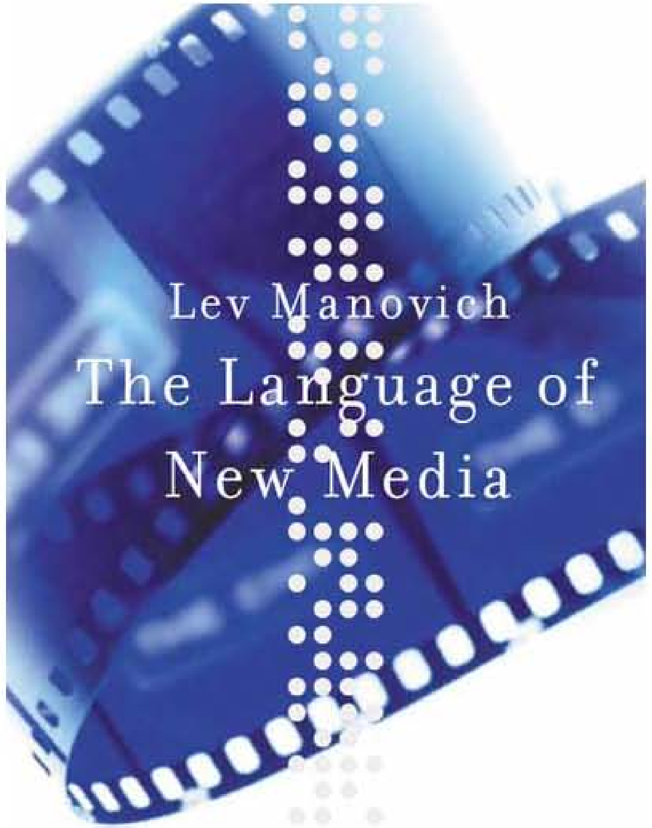
Lev Manovich
The Language of
New Media

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The Language of New Media

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What Is New Media?

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

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

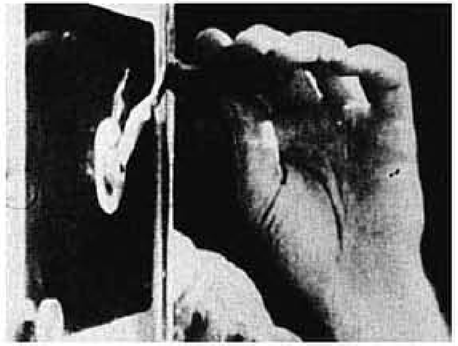
Shall we accept this definition? If we want to understand the effects of computerization on culture as a whole, I think it is too limiting. There is no reason to privilege the computer as a machine for the exhibition and distribution of media over the computer as a tool for media production or as a media 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 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 register its initial effects. Indeed, the introduction of the printing press affected only one stage of cultural communication—the distribution of media. Similarly, the introduction of photography affected only one type of cultural communication—still images. In contrast, the computer media revolution affects all stages of communication, including acquisition, manipulation, storage, and distribution; it also affects all types of media—texts, 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 the 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 1830s 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 widely employed by companies and governments since the turn of the century. In a parallel movement, we witness the rise of modern media technologies that allow the storage of images, image sequences, sounds, and text using different material forms—photographic plates, film stocks, gramophone records, etc. The synthesis of these two histories? The translation of all existing media into numerical data accessible through computers. The result is new media—graphics, moving images, sounds, shapes, spaces, and texts that have become computable; that is, they comprise 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 that 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 in and of themselves are in sufficient to distinguish new media from old.

How Media Became New



On August 19, 1839, the Palace of the Institute in Paris was filled with curious Parisians who had come 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."[1] The media frenzy had begun. Within five months more than thirty different descriptions of the technique had been published around the world— Barcelona, Edinburgh, Naples, Philadelphia, St. Petersburg, Stockholm. At first, daguerreotypes of architecture and landscapes dominated the public's imagination; two years later, after various technical improvements to the process had been made, portrait galleries had opened everywhere—and everyone rushed to have her picture taken by the new media machine.[2]

In 1833 Charles Babbage began designing a device he called "the Analytical Engine." The Engine contained most of the key features of the modern digital computer. 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 on intermediate results. However, in contrast to the daguerreotype, not a single copy of the Engine was completed. While the invention of the daguerreotype, a modern media tool for the reproduction of reality, impacted society immediately, the impact of the computer was yet to be seen.

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 that 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."[3] Thus a programmed machine was already synthesizing images even before it was put to processing 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 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 complementary technologies; they appear together and develop side by side, making modern mass society possible.

For a long time the two trajectories ran in parallel without ever crossing paths. Throughout the nineteenth and the early twentieth centuries, numerous mechanical and electrical tabulators and calculators were developed; they gradually became faster and their use more widespread. In a parallel movement, we witness the rise of modern media that allow the storage of images, image sequences, sounds, and texts in different material forms— photographic plates, film stock, gramophone records, 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 1893, the first movie studio—Edison's "Black Maria"—started producing twenty-second shorts that 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 1895, to the paying public. Within a year, audiences in Johannesburg, Bombay, Rio de Janeiro, Melbourne, Mexico City, and Osaka were subjected to the new media machine, and they found it irresistible.[4] Gradually scenes grew longer, the staging of reality before the camera and the subsequent editing of samples became more intricate, and copies multiplied. In Chicago and Calcutta, London and St. Petersburg, Tokyo and Berlin, and thousands of smaller places, film images would soothe movie audiences, who were facing an increasingly dense information environment outside the theater, an environment that 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 individual brains were overwhelmed by the amount of information they had to process, the same was true of corporations and of governments. In 1887, the U.S. Census Bureau was still interpreting figures from the 1880 census. For the 1890 census, the Census Bureau adopted electric tabulating machines designed by Herman Hollerith. The data collected on 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 utility companies, railroad offices, 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.[5]

Moving into the twentieth century, the key year for the history of media and computing is 1936. 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 capable of only four operations, the machine could perform any calculation that could 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, read the data, or 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 the prehistory of both cinema and the computer. As we know, the inventors of cinema eventually settled on using discrete images recorded on a strip of celluloid; the inventors of the computer— which needed much greater speed of access as well as the ability to quickly read and write data—eventually decided to store it electronically in a binary code.

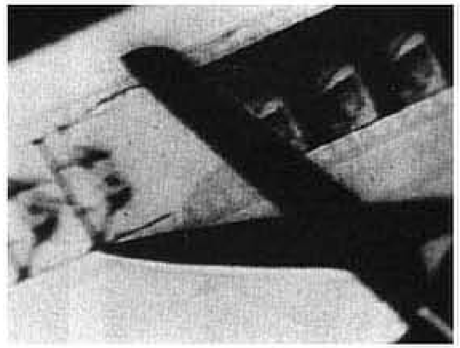
The histories of media and computing became further entwined when German engineer Konrad Zuse began building a computer in the living room of his parents' apartment in Berlin—the same year that Turing wrote his seminal paper. Zuse's computer was the first working digital computer. One of his innovations was using punched tape to control computer programs. The tape Zuse used was actually discarded 35mm movie film.[6]

One of the 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 data carrier. The pretense of modern media to create simulations of sensible reality is similarly canceled; media are reduced to their original condition as information carrier, nothing less, 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 binary over iconic code, anticipates the convergence that will follow 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 computer. The result: graphics, moving images, sounds, shapes, spaces, and texts become computable, that is, simply sets of computer data. In short, media become new media.

This meeting changes the identity of both media and the computer itself. No longer just a calculator, control mechanism, or communication device, the 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 on 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 actors. In a historical loop, the computer has returned to its origins. No longer just an Analytical Engine, suitable only for crunching numbers, it has become Jacquard's loom—a media synthesizer and manipulator.

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. Following are some of the popularly held notions about the difference between new and old media that I 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 (texts, still images, visual or audio time data, shapes, 3-D spaces) share the same digital code. This allows different media types to be displayed using one machine—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 it possible to access any data element equally fast.
4. Digitization inevitably involves 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 old media where the order of presentation is 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. In this way 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 the principles above are not unique to new media, but can be found in older media technologies as well. I will illustrate this fact 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 of a limited number of samples. For example, a digital still image is a matrix of pixels—a 2-D sampling of space. However, cinema was from its beginnings based on sampling—the sampling of time. Cinema sampled time twenty-four times a second. So we can say that cinema 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 emerging toward the end of the nineteenth century that employed a discrete representation. If cinema sampled time, fax transmission of images, starting in 1907, sampled a 2-D space; even earlier, the first television experiments (Carey 1875; Nipkow 1884) already involved sampling of both time and space.[27] However, reaching mass popularity much earlier than these other technologies, cinema was the first to make the principle of discrete representation of the visual public knowledge.

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

Although computer multimedia became commonplace only around 1990, filmmakers had been combining moving images, sound, and text (whether the intertitles of the silent era or the title sequences of the later period) for a whole century. Cinema was thus the original modern "multimedia." We can also point to much earlier examples of multiple-media displays, such as medieval illuminated manuscripts that combine text, graphics, and representational images.

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

For example, once a film is digitized and loaded in the computer's 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—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 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.[28] The storage capacity of this medium was twenty-eight minutes—twenty-eight minutes of continuous time taken apart, flattened on a surface, and mapped onto a two-dimensional grid. (In short, time was prepared for manipulation and reordering, something 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 the remaining 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 that radically redefines media? The answer is not so straightforward, however, because 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 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. In "Principles of New Media" I showed that numerical representation is the one really crucial concept of the three. Numerical representation turns media into computer data, thus making it programmable. And this indeed radically changes the nature of media.

In contrast, as I will show below, the alleged principles of new media that 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—do not hold up under closer examination; that is, although these principles are indeed logical consequences of digitization, they do not apply to concrete computer technologies in the way in which they are currently used.

