Lev Manovich

The Language of New Media

To Norman Klein / Peter Lunenfeld / Vivian Sobchack

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Prologue: Vertov's Dataset

The avant-garde masterpiece A Man With a Movie Camera completed by Russian director Dziga Vertov in 1929 will serve as our guide to the language of new media.This prologue consists of a number of stills from the film. Each still is accompanied by quote from the text summarizing a particular principle of new media. The number in brackets indicates a page from which the quote is taken. The prologue thus acts as a visual index to some of the book's ideas.

1.
[figure 1]

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

2.
[figure 2] [figure 3] [figure 4] [figure 5]

(91) “The incorporation of virtual camera controls into the very hardware of a game consoles is truly a historical event. Directing the virtual camera becomes as important as controlling the hero's actions… the computer games are returning to "The New Vision" movement of the 1920s (Moholy-Nagy, Rodchenko, Vertov and others), which foregrounded new mobility of a photo and film camera, and made unconventional points of view the key part of their poetics.

3.
[figure 6] [figure 7] [figure 8] [figure 9]

(140) "Editing, or montage, is the key twentieth technology for creating fake realities. Theoreticians of cinema have distinguished between many kinds of montage but, for the purposes of sketching the archeology of the technologies of simulation leading to digital compositing, I will distinguish between two basic techniques. The first technique is temporal montage: separate realities form consecutive moments in time. The second technique is montage within a shot. It is the opposite of the first: separate realities form contingent parts of a single image… examples [of montage within a shot] include the superimposition of a few images and multiple screens used by the avant-garde filmmakers in the 1920's (for instance, superimposed images in Vertov's Man with a Movie Camera and a three-part screen in Gance Abel's 1927 Napoléon).

4.
[figure 10] [figure 11] [figure 12]

(140) “As theorized by Vertov, through [temporal] montage, film can overcome its indexical nature, presenting a viewer with objects which never existed in reality.”

5.
[figure 13] [figure 14]

(147) “While the dominant use of digital compositing is to create a seamless virtual space, it does not have to be subordinated to this goal. The borders between different worlds do not have to be erased; the different spaces do not have to be matched in perspective, scale and lighting; the individual layers can retain their separate identity rather then being merged into a single space; the different worlds can clash semantically rather than form a single universe.”

6.
[figure 15] [figure 16] [figure 17] [figure 18] [figure 19]

(158) “The cameraman, whom Benjamin compares to a surgeon, ‘penetrates deeply into its [reality] web’; his camera zooms in order to ‘pray an object from its shell.’ With its new mobility, glorified in such films as A Man with the Movie Camera, the camera can be anywhere, and, with its superhuman vision, it can obtain a close-up of any object... Along with disregarding the scale, the unique locations of the objects are discarded as well as their photographs brought together within a single picture magazine or a film newsreel, the forms which fit in with the demand of mass democratic society for ‘the universal equality of things.’”

7.
[figure 20] [figure 21]

(160) “Modernization is accompanied by the process of disruption of physical space and matter, the process which privileges interchangeable and mobile signs over the original objects and relations…The concept of modernization fits equally well Benjamin's account of film and Virilio's account of telecommunication, the latter just being a more advanced stage in this continual process of turning objects into mobile signs. Before, different physical locations met within a single magazine spread or a film newsreel; now, they meet within a single electronic screen.”

8.
[figure 22] [figure 23]

(183) “Whose vision is it? It is the vision of a computer, a cyborg, a automatic missile. It is a realistic representation of human vision in the future when it will be augmented by computer graphics and cleansed from noise. It is the vision of a digital grid. Synthetic computer-generated image is not an inferior representation of our reality, but a realistic representation of a different reality.”

9.
[figure 24]

(209) "Along with Greenaway, Dziga Vertov can be thought of as a major 'database filmmaker' of the twentieth century. Man with a Movie Camera is perhaps the most important example of database imagination in modern media art."

10.
[figure 25] [figure 26] [figure 27]

(210) “Just as new media objects contain a hierarchy of levels (interface — content; operating system — application; Web page — HTML code; high-level programming language — assembly language — machine language), Vertov's film consists of at least three levels. One level is the story of a cameraman filming material for the film. The second level is the shots of an audience watching the finished film in a movie theater. The third level is this film, which consists from footage recorded in Moscow, Kiev and Riga and is arranged according to a progression of one day: waking up — work — leisure activities. If this third level is a text, the other two can be thought of as its meta-texts.”

11.
[figure 28] [figure 29] [figure 30] [figure 31] [figure 32] [figure 33] [figure 34]

(211) ”If a ‘normal’ avant-garde film still proposes a coherent language different from the language of mainstream cinema, i.e. a small set of techniques which are repeated, Man with a Movie Camera never arrives at anything like a well-defined language. Rather, it proposes an untamed, and apparently endless unwinding of cinematic techniques, or, to use contemporary language, ‘effects’, as cinema's new way of speaking.”

12.
[figure 35] [figure 36]

(212) ”And this is why Vertov’s film has a particular relevance to new media. It proves that it is possible to turn “effects” into a meaningful artistic language. Why in the case of Witney's computer films and music videos the effects are just effects, while in the hands of Vertov they acquire meaning? Because in Vertov's film they are motivated by a particular argument, this being that the new techniques to obtain images and manipulate them, summed up by Vertov in his term "kino-eye," can be used to decode the world. As the film progresses, "straight" footage gives way to manipulated footage; newer techniques appear one after one, reaching a roller coaster intensity by the film's end, a true orgy of cinematography. It is as though Vertov re-stages his discovery of the kino-eye for us. Along with Vertov, we gradually realize the full range of possibilities offered by the camera. Vertov's goal is to seduce us into his way of seeing and thinking, to make us share his excitement, his gradual process of discovery of film's new language. This process of discovery is film's main narrative and it is told through a catalog of discoveries being made. Thus, in the hands of Vertov, a database, this normally static and "objective" form, becomes dynamic and subjective. More importantly, Vertov is able to achieve something which new media designers and artists still have to learn — how to merge database and narrative merge into a new form.”

13.
[figure 37] [figure 38] [figure 39]

(226) “If modern visual culture exemplified by MTV can be thought of as a Mannerist stage of cinema, its perfected techniques of cinematography, mise-en-scene and editing self-consciously displayed and paraded for its own sake, Waliczky's film presents an alternative response to cinema’s classical age, which is now behind us. In this meta-film, the camera, part of cinema’s apparatus, becomes the main character (in this we may connect The Forest to another meta-film, A Man with a Movie Camera).”

14.
[figure 40] [figure 41] [figure 42] [figure 43]

(236) “Vertov stands half-way between Baudelaire's flâneur and computer user: no longer just a pedestrian walking through a street, but not yet Gibson’s data cowboy who zooms through pure data armed with data mining algorithms. In his research on what can be called “kino-eye interface,” Vertov systematically tried different ways to overcome what he thought were the limits of human vision. He mounted cameras on the roof of a building and a moving automobile; he slowed and speed up film speed; he superimposed a number of images together in time and space (temporal montage and montage within a shot). A Man with a Movie Camera is not only a database of city life in the 1920s, a database of film techniques, and a database of new operations of visual epistemology, but it is also a database of new interface operations which together aim to go beyond a simple human navigation through a physical space.”

15.
[figure 44] [figure 45]

(258) “Avant-garde aesthetic strategies became embedded in the commands and interface metaphors of computer software. The avant-garde became materialized in a computer. Digital cinema technology is a case in point. The avant-garde strategy of collage reemerged as a "cut and paste" command, the most basic operation one can perform on digital data. The idea of painting on film became embedded in 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 single all-in-one packages.”

16.
[figure 46] [figure 47]

(265) “Cinema's birth from a loop form was reenacted at least once during its history. In one of the sequences of A 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 an 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 which is also quintessentially modern: a camera moving through space recording whatever is in its way.”

17.
[figure 48]

(266) “Can the loop be a new narrative form appropriate for the computer age? 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…. As the practice of computer programming illustrates, the loop and the sequential progression do not have to be thought as being mutually exclusive. A computer program progresses from start to end end by executing a series of loops.”

18.
[figure 49] [figure 50] [figure 51]

(270) “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 a set of repetitive, sequential, and simple activities. The same principle made computer programming possible: a computer program breaks a tasks 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 which appear on the screen one at a time. A sequential narrative turned out to be particularly incompatible with a spatial narrative which played a prominent role in European visual culture for centuries.”

19.
[figure 52]

(271) “Since the Xerox Park Alto workstation, GUI used multiple windows. It would be logical to expect that cultural forms based on moving images will eventually adopt similar conventions… We may expect that computer-based cinema will eventually have to follow the same direction — especially when the limitations of communication bandwidth will disappear, while the resolution of displays will significantly increase, from the typical 1-2K in 2000 to 4K, 8K or beyond. I believe that the next generation of cinema — broadband cinema — will add multiple windows to its language.”

20.
[figure 53]
[figure 54]
[figure 55]

(273) "If HCI is an interface to computer data, and a book is interface to text, cinema can be thought of an interface to events taking place in 3D space. Just as painting before it, cinema presented 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… It would be 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 dozens commands at once."

