of other lines, images, memories. Now interactive media asks us to click on a highlighted sentences to go to another sentence. In short, we are asked to follow pre-programmed, objectively existing associations. Put diffidently, in what can be read as a new updated version of French philosopher Louis Althusser's concept of "interpellation," we are asked to mistake the structure of somebody's else mind for our own.⁵⁶

This is a new kind of identification appropriate for the information age of cognitive labor. The cultural technologies of an industrial society -- cinema and fashion -- asked us to identify with somebody's bodily image. The interactive media asks us to identify with somebody's else mental structure. If a cinema viewer, both male and female was lasting after and trying to emulate the body of movie star, a computer user is asked to follow the mental trajectory of a new media designer.

II. The Interface

In 1984 the director of Blade Runner Ridley Scott was hired to create a commercial which introduced Apple Computer's new Macintosh. In retrospect, this event is full of historical significance. Released within two years of each other, Blade Runner (1982) and Macintosh computer (1984) defined the two aesthetics which, twenty years, still rule contemporary culture. One was a futuristic dystopia which combined futurism and decay, computer technology and fetishism, retro-styling and urbanism, Los Angeles and Tokyo. Since Blade Runner release, its techno-noir was replayed in countless films, computer games, novels and other cultural objects. And while a number of strong aesthetic systems have been articulated in the following decades, both by individual artists (Mathew Barney, Mariko Mori) and by commercial culture at large (the 1980s "post-modern" pastiche, the 1990s techno-minimalism), none of them was able to challenge the hold of Blade Runner on our vision of the future.

In contrast to the dark, decayed, "post-modern" vision of Blade Runner, Graphical User Interface (GUI), popularized by Macintosh, remained true to the modernist values of clarity and functionality. The user's screen was ruled by strait lines and rectangular windows which contained smaller rectangles of individual files arranged in a grid. The computer communicated with the user via rectangular boxes containing clean black type rendered against white background. Subsequent versions of GUI added colors and made possible for users to customize the appearance of many interface elements, thus somewhat deluding the sterility and boldness of the original monochrome 1984 version. Yet its original aesthetic survived in the displays of hand-held communicators such as Palm Pilot, cellular telephones, car navigation systems and other consumer electronic products which use small LCD displays comparable in quality to 1984 Macintosh screen.

Like Blade Runner, Macintosh's GUI articulated a vision of the future, although a very different one. In this vision, the lines between human and its technological creations (computers, androids) are clearly drawn and decay is not tolerated. In computer, once a file is created, it never disappears except when explicitly deleted by the user. And even then deleted items can be usually recovered. Thus if in "meatspace" we have to work to remember, in cyberspace we have to work to forget. (Of course while they run, OS and applications constantly create, write to and erase various temporary files, as well as swap data between RAM and virtual memory files on a hard drive, but most of this activity remains invisible to the user.)

Also like Blade Runner, GUI vision also came to influence many other areas of culture. This influence ranges from purely graphical (for instance, use of GUI elements by print and TV designers) to more conceptual. In the 1990s, as the Internet progressively grew in popularity, the role of a digital computer shifted

from being a particular technology (a calculator, a symbol processor, an image manipulator, etc.) to being a filter to all culture, a form through which all kinds of cultural and artistic production is being mediated. As a window of a Web browser comes to replace cinema and television screen, a wall in art gallery, a library and a book, all at once, the new situation manifest itself: all culture, past and present, is being filtered through a computer, with its particular human-computer interface.⁵⁷

In semiotic terms, the computer interface acts as a code which carries cultural messages in a variety of media. When you use the Internet, everything you access — texts, music, video, navigable spaces — passes through the interface of the browser and then, in its turn, the interface of the OS. In cultural communication, a code is rarely simply a neutral transport mechanism; usually it affects the messages transmitted with its help. For instance, it may make some messages easy to conceive and render others unthinkable. A code may also provide its own model of the world, its own logical system, or ideology; subsequent cultural messages or whole languages created using this code will be limited by this model, system or ideology. Most modern cultural theories rely on these notions which I will refer to together as “non-transparency of the code” idea. For instance, according to Whorf-Sapir hypothesis which enjoyed popularity in the middle of the twentieth century, human thinking is determined by the code of natural language; the speakers of different natural languages perceive and think about world differently.⁵⁸ Whorf-Sapir hypothesis is an extreme expression of “non-transparency of the code” idea; usually it is formulated in a less extreme form. But then we think about the case of human-computer interface, applying a “strong” version of this idea makes sense. The interface shapes how the computer user conceives the computer itself. It also determines how users think of any media object accessed via a computer. Stripping different media of their original distinctions, the interface imposes its own logic on them. Finally, by organizing computer data in particular ways, the interface provides distinct models of the world. For instance, a hierarchical file system assumes that the world can be organized in a logical multi-level hierarchy. In contrast, a hypertext model of the World Wide Web models the world as a non-hierarchical system ruled by metonymy. In short, far from being a transparent window into the data inside a computer, the interface bring with it strong messages of its own.

As an example of how the interface imposes its own logic on media, consider “cut and paste” operation, standard in all software running under modern GUI. This operation renders insignificant the traditional distinction between spatial and temporal media, since the user can cut and paste parts of images, regions of space and parts of a temporal composition in exactly the same way. It is also “blind” to traditional distinctions in scale: the user can cut and paste a single pixel, an image, a whole digital movie in the same way. And last, this operation also renders insignificant traditional distinctions between media: “cut

and paste” can be applied to texts, still and moving images, sounds and 3D objects in the same way.

The interface comes to play a crucial role in information society yet in a another way. In this society, not only work and leisure activities increasingly involve computer use, but they also converge around the same interfaces. Both “work” applications (word processors, spreadsheet programs, database programs) and “leisure” applications (computer games, informational DVD) use the same tools and metaphors of GUI. The best example of this convergence is a Web browser employed both in the office and at home, both for work and for play. In this respect information society is quite different from industrial society, with its clear separation between the field of work and the field of leisure. In the nineteenth century Karl Marx imagined that a future communist state would overcome this work-leisure divide as well as the highly specialized and piecemeal character of modern work itself. Marx's ideal citizen would be cutting wood in the morning, gardening in the afternoon and composing music in the evening. Now a subject of information society is engaged in even more activities during a typical day: inputting and analyzing data, running simulations, searching the Internet, playing computer games, watching streaming video, listening to music online, trading stocks, and so on. Yet in performing all these different activities the user in essence is always using the same few tools and commands: a computer screen and a mouse; a Web browser; a search engine; cut, paste, copy, delete and find commands. (In the introduction to “Forms” chapter I will discuss how the two key new forms of new media — database and navigable space — can be also understood in relation to work--leisure opposition.)

If human-computer interface become a key semiotic code of the information society as well as its meta-tool, how does this affect the functioning of cultural objects in general and art objects in particular? As I already noted (“Principles of New Media,” 4.2), in computer culture it becomes common to construct the number of different interfaces to the same “content.” For instance, the same data can be represented as a 2D graph or as an interactive navigable space. Or, a Web site may guide the user to different versions of the site depending on the bandwidth of her Internet connection. (I will elaborate on this in “Database” section where a new media object will be defined as one or more interfaces to a multimedia database.) Given these examples, we may be tempted to think of a new media artwork as also having two separate levels: content and interface. Thus the old dichotomies content — form and content — medium can be re-written as content — interface. But postulating such an opposition assumes that artwork’s content is independent of its medium (in an art historical sense) or its code (in a semiotic sense). Situated in some idealized medium-free realm, content is assumed to exist before its material expression. These assumptions are correct in the case of visualization of quantified data; they also apply to classical art with its well-defined iconographic motives and representational conventions.

But just as modern thinkers, from Whorf to Derrida, insisted on “non-transparency of a code” idea, modern artists assumed that content and form can’t be separated. In fact, from the 1910s “abstraction” to the 1960s “process,” artists keep inventing concepts and procedures to assure that they can’t paint some pre-existent content.

This leaves us with an interesting paradox. Many new media artworks have what can be called “an informational dimension,” the condition which they share with all new media objects. Their experience includes retrieving, looking at and thinking about quantified data. Therefore when we refer to such artworks we are justified in separating the levels of content and interface. At the same time, new media artworks have more traditional “experiential” or aesthetic dimensions, which justifies their status as art rather than as information design. These dimensions include a particular configuration of space, time, and surface articulated in the work; a particular sequence of user’s activities over time to interact with the work; a particular formal, material and phenomenological user experience. And it is the work’s interface that creates its unique materiality and the unique user experience. To change the interface even slightly is to dramatically change the work. From this perspective, to think of an interface as a separate level, as something that can be arbitrary varied is to eliminate the status of a new media artwork as art.

There is another way to think about the difference between new media design and new media art in relation to the content — interface dichotomy. In contrast to design, in art the connection between content and form (or, in the case of new media, content and interface) is motivated. That is, the choice of a particular interface is motivated by work’s content to such degree that it can no longer be thought of as a separate level. Content and interface merge into one entity, and no longer can be taken apart.