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

6
What Is Cinema?

It is useful to think about the relations between cinema and new media in terms of two vectors. The first vector goes from cinema to new media, and it constitutes the backbone of this book. Chapters 1-5 uses the history and theory of cinema to map out the logic driving the technical and stylistic development of new media. I also trace the key role played by cinematic language in new media interfaces—both the traditional HCI (the interface of the operating system and software applications) and what I call "cultural interfaces"—interfaces between the human user and cultural data.

The second vector goes in the opposite direction—from computers to cinema. How does computerization affect our very concept of moving images? Does it offer new possibilities for film language? Has it led to the development of totally new forms of cinema? This last chapter is devoted to these questions. In part I started to address them in the "Compositing" section and the "Illusion" chapter. The main part of that chapter focuses on the new identity of the computer-generated image; it is logical that we now extend our inquiry to include moving images.

Before proceeding, I would like to offer two lists. My first list summarizes the effects of computerization on cinema proper:

1. Use of computer techniques in traditional filmmaking:

1.1 3-D computer animation/digital composing. Examples: *Titanic* (James Cameron, 1997), *The City of Lost Children* (Marc Caro and J. P. Jeunet, 1995).

1.2 Digital painting. Example: *Forrest Gump* (Robert Zemeckis, 1994).

1.3 Virtual sets. Example: *Ada* (Lynn Hershman, 1997).

1.4 Virtual actors/motion capture. Example: *Titanic.*

2. New forms of computer-based cinema:

2.1 Motion rides/location-based entertainment. Example: rides produced by Douglas Trumbull.

2.2 Motion graphics, or what I might call *typographic cinema:* film + graphic design + typography. Example: film title sequences.

2.3 Net.cinema: films designed exclusively for Internet distribution. Example: New Venue, one of the first onlines sites devoted to showcasing short digital films. In 1998 it accepted only QuickTime files under five Mb.

2.4 Hypermedia interfaces to a film that allows nonlinear access at different scales. Examples: *WaxWeb* (David Blair, 1994-1999), Stephen Mamber's database interface to Hitchcock's *Psycho* (Mamber, 1996-).

2.5 Interactive movies and games structured around film-like sequences. These sequences can be created using traditional film techniques (example: the *Johnny Mnemonic* game) or computer animation (example: the *Blade Runner* game). (The pioneer of interactive cinema is experimental filmmaker Grahame Weinbren, whose laserdisks *Sonata* and *The Erl King* are the true classics of this new form.) Note that it is hard to draw a strict line between such interactive movies and many other games that may not use traditional film sequences yet follow many other conventions of film language in their structure. From this perspective, the majority of the computer games of the 1990s can actually be considered interactive movies.

2.6 Animated, filmed, simulated, or hybrid sequences that follow film language, and appear in HCI, Web sites, computer games, and other areas of new media. Examples: transitions and QuickTime movies in *Myst,* FMV (full motion video) openings in *Tomb Raider* and many other games.

3. Filmmakers' reactions to the increasing reliance of cinema on computer techniques in postproduction:

3.1 Films by Dogme 95 movement. Example: *Celebration* (Vinterberg, 1998).

3.2 Films that focus on the new possibilities offered by inexpensive DV (Digital Video) cameras. Example: *Time Code* (Figgis, 2000).

4. Filmmakers' reactions to the conventions of new media:

4.1 Conventions of a computer screen. Example: *Prospero's Books* (Greenaway).

4.2 Conventions of game narratives. Examples: *Run, Lola, Run* (Tykwer, 1999), *Sliding Doors* (Howitt, 1998).

The first section of this chapter, "Digital Cinema and the History of a Moving Image," will focus on 1.1-1.3. The second section, "New Language of Cinema," will use examples drawn from 2.3-2.6.[1]

Note that I do not include on this list new distribution technologies such as digital film projection or network film distribution, which by 1999 was already used in Hollywood on a experimental basis, nor do I mention the growing number of Web sites devoted to distribution of films.[2] Although all these developments will undoubtedly have an important effect on the economics of film production and distribution, they do not appear to have a direct effect on film language, which is my main concern here.

My second, and highly tentative, list summarizes some of the distinct qualities of a computer-based image. This list pulls together arguments presented throughout the book so far. As I noted in chapter 1, I feel that it is important to pay attention not only to the new properties of a computer image that can be logically deduced from its new "material" status, but also to how images are actually used in computer culture. Therefore, the number of properties on this list reflects the typical usage of images rather than some "essential" properties it may have due to its digital form. It is also legitimate to think of some of these qualities as particular consequences of the oppositions that define the concept of representation, as summarized in the Introduction:

1. The computer-based image is discrete, because it is broken into pixels. This makes it more like a human language (but not in the semiotic sense of having distinct units of meaning).

2. The computer-based image is modular, because it typically consists of a number of layers whose contents often correspond to meaningful parts of the image.

3. The computer-based image consists of two levels, a surface appearance and the underlying code (which may be the pixel values, a mathematical function, or HTML code). In terms of its "surface," an image participates in dialog with other cultural objects. In terms of its code, an image exists on the same conceptual plane as other computer objects. (Surface-code can be related to other pairs: signifier—signified, base—superstructure, unconscious—conscious. So just as a signifier exists in a structure with other signifiers of a language, the "surface" of an image, that is, its "contents," enters into dialog with all other images in a culture.)

4. Computer-based images are typically compressed using lossy compression techniques, such as JPEG. Therefore, the presence of noise (in the sense of undesirable artifacts and loss of original information) is its essential, rather than accidental, quality.

5. An image acquires the new role of an interface (for instance, imagemaps on the Web, or the image of a desktop as a whole in GUI). Thus, image becomes image-interface. In this role it functions as a portal into another world, like an icon in the Middle Ages or a mirror in modern literature and cinema. Rather than staying on its surface, we expect to go "into" the image. In effect, every computer user becomes Carroll's Alice. The image can function as an interface because it can be "wired" to programming code; thus clicking on the image activates a computer program (or its part).

6. The new role of an image as image-interface competes with its older role as representation. Therefore, conceptually, a computer image is situated between two opposing poles—an illusionistic window into a fictional universe and a tool for computer control. The task of new media design and art is to learn how to combine these two competing roles of an image.

7. Visually, this conceptual opposition translates into the opposition between depth and surface, between a window into a fictional universe and a control panel.

8. Along with functioning as image-interfaces, computer images also function as image-instruments. If an image-interface controls a computer, an image-instrument allows the user to remotely affect physical reality in real time. This ability not only to act but to "teleact" distinguishes the new computer-based image-instrument from its predecessors. In addition, if old image-instruments such as maps were clearly distinguished from illusionistic images such as paintings, computer images often combine both functions.

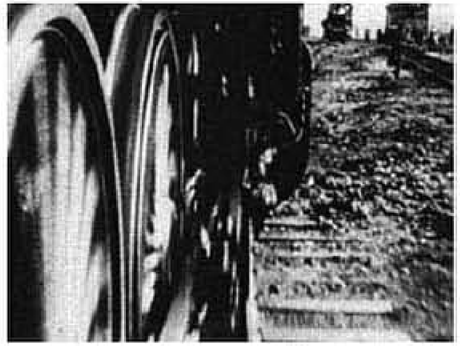
9. A computer image is frequently hyperlinked to other images, texts, and other media elements. Rather than being a self-enclosed entity, it points, leads to, and directs the user outside itself toward something else. A moving image may also include hyperlinks (for instance, in QuickTime format.) We can say that a hyperlinked image, and hypermedia in general, "externalizes" Pierce's idea of infinite semiosis and Derrida's concept of infinite deferral of meaning—although this does not mean that this "externalization" automatically legitimizes these concepts. Rather than celebrating "the convergence of technology and critical theory," we should use new media technology as an opportunity to question our accepted critical concepts and models.

10. Variability and automation, these general principles of new media, also apply to images. For example, a designer using a computer program can automatically generate infinite versions of the same image, which can vary in size, resolution, colors, composition, and so on.

11. From a single image that represents the "cultural unit" of a previous period, we move to a database of images. Thus if the hero of Antonioni's *Blow-Up* (1966) was looking for truth within a single photographic image, the equivalent of this operation in a computer age is to work with a whole database of many images, searching and comparing them with each other. (Although many contemporary films include scenes of image search, none of them makes it a subject in the way *Blow-Up* does by zooming into a photograph. From this perspective, it is interesting that fifteen years after *BlowUp, Blade Runner* still applies "old" cinematic logic in relation to the computer-based image. In a well-known scene, the hero uses voice commands to direct a futuristic computer device to pan and zoom into a *single* image. In reality, the military has used various computer techniques that rely on *databases* of images to automatically identify objects represented in a single image, detect changes in images over time, and so forth, since the 1950s.)[3] Any unique image that you desire probably already exists on the Internet or in some database. As I have already noted, the problem today is no longer how to create the right image, but how to find an already existing one.

Since a computer-based moving image, like its analog predecessor, is simply a sequence of still images, all these properties apply to it as well. To delineate the new qualities of a computer-based still image, I have compared it with other types of modern images commonly used before it—drawings, maps, paintings, and most importantly, still photographs. It would be logical to begin discussion of the computer-based moving image by also relating it to the two most common types of moving images it replaces in turn—the film image and the animated image. In the first section, "Digital Cinema and the History of a Moving Image," I attempt precisely this. I ask how the shift to computer-based representation and production processes redefines the identity of the moving image and the relationship between cinema and animation. This section also deals with the question of computer-based illusionism, considering it in relation to animation, analog cinema, and digital cinema. The following section, "The New Language of Cinema," presents examples of some new directions for film language—or, more generally, the language of moving images—opened up by computerization. My examples come from different areas in which computer-based moving images are used—digital films, net.films, self-contained hypermedia, and Web sites.