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Word processor: Microsoft Word.

Web browser: Netscape Navigator, Internet Explorer.

Favorite search engine: www.hotbot.com

Favorite moving image format: QuickTime

HTML editor: Netscape Communicator, Macromedia Dreamweather.

OS: Windows 98.

Hardware: SONY PCG505FX laptop.

Mobile phone: Nokia.

The principal editing of his book was done between July 1998 and November 1999 in La Jolla and Del Mar, California; Los Angeles; New York; Stockholm, Helsinki, and Amsterdam.

While significant parts of this book have been written anew, it have drawn on material from a number of previously published articles. Sometimes only a part of an article made it into the final manuscript; in other cases, its parts ended up in different chapters of the book; in yet other case, a whole article became the basis for one of the sections. In the following I list the articles which were used as material for the book. Many of them were reprinted and translated into other languages; here I list the first instance of publication in English. Also, it has been my practice for a number of years to post any new writing I do to Nettime [1] and Rhizome[2], the two important Internet email lists devoted to discussions of new media art, criticism and politics. This helped me to receive immediate feedback on my work and also provided me with a sense of community interested in my

work. Therefore, most of the articles appeared on these two email lists before being published in more traditional print venues such as journals and anthologies or in Internet journals.

"Assembling Reality: Myths of Computer Graphics." In Afterimage 20, no. 2 (September 1992): 12-14.

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"Cinema by Numbers: ASCII Films by Vuk Cosic." In Vuk Cosic: Contemporary ASCII (Ljubljana, Slovenija: forthcoming). (http://www.vuk.org/ascii/)

"New Media: a User's Guide" in NET.CONDITION (ZKM / Zentrum für

Kunst und Medientechnologie Karlsruhe and The MIT Press, forthcoming).

Introduction

A Personal Chronology

Moscow, 1975. Although my ambition is to become a painter, I enroll in the so-called "mathematical" ("matematicheskaya") high school which in addition to a regular curriculum has courses in calculus and computer programming. The programming course lasts two years during which we never see a computer. Our teacher uses a black board to explain the concepts of computer programming. First we learn a computer language invented in Soviet Union in the late 1950s. The language has a wonderful Cold War name: Peace-1 (Mir-1.) Later we learn a more standard high-level language: ALGOL-60. For two years, we write computer programs in our notebooks. Our teaches grades them and returns them back with corrections: missed end of the loop statement; undeclared variable; forgotten semi-colon. At the end of the two-year course we are taken—just once—to a data processing center, which normally requires clearance to enter. I enter my program into a computer but it does not run: since I never saw a computer keyboard before, I use capital O whenever I need to input zero.

The same year, 1975, I start taking private lessons in classical drawing, which also last two years. Moscow Architectural Institute entrance exams include a test in which the applicants have to complete a drawing of an antique cast in eight hours. To get the top grade one has to produce a drawing which not only looks like the cast and has perfect perspective but also has perfect shading. Which means that all shadows and surfaces are defined completely through shading, so all lines originally used to define them disappear. Hundreds of hours spent in front of a drawing board pay off: I get an A on the exam, even though out of eight possible casts I get the most difficult one: Venera. It is more difficult because, in contrast to casts of male heads such as Socrates, it does not have well-defined facets; the surfaces join smoothly together as though constructed using a spline modeling program. (Later I learn that, during the 1970s, computer scientists were working on the same problem: how to produce smoothly shaded images of 3D objects in a computer. The standard rendering algorithm still used today was invented at the University of Utah in 1975—the same year I started my drawing lessons.[3]

New York, 1985. It is early morning and I am sitting in front of a Tetronics terminal in Midtown Manhattan. I have just finished my night shift at Digital Effects, one of the first companies in the world devoted to producing 3D computer animation for film and television. The company worked on <u>Tron</u> and produced computer animation for all of the major television networks; my job was to operate the Harris-500 mainframe, used to compute animations, and also the PDP-11, which controlled Dicomed film recorder, used to output animation on 35mm film. After a few months I am able to figure out company's proprietary computer graphics software written in APL, and am now working on my first images. I would like to produce a synthetic image of an antique cast, but it turns out to be impossible. The software is only able to create 3D objects out of primitive geometric forms such as cubes, cylinders and spheres; a decade would have to pass before one could go on the Internet and download tens of thousands of ready-made 3D models of all kinds of objects . So I settle for a composition made out of these primitive forms. Tetronics is a vector rather than raster terminal, which means that it does not update its screen in real time. Each time I make a change in my program or simply change a point of view, I hit the enter key and wait while the computer redraws the lines, one by one. I wonder why I had to spend years learning to draw images in perspective when a computer could do it in seconds. A few of the images I create are exhibited in shows of computer art in New York. But this is heyday of post-modernism, the art market is hot, paintings by young New York artists are selling for hundreds of thousands of dollars, and the art world has little interest in computer animation or even computer art.

Linz, Austria, 1995. I am at Ars Electronica, the world's most prestigious annual computer art festival. This year it drops the "Computer Graphics" category, replacing it with the new "net art" category, signaling a new stage in the evolution of modern culture and media. The computer, which since the early 60s was used as a production tool, has become a universal media machine: a tool used not only for production, but also for storage, distribution and playback. The World Wide Web crystallized this new condition; on the level of language, it was recognized already around 1990 when the term "digital media" came to be used along with "computer graphics." At the same time, along with existing cultural forms, during the 1990s computers came to host an array of new forms: Web sites and computer games, hypermedia CD-ROMs and interactive installations—in short, "new media." And if in 1985 I had to write a long computer program in a specialized computer language just to put a picture of a shaded cube on a computer screen, ten years later I can choose from a number of inexpensive, menu-based 3D software tools which run on ordinary PCs and which come with numerous ready-made 3D models, including detailed human figures and heads.

What else can be said about 1995? The Soviet Union, where I was born, no longer exists. With its demise, the tensions which animated creative imaginations both in the East and the West—between freedom and confinement, between interactivity and predetermination, between consumerism in the West and something which thinkers and artists in the East called "spirituality"— had disappeared. What came in their place? A triumph of consumerism, commercial culture (based on stereotypes and limited clichés), mega-corporations which laid claims on such basic categories as space, time and the future ("Where do You

Want to Go Today?" ads by Microsoft; Internet Time by Swatch which breaks 24 hours into 1,000 Swatch 'beats'; "You will" ads by AT&T), and something which thinkers and artists call "globalization" (a term at least as elusive as "spirituality").

When I visited St. Petersburg in 1995 to participate in small computer art festival called "In Search of Third Reality," I saw a curious performance, which may be a good parable of globalization. Like the rest of the festival, the performance took place in the Planetarium. The Director of the Planetarium, forced like everybody else to make his own living in the new Russian economic order (or lack thereof), rented the Planetarium to conference organizers. Under the black semi-spherical ceiling with mandatory models of planets and stars, a young artist was methodically painting an abstract painting. Probably trained in the same classical style as I was earlier, he was no Pollock; cautiously and systematically, he made careful brushstrokes on the canvas in front of him. On his hand he wore a Nintendo Dataglove, which in 1995 was a common media object in the West but a rare sight in St. Petersburg. The Dataglove was transmitting the movements of his hand to a small electronic synthesizer, assembled in the laboratory of some Moscow institute. The music coming out of the synthesizer served as an accompaniment to two dancers, a male and a female. Dressed in Isidora Dunkan like clothing, they improvised a "modern dance" in front of the older and, apparently, completely puzzled audience. Classical art, abstraction and a Nintendo Dataglove; electronic music and early twentieth century modernism; discussions of virtual reality (VR) in a Planetarium located in this classical city which, like Venice, is obsessed with its past—what for me, coming from the West, were incompatible historical and conceptual layers were here composited together, with the Nintendo Dataglove being just one layer in this mix.

What had also come by 1995 was Internet—the most material and visible sign of globalization. And, by the end of the decade, it has also become clear that the gradual computerization of culture will eventually transform all of it. So, to invoke the old Marxist model of base and superstructure, if the economic base of modern society from the 1950s onward started to shift toward a service and information economy, becoming by the 1970s a so-called "post-industrial society" (Daniel Bell), and then later a "network society" (Manual Castells), by the 1990s the superstructure started to feel the full impact of this change.[4] If the "post-modernism" of the 1980s was the first, preliminary echo of this shift still to come—still weak, still possible to ignore—the 1990s' rapid transformation of culture into e-culture, of computers into universal culture carriers, of media into new media, demanded that we rethink our categories and models.

The year is 2005…

Theory of the Present

I wish that somebody, in 1895, 1897 or at least in 1903, had realized the fundamental significance of cinema's emergence and produced a comprehensive record of the new medium's emergence: interviews with the audiences; a systematic account of the narrative strategies, scenography and camera positions as they developed year by year; an analysis of the connections between the emerging language of cinema and different forms of popular entertainment which coexisted with it. Unfortunately, such records do not exist. Instead, we are left with newspaper reports, diaries of cinema's inventors, programs of film showings and other bits and pieces—a set of random and unevenly distributed historical samples.