Finally, the idea of content pre-existing the interface is challenged in yet another way by new media artworks which dynamically generate their data in real time. While in a menu-based interactive multimedia application or a static Web site all data already exists before the user accesses it, in dynamic new media artworks the data is created on the fly, or, to use the new media lingo, at run time. This can be accomplished in a variety of ways: procedural computer graphics, formal language systems, Artificial Intelligence (AI) and Artificial Life (AL) programming. All these methods share the same principle: a programmer setups some initial conditions, rules or procedures which control the computer program generating the data. For the purposes of the present discussion, the most interesting of these approaches are AL and the evolution paradigm. In AL approach, the interaction between a number of simple objects at run time leads to the emergence of complex global behaviors. These behaviors can only be obtained in the course of running the computer program; they can’t be predicted beforehand. The evolution paradigm applies the metaphor of the evolution theory to the generation of images, shapes, animations and other media data. The initial

data supplied by the programmer acts as a genotype which is expanded into a full phenotype by a computer. In either case, the content of an artwork is the result of a collaboration between the artist/programmer and the computer program, or, if the work is interactive, between the artist, the computer program and the user. New media artists who most systematically explored AL approach is the team of Christa Sommerer and Laurent Mignonneau. In their installation "Life Species" virtual organisms appear and evolve in response to the position, movement and interactions of the visitors. Artist/programmer Karl Sims made the key contribution to applying the evolution paradigm to media generation. In his installation "Galapagos" the computer programs generates twelfth different virtual organisms at every iteration; the visitors select an organism which will continue to leave, copulate, mutate and reproduce.⁵⁹ The commercial products which use AL and evolution approaches are computer games such as Creatures series (Mindscape Entertainment) and "virtual pet" toys such as Tamagochi.

In organizing this book I wanted to highlight the importance of the interface category by placing its discussion right in the beginning. The two sections of this chapter present the examples of different issues raised this category -- but they in no way exhaust it. In "The Language of Cultural Interface" I introduce the term "cultural interfaces" to describe interfaces used by stand-alone hypermedia (CD-ROM and DVD titles), Web sites, computer games and other cultural objects distributed via a computer. I think we need such a term because as the role of a computer is shifting from being a tool to a universal media machine, we are increasingly "interfacing" to predominantly cultural data: texts, photographs, films, music, multimedia documents, virtual environments. Therefore, human-computer interface is being supplemented by human-computer-culture interface, which I abbreviate as "cultural interface." The section then discusses the how the three cultural forms -- cinema, the printed word, and a general-purpose human-computer interface — contributed to shaping the appearance and functionality of cultural interfaces during the 1990s.

The second section "The Screen and the User" discusses the key element of the modern interface — the computer screen. As in the first section, I am interested in analyzing continuities between a computer interface and older cultural forms, languages and conventions. The section positions the computer screen within a longer historical tradition and it traces different stages in the development of this tradition: the static illusionistic image of Renaissance painting; the moving image of film screen, the real-time image of radar and television; and real-time interactive image of a computer screen.

The Language of Cultural Interfaces

Cultural Interfaces

The term human-computer interface (HCI) describes the ways in which the user interacts with a computer. HCI includes physical input and output devices such as a monitor, a keyboard, and a mouse. It also consists of metaphors used to conceptualize the organization of computer data. For instance, the Macintosh interface introduced by Apple in 1984 uses the metaphor of files and folders arranged on a desktop. Finally, HCI also includes ways of manipulating this data, i.e. a grammar of meaningful actions which the user can perform on it. The example of actions provided by modern HCI are copy, rename and delete file; list the contents of a directory; start and stop a computer program; set computer's date and time.

The term HCI was coined when computer was mostly used as a tool for work. However, during the 1990s, the identity of computer has changed. In the beginning of the decade, a computer was still largely thought of as a simulation of a typewriter, a paintbrush or a drafting ruler -- in other words, as a tool used to produce cultural content which, once created, will be stored and distributed in its appropriate media: printed page, film, photographic print, electronic recording. By the end of the decade, as Internet use became commonplace, the computer's public image was no longer that of tool but also that a universal media machine, used not only to author, but also to store, distribute and access all media.

As distribution of all forms of culture becomes computer-based, we are increasingly "interfacing" to predominantly cultural data: texts, photographs, films, music, virtual environments. In short, we are no longer interfacing to a computer but to culture encoded in digital form. I will use the term "cultural interfaces" to describe human-computer-culture interface: the ways in which computers present and allows us to interact with cultural data. Cultural interfaces include the interfaces used by the designers of Web sites, CD-ROM and DVD titles, multimedia encyclopedias, online museums and magazines, computer games and other new media cultural objects.

If you need to remind yourself what a typical cultural interface looked in the second part of the 1990s, say 1997, go back in time and click to a random Web page. You are likely to see something which graphically resembles a magazine layout from the same decade. The page is dominated by text: headlines, hyperlinks, blocks of copy. Within this text are few media elements: graphics, photographs, perhaps a QuickTime movie and a VRML scene. The page also includes radio buttons and a pull-down menu which allows you to choose an item from the list. Finally there is a search engine: type a word or a phrase, hit the

search button and the computer will scan through a file or a database trying to match your entry.

For another example of a prototypical cultural interface of the 1990s, you may load (assuming it would still run on your computer) the most well-known CD-ROM of the 1990s — Myst (Broderbund, 1993). Its opening clearly recalls a movie: credits slowly scroll across the screen, accompanied by a movie-like soundtrack to set the mood. Next, the computer screen shows a book open in the middle, waiting for your mouse click. Next, an element of a familiar Macintosh interface makes an appearance, reminding you that along with being a new movie/book hybrid, Myst is also a computer application: you can adjust sound volume and graphics quality by selecting from a usual Macintosh-style menu in the upper top part of the screen. Finally, you are taken inside the game, where the interplay between the printed word and cinema continue. A virtual camera frames images of an island which dissolve between each other. At the same time, you keep encountering books and letters, which take over the screen, providing with you with clues on how to progress in the game.

Given that computer media is simply a set of characters and numbers stored in a computer, there are numerous ways in which it could be presented to a user. Yet, as it always happens with cultural languages, only a few of these possibilities actually appear viable in a given historical moment. Just as early fifteenth century Italian painters could only conceive of painting in a very particular way — quite different from, say, sixteenth century Dutch painters — today's digital designers and artists use a small set of action grammars and metaphors out of a much larger set of all possibilities.

Why do cultural interfaces — Web pages, CD-ROM titles, computer games — look the way they do? Why do designers organize computer data in certain ways and not in others? Why do they employ some interface metaphors and not others?

My theory is that the language of cultural interfaces is largely made up from the elements of other, already familiar cultural forms. In the following I will explore the contributions of three such forms to this language during its first decades -- the 1990s. The three forms which I will focus make their appearance in the opening sequence of the already discussed prototypical new media object of the 1990s — Myst. Its opening activates them before our eyes, one by one. The first form is cinema. The second form is the printed word. The third form is a general-purpose human-computer interface (HCI).

As it should become clear from the following, I use words "cinema" and "printed word" as shortcuts. They stand not for particular objects, such as a film or a novel, but rather for larger cultural traditions (we can also use such words as cultural forms, mechanisms, languages or media). "Cinema" thus includes mobile camera, representation of space, editing techniques, narrative conventions, activity of a spectator -- in short, different elements of cinematic perception, language and reception. Their presence is not limited to the twentieth-century

institution of fiction films, they can be already found in panoramas, magic lantern slides, theater and other nineteenth-century cultural forms; similarly, since the middle of the twentieth century, they are present not only in films but also in television and video programs. In the case of the "printed word" I am also referring to a set of conventions which have developed over many centuries (some even before the invention of print) and which today are shared by numerous forms of printed matter, from magazines to instruction manuals: a rectangular page containing one or more columns of text; illustrations or other graphics framed by the text; pages which follow each sequentially; a table of contents and index.

Modern human-computer interface has a much shorter history than the printed word or cinema -- but it is still a history. Its principles such as direct manipulation of objects on the screen, overlapping windows, iconic representation, and dynamic menus were gradually developed over a few decades, from the early 1950s to the early 1980s, when they finally appeared in commercial systems such as Xerox Star (1981), the Apple Lisa (1982), and most importantly the Apple Macintosh (1984).⁶⁰ Since then, they have become an accepted convention for operating a computer, and a cultural language in their own right.

Cinema, the printed word and human-computer interface: each of these traditions has developed its own unique ways of how information is organized, how it is presented to the user, how space and time are correlated with each other, how human experience is being structured in the process of accessing information. Pages of text and a table of contents; 3D spaces framed by a rectangular frame which can be navigated using a mobile point of view; hierarchical menus, variables, parameters, copy/paste and search/replace operations -- these and other elements of these three traditions are shaping cultural interfaces today. Cinema, the printed word and HCI: they are the three main reservoirs of metaphors and strategies for organizing information which feed cultural interfaces.