Digital Cinema and the History of a Moving Image



Cinema, the Art of the Index

Most discussions of cinema in the computer age have focused on the possibilities of interactive narrative. It is not hard to understand why: Since the majority of viewers and critics equate cinema with storytelling, computer media is understood as something that will let cinema tell its stories in a new way. Yet as exciting as the idea of a viewer participating in a story, choosing different paths through the narrative space, and interacting with characters may be, it addresses only one aspect of cinema that is neither unique nor, as many will argue, essential to it—narrative.

The challenge that computer media pose to cinema extends far beyond the issue of narrative. Computer media redefine the very identity of cinema. In a symposium that took place in Hollywood in the spring of 1996, one of the participants provocatively referred to movies as "flatties" and to human actors as "organics" and "soft fuzzies."[4] As these terms accurately suggest, what used to be cinema's defining characteristics are now just default options, with many others available. Now that one can "enter" a virtual threedimensional space, viewing flat images projected on a screen is no longer the only option. Given enough time and money, almost everything can be simulated on a computer; filming physical reality is but one possibility.

This "crisis" of cinema's identity also affects the terms and categories used to theorize cinema's past. French film theorist Christian Metz wrote in the 1970s that "most films shot today, good or bad, original or not, 'commercial' or not, have as a common characteristic that they tell a story; in this measure they all belong to one and the same genre, which is, rather, a sort of 'supergenre' [*sur-genre*]."[5] In identifying fictional film as a "super-genre" of twentieth-century cinema, Metz did not bother to mention another characteristic of this genre because at that time it was too obvious: Fictional films are *liveaction* films; that is, they largely consist of unmodified photographic recordings of real events that took place in real, physical space. Today, in the age of photorealistic 3-D computer animation and digital compositing, invoking this characteristic becomes crucial in defining the specificity of twentiethcentury cinema. From the perspective of a future historian of visual culture, the differences between classical Hollywood films, European art films, and avant-garde films (apart from abstract ones) may appear less significant than this common feature—their reliance on lens-based recordings of reality. This section is concerned with the effect of computerization on cinema as defined by its "super-genre," fictional live-action film.[6]

During cinema's history, a whole repertoire of techniques (lighting, art direction, the use of different film stocks and lenses, etc.) was developed to modify the basic record obtained by a film apparatus. Yet behind even the most stylized cinematic images, we can discern the bluntness, sterility, and banality of early nineteenth-century photographs. No matter how complex its stylistic innovations, the cinema has found its base in these deposits of reality, these samples obtained by a methodical and prosaic process. Cinema emerged out of the same impulse that engendered naturalism, court stenography, and wax museums. Cinema is the art of the index; it is an attempt to make art out of a footprint.

Even for director Andrey Tarkovsky, film-painter par excellence, cinema's identity lies in its ability to record reality. Once, during a public discussion in Moscow sometime in the 1970s, he was asked whether he was interested in making abstract films. He replied that there can be no such thing. Cinema's most basic gesture is to open the shutter and to start the film rolling, recording whatever happens to be in front of the lens. For Tarkovsky, an abstract cinema is thus impossible.

But what happens to cinema's indexical identity if it is now possible to generate photorealistic scenes entirely on a computer using 3-D computer animation; modify individual frames or whole scenes with the help a digital paint program; cut, bend, stretch, and stitch digitized film images into something with perfect photographic credibility, even though it was never actually filmed?

This section will address the meaning of these changes in the filmmaking process from the point of view of the larger cultural history of the moving image. Seen in this context, the manual construction of images in digital cinema represents a return to the pro-cinematic practices of the nineteenth century, when images were hand-painted and hand-animated. At the turn of the twentieth century, cinema was to delegate these manual techniques to animation and define itself as a recording medium. As cinema enters the digital age, these techniques are again becoming commonplace in the filmmaking process. Consequently, cinema can no longer be clearly distinguished from animation. It is no longer an indexical media technology but, rather, a subgenre of painting.

This argument will be developed in two stages. I will first follow a historical trajectory from nineteenth-century techniques for creating moving images to twentieth-century cinema and animation. Next I will arrive at a definition of digital cinema by abstracting the common features and interface metaphors of a variety of computer software and hardware that are currently replacing traditional film technology. Seen together, these features and metaphors suggest the distinct logic of a digital moving image. This logic subordinates the photographic and the cinematic to the painterly and the graphic, destroying cinema's identity as a media art. In the beginning of the next section, "New Language of Cinema," I will examine different production contexts that already use digital moving images—Hollywood films, music videos, CD-ROM-based games, and other stand-alone hypermedia—to see if and how this logic has begun to manifest itself.

A Brief Archeology of Moving Pictures

As testified by its original names (kinetoscope, cinematograph, moving pictures), cinema was understood from its birth as the art of motion, the art that finally succeeded in creating a convincing illusion of dynamic reality. If we approach cinema in this way (rather than as the art of audio-visual narrative, or the art of the projected image, or the art of collective spectatorship, etc.), we can see how it superseded earlier techniques for creating and displaying moving images.

These earlier techniques share a number of common characteristics. First, they all relied on hand-painted or hand-drawn images. Magic-lantern slides were painted at least until the 1850s, as were the images used in the Phenakistiscope, the Thaumatrope, the Zootrope, the Praxinoscope, the Choreutoscope, and numerous other nineteenth-century pro-cinematic devices. Even Muybridge's celebrated Zoopraxiscope lectures of the 1880s featured not actual photographs but colored drawings painted from photographs.[7]

Not only were the images created manually, they were also manually animated. In Robertson's *Phantasmagoria,* which premiered in 1799, magiclantern operators moved behind the screen to make projected images appear to advance and withdraw.[8] More often an exhibitor used only his hands, rather than his whole body, to put the images in motion. One animation technique involved using mechanical slides consisting of a number of layers. An exhibitor would slide the layers to animate the image.[9] Another technique was to move a long slide containing separate images slowly in front of a magic lantern lens. Nineteenth-century optical toys enjoyed in private homes also required manual action to create movement—twirling the strings of the Thaumatrope, rotating the Zootrope's cylinder, turning the Viviscope's handle.

It was not until the last decade of the nineteenth century that the automatic generation of images and automatic projection were finally combined. A mechanical eye was coupled with a mechanical heart; photography met the motor. As a result, cinema—a very particular regime of the visible—was born. Irregularity, nonuniformity, the accident, and other traces of the human body that previously had inevitably accompanied moving-image exhibitions, were replaced by the uniformity of machine vision.[10] A machine, like a conveyer belt, now spat out images, all sharing the same appearance and the same size, all moving at the same speed, like a line of marching soldiers.

Cinema also eliminated the discrete character of both space and movement in moving images. Before cinema, the moving element was visually separated from the static background, as with a mechanical slide show or Reynaud's Praxinoscope Theater (1892).[11] The movement itself was limited in range and affected only a clearly defined figure rather than the whole image. Thus, typical actions would include a bouncing ball, a raised hand or raised eyes, a butterfly moving back and forth over the heads of fascinated children—simple vectors charted across still fields.

Cinema's most immediate predecessors share something else. As the nineteenth-century obsession with movement intensified, devices that could animate more than just a few images became increasingly popular. All of them—the Zootrope, Phonoscope, Tachyscope, and Kinetoscope—were based on loops, sequences of images featuring complete actions that can be played repeatedly. Throughout the nineteenth-century, the loops grew progressively longer. The Thaumatrope (1825), in which a disk with two different images painted on each face was rapidly rotated by twirling strings attached to it, was, in essence, a loop in its most minimal form—two elements replacing one another in succession. In the Zootrope (1867) and its numerous variations, approximately a dozen images were arranged around the perimeter of a circle.[12] The Mutoscope, popular in America throughout the 1890s, increased the duration of the loop by placing a larger number of images radially on an axle.[13] Even Edison's Kinetoscope (1892-1896), the first modern cinematic machine to employ film, continued to arrange images in a loop.[14] Fifty feet of film translated to an approximately twenty-secondlong presentation—a genre whose potential development was cut short when cinema adopted a much longer narrative form.

From Animation to Cinema

Once the cinema was stabilized as a technology, it cut all references to its origins in artifice. Everything that characterized moving pictures before the twentieth century—the manual construction of images, loop actions, the discrete nature of space and movement—was delegated to cinema's bastard relative, its supplement and shadow—animation. Twentieth-century animation became a depository for nineteenth-century moving-image techniques left behind by cinema.

The opposition between the styles of animation and cinema defined the culture of the moving image in the twentieth century. Animation foregrounds its artificial character, openly admitting that its images are mere representations. Its visual language is more aligned to the graphic than to the photographic. It is discrete and self-consciously discontinuous—crudely rendered characters moving against a stationary and detailed background, sparsely and irregularly sampled motion (in contrast to the uniform sampling of motion by a film camera—recall Jean-Luc Godard's definition of cinema as "truth 24 frames per second"), and finally space constructed from separate image layers.

In contrast, cinema works hard to erase any traces of its own production process, including any indication that the images that we see could have been constructed rather than simply recorded. It denies that the reality it shows often does not exist outside the film image, an image arrived at by photographing an already impossible space, itself put together with the use of models, mirrors, and matte paintings, and then combined with other images through optical printing. It pretends to be a simple recording of an already existing reality— both to the viewer and to itself.[15] Cinema's public image stressed the aura of reality "captured" on film, thus implying that cinema was about photographing what existed before the camera rather than creating the "never-was" of special effects.[16] Rear-projection and blue-screen photography, matte paintings and glass shots, mirrors and miniatures, push development, optical effects, and other techniques that allowed filmmakers to construct and alter moving images, and thus could reveal that cinema was not really different from animation, were pushed to cinema's periphery by its practitioners, historians, and critics.[17]

In the 1990s, with the shift to computer media, these marginalized techniques moved to the center.