Today we are witnessing the emergence of a new medium—the meta-medium of the digital computer. In contrast to a hundred years ago, when cinema was coming into being, we are fully aware of the significance of this new media revolution. And yet I am afraid that future theorists and historians of computer media will be left with not much more than the equivalents of newspaper reports and film programs left from cinema's first decades. They will find that the analytical texts from our era are fully aware of the significance of computer's takeover of culture yet, by and large, mostly contain speculations about the future rather than a record and a theory of the present. Future researchers will wonder why the theoreticians, who already had plenty of experience analyzing older cultural forms, did not try to describe computer media's semiotic codes, modes of address, and audience reception patterns. Having painstakingly reconstructed how cinema emerged out of preceding cultural forms (panorama, optical toys, peep shows), why didn't they attempt to construct a similar genealogy for the language of computer media at the moment when it was just coming into being, while the elements of previous cultural forms going into its making were still clearly visible, still recognizable before melting into a new unity? Where were the theoreticians at the moment when the icons and the buttons of multimedia interfaces were like wet paint on a just-completed painting, before they became universal conventions and thus slipped into invisibility? Where were they at the moment when the designers of <u>Myst</u> were debugging their code, converting graphics to 8-bit and massaging QuickTime clips? Or at the historical moment when a young 20-something programmer at Netscape took the chewing gum out of his mouth, sipped warm Coke out of the can—he was at a computer for 16 hours straight, trying to meet a marketing deadline—and, finally satisfied with its small file size, saved a short animation of stars moving across the night sky? This animation was to appear in the upper right corner of Netscape Navigator, thus becoming the most widely seen moving image sequence ever until the next release of the software

The following is an attempt at both a record, and a theory, of the present. Just as film historians traced the development of film language during cinema's first decades, I aim to describe and understand the logic driving the development of the language of new media. (I am not claiming that there is a single language of new media; rather, I use it as an umbrella term to refer to a number of various conventions used by designers of new media objects to organize data and structure user's experience.) It is tempting to extend this parallel a little further and to speculate whether today this new language is already getting closer to acquiring its final and stable form, just as film language acquired its "classical" form during the 1910's. Or it may be that the 1990's are more like the 1890's, because the computer media language of the future will be entirely different from the one used today.

Does it make sense to theorize the present when it seems to be changing so fast? It is a hedged bet. If subsequent developments prove my theoretical projections correct, I win. But even if the language of computer media develops in a different direction than the one suggested by the present analysis the analysis presented here will become a record of possibilities which were heretofore unrealized, of a horizon which was visible to us today but later became unimaginable.

We no longer think of the history of cinema as a linear march towards a single possible language, or as a progression towards perfect verisimilitude. On the contrary, we have come to see its history 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 Thomas Kuhn's analysis of scientific paradigms.)[5] Similarly, every stage in the history of computer media offers its own aesthetic opportunities, as well as its own imagination of the future: in short, its own "research paradigm." Each paradigm is modified or even abandoned at the next stage. In this book I wanted to record the "research paradigm" of new media during its first decade, before it slips into invisibility.

Mapping New Media: the Method

In this book I analyze the language of new media by placing it within the history of modern visual and media cultures. What are the ways in which new media relies on older cultural forms and languages and what are the ways in which it breaks with them? What is unique about how new media objects create the illusion of reality, address the viewer, and represent space and time? How do conventions and techniques of old media—such as the rectangular frame, mobile viewpoint and montage—operate in new media? If we are to construct an archeology which will connect new computer-based techniques of media creation with previous techniques of representation and simulation, where should we locate the essential historical breaks?

To answer these questions, I look at several areas of new media: Web sites, virtual worlds[6], VR, multimedia, computer games, interactive installations, computer animation, digital video, cinema, and human-computer interfaces. While the book's main emphasis is on theoretical and historical arguments, I also analyze many key new media objects created during the field's history, from such American commercial classics as Myst and Doom, Jurassic Park and Titanic, to the works of international new media artists and collectives such as ART+COM, antirom, jodi.org, George Legrady, Olga Lialina, Jeffrey Shaw, and Tamas Waliczky.

The computerization of culture not only leads to the emergence of new cultural forms such as computer games and virtual worlds; it redefines existing ones such as photography and cinema. I therefore also investigate the effects of the computer revolution on visual culture at large. How does the shift to computer-based media redefine the nature of static and moving images? What is the effect of computerization on the visual languages used by our culture? What are the new aesthetic possibilities which become available to us?

In answering these questions, I draw upon the histories of art, photography, video, telecommunication, design and, last but not least, the key cultural form of the twentieth century—cinema. The theory and history of cinema serve as the key conceptual "lens" though which I look at new media. The book explores the following topics:

- the parallels between cinema history and the history of new media;
- the identity of digital cinema;
- the relations between the language of multimedia and nineteenth century pre-cinematic cultural forms;
- the functions of screen, mobile camera and montage in new media as compared to cinema;
- the historical ties between new media and avant-garde film.

Along with film theory, this book draws its theoretical frameworks from both the humanities and the sciences, utilizing art history, literary theory, media studies, social theory, and computer science. Its overall method could be called "digital materialism." Rather than imposing some *a priori* theory from above, I build a theory of new media from the ground up. I scrutinize the principles of computer hardware and software, and the operations involved in creating cultural objects on a computer, in order to uncover a new cultural logic at work.

Most writings on new media are full of speculation about the future. This book analyses new media as it has actually developed up until this point, at the same time pointing to directions for new media artists and designers which have not been yet explored. It is my hope that the theory of new media developed here can act not only as an aid to help understand the present, but also as a grid for practical experimentation. For example, “Theory of Cultural Interfaces” section analyzes how the interfaces of new media objects are being shaped by three cultural traditions: print, cinema and human-computer interface. By describing the elements of these traditions which are already used in new media, this analysis points towards other elements and their combinations which are still waiting to be experimented with. “Compositing” section provides another set of directions for experiments by outlining a number of new types of montage. Yet another direction is discussed in “Database” were I suggest that new media narratives can explore the new compositional and aesthetic possibilities offered by a computer database.

While this book does not speculate about the future, it does contain an implicit theory of how new media will develop. This is the advantage of placing new media within a larger historical perspective. We begin to see the long trajectories which lead to new media in its present state; and we can extrapolate these trajectories into the future. The section “Principles of New Media” describes four key trends which, in my view, are shaping the development of new media over time: modularity, automation, variability and transcoding.

Of course we don’t have to blindly accept these trends. Understanding the logic which is shaping the evolution of new media language allows us to develop different alternatives. Just as avant-garde filmmakers throughout cinema's existence offered alternatives to its particular narrative audio-visual regime, the task of avant-garde new media artists today is to offer alternatives to the existing language of computer media. This can be better accomplished if we have a theory of how "mainstream" language is structured now and how it is evolving over time.

Mapping New Media: Organization

This book aims to contribute to the emerging field of new media studies (other names which have been already used to describe it are “digital studies” and “digital culture”) by providing one potential map of what the field can be. If a textbook of literary theory may, for instance, have chapters on narrative and voice, and a textbook of film studies may discuss cinematography and editing, this book proposes that new media theory requires the definition and refinement of separate categories such as interface and operations.

I’ve divided the book into a number of chapters, each chapter covering one key concept or problem. My overall argument—that we should approach new media in relation to other visual cultural forms and put it in historical perspective—affects my approach to each problem, but it does not drive the overall structure of the book. Instead, concepts developed in earlier chapters become building blocks for analyses in later chapters. In ordering the chapters, I also considered textbooks in other established fields relevant to new media, such as film studies, narratology and art history; much as a textbook on film may begin with film technology and end up with film genres, this book progresses from the material foundations of new media to its forms.

One could also draw an analogy between the "bottom-up" approach I use here and the organization of computer software. A computer program written by a programmer undergoes a series of translations: high-level computer language is compiled into executable code, which is then converted by an assembler into binary code. In this book I follow this order in reverse, advancing from the level of binary code to the level of a computer program, and then moves further to consider the logic of new media objects driven by these programs:

I. "What is New Media": the digital "medium" itself, its material and logical organization.
II. "The Interface": the human-computer interface; the operating system (OS).
III. "The Operations": software applications which run on top of the OS, their interfaces and typical operations.
IV. "The Illusions": appearance, and the new logic of digital images created and accessed using software applications.
V. "The Forms": the commonly used conventions for organizing a new media object as as a whole.

The last chapter "What is Cinema?" mirrors the book's beginning. Chapter I points out that many of its allegedly unique principles can be already found in cinema. The subsequent chapters continue this perspective of using film history and theory to analyze new media. Having discussed different levels of new media — the interface, the operations, the illusion, and the forms — in this chapter I turn my conceptual "lens" around to look at how computerization changes cinema itself. I first analyze the identity of digital cinema by placing it within a history of a moving image and then discuss how computerization offers new opportunities for the development of film language.

At the same time, the last chapter continues "bottom-up" trajectory of the book as a whole. If Chapter V looks at organization of new cultural objects, such as Web sites, hypermedia CD-ROMs and virtual worlds, which are all the "children" of a computer, Chapter 6 considers the effects of a computerization on a older cultural form which exists, so to speak, "outside" of computer culture proper — cinema.