Bringing cinema, the printed word and HCI interface together and treating them as occupying the same conceptual plane has an additional advantage -- a theoretical bonus. It is only natural to think of them as belonging to two different kind of cultural species, so to speak. If HCI is a general purpose tool which can be used to manipulate any kind of data, both the printed word and cinema are less general. They offer ways to organize particular types of data: text in the case of print, audio-visual narrative taking place in a 3D space in the case of cinema. HCI is a system of controls to operate a machine; the printed word and cinema are cultural traditions, distinct ways to record human memory and human experience, mechanisms for cultural and social exchange of information. Bringing HCI, the printed word and cinema together allows us to see that the three have more in common than we may anticipate at first. On the one hand, being a part of our culture now for half a century, HCI already represents a powerful cultural

tradition, a cultural language offering its own ways to represent human memory and human experience. This language speaks in the form of discrete objects organized in hierarchies (hierarchical file system), or as catalogs (databases), or as objects linked together through hyperlinks (hypermedia). On the other hand, we begin to see that the printed word and cinema also can be thought of as interfaces, even though historically they have been tied to particular kinds of data. Each has its own grammar of actions, each comes with its own metaphors, each offers a particular physical interface. A book or a magazine is a solid object consisting from separate pages; the actions include going from page to page linearly, marking individual pages and using table of contents. In the case of cinema, its physical interface is a particular architectural arrangement of a movie theater; its metaphor is a window opening up into a virtual 3D space.

Today, as media is being "liberated" from its traditional physical storage media — paper, film, stone, glass, magnetic tape — the elements of printed word interface and cinema interface, which previously were hardwired to the content, become "liberated" as well. A digital designer can freely mix pages and virtual cameras, table of contents and screens, bookmarks and points of view. No longer embedded within particular texts and films, these organizational strategies are now free floating in our culture, available for use in new contexts. In this respect, printed word and cinema have indeed become interfaces -- rich sets of metaphors, ways of navigating through content, ways of accessing and storing data. For a computer user, both conceptually and psychologically, their elements exist on the same plane as radio buttons, pull-down menus, command line calls and other elements of standard human-computer interface.

Let us now discuss some of the elements of these three cultural traditions - - cinema, the printed word and HCI -- to see how they have shaped the language of cultural interfaces.

Printed Word

In the 1980's, as PCs and word processing software became commonplace, text became the first cultural media to be subjected to digitization in a massive way. But already in the 1960's, two and a half decades before the concept of digital media was born, researchers were thinking about having the sum total of human written production -- books, encyclopedias, technical articles, works of fiction and so on -- available online (Ted Nelson's Xanadu project⁶¹).

Text is unique among other media types. It plays a privileged role in computer culture. On the one hand, it is one media type among others. But, on the other hand, it is a meta-language of computer media, a code in which all other media are represented: coordinates of 3D objects, pixel values of digital images, the formatting of a page in HTML. It is also the primary means of communication

between a computer and a user: one types single line commands or runs computer programs written in a subset of English; the other responds by displaying error codes or text messages.⁶²

If a computer uses text as its meta-language, cultural interfaces in their turn inherit the principles of text organization developed by human civilization throughout its existence. One of these is a page: a rectangular surface containing a limited amount of information, designed to be accessed in some order, and having a particular relationship to other pages. In its modern form, the page is born in the first centuries of the Christian era when the clay tablets and papyrus rolls are replaced by a codex — the collection of written pages stitched together on one side.

Cultural interfaces rely on our familiarity with the "page interface" while also trying to stretch its definition to include new concepts made possible by a computer. In 1984, Apple introduced a graphical user interface which presented information in overlapping windows stacked behind one another — essentially, a set of book pages. The user was given the ability to go back and forth between these pages, as well as to scroll through individual pages. In this way, a traditional page was redefined as a virtual page, a surface which can be much larger than the limited surface of a computer screen. In 1987, Apple shipped popular Hypercard program which extended the page concept in new ways. Now the users were able to include multimedia elements within the pages, as well as to establish links between pages regardless of their ordering. A few years later, designers of HTML stretched the concept of a page even more by enabling the creation of distributed documents, where different parts of a document are located on different computers connected through the network. With this development, a long process of gradual "virtualization" of the page reached a new stage. Messages written on clay tablets, which were almost indestructible, were replaced by ink on paper. Ink, in its turn, was replaced by bits of computer memory, making characters on an electronic screen. Now, with HTML, which allows parts of a single page to be located on different computers, the page became even more fluid and unstable.

The conceptual development of the page in computer media can also be read in a different way — not as a further development of a codex form, but as a return to earlier forms such as the papyrus roll of ancient Egypt, Greece and Rome. Scrolling through the contents of a computer window or a World Wide Web page has more in common with unrolling than turning the pages of a modern book. In the case of the Web of the 1990s, the similarity with a roll is even stronger because the information is not available all at once, but arrives sequentially, top to bottom, as though the roll is being unrolled.

A good example of how cultural interfaces stretch the definition of a page while mixing together its different historical forms is the Web page created in 1997 by the British design collective antirom for HotWired RGB Gallery.⁶³ The designers have created a large surface containing rectangular blocks of texts in

different font sizes, arranged without any apparent order. The user is invited to skip from one block to another moving in any direction. Here, the different directions of reading used in different cultures are combined together in a single page.

By the mid 1990's, Web pages included a variety of media types — but they were still essentially traditional pages. Different media elements — graphics, photographs, digital video, sound and 3D worlds — were embedded within rectangular surfaces containing text. To that extent a typical Web page was conceptually similar to a newspaper page which is also dominated by text, with photographs, drawings, tables and graphs embedded in between, along with links to other pages of the newspaper. VRML evangelists wanted to overturn this hierarchy by imaging the future in which the World Wide Web is rendered as a giant 3D space, with all the other media types, including text, existing within it.⁶⁴ Given that the history of a page stretches for thousands of years, I think it is unlikely that it would disappear so quickly.

As Web page became a new cultural convention of its own, its dominance was challenged by two Web browsers created by artists — Web Stalker (1997) by I/O/D collective⁶⁵ and Netomat (1999) by Maciej Wisniewski.⁶⁶ Web Stalker emphasizes the hypertextual nature of the Web. Instead of rendering standard Web pages, it renders the networks of hyperlinks these pages embody. When a user enters a URL for a particular page, Web Stalker displays all pages linked to this page as a line graph. Netomat similarly refuses the page convention of the Web. The user enters a word or a phrase which are passed to search engines. Netomat then extracts page titles, images, audio or any other media type, as specified by the user, from the found pages and floats them across the computer screen. As can be seen, both browsers refuse the page metaphor, instead substituting their own metaphors: a graph showing the structure of links in the case of Web Stalker, a flow of media elements in the case of Netomat.

While the 1990's Web browsers and other commercial cultural interfaces have retained the modern page format, they also have come to rely on a new way of organizing and accessing texts which has little precedent within book tradition — hyperlinking. We may be tempted to trace hyperlinking to earlier forms and practices of non-sequential text organization, such as the Torah's interpretations and footnotes, but it is actually fundamentally different from them. Both the Torah's interpretations and footnotes imply a master-slave relationship between one text and another. But in the case of hyperlinking as implemented by HTML and earlier by Hypercard, no such relationship of hierarchy is assumed. The two sources connected through a hyperlink have an equal weight; neither one dominates the other. Thus the acceptance of hyperlinking in the 1980's can be correlated with contemporary culture's suspicion of all hierarchies, and preference for the aesthetics of collage where radically different sources are brought together within the singular cultural object ("post-modernism").

Traditionally, texts encoded human knowledge and memory, instructed, inspired, convinced and seduced their readers to adopt new ideas, new ways of interpreting the world, new ideologies. In short, the printed word was linked to the art of rhetoric. While it is probably possible to invent a new rhetoric of hypermedia, which will use hyperlinking not to distract the reader from the argument (as it is often the case today), but instead to further convince her of argument's validity, the sheer existence and popularity of hyperlinking exemplifies the continuing decline of the field of rhetoric in the modern era. Ancient and Medieval scholars have classified hundreds of different rhetorical figures. In the middle of the twentieth century linguist Roman Jakobson, under the influence of computer's binary logic, information theory and cybernetics to which he was exposed at MIT where he was teaching, radically reduced rhetoric to just two figures: metaphor and metonymy.⁶⁷ Finally, in the 1990's, the World Wide Web hyperlinking has privileged the single figure of metonymy at the expense of all others.⁶⁸ The hypertext of the World Wide Web leads the reader from one text to another, ad infinitum. Contrary to the popular image, in which computer media collapses all human culture into a single giant library (which implies the existence of some ordering system), or a single giant book (which implies a narrative progression), it maybe more accurate to think of the new media culture as an infinite flat surface where individual texts are placed in no particular order, like the Web page designed by antirom for HotWired. Expanding this comparison further, we can note that Random Access Memory, the concept behind the group's name, also implies the lack of hierarchy: any RAM location can be accessed as quickly as any other. In contrast to the older storage media of book, film, and magnetic tape, where data is organized sequentially and linearly, thus suggesting the presence of a narrative or a rhetorical trajectory, RAM "flattens" the data. Rather than seducing the user through the careful arrangement of arguments and examples, points and counterpoints, changing rhythms of presentation (i.e., the rate of data streaming, to use contemporary language), simulated false paths and dramatically presented conceptual breakthroughs, cultural interfaces, like RAM itself, bombards the users with all the data at once.⁶⁹

In the 1980's many critics have described one of key's effects of "post-modernism" as that of spatialization: privileging space over time, flattening historical time, refusing grand narratives. Computer media, which has evolved during the same decade, accomplished this spatialization quite literally. It replaced sequential storage with random-access storage; hierarchical organization of information with a flattened hypertext; psychological movement of narrative in novel and cinema with physical movement through space, as witnessed by endless computer animated fly-throughs or computer games such as Myst, Doom and countless others (see "Navigable Space.") In short, time becomes a flat image or a landscape, something to look at or navigate through. If there is a new rhetoric or

aesthetic which is possible here, it may have less to do with the ordering of time by a writer or an orator, and more with spatial wandering. The hypertext reader is like Robinson Crusoe, walking through the sand and water, picking up a navigation journal, a rotten fruit, an instrument whose purpose he does not know; leaving imprints in the sand, which, like computer hyperlinks, follow from one found object to another.