Cinema Redefined

A visible sign of this shift is the new role that computer-generated special effects have come to play in the Hollywood industry in the 1990s. Many blockbusters have been driven by special effects; feeding on their popularity, Hollywood has even created a new minigenre of "The Making of . . . ," videos and books that reveal how special effects are created.

I will use special effects from 1990s' Hollywood films as illustrations of some of the possibilities of digital filmmaking. Until recently, Hollywood studios were the only ones who had the money to pay for digital tools and for the labor involved in producing digital effects. However, the shift to digital media affects not just Hollywood, but filmmaking as a whole. As traditional film technology is universally being replaced by digital technology, the logic of the filmmaking process is being redefined. What I describe below are the new principles of digital filmmaking that are equally valid for individual or collective film productions, regardless of whether they are using the most expensive professional hardware and software or amateur equivalents.

Consider, the following principles of digital filmmaking:

1. Rather than filming physical reality, it is now possible to generate filmlike scenes directly on a computer with the help of 3-D computer animation. As a result, live-action footage is displaced from its role as the only possible material from which a film can be constructed.

2. Once live-action footage is digitized (or directly recorded in a digital format), it loses its privileged indexical relationship to prefilmic reality. The computer does not distinguish between an image obtained through a photographic lens, an image created in a paint program, or an image synthesized in a 3-D graphics package, since they are all made from the same material— pixels. And pixels, regardless of their origin, can be easily altered, substituted one for another, and so on. Live-action footage is thus reduced to just another graphic, no different than images created manually.[18]

3. If live-action footage were left intact in traditional filmmaking, now it functions as raw material for further compositing, animating, and morphing. As a result, while retaining the visual realism unique to the photographic process, film obtains a plasticity that was previously only possible in painting or animation. To use the suggestive title of a popular morphing software, digital filmmakers work with “elastic reality.” For example, the opening shot of *Forrest Gump* (Zemeckis, Paramount Pictures, 1994; special effects by Industrial Light and Magic) tracks an unusually long and extremely intricate flight of a feather. To create the shot, the real feather was filmed against a blue background in different positions; this material was then animated and composited against shots of a landscape.[19] The result: a new kind of realism, which can be described as “something which looks exactly as if it could have happened, although it really could not.”

4. In traditional filmmaking, editing and special effects were strictly separate activities. An editor worked on ordering sequences of images; any intervention within an image was handled by special-effects specialists. The computer collapses this distinction. The manipulation of individual images via a paint program or algorithmic image-processing becomes as easy as arranging sequences of images in time. Both simply involve “cut and paste.” As this basic computer command exemplifies, modification of digital images (or other digitized data) is not sensitive to distinctions of time and space or to differences in scale. So, reordering sequences of images in time, compositing them together in space, modifying parts of an individual image, and changing individual pixels become the same operation, conceptually and practically.

Given the preceding principles, we can define digital film in this way:

> digital film = live action material + painting + image processing +
> compositing + 2-D computer animation + 3-D computer animation

Live-action material can either be recorded on film or video or directly in a digital format.[20] Painting, image processing, and computer animation refer to the processes of modifying already existent images as well as creating new ones. In fact, the very distinction between creation and modification, so clear in film-based media (shooting versus darkroom processes in photography, production versus postproduction in cinema), no longer applies to digital cinema, given that each image, regardless of its origin, goes through a number of programs before making it into the final film.[21]

Let us summarize these principles. Live-action footage is now only raw material to be manipulated by hand—animated, combined with 3-D computer generated scenes, and painted over. The final images are constructed manually from different elements, and all the elements are either created entirely from scratch or modified by hand. Now we can finally answer the question “What is digital cinema?” *Digital cinema is a particular case of animation that uses live-action footage as one of its many elements.*

This can be reread in view of the history of the moving image sketched earlier. Manual construction and animation of images gave birth to cinema and slipped into the margins . . . only to reappear as the foundation of digital cinema. The history of the moving image thus makes a full circle. *Born from* *animation, cinema pushed animation to its periphery, only in the end to become one particular case of animation.*

The relationship between "normal" filmmaking and special effects is similarly reversed. Special effects, which involved human intervention into machine-recorded footage and which were therefore delegated to cinema's periphery throughout its history, become the norm of digital filmmaking.

The same logic applies to the relationship between production and postproduction. Cinema traditionally involved arranging physical reality to be filmed through the use of sets, models, art direction, cinematography, and so forth. Occasional manipulation of recorded film (for instance, through optical printing) was negligible compared to the extensive manipulation of reality in front of the camera. In digital filmmaking, shot footage is no longer the final point, it is merely raw material to be manipulated on a computer, where the real construction of a scene will take place. In short, production becomes just the first stage of postproduction.

The following example illustrates this new relationship between different stages of the filmmaking process. Traditional on-set filming for *Stars Wars: Episode 1—The Phantom Menace* (Lucas, 1999) was done in just sixtyfive days. The postproduction, however, stretched over two years, since ninety-five percent of the film (approximately two thousand shots out of the total 2,200) was constructed on a computer.[22]

Here are two further examples illustrating the shift from rearranging reality to rearranging its images. From the analog era: for a scene in *Zabriskie Point* (1970), Michaelangelo Antonioni, trying to achieve a particularly saturated color, ordered a field of grass to be painted. From the digital era: To create the launch sequence in *Apollo 13* (Howard, 1995; special effects by Digital Domain), the crew shot footage at the original location of the launch at Cape Canaveral. The artists at Digital Domain scanned the film and altered it on computer workstations, removing recent building construction, adding grass to the launch pad and painting the skies to make them more dramatic. This altered film was then mapped onto 3-D planes to create a virtual set that was animated to match a 180-degree dolly movement of a camera following a rising rocket.[23]

The last example brings us to another conceptualization of digital cinema—as painting. In his study of digital photography, Mitchell focuses our attention on what he calls the inherent mutability of the digital image: "The essential characteristic of digital information is that it can be manipulated easily and very rapidly by computer. It is simply a matter of substituting new digits for old . . . Computational tools for transforming, combining, altering, and analyzing images are as essential to the digital artist as brushes and pigments to a painter."[24] As Mitchell points out, this inherent mutability erases the difference between a photograph and a painting. Since a film is a series of photographs, it is appropriate to extend Mitchell's argument to digital film. Given that an artist is easily able to manipulate digitized footage either as a whole or frame by frame, a film in a general sense becomes a series of paintings.[25]

Hand-painting digitized film frames, made possible by a computer, is probably the most dramatic example of the new status of cinema. No longer strictly locked in the photographic, cinema opens itself toward the painterly. Digital hand-painting is also the most obvious example of the return of cinema to its nineteenth-century origins—in this case, the hand-crafted images of magic lantern slides, the Phenakistiscope, and Zootrope.

We usually think of computerization as automation, but here the result is the reverse: What was previously recorded by a camera automatically now has to be painted one frame at a time. And not just a dozen images, as in the nineteenth century, but thousands and thousands. We can draw another parallel with the practice of manually tinting film frames in different colors according to a scene's mood, a practice common in the early days of silent cinema.[26] Today, some of the most visually sophisticated digital effects are often achieved using the same simple method: painstakingly altering thousands of frames by hand. The frames are painted over either to create mattes ("hand-drawn matte extraction") or to change the images directly, as, for instance, in *Forrest Gump*, where President Kennedy is made to speak new sentences by altering the shape of his lips, one frame at a time.[27] In principle, given enough time and money, one can create what will be the ultimate digital film: 129,600 frames (ninety minutes) completely painted by hand from scratch, but indistinguishable in appearance from live photography.

The concept of digital cinema as painting can also be developed in a different way. I would like to compare the shift from analog to digital filmmaking to the shift from fresco and tempera to oil painting in the early Renaissance. A painter making a fresco has limited time before the paint dries, and once it has dried, no further changes to the image are possible. Similarly, a traditional filmmaker has limited means of modifying images once they are recorded on film. Medieval tempera painting, can be compared to the practice of special effects during the analog period of cinema. A painter working with tempera could modify and rework the image, but the process was painstaking and slow. Medieval and early Renaissance masters would spend up to six months on a painting only a few inches tall. The switch to oils greatly liberated painters by allowing them to quickly create much larger compositions (think, for instance, of the works by Veronese and Titian) as well as to modify them as long as necessary. This change in painting technology led the Renaissance painters to create new kinds of compositions, new pictorial space, and new narratives. Similarly, by allowing a filmmaker to treat a film image as an oil painting, digital technology redefines what can be done with cinema.

If digital compositing and digital painting can be thought of as an extension of cell animation techniques (since composited images are stacked in depth parallel to each other, as cells on a animation stand), the newer method of computer-based postproduction makes filmmaking a subset of animation in a different way. In this method, the live-action photographic stills and/or graphic elements are positioned in a 3-D virtual space, thus giving the director the ability to move the virtual camera freely through this space, dollying and panning. Thus cinematography is subordinated to 3-D computer animation. We may think of this method as an extension of the multiplane animation camera. However, if the camera mounted over a multiplane stand could only move perpendicular to the images, now it can move in an arbitrary trajectory. An example of a commercial film that relies on this newer method, which one day may become the standard of filmmaking (because it gives the director the most flexibility), is Disney's *Aladdin;* an example of an independent work that fully explores the new aesthetic possibilities of this method without subordinating it to traditional cinematic realism is Waliczky's *The Forest*.

In the "Compositing" section, I pointed out that digital compositing can be thought off as an intermediary step between 2-D images and 3-D computer representation. The newer postproduction method represents the next logical step toward completely computer-generated 3-D representations. Instead of the 2-D space of "traditional" composite, we now have layers of moving images positioned in a virtual 3-D space.