Each chapter begins with a short introduction which discusses its concept (or "level") and summarizes the arguments developed in individual sections. For example, Chapter II, "The Interface," begins with a general discussion of the importance of the concept of the interface in new media. The two sections of Chapter II then look at different aspects of new media interfaces: their reliance on the conventions of other media and the relationship between the body of the user and the interface.

The Terms: Language, Object, Representation

In putting the word "language" into the title of the book, I did not want to suggest that there is some "single" language of new media or that we need to return to the structuralist phase of semiotics in understanding new media. However, given that most studies of new media and cyber culture focus on its sociological, economic and political dimensions, I felt justified in using the word "language" to signal the different focus of this work: the emergent conventions, the recurrent design patterns, and the key forms of new media. I considered using the words "aesthetics" and "poetics" instead of "language," eventually deciding against them. Aesthetics implies a set of oppositions which I would like to avoid—between art and mass culture, between the beautiful and the ugly, between the valuable and the unimportant. Poetics also brings with it undesirable connotations. Continuing the project of Russian formalists of the 1910s, poetics was defined in the 1920s as a study of specific properties of particular arts, such as narrative literature. In <u>Introduction to Poetics</u> (1968) literary scholar Tzvetan Todorov writes:

> In contradistinction to the interpretation of particular works, it [poetics] does not seen to name meaning, but aims at a knowledge of the general laws that preside over the birth of each work. But in contrasdistinction to such sciences as psychology, sociology, etc., it seeks these laws within literature itself. Poetics is therefore an approach to literature at once "abstract" and "internal."[7]

In contrast to such "internal" aproach, in describing conventions, elements and forms of new media, I neither claim that they are unique to new media, nor do I consider it useful to look at it in isolation from other areas of culture. On the contrary, this book aims to situate new media in relation to a number of other areas of culture, both past and present:

- other arts and media traditions: their visual languages, their strategies for organizing information and the viewer's experience;
- the material properties of the computer; the ways in which it is used in modern society; the structure of its interface and key software applications;
- contemporary <u>visual culture</u>: the internal organization, iconography, iconology and viewer experience of various visual sites in our culture: fashion

and advertising, supermarkets and fine art objects, television programs and publicity banners, offices and techno clubs;
- contemporary <u>information culture</u>.

The concept "information culture," which is my term, can be thought of as a parallel to another, already familiar concept—visual culture. It includes the ways in which different cultural sites and objects present information: airport and train stations displays; road signs; television on-screen menus; graphic layouts of television news; the layouts of books, newspapers and magazines; the interior designs of banks, hotels and other commercial and leisure spaces; the interfaces of planes and cars and, last but not least, the interfaces of computer operating systems (Windows, MAC OS, UNIX) and software applications (Word, Excel, PowerPoint, Eudora, Navigator, RealPlayer, Filemaker, Photoshop, etc.). Extending the parallels with visual culture, information culture also includes historical methods for organizing and retrieving information (analogs of iconography) as well as patterns of user interaction with information objects and displays.

Another word which needs to be commented on is "object." Throughout the book, I use the term "new media object," rather than "product," "artwork," "interactive media," or other possible terms. A new media object may be a still digital image, a digitally composited film, a virtual 3D environment, a computer game, a self-contained hypermedia DVD, a hypermedia Web site, or the Web as a whole. The term thus fits with my aim of describing the general principles of new media which would hold true across all media types, all forms of organization and all scales. I also use "object" to emphasize that my concern is with the culture at large rather than with new media art alone. Moreover, "Object" is a standard term in the computer science and industry, used to emphasize the modular nature of object-oriented programming languages such as C++ and Java, object-oriented databases and the OLE technology used in Microsoft Office products. Thus it also serves my purpose to adopt the terms and paradigms of computer science for a theory of computerized culture. (See "Principles of New Media" for an elaboration of this idea).

In addition, I hope to activate connotations which accompanied the use of the word "object" by the Russian avant-garde artists of the 1920s. Russian Constructivists and Productivists referred to their creations as objects ("vesh," "construktsia," "predmet") rather than works of art. Like their Bauhaus counterparts, they wanted to take on the roles of industrial designers, graphic designers, architects, clothing designers and so on, rather than remain fine artists producing one-of-a kind works for museums or private collections. The word pointed toward the model of industrial mass production rather than the traditional artist's studio, and it implied the ideals of rational organization of labor and engineering efficiency which artists wanted to bring into their own work.

In the case of "new media objects," all these connotations are worth invoking. In the world of new media, the boundary between art and design is fuzzy at best. On the one hand, many artists make their living as commercial designers; on the other hand, professional designers are typically the ones who really push the language of new media forward by being engaged in systematic experimentation and also by creating new standards and conventions. The second connotation, that of industrial production, also holds true for new media. Many new media projects are put together by large teams of people (although, in contrast to the studio system of the classical Hollywood era, single producers or small teams of just a few people are also common). Many new media objects, such as popular games or software applications, sell millions of copies. Yet another feature of the new media field which unites it with big industry is the strict adherence to various hardware and software standards.[8]

Finally, and most importantly, I use the word object to activate the concept of laboratory experimentation practiced by the avant-garde of the 1920s. Today, as more and more artists are turning to new media, few are willing to undertake systematic, laboratory-like research into its elements, and basic compositional, expressive and generative strategies. Yet this is exactly the kind of research which was undertaken by Russian and German avant-garde artists of the 1920's in places like Vkhutemas[9] and Bauhaus in relation to the new media of their time: photography, film, new print technologies , telephony. Today, those few who are able to resist the temptation to immediately create an "interactive CD-ROM," or to make a feature length "digital film," and instead are able to focus on determining the new media equivalent of a shot, a sentence, a word, or even a letter, are rewarded with amazing findings.

A third term which is used throughout the book and which needs to be commented upon is "representation." In using this term I wanted to invoke complex and nuanced understanding of the functioning of cultural objects developed in humanities over the last decades. New media objects are no different in that respect. Thus, any new media object — a Web site, a computer game, a digital image, and so on — represents, as well as helps to construct, some outside referent: a physically existing object, historical information presented in other documents, a system of categories currently employed by culture as a whole or by some social groups or interests. As it is the case with all cultural representations, new media representations are also always biased. They represent / construct some features of physical reality at the expenses of others, one world view among many, one possible system of categories among numerous others possible.

In this book I suggest that not only individual new media objects, but also <u>the interfaces, both of an operating system and of commonly used software applications, also act as representations</u>. That is, by organizing data in particular ways and by making it possible to access it in particular ways, they privilege particular models of the world and of the human subject. For instance, the two key ways to organize computer data commonly used today — a hierarchical file system (Graphical User Interface from 1984 Macintosh onward) and a "flat," non-hierarchical network of hyperlinks (1990s World Wide Web) — represent the world in two fundamentally different and, in fact, opposing ways. Hierarchical file system assumes that the world can be reduced to a logical and hierarchical order, where every object has a distinct and well defined place. World Wide Web assumes that every object has the same importance as any other, and that everything is, or can be connected to everything else. Interfaces also privilege particular modes of data access traditionally associated with particular arts and media technologies. For instance, the World Wide Web of the 1990s foregrounded page as a basic unit of data organization (regardless of which media types it contains), while Acrobat software applies uses metaphor of "video playback" to text-based documents. Thus interfaces act as "representations" of older cultural forms and media, privileging some at the expense of others. This idea will be developed further in "Cultural Interfaces" section where I will analyze the role of cinematic and print conventions in new media.

In describing the language of new media I found it useful to use the term "representation" in oppositions to other terms. Depending which term it is opposed to, the meaning of "representation" changes. Since these oppositions are introduced in different sections of the book, here I summarize all of them:

(1) Representation — simulation ("Screen" section). Here representation refers to various screen technologies such as post-Renaissance painting, film, radar and television. I define screen as a rectangular surface which frames a virtual world and which exists within the physical world of a viewer without completely blocking her visual field. Simulation refers to technologies which aim to completely "immerse" the viewer within the virtual universe: Baroque Jesuit churches, nineteenth century panorama, twentieth century movie theaters.

(2) Representation — control ("Cultural Interfaces" section). Here I oppose an image as a representation of an illusionary fictional universe and an image as a simulation of a control panel (for instance, GUI with its different icons and menus) which allows the user to control a computer. This new type of image can be called <u>image-interface</u>. The opposition representation — control corresponds to an opposition between depth and surface: a computer screen as a window into an illusionistic space versus computer screen as a flat control panel.

(3) Representation — action ("Teleaction" section.) This is the opposition between technologies for creating illusions (fashion, realist paintings, dioramas, military decoys, film montage, digital compositing) and representational technologies used to enable action, i.e. to allow the viewer to manipulate reality through representations (maps, architectural drawings, x-ray, telepresence). I refer to images produced by later technologies as <u>image-instruments</u>.