Cinema

Printed word tradition which has initially dominated the language of cultural interfaces, is becoming less important, while the part played by cinematic elements is getting progressively stronger. This is consistent with a general trend in modern society towards presenting more and more information in the form of time-based audio-visual moving image sequences, rather than as text. As new generations of both computer users and computer designers are growing up in a media-rich environment dominated by television rather than by printed texts, it is not surprising that they favor cinematic language over the language of print.

A hundred years after cinema's birth, cinematic ways of seeing the world, of structuring time, of narrating a story, of linking one experience to the next, are being extended to become the basic ways in which computer users access and interact with all cultural data. In this way, the computer fulfills the promise of cinema as a visual Esperanto which pre-occupied many film artists and critics in the 1920s, from Griffith to Vertov. Indeed, millions of computer users communicate with each other through the same computer interface. And, in contrast to cinema where most of its "users" were able to "understand" cinematic language but not "speak" it (i.e., make films), all computer users can "speak" the language of the interface. They are active users of the interface, employing it to perform many tasks: send email, organize their files, run various applications, and so on.

The original Esperanto never became truly popular. But cultural interfaces are widely used and are easily learned. We have an unprecedented situation in the history of cultural languages: something which is designed by a rather small group of people is immediately adopted by millions of computer users. How is it possible that people around the world adopt today something which a 20-something programmer in Northern California has hacked together just the night before? Shall we conclude that we are somehow biologically "wired" to the interface language, the way we are "wired," according to the original hypothesis of Noam Chomsky, to different natural languages?

The answer is of course no. Users are able to "acquire" new cultural languages, be it cinema a hundred years ago, or cultural interfaces today, because these languages are based on previous and already familiar cultural forms. In the

case of cinema, it was theater, magic lantern shows and other nineteenth century forms of public entertainment. Cultural interfaces in their turn draw on older cultural forms such as the printed word and cinema. I have already discussed some ways in which the printed word tradition structures interface language; now it is cinema's turn.

I will begin with probably the most important case of cinema's influence on cultural interfaces — the mobile camera. Originally developed as part of 3D computer graphics technology for such applications as computer-aided design, flight simulators and computer movie making, during the 1980's and 1990's the camera model became as much of an interface convention as scrollable windows or cut and paste operations. It became an accepted way for interacting with any data which is represented in three dimensions — which, in a computer culture, means literally anything and everything: the results of a physical simulation, an architectural site, design of a new molecule, statistical data, the structure of a computer network and so on. As computer culture is gradually spatializing all representations and experiences, they become subjected to the camera's particular grammar of data access. Zoom, tilt, pan and track: we now use these operations to interact with data spaces, models, objects and bodies.

Abstracted from its historical temporary "imprisonment" within the physical body of a movie camera directed at physical reality, a virtualized camera also becomes an interface to all types of media and information beside 3D space. As an example, consider GUI of the leading computer animation software — PowerAnimator from Alias/Wavefront.⁷⁰ In this interface, each window, regardless of whether it displays a 3D model, a graph or even plain text, contains Dolly, Track and Zoom buttons. It is particularly important that the user is expected to dolly and pan over text as if it was a 3D scene. In this interface, cinematic vision triumphed over the print tradition, with the camera subsuming the page. The Gutenberg galaxy turned out to be just a subset of the Lumières' universe.

Another feature of cinematic perception which persists in cultural interfaces is a rectangular framing of represented reality.⁷¹ Cinema itself inherited this framing from Western painting. Since the Renaissance, the frame acted as a window onto a larger space which was assumed to extend beyond the frame. This space was cut by the frame's rectangle into two parts: "onscreen space," the part which is inside the frame, and the part which is outside. In the famous formulation of Leon-Battista Alberti, the frame acted as a window onto the world. Or, in a more recent formulation of French film theorist Jacques Aumont and his co-authors, "The onscreen space is habitually perceived as included within a more vast scenographic space. Even though the onscreen space is the only visible part, this larger scenographic part is nonetheless considered to exist around it."⁷²

Just as a rectangular frame of painting and photography presents a part of a larger space outside it, a window in HCI presents a partial view of a larger document. But if in painting (and later in photography), the framing chosen by an artist was final, computer interface benefits from a new invention introduced by cinema: the mobility of the frame. As a kino-eye moves around the space revealing its different regions, so can a computer user scroll through a window's contents.

It is not surprising to see that screen-based interactive 3D environments, such as VRML worlds, also use cinema's rectangular framing since they rely on other elements of cinematic vision, specifically a mobile virtual camera. It may be more surprising to realize that Virtual Reality (VR) interface, often promoted as the most "natural" interface of all, utilizes the same framing.⁷³ As in cinema, the world presented to a VR user is cut by a rectangular frame. As in cinema, this frame presents a partial view of a larger space.⁷⁴ As in cinema, the virtual camera moves around to reveal different parts of this space.

Of course, the camera is now controlled by the user and in fact is identified with his/her own sight. Yet, it is crucial that in VR one is seeing the virtual world through a rectangular frame, and that this frame always presents only a part of a larger whole. This frame creates a distinct subjective experience which is much more close to cinematic perception than to unmediated sight.

Interactive virtual worlds, whether accessed through a screen-based or a VR interface, are often discussed as the logical successor to cinema, as potentially the key cultural form of the twenty-first century, just as cinema was the key cultural form of the twentieth century. These discussions usually focus on the issues of interaction and narrative. So, the typical scenario for twenty-first century cinema involves a user represented as an avatar existing literally "inside" the narrative space, rendered with photorealistic 3D computer graphics, interacting with virtual characters and perhaps other users, and affecting the course of narrative events.

It is an open question whether this and similar scenarios commonly invoked in new media discussions of the 1990's, indeed represent an extension of cinema or if they rather should be thought of as a continuation of some theatrical traditions, such as improvisational or avant-garde theater. But what undoubtedly can be observed in the 1990's is how virtual technology's dependence on cinema's mode of seeing and language is becoming progressively stronger. This coincides with the move from proprietary and expensive VR systems to more widely available and standardized technologies, such as VRML (Virtual Reality Modeling Language). (The following examples refer to a particular VRML browser — WebSpace Navigator 1.1 from SGI.⁷⁵ Other VRML browsers have similar features.)

The creator of a VRML world can define a number of viewpoints which are loaded with the world.⁷⁶ These viewpoints automatically appear in a special menu in a VRML browser which allows the user to step through them, one by one. Just as in cinema, ontology is coupled with epistemology: the world is designed to be viewed from particular points of view. The designer of a virtual world is thus a cinematographer as well as an architect. The user can wander around the world or she can save time by assuming the familiar position of a cinema viewer for whom the cinematographer has already chosen the best viewpoints.

Equally interesting is another option which controls how a VRML browser moves from one viewpoint to the next. By default, the virtual camera smoothly travels through space from the current viewpoint to the next as though on a dolly, its movement automatically calculated by the software. Selecting the "jump cuts" option makes it cut from one view to the next. Both modes are obviously derived from cinema. Both are more efficient than trying to explore the world on its own.

With a VRML interface, nature is firmly subsumed under culture. The eye is subordinated to the kino-eye. The body is subordinated to a virtual body of a virtual camera. While the user can investigate the world on her own, freely selecting trajectories and viewpoints, the interface privileges cinematic perception — cuts, pre-computed dolly-like smooth motions of a virtual camera, and pre-selected viewpoints.