The reader who has followed my analysis of the new possibilities of digital cinema may wonder why I have stressed the parallels between digital cinema and the pro-cinematic techniques of the nineteenth century, but have not mentioned twentieth-century avant-garde filmmaking. Did not the avant-garde filmmakers already explore many of these new possibilities? To take the notion of cinema as painting, Len Lye, one of the pioneers of abstract animation, was painting directly on film as early as 1935; he was followed by Norman McLaren and Stan Brackage, the latter extensively covering shot footage with dots, scratches, splattered paint, smears, and lines in an attempt to turn his films into equivalents of Abstract Expressionist paintings. More generally, one of the major impulses in all avant-garde filmmaking from Leger to Godard was to combine the cinematic, the painterly, and the graphic—by using live-action footage and animation within one film or even a single frame, by altering this footage in a variety of ways, or by juxtaposing printed texts and filmed images.

When the avant-garde filmmakers collaged multiple images within a single frame, or painted and scratched film, or revolted against the indexical identity of cinema in other ways, they were working against "normal" filmmaking procedures and the intended uses of film technology. (Film stock was not designed to be painted on.) Thus they operated on the periphery of commercial cinema not only aesthetically but also technically.

One general effect of the digital revolution is that avant-garde aesthetic strategies came to be embedded in the commands and interface metaphors of computer software.[28] In short, *the avant-garde became materialized in a computer*. Digital-cinema technology is a case in point. The avant-garde strategy of collage reemerged as the "cut-and-paste" command, the most basic operation one can perform on digital data. The idea of painting on film became embedded in the paint functions of film-editing software. The avant-garde move to combine animation, printed texts, and live-action footage is repeated in the convergence of animation, title generation, paint, compositing, and editing systems into all-in-one packages. Finally, the move to combine a number of film images within one frame (for instance, in Leger's 1924 *Ballet Mechanique* or in *Man with a Movie Camera*) also becomes legitimized by technology, given that all editing software, including Photoshop, Premiere, After Effects, Flame, and Cineon, assume by default that a digital image consists of a number of separate image layers. All in all, what used to be exceptions for traditional cinema have become the normal, intended techniques of digital filmmaking, embedded in technology design itself.[29]

From Kino-Eye to Kino-Brush

In the twentieth century, cinema played two roles at once. As a media technology, its role was to capture and store visible reality. The difficulty of modifying images once recorded was precisely what lent it value as a document, assuring its authenticity. This same rigidity has defined the limits of cinema as a "super-genre" of *live-action* narrative. Although cinema includes within itself a variety of styles—the result of the efforts of numerous directors, designers, and cinematographers—these styles share a strong family resemblance. They are all children of a recording process that uses lenses, regular sampling of time, and photographic media. They are all children of a machine vision.

The mutability of digital data impairs the value of cinema recordings as documents of reality. In retrospect, we can see that twentieth-century cinema's regime of visual realism, the result of automatically recording visual reality, was only an exception, an isolated accident in the history of visual representation, which has always involved, and now again involves, the manual construction of images. Cinema becomes a particular branch of painting—painting in time. No longer a kino-eye, but a kino-brush.[30]

The privileged role played by the manual construction of images in digital cinema is one example of a larger trend—the return of pro-cinematic moving-image techniques. Although marginalized by the twentiethcentury institution of live-action, narrative cinema, which relegated them to the realms of animation and special effects, these techniques are reemerging as the foundation of digital filmmaking. What was once supplemental to cinema becomes its norm; what was at the periphery comes into the center. Computer media return to us the repressed of the cinema.

As the examples in this section suggest, directions that were closed off at the turn of the century when cinema came to dominate the modern movingimage culture are now again beginning to be explored. The moving-image culture is being redefined once again; cinematic realism is being displaced from the dominant mode to merely one option among many.

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linear narratives from start to finish, they rely on film (or video) images but change them beyond the norms of traditional cinematic realism. The manipulation of images through hand-painting and image processing, hidden techniques in Hollywood cinema, is brought into the open on a television screen. Similarly, the construction of an image from heterogeneous sources is not subordinated to the goal of photorealism, but functions as an aesthetic strategy. The genre of music video has served as a laboratory for exploring numerous new possibilities of manipulating photographic images made possible by computers—the numerous points that exist in the space between the 2-D and the 3-D, cinematography and painting, photographic realism and collage. In short, it is a living and constantly expanding textbook for digital cinema.

A detailed analysis of the evolution of music video imagery (or, more generally, broadcast graphics in the electronic age) deserves a separate treatment, and I will not try to take it up here. Instead, I will discuss another new cinematic non-narrative form, CD-ROM-based games, which, in contrast to the music video, has relied on the computer for storage and distribution from the very beginning. And unlike music video designers, who were consciously pushing traditional film or video images into something new, the designers of CD-ROMs arrived at a new visual language unintentionally while attempting to emulate traditional cinema.

In the late 1980s, Apple began to promote the concept of computer multimedia, and in 1991 it released QuickTime software to enable an ordinary personal computer to play movies. During the first few years the computer did not perform its new role very well. First, CD-ROMs could not hold anything close to the length of a standard theatrical film. Second, the computer could not smoothly play a movie larger than the size of a stamp. Finally, the movies had to be compressed, degrading their visual appearance. Only in the case of still images was the computer able to display photographic-like detail at full-screen size.

Because of these particular hardware limitations, the designers of CD-ROMs had to invent a different kind of cinematic language in which a range of strategies, such as discrete motion, loops, and superimposition—previously used in nineteenth-century moving-image presentations, twentieth-century animation, and the avant-garde tradition of graphic cinema—were applied to photographic or synthetic images. This language synthesized cinematic illusionism and the aesthetics of graphic collage, with its characteristic heterogeneity and discontinuity. The photographic and the graphic, divorced when cinema and animation went their separate ways, met again on the computer screen.

The graphic also met the cinematic. The designers of CD-ROMs were aware of the techniques of twentieth-century cinematography and film editing, but they had to adapt these techniques both to an interactive format and to hardware limitations. As a result, the techniques of modern cinema and of nineteenth-century moving-image presentations merged in a new hybrid language that can be called “cinegratography.”

We can trace the development of this language by analyzing a few wellknown CD-ROM titles. The best-selling game *Myst* unfolds its narrative strictly through still images, a practice that takes us back to magic-lantern shows (and to Chris Marker’s *La Jetée*).[34] But in other ways *Myst* relies on the techniques of twentieth-century cinema. For instance, the CD-ROM uses simulated camera turns to switch from one image to the next. It also employs the basic technique of film editing to subjectively speed up or slow down time. In the course of the game, the user moves around a fictional island by clicking on a mouse. Each click advances a virtual camera forward, revealing a new view of the 3-D environment. When the user begins to descend into the underground chambers, the spatial distance between the points of view of each two consecutive views sharply decreases. If before, the user was able to cross a whole island with just a few clicks, now it takes a dozen clicks to get to the bottom of the stairs! In other words, just as in traditional cinema, *Myst* slows down time to create suspense and tension.

In *Myst,* miniature animations are sometimes embedded within the still images. In the next best-selling CD-ROM, *7th Guest* (Virgin Games, 1993), the user is presented with video clips of live actors superimposed over static backgrounds created with 3-D computer graphics. The clips are looped, and the moving human figures clearly stand out against the backgrounds. Both of these features connect the visual language of *7th Guest* to nineteenthcentury pre-cinematic devices and twentieth-century cartoons rather than to cinematic verisimilitude. But like *Myst, 7th Guest* also evokes distinctly modern cinematic codes. The environment where all the action takes place (an interior of a house) is rendered using a wide angle lens; to move from one view to the next, a camera follows a complex curve, as though mounted on a virtual dolly.

Next, consider the CD-ROM *Johnny Mnemonic* (Sony Imagesoft, 1995). Produced to complement the fiction film of the same title, marketed not as a “game” but as an “interactive movie,” and featuring full-screen video throughout, *Johnny Mnemonic* comes closer to cinematic realism than the previous CD-ROMs—yet it is still quite distinct from it. With all action shot against a green screen and then composited with graphic backgrounds, its visual style exists within the space between cinema and collage.

It would not be entirely inappropriate to read this short history of the digital moving image as a teleological development that replays the emergence of cinema a hundred years earlier. Indeed, as the speed of computers keeps increasing, CD-ROM designers have been able to go from a slide-show format to the superimposition of small moving elements over static backgrounds and finally to full-frame moving images. This evolution repeats the nineteenthcentury progression—from sequences of still images (magic-lantern slide presentations) to moving characters over static backgrounds (as in, for instance, Reynaud's Praxinoscope Theater) to full motion (the Lumières' cinematograph). Moreover, the introduction of QuickTime in 1991 can be compared to the introduction of the Kinetoscope in 1892: Both were used to present short loops, both featured images approximately two by three inches in size, both called for private viewing rather than collective exhibition. The two technologies even appear to play a similar cultural role. If in the early 1890s the public patronized Kinetoscope parlors where peep-hole machines presented them with the latest marvel—tiny, moving photographs arranged in short loops— exactly a hundred years later, computer users were equally fascinated with tiny QuickTime movies that turned a computer in a film projector, however imperfect.[35] Finally, the Lumières' first film screenings of 1895 that shocked their audiences with huge moving images found their parallel in 1995 CD-ROMs in which the moving image finally fills the entire computer screen (for instance, *Johnny Mnemonic*.) Thus, exactly a hundred years after cinema was officially "born," it was reinvented on a computer screen.