(4) Representation — communication ("Teleaction" section.) This is the opposition between representational technologies (film, audio and video magnetic

tape, digital storage formats) and real-time communication technologies, i.e. everything which begins with “tele” (telegraph, telephone, telex, television, telepresence). Representational technologies allow for creation of traditional aesthetic objects, i.e. something which is fixed in space or time and which refers to some referent(s) outside itself. By foregrounding the importance of person-to-person telecommunication, and “tele”-cultural forms in general which do not produce any objects, new media forces us to reconsider the traditional equation between culture and objects.

(5) Visual illusionism — simulation (introduction to “Illusions” chapter). Illusionism here refers both to representation and simulation as these terms are used in “Screen” section. Thus, illusionism combines traditional techniques and technologies which aim to create visual resemblance of reality: perspectival painting, cinema, panorama, etc. Simulation refers to various computer methods for modeling other aspects of reality beyond its visual appearance: movement of physical objects, shape changes over time in natural phenomena (water surface, smoke), motivations, behavior, speech and language comprehension in human beings.

(6) Representation — information (introduction to “Forms” chapter). This opposition refers to two opposing goals of new media design: (1) immersing users in an imaginary fictional universe similar to traditional fiction; giving users efficient access to a body of information (for instance, a search engine Web site or an online encyclopedia.)

I. What is New Media?

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

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

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

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

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

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

How Media Became New

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

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

Interestingly, Babbage borrowed the idea of using punch cards to store information from an earlier programmed machine. Around 1800, J.M. Jacquard invented a loom which was automatically controlled by punched paper cards. The loom was used to weave intricate figurative images, including Jacquard's portrait. This specialized graphics computer, so to speak, inspired Babbage in his work on the Analytical Engine, a general computer for numerical calculations. As Ada Augusta, Babbage's supporter and the first computer programmer, put it, "the Analytical Engine weaves algebraical patterns just as the Jacquard loom weaves flowers and leaves."[12] Thus, a programmed machine was already synthesizing images even before it was put to process numbers. The connection between the Jacquard loom and the Analytical Engine is not something historians of computers make much of, since for them computer image synthesis represents just one application of the modern digital computer among thousands of others; but for a historian of new media it is full of significance.

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

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

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

The 1890s was the crucial decade, not only for the development of media, but also for computing. If individuals' brains were overwhelmed by the amounts of information they had to process, the same was true of corporations and of government. In 1887, the U.S. Census office was still interpreting the figures from the 1880 census. For the next 1890 census, the Census Office adopted electric tabulating machines designed by Herman Hollerith. The data collected for every person was punched into cards; 46, 804 enumerators completed forms for a total population of 62,979,766. The Hollerith tabulator opened the door for the adoption of calculating machines by business; during the next decade electric tabulators became standard equipment in insurance companies, public utilities companies, railroads and accounting departments. In 1911, Hollerith's Tabulating Machine company was merged with three other companies to form the Computing-Tabulating-Recording Company; in 1914 Thomas J. Watson was chosen as its head. Ten years later its business tripled and Watson renamed the company the International Business Machines Corporation, or IBM.[14]

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

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

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

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

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

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

Principles of New Media

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

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

1. Numerical Representation

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

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

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

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

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

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

As the last example demonstrates, while old media contains level(s) of discrete representation, the samples were never quantified. This quantification of samples is the crucial step accomplished by digitization. But why, we may ask, modern media technologies were often in part discrete? The key assumption of modern semiotics is that communication requires discrete units. Without discrete units, there is no language. As Roland Barthes has put it, "language is, as it were, that which divides reality (for instance the continuos spectrum of the colors is verbally reduced to a series of discontinuous terms).[18] In postulating this, semioticians took human language as a prototypical example of a communication system. A human language is discrete on most scales: we speak in sentences; a sentence is made from words; a word consists from morphemes, and so on. If we are to follow the assumption that any form of communication requires discrete representation, we may expect that media used in cultural communication will have discrete levels. At first this explanation seems to work. Indeed, a film samples continuos time of human existence into discrete frames; a drawing samples visible reality into discrete lines; and a printed photograph samples it into discrete dots. This assumption does not universally work, however: photographs, for instance, do not have any apparent units. (Indeed, in the 1970s semiotics was criticized for its linguistic bias, and most semioticians came to recognize that language-based model of distinct units of meaning can't be applied to many kinds of cultural communication.) More importantly, the discrete units of modern media are usually not the units of meanings, the way morphemes are. Neither film frames not the halftone dots have any relation to how film or a photographs affect the viewer (except in modern art and avant-garde film — think of paintings by Roy Lichtenstein and films of Paul Sharits — which often make the "material" units of media into the units of meaning.)

The more likely reason why modern media has discrete levels is because it emerges during Industrial Revolution. In the nineteenth century, a new organization of production known as factory system gradually replaced artisan labor. It reached its classical form when Henry Ford installed first assembly line in his factory in 1913. The assembly line relied on two principles. The first was standardization of parts, already employed in the production of military uniforms in the nineteenth century. The second, never principle, was the separation of the production process into a set of repetitive, sequential, and simple activities that could be executed by workers who did not have to master the entire process and could be easily replaced.

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

2. Modularity

This principle can be called "fractal structure of new media." Just as a fractal has the same structure on different scales, a new media object has the same modular structure throughout. Media elements, be it images, sounds, shapes, or behaviors, are represented as collections of discrete samples (pixels, polygons, voxels, characters, scripts). These elements are assembled into larger-scale objects but they continue to maintain their separate identity. The objects themselves can be combined into even larger objects -- again, without losing their independence. For example, a multimedia "movie" authored in popular Macromedia Director software may consist from hundreds of still images, QuickTime movies, and sounds which are all stored separately and are loaded at run time. Because all elements are stored independently, they can be modified at any time without having to change Director movie itself. These movies can be assembled into a larger "movie," and so on. Another example of modularity is the concept of "object" used in Microsoft Office applications. When an object is inserted into a document (for instance, a media clip inserted into a Word document), it continues to maintain its independence and can always be edited with the program used originally to create it. Yet another example of modularity is the structure of a HTML document: with the exemption of text, it consists from a number of separate objects — GIF and JPEG images, media clips, VRML scenes, Schockwave and Flash movies -- which are all stored independently locally and/or on a network. In short, a new media object consists from independent parts which, in their turn, consist from smaller independent parts, and so on, up to the level of smallest "atoms" such as pixels, 3D points or characters.

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

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

3. Automation

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

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

The researchers are also working on what can be called "high-level" automation of media creation which requires a computer to understand, to a certain degree, the meanings embedded in the objects being generated, i.e. their semantics. This research can be seen as a part of a larger initiative of artificial intelligence (AI). As it is well known, AI project achieved only very limited success since its beginnings in the 1950s. Correspondingly, work on media generation which requires understanding of semantics is also in the research stage and is rarely included in commercial software. Beginning in the 1970s, computers were often used to generate poetry and fiction. In the 1990s, the users of Internet chat rooms became familiar with bots -- the computer programs which simulate human conversation. The researchers at New York University showed a "virtual theater" composed of a few "virtual actors" which adjust their behavior in real-time in response to user's actions.[20] The MIT Media Lab developed a number of different projects devoted to "high-level" automation of media creation and use: a "smart camera" which can automatically follow the action and frame the shots given a script;[21] ALIVE, a virtual environment where the user interacted with animated characters;[22] a new kind of human-computer interface where the computer presents itself to a user as an animated talking character. The character, generated by a computer in real-time, communicates with user using natural language; it also tries to guess user's emotional state and to adjust the style of interaction accordingly.[23]

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

Along with "low-level" and "high-level" automation of media creation, another area of media use which is being subjected to increasing automation is media access. The switch to computers as means to store and access enormous amount of media material, exemplified by the by "media assets" stored in the databases of stock agencies and global entertainment conglomerates, as well as by the public "media assets" distributed across numerous Web sites, created the need to find more efficient ways to classify and search media objects. Word processors and other text management software for a long time provided the abilities to search for specific strings of text and automatically index documents. UNIX operating system also always included powerful commands to search and filter text files. In the 1990s software designers started to provide media users with similar abilities. Virage introduced Virage VIR Image Engine which allows to search for visually similar image content among millions of images as well as a set of video search tools to allow indexing and searching video files.[24] By the end of the 1990s, the key Web search engines already included the options to search the Internet by specific media such as images, video and audio.

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

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

4. Variability

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

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

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

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

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

4.1. Media elements are stored in a media database; a variety of end-user objects which vary both in resolution, in form and in content can be generated, either beforehand, or on demand, from this database. At first, we may think that this is simply a particular technological implementation of variability principle, but, as I will show in “Database” section, in a computer age database comes to function as a cultural form of its own. It offers a particular model of the world and of the human experience. It also affects how the user conceives of data which it contains.

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

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

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

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

4.6. Another way in which different versions of the same media objects are commonly generated in computer culture is through periodic updates. Networks allow the content of a new media object to be periodically updating while keeping its structure intact. For instance, modern software applications can periodically check for updates on the Internet and then download and install these updates, sometimes without any actions from the user. Most Web sites are also periodically updated either manually or automatically, when the data in the databases which drives the sites changes. A particularly interesting case of this "updateability" feature is the sites which update some information, such as such as stock prices or weather, continuosly.