The area of computer culture where cinematic interface is being transformed into a cultural interface most aggressively is computer games. By the 1990's, game designers have moved from two to three dimensions and have begun to incorporate cinematic language in an increasingly systematic fashion. Games started featuring lavish opening cinematic sequences (called in the game business "cinematics") to set the mood, establish the setting and introduce the narrative. Frequently, the whole game would be structured as an oscillation between interactive fragments requiring user's input and non-interactive cinematic sequences, i.e. "cinematics." As the decade progressed, game designers were creating increasingly complex — and increasingly cinematic — interactive virtual worlds. Regardless of a game's genre — action/adventure, fighting, flight simulator, first-person action, racing or simulation — they came to rely on cinematography techniques borrowed from traditional cinema, including the expressive use of camera angles and depth of field, and dramatic lighting of 3D computer generated sets to create mood and atmosphere. In the beginning of the decade, many games such as The 7th Guest (Trilobyte, 1993) or Voyeur (1994) or used digital video of actors superimposed over 2D or 3D backgrounds, but by its end they switched to fully synthetic characters rendered in real time.⁷⁷ This switch allowed game designers to go beyond branching-type structure of earlier games based on digital video where all the possible scenes had to be taped beforehand. In contrast, 3D characters animated in real time move arbitrary

around the space, and the space itself can change during the game. (For instance, when a player returns to the already visited area, she will find any objects she left there earlier.) This switch also made virtual worlds more cinematic, as the characters could be better visually integrated with their environments.⁷⁸

A particularly important example of how computer games use — and extend — cinematic language, is their implementation of a dynamic point of view. In driving and flying simulators and in combat games, such as Tekken 2 (Namco, 1994 -), after a certain event takes place (car crashes, a fighter being knocked down), it is automatically replayed from a different point of view. Other games such as the Doom series (Id Software, 1993 -) and Dungeon Keeper (Bullfrog Productions, 1997) allow the user to switch between the point of view of the hero and a top down "bird's eye" view. The designers of online virtual worlds such as Active Worlds provide their users with similar capabilities. Finally, Nintendo went even further by dedicating four buttons on their N64 joystick to controlling the view of the action. While playing Nintendo games such as Super Mario 64 (Nintendo, 1996) the user can continuously adjust the position of the camera. Some Sony Playstation games such as Tomb Rider (Eidos, 1996) also use the buttons on the Playstation joystick for changing point of view. Some games such as Myth: The Fallen Lords (Bungie, 1997) go further, using an AI engine (computer code which controls the simulated "life" in the game, such as human characters the player encounters) to automatically control their camera.

The incorporation of virtual camera controls into the very hardware of a game console is truly a historical event. Directing the virtual camera becomes as important as controlling the hero's actions. This is admitted by the game industry itself. For instance, a package for Dungeon Keeper lists four key features of the game, out of which the first two concern control over the camera: "switch your perspective," "rotate your view," "take on your friend," "unveil hidden levels." In games such as this one, cinematic perception functions as the subject in its own right.⁷⁹ Here, the computer games are returning to "The New Vision" movement of the 1920s (Moholy-Nagy, Rodchenko, Vertov and others), which foregrounded new mobility of a photo and film camera, and made unconventional points of view the key part of their poetics.

The fact that computer games and virtual worlds continue to encode, step by step, the grammar of a kino-eye in software and in hardware is not an accident. This encoding is consistent with the overall trajectory driving the computerization of culture since the 1940's, that being the automation of all cultural operations. This automation gradually moves from basic to more complex operations: from image processing and spell checking to software-generated characters, 3D worlds, and Web Sites. The side effect of this automation is that once particular cultural codes are implemented in low-level software and hardware, they are no longer seen as choices but as unquestionable defaults. To take the automation of imaging as an example, in the early 1960's the newly emerging field of computer graphics

incorporated a linear one-point perspective in 3D software, and later directly in hardware.⁸⁰ As a result, linear perspective became the default mode of vision in computer culture, be it computer animation, computer games, visualization or VRML worlds. Now we are witnessing the next stage of this process: the translation of cinematic grammar of points of view into software and hardware. As Hollywood cinematography is translated into algorithms and computer chips, its convention becomes the default method of interacting with any data subjected to spatialization, with a narrative, and with other human beings. (At SIGGRAPH '97 in Los Angeles, one of the presenters called for the incorporation of Hollywood-style editing in multi-user virtual worlds software. In such implementation, user interaction with other avatar(s) will be automatically rendered using classical Hollywood conventions for filming dialog.⁸¹) To use the terms from the 1996 paper authored by Microsoft researchers and entitled "The Virtual Cinematographer: A Paradigm for Automatic Real-Time Camera Control and Directing," the goal of research is to encode "cinematographic expertise," translating "heuristics of filmmaking" into computer software and hardware.⁸² Element by element, cinema is being poured into a computer: first one-point linear perspective; next the mobile camera and a rectangular window; next cinematography and editing conventions, and, of course, digital personas also based on acting conventions borrowed from cinema, to be followed by make-up, set design, and the narrative structures themselves. From one cultural language among others, cinema is becoming the cultural interface, a toolbox for all cultural communication, overtaking the printed word.

Cinema, the major cultural form of the twentieth century, has found a new life as the toolbox of a computer user. Cinematic means of perception, of connecting space and time, of representing human memory, thinking, and emotions become a way of work and a way of life for millions in the computer age. Cinema's aesthetic strategies have become basic organizational principles of computer software. The window in a fictional world of a cinematic narrative has become a window in a datascape. In short, what was cinema has become human-computer interface.

I will conclude this section by discussing a few artistic projects which, in different ways, offer alternatives to this trajectory. To summarize it once again, the trajectory involves gradual translation of elements and techniques of cinematic perception and language into a de-contextualized set of tools to be used as an interface to any data. In the process of this translation, cinematic perception is divorced from its original material embodiment (camera, film stock), as well as from the historical contexts of its formation. If in cinema the camera functioned as a material object, co-existing, spatially and temporally, with the world it was showing us, it has now become a set of abstract operations. The art projects described below refuse this separation of cinematic vision from the material

world. They reunite perception and material reality by making the camera and what it records a part of a virtual world's ontology. They also refuse the universalization of cinematic vision by computer culture, which (just as post-modern visual culture in general) treats cinema as a toolbox, a set of "filters" which can be used to process any input. In contrast, each of these projects employs a unique cinematic strategy which has a specific relation to the particular virtual world it reveals to the user.

In The Invisible Shape of Things Past Joachim Sauter and Dirk Lüssenbrink of the Berlin-based Art+Com collective created a truly innovative cultural interface for accessing historical data about Berlin's history.⁸³ The interface de-virtualizes cinema, so to speak, by placing the records of cinematic vision back into their historical and material context. As the user navigates through a 3D model of Berlin, he or she comes across elongated shapes lying on city streets. These shapes, which the authors call "filmobjects", correspond to documentary footage recorded at the corresponding points in the city. To create each shape the original footage is digitized and the frames are stacked one after another in depth, with the original camera parameters determining the exact shape. The user can view the footage by clicking on the first frame. As the frames are displayed one after another, the shape is getting correspondingly thinner.

In following with the already noted general trend of computer culture towards spatialization of every cultural experience, this cultural interface spatializes time, representing it as a shape in a 3D space. This shape can be thought of as a book, with individual frames stacked one after another as book pages. The trajectory through time and space taken by a camera becomes a book to be read, page by page. The records of camera's vision become material objects, sharing the space with the material reality which gave rise to this vision. Cinema is solidified. This project, then, can be also understood as a virtual monument to cinema. The (virtual) shapes situated around the (virtual) city, remind us about the era when cinema was the defining form of cultural expression — as opposed to a toolbox for data retrieval and use, as it is becoming today in a computer.

Hungarian-born artist Tamás Waliczky openly refuses the default mode of vision imposed by computer software, that of the one-point linear perspective. Each of his computer animated films The Garden (1992), The Forest (1993) and The Way (1994) utilizes a particular perspectival system: a water-drop perspective in The Garden, a cylindrical perspective in The Forest and a reverse perspective in The Way. Working with computer programmers, the artist created custom-made 3D software to implement these perspectival systems. Each of the systems has an inherent relationship to the subject of a film in which it is used. In The Garden, its subject is the perspective of a small child, for whom the world does not yet have an objective existence. In The Forest, the mental trauma of emigration is transformed into the endless roaming of a camera through the forest which is actually just a set of transparent cylinders. Finally, in The Way, the self-

sufficiency and isolation of a Western subject are conveyed by the use of a reverse perspective.

In Waliczky's films the camera and the world are made into a single whole, whereas in The Invisible Shape of Things Past the records of the camera are placed back into the world. Rather than simply subjecting his virtual worlds to different types of perspectival projection, Waliczky modified the spatial structure of the worlds themselves. In The Garden, a child playing in a garden becomes the center of the world; as he moves around, the actual geometry of all the objects around him is transformed, with objects getting bigger as he gets close to him. To create The Forest, a number of cylinders were placed inside each other, each cylinder mapped with a picture of a tree, repeated a number of times. In the film, we see a camera moving through this endless static forest in a complex spatial trajectory — but this is an illusion. In reality, the camera does move, but the architecture of the world is constantly changing as well, because each cylinder is rotating at its own speed. As a result, the world and its perception are fused together.