But this is only one reading. We no longer think of the history of cinema as a linear march toward one language, or as a progression toward increasingly accurate verisimilitude. Rather, we have come to see it as a succession of distinct and equally expressive languages, each with its own aesthetic variables, each new language closing off some of the possibilities of the previous one—a cultural logic not dissimilar to Kuhn's analysis of scientific paradigms.[36] Similarly, instead of dismissing the visual strategies of early multimedia titles as the result of technological limitations, we may want to think of them as an alternative to traditional cinematic illusionism, as the beginning of digital cinema's new language.

For the computer/entertainment industries, these strategies represent only a temporary limitation, an annoying drawback that needs to be overcome. This is one important difference between the situation at the end of the nineteenth century and the situation at the end of the twentieth century: If cinema was developing toward a still open horizon of many possibilities, the development of commercial multimedia, and of corresponding computer hardware (compression boards, storage formats such as DVD), was driven by a clearly defined goal—the exact duplication of cinematic realism. So if the computer screen increasingly emulates cinema's screen, this is not an accident, but the result of conscious planning by the computer and entertainment industries. But this drive to turn new media into a simulation of classical film language, which parallels the encoding of cinema's techniques in software interfaces and in the hardware itself, as described in the "Cultural Interfaces" section, is just one direction for new media development among numerous others. I will next examine a number of new media and old media objects that point toward other possible trajectories.

The New Temporality: The Loop as a Narrative Engine

One of the underlying assumptions of this book is that, by looking at the history of visual culture and media, in particular, cinema, we can find many strategies and techniques relevant to new media design. Put differently, to develop a new aesthetics of new media, we should pay as much attention to cultural history as to the computer's unique new possibilities to generate, organize, manipulate, and distribute data.

As we scan cultural history (which includes the history of new media up until the time of research), three kinds of situations will be particularly relevant for us:

- An interesting strategy or technique is abandoned or forced "underground" without fully developing its potential.
- A strategy can be understood as a response to technological constraints (I am purposefully using this more technical term instead of the more ideologically loaded "limitations") similar to those of new media.
- A strategy is used in a situation similar to that faced by new media designers. For instance, montage was a strategy for dealing with the modularity of film (how do you join separate shots?) as well as the problem of coordinating different media types such as images and sound. Both of these situations are being faced once again by new media designers.

I have already used these principles in discussing the parallels between nineteenth-century pro-cinematic techniques and the language of new media; they have also guided me in thinking about animation (the "underground" of twentieth-century cinema) as the basis for digital cinema. I will now use a particular parallel between early cinematic and new media technology to highlight another older technique useful to new media—the loop. Characteristically, many new media products, whether cultural objects (such as games) or software (various media players such as QuickTime Player) use loops in their design, while treating them as temporary technological limitations. I, however, want to think about them as a source of new possibilities for new media.[37]

As already mentioned in the previous section, all nineteenth-century procinematic devices, up through Edison's Kinetoscope, were based on short loops. As "the seventh art" began to mature, it banished the loop to the low-art realms of the instructional film, pornographic peep-show, and animated cartoon. In contrast, narrative cinema avoids repetitions; like modern Western fictional forms in general, it puts forward a notion of human existence as a linear progression through numerous unique events.

Cinema's birth from a loop form was reenacted at least once during its history. In one of the sequences of *Man with a Movie Camera*, Vertov shows us a cameraman standing in the back of a moving automobile. As he is being carried forward by the automobile, he cranks the handle of his camera. A loop, a repetition, created by the circular movement of the handle, gives birth to a progression of events—a very basic narrative that is also quintessentially modern—a camera moving through space recording whatever is in its way. In what seems to be a reference to cinema's primal scene, these shots are intercut with the shots of a moving train. Vertov even restages the terror that the Lumières' film supposedly provoked in its audience; he positions his camera right along the train track so the train runs over our point of view a number of times, crushing us again and again.

Early digital movies shared the same limitations of storage as nineteenthcentury pro-cinematic devices. This is probably why the loop playback function was built into the QuickTime interface, giving it the same weight as the VCR-style "play" function. So, in contrast to films and videotapes, QuickTime movies were supposed to be played forward, backward, or looped. Computer games also heavily relied on loops. Since it was not possible to animate every character in real time, designers stored short loops of a character's motions—for instance, an enemy soldier or a monster walking back and forth—that would be recalled at appropriate times in the game. Internet pornography also heavily relied on loops. Many sites featured numerous "channels" that were supposed to stream either feature-length feature films or "live feeds"; in reality, they would usually play short loops (a minute or so) over and over. Sometimes a few films would be cut into a number of short loops that would become the content of one hundred, five hundred, or one thousand channels.[38]

The history of new media tells us that hardware limitations never go away: They disappear in one area only to come back in another. One example I have already noted is the hardware limitations of the 1980s in the area of 3-D computer animation. In the 1990s they returned in a new area—Internet-based real-time virtual worlds. What used to be the slow speed of CPUs became slow bandwidth. As a result, the VRML worlds of the 1990s look like the prerendered animations done ten years earlier.

A similar logic applies to loops. Early QuickTime movies and computer games relied heavily on loops. As the CPU speed increased and larger storage media such as CD-ROM and DVD became available, the use of loops in stand-alone hypermedia declined. However, online virtual worlds such as Active Worlds came to use loops extensively, as they provide a cheap (in terms of bandwidth and computation) means of adding some signs of "life" to their geometric-looking environments.[39] Similarly, we may expect that when digital videos appear on small displays in our cellular phones, personal managers such as Palm Pilot, or other wireless communication devices, they will once again be arranged in short loops because of bandwidth, storage, or CPU limitations.

Can the loop be a new narrative form appropriate for the computer age?[40] It is relevant to recall that the loop gave birth not only to cinema but also to computer programming. Programming involves altering the linear flow of data through control structures, such as "if/then" and "repeat/while"; the loop is the most elementary of these control structures. Most computer programs are based on repetitions of a set number of steps; this repetition is controlled by the program's main loop. So if we strip the computer from its usual interface and follow the execution of a typical computer program, the computer will reveal itself to be another version of Ford's factory, with the loop as its conveyer belt.

As the practice of computer programming illustrates, the loop and the sequential progression do not have to be considered mutually exclusive. A computer program progresses from start to finish by executing a series of loops. Another illustration of how these two temporal forms can work together is

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As the practice of computer programming illustrates, the loop and the sequential progression do not have to be considered mutually exclusive. A computer program progresses from start to finish by executing a series of loops. Another illustration of how these two temporal forms can work together is positioned side by side. Both windows show the same video loop made from a few different shots. The two loops are offset from each other in time. Thus the images appearing in the left window reappear in a moment on the right and vice versa, as though an invisible wave is running through the screen. This wave soon becomes materialized—when we click inside the windows, we are taken to a new screen that also contains two windows, each showing the loop of a rhythmically vibrating water surface. The loops of water surfaces can be thought of as two sine waves offset in phase. This structure, then, functions as a metatext of the structure in the first screen. In other words, the loops of a water surface act as a diagram of the loop structure that controls the correlations between shots in the first screen, similar to how Marey and the Gibsons diagrammed human motion in their film studies at the beginning of the twentieth century.

As each mouse click reveals another loop, the viewer becomes an editor, but not in the traditional sense. Rather than constructing a singular narrative sequence and discarding material not used, here the viewer brings to the forefront, one by one, numerous layers of looped actions that seem to be taking place all at once, a multitude of separate but coexisting temporalities. The viewer is not cutting but reshuffling. In a reversal of Vertov's sequence in which a loop generates a narrative, the viewer's attempt to create a story in *Flora petrinsularis* leads to a loop.

It is useful to analyze the loop structure of *Flora petrinsularis* in terms of montage theory. From this perspective, the repetition of images in two adjoining windows can be interpreted as an example of what Eisenstein called "rhythmical montage." At the same time, Boissier takes montage apart, so to speak. Shots that in traditional temporal montage would follow each in time here appear next to one other in space. In addition, rather than being "hard-wired" by an editor in only one possible structure, here the shots can appear in different combinations since they are activated by a user moving a mouse across the windows.

It is also possible to find other examples of traditional temporal montage in this work as well—for instance, the move from the first screen, which shows a close-up of a woman, to a second screen, which shows water surfaces, and back to the first screen. This move can be interpreted as traditional parallel editing. In cinema, parallel editing involves alternating between two subjects. For instance, a chase sequence may go back and forth between the images of two cars, one pursuing another. However, in our case the water images are always present "underneath" the first set of images. So the logic here again is coexistence rather than replacement.

The loop that structures *Flora petrinsularis* on a number of levels becomes a metaphor for human desire that can never achieve resolution. It can also be read as a comment on cinematic realism. What are the minimal conditions necessary to create the impression of reality? In the case of a field of grass, or a close-up of a plant or stream, just a few looped frames, as Boissier demonstrates, is sufficient to produce the illusion of life and of linear time.

Steven Neale describes how early film demonstrated its authenticity by representing moving nature: "What was lacking [in photographs] was the wind, the very index of real, natural movement. Hence the obsessive contemporary fascination, not just with movement, not just with scale, but also with waves and sea spray, with smoke and spray."[45] What for early cinema was its biggest pride and achievement—a faithful documentation of nature's movement—becomes for Boissier a subject of ironic and melancholic simulation. As the few frames are looped over and over, we see blades of grass shifting slightly back and forth, rhythmically responding to a nonexistent wind, almost approximated by the noise of a computer reading data from a CD-ROM.

Something else is being simulated here as well, perhaps unintentionally. As you watch the CD-ROM, the computer periodically staggers, unable to maintain consistent data rate. As a result, the images on the screen move in uneven bursts, slowing and speeding up with human-like irregularity. It is as though they are brought to life not by a digital machine but by a human operator, cranking the handle of the Zootrope a century and a half ago . . .