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

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

Among new media artworks, David Blair's WaxWeb, a Web site which is an "adaptation" of an hour long video narrative, offers a more radical implementation of the scalability principle. While interacting with the narrative, the user at any point can change the scale of representation, going from an image-based outline of the movie to a complete script or a particular shot, or a VRML scene based on this shot, and so on.[28] Another example of how use of scalability principle can create a dramatically new experience of an old media object is Stephen Mamber's database-driven representation of Hitchock's Birds. Mamber's software generates a still for every shot of the film; it then automatically combines all the stills into a rectangular matrix. Every cell in the matrix corresponds to a particular shot from the film. As a result, time is spatialized, similar to how it was done in Edisons's early Kinetoscope cylinders (see "The Myths of New Media.") Spatializing the film allows us to study its different temporal structures which would be hard to observe otherwise. As in WaxWeb, the user can at any point change the scale of representation, going from a complete film to a particular shot.

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

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

Hypermedia, the other popular structure of new media, can also be seen as a particular case of the more general principle of variability. According to the definition by Halacz and Swartz, hypermedia systems "provide their users with the ability to create, manipulate and/or examine a network of information-containing nodes interconnected by relational links."[29] Since in new media the individual media elements (images, pages of text, etc.) always retain their individual identity (the principle of modularity), they can be "wired" together into more than one object. Hyperlinking is a particular way to achieve this wiring. A hyperlink creates a connection between two elements, for example between two words in two different pages or a sentence on one page and an image in another, or two different places within the same page. The elements connected through hyperlinks can exist on the same computer or on different computers connected on a network, as in the case of World Wide Web.

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

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

In a post-industrial society, every citizen can construct her own custom lifestyle and "select" her ideology from a large (but not infinite) number of choices. Rather than pushing the same objects/information to a mass audience, marketing now tries to target each individual separately. The logic of new media technology reflects this new social logic. Every visitor to a Web site automatically gets her own custom version of the site created on the fly from a database. The language of the text, the contents, the ads displayed — all these can be customized by interpreting the information about where on the network the user is coming from; or, if the user previously registered with the site, her personal profile can be used for this customization. According to a report in USA Today (November 9, 1999), "Unlike ads in magazines or other real-world publications, 'banner' ads on Web pages change wit every page view. And most of the companies that place the ads on the Web site track your movements across the Net, 'remembering' which ads you've seen, exactly when you saw them, whether you clicked on them, where you were at the time and the site you have visited just before."[31]

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

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

While I deduced the principle of variability from more basic principles of new media — numerical representation (1) and modularity of information (2) — it can also be seen as a consequence of computer's way of to represent data and model the world itself: as variables rather than constants. As new media theorist and architect Marcos Novak notes, a computer — and computer culture in its wake — substitute every constant by a variable.[33] In designing all functions and data structures, a computer programmer tries to always use variables rather than constants. On the level of human-computer interface, this principle means that the user is given many options to modify the performance of a program of a media object, be it a computer game, a Web site, a Web browser, or the operating system itself. The user can change the profile of a game character, modify how the folders appear on the desktop, how files are displayed, what icons are used, etc. If we apply this principle to culture at large, it would mean that every choice responsible for giving a cultural object a unique identity can potentially remain always open. Size, degree of detail, format, color, shape, interactive trajectory, trajectory through space, duration, rhythm, point of view, the presence or absence of particular characters, the development of the plot — to name just a few dimensions of cultural objects in different media — all these can be defined as variables, to be freely modified by a user.

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

I should fictionalize it more, I should conceal myself. I should consider the responsibilities of characterization, I should conflate her two children into one, or reverse their genders, or otherwise alter them, I should make her boyfriend a husband, I should explicate all the tributaries of my extended family (its remarriages, its internecine politics), I should novelize the whole thing, I should make it multigenerational, I should work in my forefathers (stonemasons and newspapermen), I should let artifice create an elegant surface, I should make the events orderly, I should wait and write about it later, I should wait until I’m not angry, I shouldn’t clutter a narrative with fragments, with mere recollections of good times, or with regrets, I should make Meredith’s death shapely and persuasive, not blunt and disjunctive, I shouldn’t have to think the unthinkable, I shouldn’t have to suffer, I should address her here directly (these are the ways I miss you), I should write only of affection, I should make our travels in this earthy landscape safe and secure, I should have a better ending, I shouldn’t say her life was short and often sad, I shouldn’t say she had demons, as I do too.

5. Transcoding

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

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

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

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

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

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

Throughout the book, we will encounter many examples of the principle of transcoding at work. For instance, "The Language of Cultural Interfaces" section will look at how conventions of printed page, cinema and traditional HCI interact together in the interfaces of Web sites, CD-ROMs, virtual spaces and computer games.
"Database" section will discuss how a database, originally a computer technology to organize and access data, is becoming a new cultural form of its own. But we can also reinterpret some of the principles of new media already discussed above as consequences of the transcoding principle. For instance, hypermedia can be understood as one cultural effect of the separation between a algorithm and a data structure, essential to computer programming. Just as in programming algorithms and data structures exist independently of each other, in hypermedia data is separated from the navigation structure. (For another example of the cultural effect of algorithm—data structure dichotomy see "Database" section.) Similarly, the modular structure of new media can be seen as an effect of the modularity in structural computer programming. Just as a structural computer program consist from smaller modules which in their turn consist from even smaller modules, a new media object as a modular structure, as I explained in my discussion of modularity above.

In new media lingo, to "transcode" something is to translate it into another format. The computerization of culture gradually accomplishes similar transcoding in relation to all cultural categories and concepts. That is, cultural categories and concepts are substituted, on the level of meaning and/or the language, by new ones which derive from computer's ontology, epistemology and pragmatics. New media thus acts as a forerunner of this more general process of cultural re-conceptualization.

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

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

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

What New Media is Not

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

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

Cinema as New Media

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

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

Indeed, any digital representation consists from a limited number of samples. For example, a digital still image is a matrix of pixels — a 2D sampling of space. However, as I already noted, cinema was already based on sampling — the sampling of time. Cinema sampled time twenty four times a second. So we can say that cinema already prepared us for new media. All that remained was to take this already discrete representation and to quantify it. But this is simply a mechanical step; what cinema accomplished was a much more difficult conceptual break from the continuous to the discrete.

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

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

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

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

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

Such mapping was already widely used in the nineteenth century cinema machines. The Phenakisticope, the Zootrope, the Zoopraxiscope, the Tachyscope, and Marey's photographic gun were all based on the same principle -- placing a number of slightly different images around the perimeter of a circle. Even more striking is the case of Thomas Edison's first cinema apparatus. In 1887 Edison and his assistant, William Dickson, began experiments to adopt the already proven technology of a phonograph record for recording and displaying of motion pictures. Using a special picture-recording camera, tiny pinpoint-size photographs were placed in spirals on a cylindrical cell similar in size to the phonography cylinder. A cylinder was to hold 42,000 images, each so small (1/32 inch wide) that a viewer would have to look at them through a microscope.[37] The storage capacity of this medium was twenty-eight minutes -- twenty-eight minutes of continuous time taken apart, flattened on a surface and mapped into a two-dimensional grid. (In short, time was prepared to be manipulated and re-ordered, something which was soon to be accomplished by film editors.)

The Myth of the Digital

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

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

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

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

In his important study of digital photography The Reconfigured Eye, William Mitchell explains this as follows: "There is an indefinite amount of information in a continuous-tone photograph, so enlargement usually reveals more detail but yields a fuzzier and grainier picture... A digital image, on the other hand, has precisely limited spatial and tonal resolution and contains a fixed amount of information."[38] From a logical point of view, this principle is a correct deduction from the idea of digital representation. A digital image consists of a finite number of pixels, each having a distinct color or a tonal value, and this number determines the amount of detail an image can represent. Yet in reality this difference does not matter. By the end of the 1990s, even cheap consumer scanners were capable of scanning images at resolutions of1200 or 2400 pixels per inch. So while a digitally stored image is still comprised of a finite number of pixels, at such resolution it can contain much finer detail than it was ever possible with traditional photography. This nullifies the whole distinction between an "indefinite amount of information in a continuous-tone photograph" and a fixed amount of detail in a digital image. The more relevant question is how much information in an image can be useful to the viewer. By the end of new media first decade, technology has already reached the point where a digital image can easily contain much more information than anybody would ever want.

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

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

Mitchell summarizes this as follows: "The continuous spatial and tonal variation of analog pictures is not exactly replicable, so such images cannot be transmitted or copied without degradation... But discrete states can be replicated precisely, so a digital image that is a thousand generations away from the original is indistinguishable in quality from any one of its progenitors."[39] Therefore, in digital culture, "an image file can be copied endlessly, and the copy is distinguishable from the original by its date since there is no loss of quality."[40] This is all true -- in principle. However, in reality, there is actually much more degradation and loss of information between copies of digital images than between copies of traditional photographs. A single digital image consists of millions of pixels. All of this data requires considerable storage space in a computer; it also takes a long time (in contrast to a text file) to transmit over a network. Because of this, the software and hardware used to acquire, store, manipulate, and transmit digital images uniformly rely on lossy compression -- the technique of making image files smaller by deleting some information. The example of lossy compression technique is JPEG format used to store still images and MPEG, used to store digital video on DVD. The technique involves a compromise between image quality and file size -- the smaller the size of a compressed file, the more visible are the visual artifacts introduced in deleting information. Depending on the level of compression, these artifacts range from barely noticeable to quite pronounced.