HCI: Representation versus Control

The development of human-computer interface, until recently, had little to do with distribution of cultural objects. Following some of the main applications from the 1940's until the early 1980's, when the current generation of GUI was developed and reached the mass market together with the rise of a PC (personal computer), we can list the most significant: real-time control of weapons and weapon systems; scientific simulation; computer-aided design; finally, office work with a secretary as a prototypical computer user, filing documents in a folder, emptying a trash can, creating and editing documents ("word processing"). Today, as the computer is starting to host very different applications for access and manipulation of cultural data and cultural experiences, their interfaces still rely on old metaphors and action grammars. Thus, cultural interfaces predictably use elements of a general-purpose HCI such as scrollable windows containing text and other data types, hierarchical menus, dialogue boxes, and command-line input. For instance, a typical "art collection" CD-ROM may try to recreate "the museum experience" by presenting a navigable 3D rendering of a museum space, while still resorting to hierarchical menus to allow the user to switch between different museum collections. Even in the case of The Invisible Shape of Things Past which uses a unique interface solution of "filmobjects" which is not directly traceable to either old cultural forms or general-purpose HCI, the designers are still relying on HCI convention in one case — the use of a pull-down menu to switch between different maps of Berlin.

In their important study of new media Remediation, Jay David Bolter and Richard Grusin define medium as “that which remediates.”⁸⁴ In contrast to a modernist view aims to define the essential properties of every medium, Bolter and Grusin propose that all media work by “remediating,” i.e. translating, refashioning, and reforming other media, both on the levels of content and form. If we are to think of human-computer interface as another media, its history and present development definitely fits this thesis. The history of human-computer interface is that of borrowing and reformulating, or, to use new media lingo, reformatting other media, both past and present: the printed page, film, television. But along with borrowing conventions of most other media and eclectically combining them together, HCI designers also heavily borrowed “conventions” of human-made physical environment, beginning with Macintosh use of desktop metaphor. And, more than an media before it, HCI is like a chameleon which keeps changing its appearance, responding to how computers are used in any given period. For instance, if in the 1970s the designers at Xerox Park modeled the first GUI on the office desk, because they imagined that the computer were designing will be used in the office, in the 1990s the primary use of computers as media access machine led to the borrowing of interfaces of already familiar media devices, such as VCR or audio CD player controls.

In general, cultural interfaces of the 1990's try to walk an uneasy path between the richness of control provided in general-purpose HCI and an "immersive" experience of traditional cultural objects such as books and movies. Modern general-purpose HCI, be it MAC OS, Windows or UNIX, allow their users to perform complex and detailed actions on computer data: get information about an object, copy it, move it to another location, change the way data is displayed, etc. In contrast, a conventional book or a film positions the user inside the imaginary universe whose structure is fixed by the author. Cultural interfaces attempt to mediate between these two fundamentally different and ultimately non-compatible approaches.

As an example, consider how cultural interfaces conceptualize the computer screen. If a general-purpose HCI clearly identifies to the user that certain objects can be acted on while others cannot (icons representing files but not the desktop itself), cultural interfaces typically hide the hyperlinks within a continuous representational field. (This technique was already so widely accepted by the 1990's that the designers of HTML offered it early on to the users by implementing the "imagemap" feature). The field can be a two-dimensional collage of different images, a mixture of representational elements and abstract textures, or a single image of a space such as a city street or a landscape. By trial and error, clicking all over the field, the user discovers that some parts of this field are hyperlinks. This concept of a screen combines two distinct pictorial conventions: the older Western tradition of pictorial illusionism in which a screen functions as a window into a virtual space, something for the viewer to look into

but not to act upon; and the more recent convention of graphical human-computer interfaces which, by dividing the computer screen into a set of controls with clearly delineated functions, essentially treats it as a virtual instrument panel. As a result, the computer screen becomes a battlefield for a number of incompatible definitions: depth and surface, opaqueness and transparency, image as an illusionary space and image as an instrument for action.

The computer screen also functions both as a window into an illusionary space and as a flat surface carrying text labels and graphical icons. We can relate this to a similar understanding of a pictorial surface in the Dutch art of the seventeenth century, as analyzed by art historian Svetlana Alpers in her classical The Art of Describing. Alpers discusses how a Dutch painting of this period functioned as a combined map / picture, combining different kinds of information and knowledge of the world.⁸⁵

Here is another example of how cultural interfaces try to find a middle ground between the conventions of general-purpose HCI and the conventions of traditional cultural forms. Again we encounter tension and struggle — in this case, between standardization and originality. One of the main principles of modern HCI is consistency principle. It dictates that menus, icons, dialogue boxes and other interface elements should be the same in different applications. The user knows that every application will contain a "file" menu, or that if she encounters an icon which looks like a magnifying glass it can be used to zoom on documents. In contrast, modern culture (including its "post-modern" stage) stresses originality: every cultural object is supposed to be different from the rest, and if it is quoting other objects, these quotes have to be defined as such. Cultural interfaces try to accommodate both the demand for consistency and the demand for originality. Most of them contain the same set of interface elements with standard semantics, such as "home," "forward" and "backward" icons. But because every Web site and CD-ROM is striving to have its own distinct design, these elements are always designed differently from one product to the next. For instance, many games such as War Craft II (Blizzard Entertainment, 1996) and Dungeon Keeper give their icons a "historical" look consistent with the mood of an imaginary universe portrayed in the game.

The language of cultural interfaces is a hybrid. It is a strange, often awkward mix between the conventions of traditional cultural forms and the conventions of HCI — between an immersive environment and a set of controls; between standardization and originality. Cultural interfaces try to balance the concept of a surface in painting, photography, cinema, and the printed page as something to be looked at, glanced at, read, but always from some distance, without interfering with it, with the concept of the surface in a computer interface as a virtual control panel, similar to the control panel on a car, plane or any other complex machine.⁸⁶ Finally, on yet another level, the traditions of the printed word and of cinema also compete between themselves. One pulls the computer

screen towards being dense and flat information surface, while another wants it to become a window into a virtual space.

To see that this hybrid language of the cultural interfaces of the 1990s represents only one historical possibility, consider a very different scenario. Potentially, cultural interfaces could completely rely on already existing metaphors and action grammars of a standard HCI, or, at least, rely on them much more than they actually do. They don't have to "dress up" HCI with custom icons and buttons, or hide links within images, or organize the information as a series of pages or a 3D environment. For instance, texts can be presented simply as files inside a directory, rather than as a set of pages connected by custom-designed icons. This strategy of using standard HCI to present cultural objects is encountered quite rarely. In fact, I am aware of only one project which uses it completely consciously, as a though through choice rather than by necessity : a CD-ROM by Gerald Van Der Kaap entitled BlindRom V.0.9. (Netherlands, 1993). The CD-ROM includes a standard-looking folder named "Blind Letter." Inside the folder there are a large number of text files. You don't have to learn yet another cultural interface, search for hyperlinks hidden in images or navigate through a 3D environment. Reading these files required simply opening them in standard Macintosh SimpleText, one by one. This simple technique works very well. Rather than distracting the user from experiencing the work, the computer interface becomes part and parcel of the work. Opening these files, I felt that I was in the presence of a new literary form for a new medium, perhaps the real medium of a computer — its interface.

As the examples analyzed here illustrate, cultural interfaces try to create their own language rather than simply using general-purpose HCI. In doing so, these interfaces try to negotiate between metaphors and ways of controlling a computer developed in HCI, and the conventions of more traditional cultural forms. Indeed, neither extreme is ultimately satisfactory by itself. It is one thing to use a computer to control a weapon or to analyze statistical data, and it is another to use it to represent cultural memories, values and experiences. The interfaces developed for a computer in its functions of a calculator, control mechanism or a communication device are not necessarily suitable for a computer playing the role of a cultural machine. Conversely, if we simply mimic the existing conventions of older cultural forms such as the printed word and cinema, we will not take advantage of all the new capacities offered by a computer: its flexibility in displaying and manipulating data, interactive control by the user, the ability to run simulations, etc.

Today the language of cultural interfaces is in its early stage, as was the language of cinema a hundred years ago. We don't know what the final result will be, or even if it will ever completely stabilize. Both the printed word and cinema eventually achieved stable forms which underwent little changes for long periods of time, in part because of the material investments in their means of production and distribution. Given that computer language is implemented in software,

potentially it can keep on changing forever. But there is one thing we can be sure of. We are witnessing the emergence of a new cultural meta-language, something which will be at least as significant as the printed word and cinema before it.

NOTES

¹ <http://www.nettime.org>

² <http://www.rhizome.org>

³ Phong, B.T. "Illumination for Computer Generated Pictures," Communication of the ACM, Volume 18, no. 6 (June 1975): 311-317.

⁵ Thomas S. Kuhn, The Structure of Scientific Revolutions, 2nd ed. (Chicago: University of Chicago Press, 1970).

⁶ By virtual worlds I mean 3D computer-generated interactive environments. This definition fits a whole range of 3D computer environments already in existence: high-end VR works which feature head-mounted displays and photo realistic graphics; arcade, CD-ROM and on-line multi-player computer games; QuickTime VR movies; VRML (The Virtual Reality Modeling Language) scenes; and graphical chat environments such as The Palace and Active Worlds.