Spatial Montage and Macrocinema

Along with taking on a loop, *Flora petrinsularis* can also be seen as a step toward what I will call *spatial montage*. Instead of the traditional singular frame of cinema, Boissier uses two images at once, positioned side by side. This can be thought of as the simplest case of spatial montage. In general, spatial montage could involve a number of images, potentially of different sizes and proportions, appearing on the screen at the same time. This juxtaposition by itself of course does not result in montage; it is up to the filmmaker to construct a logic that determines which images appear together, when they appear, and what kind of relationships they enter into with one other.

Spatial montage represents an alternative to traditional cinematic temporal montage, replacing its traditional sequential mode with a spatial one. Ford's assembly line relied on the separation of the production process into sets of simple, repetitive, and sequential activities. The same principle made computer programming possible: A computer program breaks a task into a series of elemental operations to be executed one at a time. Cinema followed this logic of industrial production as well. It replaced all other modes of narration with a sequential narrative, an assembly line of shots that appear on the screen one at a time. This type of narrative turned out to be particularly incompatible with the spatial narrative that had played a prominent role in European visual culture for centuries. From Giotto's fresco cycle at Capella degli Scrovegni in Padua to Courbet's *A Burial at Ornans,* artists presented a multitude of separate events within a single space, whether the fictional space of a painting or the physical space that can be taken in by the viewer all at once. In the case of Giotto's fresco cycle and many other fresco and icon cycles, each narrative event is framed separately, but all of them can be viewed together in a single glance. In other cases, different events are represented as taking place within a single pictorial space. Sometimes, events that form one narrative but are separated by time are depicted within a single painting. More often, the painting's subject becomes an excuse to show a number of separate "micronarratives" (for instance, works by Hiëronymous Bosch and Peter Bruegel). All in all, in contrast to cinema's sequential narrative, all the "shots" in spatial narrative are accessible to the viewer at once. Like nineteenth-century animation, spatial narrative did not disappear completely in the twentieth century, but rather, like animation, came to be delegated to a minor form of Western culture—comics.

It is not accidental that the marginalization of spatial narrative and the privileging of the sequential mode of narration coincided with the rise of the historical paradigm in human sciences. Cultural geographer Edward Soja has argued that the rise of history in the second half of the nineteenth century coincided with a decline in spatial imagination and a spatial mode of social analysis.[46] According to Soja, it is only in the last decades of the twentieth century that this mode has made a powerful comeback, as exemplified by the growing importance of such concepts as "geopolitics" and "globalization" as well as by the key role that analysis of space plays in theories of postmodernism. Indeed, although some of the best thinkers of the twentieth century, including Freud, Panofsky, and Foucault, were able to combine historical and spatial modes of analysis in their theories, they probably represent exceptions rather than the norm. The same holds for film theory, which, from Eisenstein in the 1920s to Deleuze in the 1980s, focuses on temporal rather than spatial structures of film.

Twentieth-century film practice has elaborated complex techniques of montage with different images replacing each other in time, but the possibility of what can be called a "spatial montage" of simultaneously coexisting images has not been explored as systematically. (Thus, cinema is also given to historical imagination at the expense of spatial imagination.) Notable exceptions include the use of a split screen by Abel Gance in *Napoléon* in the 1920s and also the American experimental filmmaker Stan Van der Beek in the 1960s; some of the works, or rather events, of the "expanded cinema" movement of the 1960s, and, last but not least, the legendary multi-image multimedia presentation shown in the Czech Pavilion at the 1967 World Expo. Emil Radok's *Diapolyeran* consisted of 112 separate cubes. One hundred and sixty different images could be projected onto each cube. Radok was able to "direct" each cube separately. To the best of my knowledge, no one has since attempted to create a spatial montage of this complexity in any technology.

Traditional film and video technology was designed to fill a screen completely with a single image; thus to explore spatial montage a filmmaker had to work "against" the technology. This in part explains why so few have attempted it. But when, in the 1970s, the screen became a bit-mapped computer display, with individual pixels corresponding to memory locations that could be dynamically updated by a computer program, the one image/ one screen logic was broken. Since the development of the Xerox PARC Alto workstation, GUI has used multiple windows. It would be logical to expect that cultural forms based on moving images will eventually adopt similar conventions. In the 1990s some computer games such as *Goldeneye* (Nintendo/Rare, 1997) already used multiple windows to present the same action simultaneously from different viewpoints. We may expect that computerbased cinema will eventually go in the same direction—especially once the limitations of communication bandwidth disappear and the resolution of displays significantly increases, from the typical 1-2K in 2000 to 4K, 8K, or beyond. I believe that the next generation of cinema—*broadband cinema,* or *macrocinema*—will add multiple windows to its language. When this happens, the tradition of spatial narrative that twentieth-century cinema suppressed will reemerge.

Modern visual culture and art offer us many ideas for how spatial narrative might be further developed in a computer; but what about spatial montage? In other words, what will happen if we combine two different cultural traditions—the informationally dense visual narratives of Renaissance and Baroque painters with the "attention demanding" shot juxtapositions of twentieth-century film directors? *My boyfriend came back from war!,* a Webbased work by the young Moscow artist Olga Lialina, can be read as an exploration in this direction.[47] Using the capability of HTML to create frames within frames, Lialina leads us through a narrative that begins with a single screen. This screen becomes progressively divided into more and more frames as we follow different links. Throughout, an image of a human couple and a constantly blinking window remain on the left part of the screen. These two images enter into new combinations with texts and images on the right that keep changing as the user interacts with the work. As the narrative activates different parts of the screen, montage in time gives way to montage in space. Put differently, we can say that montage acquires a new spatial dimension. In addition to montage dimensions already explored by cinema (differences in images' content, composition, and movement), we now have a new dimension—the position of images in space in relation to each other. In addition, as images do not replace each other (as in cinema) but remain on the screen throughout the movie, each new image is juxtaposed not just with the image that preceded it but with all the other images present on the screen.

The logic of replacement, characteristic of cinema, gives way to the logic of addition and coexistence. Time becomes spatialized, distributed over the surface of the screen. In spatial montage, nothing need be forgotten, nothing is erased. Just as we use computers to accumulate endless texts, messages, notes, and data, and just as a person, going through life, accumulates more and more memories, with the past slowly acquiring more weight than the future, spatial montage can accumulate events and images as it progresses through its narrative. In contrast to the cinema's screen, which primarily functions as a record of perception, here the computer screen functions as a record of memory.

As I have already noted, spatial montage can also be seen as an aesthetics appropriate to the user experience of multitasking and multiple windows of GUI. In the text of his lecture "Of other spaces," Michel Foucault writes: "We are now in the epoch of simultaneity: we are in the epoch of juxtaposition, the epoch of near and far, of the side-by-side, of the dispersed . . . our experience of the world is less of a long life developing through time that that of a network that connects points and intersects with its own skein. . . ."[48] Writing this in the early 1970s, Foucault appears to prefigure not only the network society, exemplified by the Internet ("a network which connects points"), but also GUI ("epoch of simultaneity . . . of the side-by-side"). GUI allows users to run a number of software applications at the same time, and it uses the convention of multiple overlapping windows to present both data and controls. The construct of the desktop, which presents the user with multiple icons all of which are simultaneously and continuously "active" (since all of them can be clicked at any time), follows the same logic of "simultaneity" and the "side-by-side." On the level of computer programming, this logic corresponds to object-oriented programming. Instead of a single program that, like Ford's assembly line, is executed one statement at a time, the object-oriented paradigm features a number of objects that send messages to each other. These objects are all active simultaneously. The Objectoriented paradigm and multiple windows of GUI work together; the object-oriented approach, in fact, was used to program the original Macintosh GUI that substituted the "one command at a time" logic of DOS with the logic of simultaneity of multiple windows and icons.

The spatial montage of *My boyfriend came back from war!* follows the logic of simultaneity of the modern GUI. The multiple and simultaneously active icons and windows of GUI become the multiple and simultaneously active frames and hyperlinks of this Web artwork. Just as the GUI user can click on any icon at any time, thereby changing the overall "state" of the computer environment, the user of Lialina's site can activate different hyperlinks that are all simultaneously present. Every action changes either the contents of a single frame or creates a new frame or frames. In either case, the "state" of the screen as a whole is affected. The result is a new cinema in which the diacronic dimension is no longer privileged over the syncronic dimension, time is no longer privileged over space, sequence is no longer privileged over simultaneity, montage in time is no longer privileged over montage within a shot.

Cinema as an Information Space

As I discussed earlier, cinema language, which originally was an interface to narrative taking place in 3-D space, is now becoming an interface to all types of computer data and media. I demonstrated how such elements of this language as rectangular framing, the mobile camera, image transitions, montage in time, and montage within an image reappear in the general purpose HCI, the interfaces of software applications, and cultural interfaces.

Yet another way to think about new media interfaces in relation to cinema is to interpret the latter as information space. *If HCI is an interface to computer data, and a book is an interface to text, cinema can be thought of as an interface to events taking place in 3-D space.* Just as painting before it, cinema presents us with familiar images of visible reality—interiors, landscapes, human characters—arranged within a rectangular frame. The aesthetics of these arrangements ranges from extreme scarcity to extreme density. Examples of the former are paintings by Morandi and shots in *Late Spring* (Yasujiro Ozu, 1949); examples of the latter are paintings by Bosch and Bruegel (and much of Northern Renaissance painting in general), and many shots in *Man with a Movie Camera*.[49] It would take only a small leap to relate this density of "pictorial displays" to the density of contemporary information displays such as Web portals, which may contain a few dozen hyperlinked elements, or the interfaces of popular software packages, which similarly present the user with combinations with texts and images on the right that keep changing as the user interacts with the work. As the narrative activates different parts of the screen, montage in time gives way to montage in space. Put differently, we can say that montage acquires a new spatial dimension. In addition to montage dimensions already explored by cinema (differences in images' content, composition, and movement), we now have a new dimension—the position of images in space in relation to each other. In addition, as images do not replace each other (as in cinema) but remain on the screen throughout the movie, each new image is juxtaposed not just with the image that preceded it but with all the other images present on the screen.