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

The Myth of Interactivity

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

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

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

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

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

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

When we use the concept of “interactive media” exclusively in relation to computer-based media, there is danger that we interpret "interaction" literally, equating it with physical interaction between a user and a media object (pressing a button, choosing a link, moving the body), at the sake of psychological interaction. The psychological processes of filling-in, hypothesis forming, recall and identification, which are required for us to comprehend any text or image at all, are mistakenly identified with an objectively existing structure of interactive links.[43]

This mistake is not new; on the contrary, it is a structural feature of history of modern media. The literal interpretation of interactivity is just the latest example of a larger modern trend to externalize of mental life, the process in which media technologies -- photography, film, VR -- have played a key role.[44] Beginning in the nineteenth century, we witness recurrent claims by the users and theorists of new media technologies, from Francis Galton (the inventor of composite photography in the 1870s) to Hugo Munsterberg, Sergei Eisenstein and, recently, Jaron Lanier, that these technologies externalize and objectify the mind. Galton not only claimed that "the ideal faces obtained by the method of composite portraiture appear to have a great deal in common with...so-called abstract ideas" but in fact he proposed to rename abstract ideas "cumulative ideas."[45] According to Münsterberg, who was a Professor of Psychology at Harvard University and an author of one of the earliest theoretical treatments of cinema entitled The Film: A Psychological Study (1916), the essence of films lies in its ability to reproduce, or "objectify" various mental functions on the screen: "The photoplay obeys the laws of the mind rather than those of the outer world."[46] In the 1920s Eisenstein was speculating about how film can be used to externalize — and control — thinking. As an experiment in this direction, he boldly conceived a screen adaptation of Marx's Capital. "The content of CAPITAL (its aim) is now formulated: to teach the worker to think dialectically," Eisenstein writes enthusiastically in April of 1928.[47] In accordance with the principles of "Marxist dialectics" as canonized by the official Soviet philosophy, Eisenstein planned to present the viewer with the visual equivalents of thesis and anti-thesis so that the viewer can then proceed to arrive at synthesis, i.e. the correct conclusion, pre-programmed by Eisenstein.

In the 1980s, Jaron Lanier, a California guru of VR, similarly saw VR technology as capable of completely objectifying, better yet, transparently merging with mental processes. His descriptions of its capabilities did not distinguish between internal mental functions, events and processes, and externally presented images. This is how, according to Lanier, VR can take over human memory: "You can play back your memory through time and classify your memories in various ways. You'd be able to run back through the experiential places you've been in order to be able to find people, tools."[48] Lanier also claimed that VR will lead to the age of "post-symbolic communication," communication without language or any other symbols. Indeed, why should there be any need for linguistic symbols, if everybody, rather than being locked into a "prison-house of language" (Fredric Jameson[49]), will happily live in the ultimate nightmare of democracy -- the single mental space which is shared by everybody, and where every communicative act is always ideal (Jurgen Habermas[50]). This is Lanier's example of how post-symbolic communication will function: "you can make a cup that someone else can pick when there wasn't a cup before, without having to use a picture of the word "cup."[51] Here, as with the earlier technology of film, the fantasy of objectifying and augmenting consciousness, extending the powers of reason, goes hand in hand with the desire to see in technology a return to the primitive happy age of pre-language, pre-misunderstanding. Locked in virtual reality caves, with language taken away, we will communicate through gestures, body movements, and grimaces, like our primitive ancestors...

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

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

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

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

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

II. The Interface

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

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

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

Also like Blade Runner, GUI vision also came to influence many other areas of culture. This influence ranges from purely graphical (for instance, use of GUI elements by print and TV designers) to more conceptual. In the 1990s, as the Internet progressively grew in popularity, the role of a digital computer shifted from being a particular technology (a calculator, a symbol processor, an image manipulator, etc.) to being a filter to all culture, a form through which all kinds of cultural and artistic production is being mediated. As a window of a Web browser comes to replace cinema and television screen, a wall in art gallery, a library and a book, all at once, the new situation manifest itself: all culture, past and present, is being filtered through a computer, with its particular human-computer interface.[57]

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

As an example of how the interface imposes its own logic on media, consider "cut and paste" operation, standard in all software running under modern GUI. This operation renders insignificant the traditional distinction between spatial and temporal media, since the user can cut and paste parts of images, regions of space and parts of a temporal composition in exactly the same way. It is also "blind" to traditional distinctions in scale: the user can cut and paste a single pixel, an image, a whole digital movie in the same way. And last, this operation also renders insignificant traditional distinctions between media: "cut and paste" can be applied to texts, still and moving images, sounds and 3D objects in the same way.

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

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

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

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

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

Finally, the idea of content pre-existing the interface is challenged in yet another way by new media artworks which dynamically generate their data in real time. While in a menu-based interactive multimedia application or a static Web site all data already exists before the user accesses it, in dynamic new media artworks the data is created on the fly, or, to use the new media lingo, at run time. This can be accomplished in a variety of ways: procedural computer graphics, formal language systems, Artificial Intelligence (AI) and Artificial Life (AL) programming. All these methods share the same principle: a programmer setups some initial conditions, rules or procedures which control the computer program generating the data. For the purposes of the present discussion, the most interesting of these approaches are AL and the evolution paradigm. In AL approach, the interaction between a number of simple objects at run time leads to the emergence of complex global behaviors. These behaviors can only be obtained in the course of running the computer program; they can't be predicted beforehand. The evolution paradigm applies the metaphor of the evolution theory to the generation of images, shapes, animations and other media data. The initial data supplied by the programmer acts as a genotype which is expanded into a full phenotype by a computer. In either case, the content of an artwork is the result of a collaboration between the artist/programmer and the computer program, or, if the work is interactive, between the artist, the computer program and the user. New media artists who most systematically explored AL approach is the team of Christa Sommerer and Laurent Mignonneau. In their installation "Life Spacies" virtual organisms appear and evolve in response to the position, movement and interactions of the visitors. Artist/programmer Karl Sims made the key contribution to applying the evolution paradigm to media generation. In his installation "Galapagos" the computer programs generates twelfth different virtual organisms at every iteration; the visitors select an organism which will continue to leave, copulate, mutate and reproduce.[59] The commercial products which use AL and evolution approaches are computer games such as Creatures series (Mindscape Entertainment) and "virtual pet" toys such as Tamagochi.

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

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

The Language of Cultural Interfaces

Cultural Interfaces

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

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

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

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

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

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

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

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

As it should become clear from the following, I use words "cinema" and "printed word" as shortcuts. They stand not for particular objects, such as a film or a novel, but rather for larger cultural traditions (we can also use such words as cultural forms, mechanisms, languages or media). "Cinema" thus includes mobile camera, representation of space, editing techniques, narrative conventions, activity of a spectator -- in short, different elements of cinematic perception, language and reception. Their presence is not limited to the twentieth-century institution of fiction films, they can be already found in panoramas, magic lantern slides, theater and other nineteenth-century cultural forms; similarly, since the middle of the twentieth century, they are present not only in films but also in television and video programs. In the case of the "printed word" I am also referring to a set of conventions which have developed over many centuries (some even before the invention of print) and which today are shared by numerous forms of printed matter, from magazines to instruction manuals: a rectangular page containing one or more columns of text; illustrations or other graphics framed by the text; pages which follow each sequentially; a table of contents and index.

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

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

Bringing cinema, the printed word and HCI interface together and treating them as occupying the same conceptual plane has an additional advantage -- a theoretical bonus. It is only natural to think of them as belonging to two different kind of cultural species, so to speak. If HCI is a general purpose tool which can be used to manipulate any kind of data, both the printed word and cinema are less general. They offer ways to organize particular types of data: text in the case of print, audio-visual narrative taking place in a 3D space in the case of cinema. HCI is a system of controls to operate a machine; the printed word and cinema are cultural traditions, distinct ways to record human memory and human experience, mechanisms for cultural and social exchange of information. Bringing HCI, the printed word and cinema together allows us to see that the three have more in common than we may anticipate at first. On the one hand, being a part of our culture now for half a century, HCI already represents a powerful cultural tradition, a cultural language offering its own ways to represent human memory and human experience. This language speaks in the form of discrete objects organized in hierarchies (hierarchical file system), or as catalogs (databases), or as objects linked together through hyperlinks (hypermedia). On the other hand, we begin to see that the printed word and cinema also can be thought of as interfaces, even though historically they have been tied to particular kinds of data. Each has its own grammar of actions, each comes with its own metaphors, each offers a particular physical interface. A book or a magazine is a solid object consisting from separate pages; the actions include going from page to page linearly, marking individual pages and using table of contexts. In the case of cinema, its physical interface is a particular architectural arrangement of a movie theater; its metaphor is a window opening up into a virtual 3D space.