Virtual worlds represent an important trend across computer culture, consistently promising to become a new standard in human-computer interfaces and in computer networks. (For a discussion of why this promise may never be fulfilled, see "Navigable Space" section.) For example, Silicon Graphics developed a 3-D file system which was showcased in the movie Jurassic Park. Sony used a picture of a room as an interface in its MagicLink personal communicator. Apple's short-lived E-World greeted its users with a drawing of a city. Web designers often use pictures of buildings, aerial views of cities, and maps as interface metaphors. In the words of the scientists from Sony's The Virtual Society Project (www.csl.sony.co.jp/project/VS/), "It is our belief that future online systems will be characterized by a high degree of interaction, support for multi-media and most importantly the ability to support shared 3-D spaces. In our vision, users will not simply access textual based chat forums, but will enter into 3-D worlds where they will be able to interact with the world and with other users in that world."

⁷ Tzevan Todorov, Introduction to Poetics, trans. by Richard Howard (Minneapolis: University of Minnesota Press, 1981), 6.

⁸ Examples of software standards include operating systems such as UNIX, Windows and MAC OS; file formats (JPEG, MPEG, DV, QuickTime, RTF, WAV); scripting languages (HTML, Javascript); programming languages (C++, Java); communication protocols (TCP-IP); the conventions of HCI (e.g. dialog boxes, copy and paste commands, help pointer); and also unwritten conventions,

such as the 640 by 480 pixel image size which was used for more than a decade. Hardware standards include storage media formats (ZIP, JAZ, CD-ROM, DVD), port types (serial, USB, Firewire), bus architectures (PCI), and RAM types.

⁹ Vkutemas was a Moscow art and design school in the 1920s which united most Left avant-garde artists; it functioned as a counterpart of Bauhaus in Germany.

¹⁰ Qtd. in Beumont Newhall, The History of Photography from 1839 to the Present Day. Revised and Enlarged Edition, fourth edition (New York: The Museum of Modern Art, 1964), 18.

¹¹ Newhall, The History of Photography, 17-22.

¹² Charles Eames, A Computer Perspective: Background To The Computer Age, 1990 edition (Cambridge, Mass.: Harvard University Press, 1990), 18.

¹³ David Bordwell and Kristin Thompson, Film Art: An Introduction, fifth edition (New York: The McGraw-Hill Companies), 15.

¹⁴ Eames, A Computer Perspective, 22-27, 46-51, 90-91.

¹⁵ Eames, A Computer Perspective, 120.

¹⁶ Isaac Victor Kerlov and Judson Rosebush, Computer Graphics for Designers and Artists (New York: Van Nostrand Reinhold Company, 1986), 14.

¹⁷ Kerlov and Rosebush, Computer Graphics, 21.

¹⁸ Roland Barthes, Elements of Semiology (New York: Hill and Wang, 1968), 64.

¹⁹ I discuss the particular cases of computer automation of visual communication in more detail in "Automation of Sight from Photography to Computer Vision," Electronic Culture: Technology and Visual Representation, edited by Timothy Druckery and Michael Sand (New York: Aperture, 1996); "Mapping Space: Perspective, Radar and Computer Graphics," SIGGRAPH '93 Visual Proceedings, edited by Thomas Linehan, 143-147 (New York: ACM, 1993).

²⁰ <http://www.mrl.nyu.edu/improv/>, accessed June 29, 1999.

²¹ <http://www-white.media.mit.edu/vismod/demos/smartcam/>, accessed June 29, 1999.

²² <http://pattie.www.media.mit.edu/people/pattie/CACM-95/alife-cacm95.html>, accessed June 29, 1999.

²³ This research was pursued at different groups at the MIT lab. See for instance home page of Gesture and Narrative Language Group, <http://gn.www.media.mit.edu/groups/gn/>, accessed June 29, 1999.

²⁴ See <http://www.virage.com/products>, accessed June 29, 1999.

- ²⁵ <http://agents.www.media.mit.edu/groups/agents/projects/>, accessed June 29, 1999.
- ²⁶ See my "Avant-Garde as Software," in Ostranenie, edited by Stephen Kovats (Frankfurt and New York: Campus Verlag, 1999.). (<http://visarts.ucsd.edu/~manovich>)
- ²⁷ For an experiment in creating different multimedia interfaces to the same text, see my Freud-Lissitzky Navigator (<http://visarts.ucsd.edu/~manovich/FLN>).
- ²⁸ <http://jefferson.village.virginia.edu/wax/>, accessed October 24, 1999.
- ²⁹ Frank Halacz and Mayer Swartz, "The Dexter Hypertext Reference Model," Communication of the ACM (New York: ACM, 1994), 30.
- ³⁰ Noam Chomsky, Syntactic Structures, reprint edition (Peter Lang Publishing, 1978).
- ³¹ "How Marketers 'Profile' Users," USA Today (November 9, 1999), 2A.
- ³² See <http://www.three.org>. Our conversations helped me to clarify my ideas, and I am very grateful to Jon for the ongoing exchange.
- ³³ Marcos Novak, lecture at "Interactive Frictions" conference, University of Southern California, Los Angeles, June 6, 1999.
- ³⁴ Graame Weinbren, In the Ocean of Streams of Story, Millennium Film Journal 28 (Spring 1995), <http://www.sva.edu/MFJ/journalpages/MFJ28/GWOCEAN.HTML>.
- ³⁵ Rick Moody, Demonology, first published in Conjunctions, reprinted in The KGB Bar Reader, qtd. in Vince Passaro, "Unlikely Stories," Harper's Magazine vol. 299, no. 1791 (August 1999), 88-89.
- ³⁶ Albert Abramson, Electronic Motion Pictures. A History of Television Camera (Berkeley: University of California Press, 1955), 15-24.
- ³⁷ Charles Musser, The Emergence of Cinema: The American Screen to 1907 (Berkeley: University of California Press, 1994), 65.
- ³⁸ Mitchell, The Reconfigured Eye (Cambridge, Mass.: The MIT Press, 1982), 6.
- ³⁹ Mitchell, The Reconfigured Eye, 6.
- ⁴⁰ Mitchell, The Reconfigured Eye, 49.
- ⁴¹ Ernst Gombrich analyses "the beholder's share" in decoding the missing information in visual images in his classic Art and Illusion. A Study in the Psychology of Pictorial Representation (Princeton: Princeton University Press, 1960).

⁴² The notion that computer interactive art has its origins in new art forms of the 1960s is explored in Söke Dinkla, "The History of the Interface in Interactive Art," ISEA (International Symposium on Electronic Art) 1994 Proceedings (http://www.uiah.fi/bookshop/isea_proc/nextgen/08.html, accessed August 12, 1998); "From Participation to Interaction: Toward the Origins of Interactive Art," in Lynn Hershman Leeson, ed. Clicking In: Hot Links to a Digital Culture (Seattle: Bay Press, 1996): 279-290. See also Simon Penny, "Consumer Culture and the Technological Imperative: The Artist in Dataspace," in Simon Penny, ed., Critical Issues in Electronic Media (Albany, New York: State University of New York Press, 1993): 47-74.

⁴³ This argument relies on a cognitivist perspective which stresses the active mental processes involved in comprehension of any cultural text. For an example of cognitivist approach in film studies, see David Bordwell and Kristin Thompson, Film Art: an Introduction; David Bordwell, Narration in the Fiction Film (Madison, Wisconsin: University of Wisconsin Press, 1989).

⁴⁴ For a more detailed analysis of this trend, see my article "From the Externalization of the Psyche to the Implantation of Technology," in Mind Revolution: Interface Brain/Computer, edited by Florian Rötzer (München: Akademie Zum Dritten Jahrtausend, 1995), 90-100.

⁴⁵ Qtd. in Allan Sekula, "The Body and the Archive," October 39 (1987): 51.

⁴⁶ Hugo Münsterberg, The Photoplay: A Psychological Study (New York: D. Appleton & Co., 1916), 41.

⁴⁷ Sergei Eisenstein, "Notes for a Film of 'Capital,'" trans. Maciej Sliwowski, Jay Leuda, and Annette Michelson, October 2 (1976): 10.

⁴⁸ Timothy Druckrey, "Revenge of the Nerds. An Interview with Jaron Lanier," Afterimage (May 1991), 9.

⁴⁹ Fredric Jameson, The Prison-house of Language: a Critical Account of Structuralism and Russian Formalism (Princeton, N.J.: Princeton University Press, 1972).

⁵⁰ Jürgen Habermas, The Theory of Communicative Action, trans. Thomas McCarthy (Boston, Beacon Press, c1984-).

⁵¹ Druckrey, "Revenge of the Nerds," 6.

⁵² Sigmund Freud, Standard Edition of the Complete Psychological Works (London: Hogarth Press, 1953), 4: 293.

⁵³ Edward Bradford Titchener, A Beginner's Psychology (New York: The Macmillan Company, 1915), 114.