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Cinema as an Information Space

As I discussed earlier, cinema language, which originally was an interface to narrative taking place in 3-D space, is now becoming an interface to all types of computer data and media. I demonstrated how such elements of this language as rectangular framing, the mobile camera, image transitions, montage in time, and montage within an image reappear in the general purpose HCI, the interfaces of software applications, and cultural interfaces.

Yet another way to think about new media interfaces in relation to cinema is to interpret the latter as information space. *If HCI is an interface to computer data, and a book is an interface to text, cinema can be thought of as an interface to events taking place in 3-D space.* Just as painting before it, cinema presents us with familiar images of visible reality—interiors, landscapes, human characters—arranged within a rectangular frame. The aesthetics of these arrangements ranges from extreme scarcity to extreme density. Examples of the former are paintings by Morandi and shots in *Late Spring* (Yasujiro Ozu, 1949); examples of the latter are paintings by Bosch and Bruegel (and much of Northern Renaissance painting in general), and many shots in *Man with a Movie Camera*.[49] It would take only a small leap to relate this density of "pictorial displays" to the density of contemporary information displays such as Web portals, which may contain a few dozen hyperlinked elements, or the interfaces of popular software packages, which similarly present the user with film.[51]

For Benjamin, the modern regime of perceptual labor, where the eye is constantly asked to process stimuli, manifests itself equally in work and leisure. The eye is trained to keep pace with the rhythm of industrial production at the factory and to navigate through the complex visual semiosphere beyond the factory gates. It is appropriate to expect that the computer age will follow the same logic, presenting users with similarly structured perceptual experiences at work and home, on computer screens and off. Indeed, as I have already noted, we now use the same interfaces for work and leisure, a condition exemplified most dramatically by Web browsers. Another example is the use of the same interfaces in flight and military simulators, in computer games modeled after these simulators, and in the actual controls of planes and other vehicles (recall the popular perception of the Gulf War as a "video game war"). But if Benjamin appears to regret that the subjects of industrial society lost their premodern freedom of perception, now regimented by the factory, the modern city, and film, we may instead think of the information density of our own workspaces as a new aesthetic challenge, something to explore rather than condemn. Similarly, we should explore the aesthetic possibilities of all aspects of the user's experience with a computer, this key experience of modern life—the dynamic windows of GUI, multitasking, search engines, databases, navigable space, and others.

Cinema as a Code

When radically new cultural forms appropriate for the age of wireless telecommunication, multitasking operating systems, and information appliances arrive, what will they look like? How will we even know that they are here? Will future films look like a "data shower" from the movie *The Matrix*? Does the famous Xerox PARC fountain, whose water stream reflects the strength or weakness of the stock market, with stock data arriving in real time over the Internet, represent the future of public sculpture?

We do not yet know the answers to these questions. However, what artists and critics can do is point out the radically new nature of new media by staging—as opposed to hiding—its new properties. As my last example, I will discuss Vuk Cosic's ASCII films, which effectively stage one characteristic of computer-based moving images—their identity as computer code.[52]

It is worthwhile to relate Cosic's films to both Zuse's "found footage movies" from the 1930s, which I invoked in the beginning of this book, and to the first all-digital feature-length movie made sixty years later—Lucas's *Stars Wars: Episode 1—The Phantom Menace*.[53] Zuse superimposes digital code over the film images. Lucas follows the opposite logic: In his film, digital code "lies under" his images; that is, most images in the film were put together on computer workstations; during the postproduction process, they were pure digital data. The frames were made from numbers rather than bodies, faces, and landscapes. *The Phantom Menace,* therefore, can be called the first feature-length commercial abstract film—two hours worth of frames made from a matrix of numbers. But this is hidden from the audience.

What Lucas hides, Cosic reveals. His ASCII films "perform" the new status of media as digital data. The ASCII code that results when an image is digitized is displayed on the screen. The result is as satisfying poetically as it is conceptually—for what we get is a double image—a recognizable film image and an abstract code together. Both are visible at once. Thus rather than erasing the image in favor of the code as in Zuse's film, or hiding the code from us as in Lucas's film, code and image coexist.

Like the VinylVideo project by Gebhard Sengmüller, which records TV programs and films on old vinyl disks,[54] Cosic's ASCII initiative[55] is a systematic program of translating media content from one obsolete format into another. These projects remind us that *since at least the 1960s the operation of media translation has been at the core of our culture*. Films transferred to video, video transferred from one video format to another, video transferred to digital data, digital data transferred from one format to another—from floppy disks to Jaz drives, from CD-ROMs to DVDs, and so on, indefinitely. Artists noticed this new logic of culture early on: By the 1960s, Roy Lichtenstein and Andy Warhol had already made media translation the basis of their art. Sengmüller and Cosic understand that the only way to deal with the builtin media obsolescence of a modern society is by ironically resurrecting dead media. Sengmüller translates old TV programs into vinyl disks; Cosic translates old films into ASCII images.[56]

Why do I call ASCII images an obsolete media format? Before the printers capable of outputting raster digital images became widely available toward the end of the 1980s, it was commonplace to make printouts of images on dot matrix printers by converting the images into ASCII code. In 1999 I was surprised to still find the appropriate program on my UNIX system. Called simply "toascii," the command, according to the UNIX system manual page for the program, "prints textual characters that represent the black and white image used as input."

The reference to the early days of computing is not unique to Cosic, but is shared by other net.artists. Jodi.org, the famous net.art project created by the artistic team of Joan Heemskerk and Dirk Paesmans, often evokes DOS commands and the characteristic green color of computer terminals from the 1980s;[57] Russian net.artist Alexei Shulgin has performed music in the late 1990s using an old 386PC.[58] But in the case of ASCII code, its use evokes not only a peculiar episode in the history of computer culture but a number of earlier forms of media and communication technologies as well. ASCII is the acronym of "American Standard Code for Information Interchange." The code was originally developed for teleprinters and was only later adopted for computers in the 1960s. A teleprinter was a twentieth-century telegraph system that translated the input from a typewriter keyboard into a series of coded electric impulses, that were then transmitted over communications lines to a receiving system that decoded the pulses and printed the message onto a paper tape or other medium. Teleprinters were introduced in the 1920s and were widely used until the 1980s (Telex being the most popular system), when they were gradually replaced by fax and computer networks.[59]

ASCII code was itself an extension of an earlier code invented by JeanMaurice-Emile Baudot in 1874. In Baudot code, each letter of an alphabet is represented by a five-unit combination of current-on or current-off signals of equal duration. ASCII code extends Baudot code by using eight-unit combinations (that is, eight "bits" or one "byte") to represent 256 different symbols. Baudot code itself was an improvement over the Morse code invented for early electric telegraph systems in the 1830s.

The history of ASCII code thus compresses a number of technological and conceptual developments that lead to (but I am sure will not stop at) modern digital computers—cryptography, real-time communication, communication network technology, coding systems. By juxtaposing ASCII code with the history of cinema, Cosic accomplishes what can be called an "artistic compression"; that is, along with staging the new status of moving images as a computer code, he also "encodes" many key issues of computer culture and new media art in these images.

As this book has argued, in a computer age, cinema, along with other established cultural forms, indeed becomes precisely a code. It is now used to communicate all types of data and experiences, and its language is encoded in the interfaces and defaults of software programs and in the hardware itself. Yet while new media strengthens existing cultural forms and languages, including the language of cinema, it simultaneously opens them up for redefinition. Elements of their interfaces become separated from the types of data to which they were traditionally connected. Further, cultural possibilities that were previously in the background, on the periphery, come into the center. For instance, animation comes to challenge live cinema; spatial montage comes to challenge temporal montage; database comes to challenge narrative; the search engine comes to challenge the encyclopedia; and, last but not least, online distribution of culture challenges traditional "off-line" formats. To use a metaphor from computer culture, new media transforms all culture and cultural theory into an "open source." This opening up of cultural techniques, conventions, forms, and concepts is ultimately the most promising cultural effect of computerization—an opportunity to see the world and the human being anew, in ways that were not available to "a man with a movie camera."

1. The phenomenon of motion rides has already been discussed in detail by Finnish new media theoretician and historian Erkki Huhtamo.

2. For a list of some of these sites as of October 1999, see "Small-Screen Multiplex," *Wired*7.10 (October 1999), http://www.wired.com/archive/7.10/multiplex.html.

3. On the history of computer-based image analysis, see my article "Automation of Sight from Photography to Computer Vision."

4. Scott Billups, presentation during the "Casting from Forest Lawn (Future of Performers)" panel at "The Artists Rights Digital Technology Symposium '96," Los Angeles, Directors Guild of America, 16 February 1996. Billups was a major figure in bringing together Hollywood and Silicon Valley by way of the American Film Institute's Apple Laboratory and Advanced Technologies Programs in the late 1980s and early 1990s. See Paula Parisi, "The New Hollywood Silicon Stars," *Wired* 3.12 (December 1995), 142-145, 202-210.

5. Christian Metz, "The Fiction Film and Its Spectator," 402.

6. Cinema as defined by its "super-genre" of fictional live-action film belongs to the media arts, which, in contrast to traditional arts, rely on recordings of reality as their basis. Another term not as popular as "media arts" but perhaps more precise is "recording arts." For the use of this term, see James Monaco, *How to Read a Film,* rev. ed. (New York: Oxford University Press, 1981), 7.

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