- ⁵⁴ George Lakoff, "Cognitive Linguistics," Versus 44/45 (1986): 149.
- ⁵⁵ Philip Johnson-Laird, Mental Models: Towards a Cognitive Science of Language, Inference, and Consciousness (Cambridge: Cambridge University Press, 1983).
- ⁵⁶ Louis Althusser introduced his influential notion of ideological interpellation in his "Ideology and Ideological State Apparatuses (Notes Towards an Investigation), in Lenin and Philosophy, trans. by Ben Brewster (New York: Monthly Review Press, 1971).
- ⁵⁷ Stephen Johnson's Interface Culture makes a claim for the cultural significance of computer interface.
- ⁵⁸ Other examples of cultural theories which rely on "non-transparency of the code" idea are Yuri Lotman's theory of secondary modeling systems, George Lakoff's cognitive linguistics, Jacques Derrida's critique of logocentrism and Marshall McLuhan's media theory.
- ⁵⁹ http://www.ntticc.or.jp/permanent/index_e.html, accessed July 15, 1999.
- ⁶⁰ Brad. A. Myers, "A Brief History of Human Computer Interaction Technology," technical report CMU-CS-96-163 and Human Computer Interaction Institute Technical Report CMU-HCII-96-103 (Pittsburgh, Pennsylvania: Carnegie Mellon University, Human-Computer Interaction Institute, 1996).
- ⁶¹ <http://www.xanadu.net/the.project>, accessed December 1, 1997.
- ⁶² XML which is promoted as the replacement for HTML enables any user to create her customized markup language. Thus, the next stage in computer culture may involve authoring not simply new Web documents but new languages. For more information on XML, see <http://www.ucc.ie/xml.>, accessed December 1, 1997.
- ⁶³ <http://www.hotwired.com/rgb/antirom/index2.html>, accessed December 1, 1997.
- ⁶⁴ See, for instance, Mark Pesce, "Ontos, Eros, Noos, Logos," keynote address for ISEA (International Symposium on Electronic Arts) 1995, <http://www.xs4all.nl/~mpesce/iseakey.html>, accessed December 1, 1997.
- ⁶⁵ <http://www.backspace.org/iod>, accessed July 15, 1999.
- ⁶⁶ <http://www.netomat.net>, accessed July 15, 1999.
- ⁶⁷ Roman Jakobson, "Deux aspects du langage et deux types d'aphasie", in Temps Modernes, no. 188 (January 1962).

⁶⁸ XLM diversifies types of links available by including bi-directional links, multi-way links and links to a span of text rather than a simple point.

⁶⁹ This may imply that new digital rhetoric may have less to do with arranging information in a particular order and more to do simply with selecting what is included and what is not included in the total corpus being presented.

⁷⁰ See

http://www.aw.sgi.com/pages/home/pages/products/pages/poweranimator_film_sgi/index.html, accessed December 1, 1997.

⁷¹ In The Address of the Eye Vivian Sobchack discusses the three metaphors of frame, window and mirror which underlie modern film theory. The metaphor of a frame comes from modern painting and is central to formalist theory which is concerned with signification. The metaphor of window underlies realist film theory (Bazin) which stresses the act of perception. Realist theory follows Alberti in conceptualizing the cinema screen as a transparent window onto the world. Finally, the metaphor of a mirror is central to psychoanalytic film theory. In terms of these distinctions, my discussion here is concerned with the window metaphor. The distinctions themselves, however, open up a very productive space for thinking further about the relationships between cinema and computer media, in particular the cinema screen and the computer window. Vivian Sobchack, The Address of the Eye: a Phenomenology of Film Experience (Princeton: Princeton University Press, 1992).

⁷² Jacques Aumont et al., Aesthetics of Film (Austin: Texas University Press, 1992), 13.

⁷³ By VR interface I mean the common forms of a head-mounted or head-coupled directed display employed in VR systems. For a popular review of such displays written when the popularity of VR was at its peak, see Steve Aukstakalnis and David Blatner, Silicon Mirage: The Art and Science of Virtual Reality (Berkeley: CA: Peachpit Press, 1992), pp. 80-98. For a more technical treatment, see Dean Kocian and Lee Task, "Visually Coupled Systems Hardware and the Human Interface" in Virtual Environments and Advanced Interface Design, edited by Woodrow Barfield and Thomas Furness III (New York and Oxford: Oxford University Press, 1995), 175-257.

⁷⁴ See Kocian and Task for details on field of view of various VR displays. Although it varies widely between different systems, the typical size of the field of view in commercial head-mounted displays (HMD) available in the first part of the 1990's was 30-50°.

⁷⁵ <http://webpace.sgi.com/WebSpace/Help/1.1/index.html>, accessed December 1, 1997.

⁷⁶ See John Hartman and Josie Wernecke, The VRML 2.0 Handbook: Building Moving Worlds on the Web (Reading, Mass.: Addison-Wesley Publishing Company, 1996), 363.

⁷⁷ Examples of an earlier trend are Return to Zork (Activision, 1993) and The 7th Guest (Trilobyte/Virgin Games, 1993). Examples of the later trend are Soulblade (Namco, 1997) and Tomb Raider (Eidos, 1996).

⁷⁸ Critical literature on computer games, and in particular on their visual language, remains slim. Useful facts on history of computer games, description of different genres and the interviews with the designers can be found in Chris McGowan and Jim McCullaugh, Entertainment in the Cyber Zone (New York: Random House, 1995). Another useful source is J.C. Herz, Joystick Nation: How Videogames Ate Our Quarters, Won Our Hearts, and Rewired Our Minds (Boston: Little, Brown and Company, 1997).

⁷⁹ Dungeon Keeper (Bullfrog Productions, 1997).

⁸⁰ For a more detailed discussion of the history of computer imaging as gradual automation, see my articles "Mapping Space: Perspective, Radar and Computer Graphics," and "Automation of Sight from Photography to Computer Vision."

⁸¹ Moses Ma's presentation, panel "Putting a Human Face on Cyberspace: Designing Avatars and the Virtual Worlds They Live In," SIGGRAPH '97, August 7, 1997.

⁸² Li-wei He, Michael Cohen, David Salesin, "The Virtual Cinematographer: A Paradigm for Automatic Real-Time Camera Control and Directing," SIGGRAPH '96 (<http://research.microsoft.com/SIGGRAPH96/96/VirtualCinema.htm>).

⁸³ See http://www.artcom.de/projects/invisible_shape/welcome.en, accessed December 1, 1997.

⁸⁴ Jay David Bolter and Richard Grusin, Remediation: Understanding New Media (Cambridge, Mass.: The MIT Press, 1999), 19.

⁸⁵ See Svetlana Alpers, The Art of Describing: Dutch Art in the Seventeenth Century (Chicago: University of Chicago Press, 1983). See particularly chapter "Mapping Impulse."

⁸⁶ This historical connection is illustrated by popular flight simulator games where the computer screen is used to simulate the control panel of a plane, i.e. the very type of object from which computer interfaces have developed. The conceptual origin of modern GUI in a traditional instrument panel can be seen

even more clearly in the first graphical computer interfaces of the late 1960's and early 1970's which used tiled windows. The first tiled window interface was demonstrated by Douglas Engelbart in 1968.

⁸⁷ My analysis here focuses on the continuities between a computer screen and preceding its representational conventions and technologies. For alternative readings will take up the differences between the two, see excellent articles by Vivian Sobchack, "Nostalgia for a Digital Object: Regrets on the Quickening of QuickTime," in *Millennium Film Journal* (Winter 2000) and Norman Bryson, "Summer 1999 at TATE," available from Tate Gallery, 413 West 14th Street, New York City. Bryson writes: "Though the [computer] screen is able to present a scenographic depth, it is obviously unlike the Albertian or Renaissance Window; its surface never vanishes before the imaginary depths behind it, it never truly opens into depth. But the PC screen does not behave like the modernist image, either. It cannot foreground the materiality of the surface (of pigments on canvas) since it has no materiality to speak of, other than the play of shifting light." Both Sobchack and Bryson also stress the difference between traditional image frame and multiple windows of a computer screen. Bryson: "basically the whole order of the frame is abolished, replaced by the order of superimposition or tiling."

⁸⁸ The degree to which a frame that acts as a boundary between the two spaces is emphasized seems to be proportional to the degree of identification expected from the viewer. Thus, in cinema, where the identification is most intense, the frame as a separate object does not exist at all — the screen simply ends at its boundaries — while both in painting and in television the framing is much more pronounced.

⁸⁹ Here I agree with the parallel suggested by Anatoly Prokhorov between window interface and montage in cinema.

⁹⁰ For these origins, see, for instance, C.W. Ceram, *Archeology of the Cinema* (New York: Harcourt, Brace & World, Inc., 1965).

⁹¹ Beaumont Newhall, *Airborne Camera* (New York: Hastings House, Publishers, 1969).

⁹² This is more than a conceptual similarity. In the late 1920s John H. Baird invented "phonovision," the first method for the recording and the playing back of a television signal. The signal was recorded on Edison's phonograph's record by a process very similar to making an audio recording. Baird named his recording machine "phonoscope." Albert Abramson, *Electronic Motion Pictures* (University of California Press, 1955), 41-42.

⁹³ *Echoes of War* (Boston: WGBH Boston, n.d.), videotape.

⁹⁴ *Ibid.*