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

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

Printed Word

In the 1980's, as PCs and word processing software became commonplace, text became the first cultural media to be subjected to digitization in a massive way. But already in the 1960's, two and a half decades before the concept of digital media was born, researchers were thinking about having the sum total of human written production -- books, encyclopedias, technical articles, works of fiction and so on -- available online (Ted Nelson's Xanadu project[61]).

Text is unique among other media types. It plays a privileged role in computer culture. On the one hand, it is one media type among others. But, on the other hand, it is a meta-language of computer media, a code in which all other media are represented: coordinates of 3D objects, pixel values of digital images, the formatting of a page in HTML. It is also the primary means of communication between a computer and a user: one types single line commands or runs computer programs written in a subset of English; the other responds by displaying error codes or text messages.[62]

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

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

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

A good example of how cultural interfaces stretch the definition of a page while mixing together its different historical forms is the Web page created in 1997 by the British design collective antirom for HotWired RGB Gallery.[63] The designers have created a large surface containing rectangular blocks of texts in different font sizes, arranged without any apparent order. The user is invited to skip from one block to another moving in any direction. Here, the different directions of reading used in different cultures are combined together in a single page.

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

As Web page became a new cultural convention of its own, its dominance was challenged by two Web browsers created by artists — Web Stalker (1997) by I/O/D collective[65] and Netomat (1999) by Maciej Wisniewski.[66] Web Stalker emphasizes the hypertextual nature of the Web. Instead of rendering standard Web pages, it renders the networks of hyperlinks these pages embody. When a user enters a URL for a particular page, Web Stalker displays all pages linked to this page as a line graph. Netomat similarly refuses the page convention of the Web. The user enters a word or a phrase which are passed to search engines. Netomat then extracts page titles, images, audio or any other media type, as specified by the user, from the found pages and floats them across the computer screen. As can be seen, both browsers refuse the page metaphor, instead substituting their own metaphors: a graph showing the structure of links in the case of Web Stalker, a flow of media elements in the case of Netomat.

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

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

In the 1980's many critics have described one of key's effects of "post-modernism" as that of spatialization: privileging space over time, flattening historical time, refusing grand narratives. Computer media, which has evolved during the same decade, accomplished this spatialization quite literally. It replaced sequential storage with random-access storage; hierarchical organization of information with a flattened hypertext; psychological movement of narrative in novel and cinema with physical movement through space, as witnessed by endless computer animated fly-throughs or computer games such as Myst, Doom and countless others (see “Navigable Space.”) In short, time becomes a flat image or a landscape, something to look at or navigate through. If there is a new rhetoric or aesthetic which is possible here, it may have less to do with the ordering of time by a writer or an orator, and more with spatial wandering. The hypertext reader is like Robinson Crusoe, walking through the sand and water, picking up a navigation journal, a rotten fruit, an instrument whose purpose he does not know; leaving imprints in the sand, which, like computer hyperlinks, follow from one found object to another.

Cinema

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

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

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

The answer is of course no. Users are able to "acquire" new cultural languages, be it cinema a hundred years ago, or cultural interfaces today, because these languages are based on previous and already familiar cultural forms. In the case of cinema, it was theater, magic lantern shows and other nineteenth century forms of public entertainment. Cultural interfaces in their turn draw on older cultural forms such as the printed word and cinema. I have already discussed some ways in which the printed word tradition structures interface language; now it is cinema's turn.

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

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

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

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

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

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

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

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

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

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

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

The area of computer culture where cinematic interface is being transformed into a cultural interface most aggressively is computer games. By the 1990's, game designers have moved from two to three dimensions and have begun to incorporate cinematic language in a increasingly systematic fashion. Games started featuring lavish opening cinematic sequences (called in the game business "cinematics") to set the mood, establish the setting and introduce the narrative. Frequently, the whole game would be structured as an oscillation between interactive fragments requiring user's input and non-interactive cinematic sequences, i.e. "cinematics." As the decade progressed, game designers were creating increasingly complex — and increasingly cinematic — interactive virtual worlds. Regardless of a game's genre — action/adventure, fighting, flight simulator, first-person action, racing or simulation — they came to rely on cinematography techniques borrowed from traditional cinema, including the expressive use of camera angles and depth of field, and dramatic lighting of 3D computer generated sets to create mood and atmosphere. In the beginning of the decade, many games such as The 7^{th} Guest (Trilobyte, 1993) or Voyeur (1994) or used digital video of actors superimposed over 2D or 3D backgrounds, but by its end they switched to fully synthetic characters rendered in real time.[77] This switch allowed game designers to go beyond branching-type structure of earlier games based on digital video were all the possible scenes had to be taped beforehand. In contrast, 3D characters animated in real time move arbitrary around the space, and the space itself can change during the game. (For instance, when a player returns to the already visited area, she will find any objects she left there earlier.) This switch also made virtual words more cinematic, as the characters could be better visually integrated with their environments.[78]

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

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

The fact that computer games and virtual worlds continue to encode, step by step, the grammar of a kino-eye in software and in hardware is not an accident. This encoding is consistent with the overall trajectory driving the computerization of culture since the 1940's, that being the automation of all cultural operations. This automation gradually moves from basic to more complex operations: from image processing and spell checking to software-generated characters, 3D worlds, and Web Sites. The side effect of this automation is that once particular cultural codes are implemented in low-level software and hardware, they are no longer seen as choices but as unquestionable defaults. To take the automation of imaging as an example, in the early 1960's the newly emerging field of computer graphics incorporated a linear one-point perspective in 3D software, and later directly in hardware.[80] As a result, linear perspective became the default mode of vision in computer culture, be it computer animation, computer games, visualization or VRML worlds. Now we are witnessing the next stage of this process: the translation of cinematic grammar of points of view into software and hardware. As Hollywood cinematography is translated into algorithms and computer chips, its convention becomes the default method of interacting with any data subjected to spatialization, with a narrative, and with other human beings. (At SIGGRAPH '97 in Los Angeles, one of the presenters called for the incorporation of Hollywood-style editing in multi-user virtual worlds software. In such implementation, user interaction with other avatar(s) will be automatically rendered using classical Hollywood conventions for filming dialog.[81]) To use the terms from the 1996 paper authored by Microsoft researchers and entitled "The Virtual Cinematographer: A Paradigm for Automatic Real-Time Camera Control and Directing," the goal of research is to encode "cinematographic expertise," translating "heuristics of filmmaking" into computer software and hardware.[82] Element by element, cinema is being poured into a computer: first one-point linear perspective; next the mobile camera and a rectangular window; next cinematography and editing conventions, and, of course, digital personas also based on acting conventions borrowed from cinema, to be followed by make-up, set design, and the narrative structures themselves. From one cultural language among others, cinema is becoming the cultural interface, a toolbox for all cultural communication, overtaking the printed word.

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

I will conclude this section by discussing a few artistic projects which, in different ways, offer alternatives to this trajectory. To summarize it once again, the trajectory involves gradual translation of elements and techniques of cinematic perception and language into a de-contextualized set of tools to be used as an interface to any data. In the process of this translation, cinematic perception is divorced from its original material embodiment (camera, film stock), as well as from the historical contexts of its formation. If in cinema the camera functioned as a material object, co-existing, spatially and temporally, with the world it was showing us, it has now become a set of abstract operations. The art projects described below refuse this separation of cinematic vision from the material world. They reunite perception and material reality by making the camera and what it records a part of a virtual world's ontology. They also refuse the universalization of cinematic vision by computer culture, which (just as post-modern visual culture in general) treats cinema as a toolbox, a set of "filters" which can be used to process any input. In contrast, each of these projects employs a unique cinematic strategy which has a specific relation to the particular virtual world it reveals to the user.

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

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

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

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

HCI: Representation versus Control

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

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

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

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

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

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

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

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

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

Today the language of cultural interfaces is in its early stage, as was the language of cinema a hundred years ago. We don't know what the final result will be, or even if it will ever completely stabilize. Both the printed word and cinema eventually achieved stable forms which underwent little changes for long periods of time, in part because of the material investments in their means of production and distribution. Given that computer language is implemented in software, potentially it can keep on changing forever. But there is one thing we can be sure of. We are witnessing the emergence of a new cultural meta-langauge, something which will be at least as significant as the printed word and cinema before it.

The Screen and the User

Contemporary human-computer interfaces offer radical new possibilities for art and communication. Virtual reality allows us to travel through non-existent three-dimensional spaces. A computer monitor connected to a network becomes a window through which we can be present in a place thousands of miles away. Finally, with the help of a mouse or a video camera, a computer is transformed into an intelligent being capable of engaging us in a dialogue.

VR, interactivity and telepresence are made possible by the recent technology of a digital computer. However, they are made real by a much, much older technology — the screen. It is by looking at a screen — a flat, rectangular surface positioned at some distance from the eyes — that the user experiences the illusion of navigating through virtual spaces, of being physically present somewhere else or of being hailed by the computer itself. If computers have become a common presence in our culture only in the last decade, the screen, on the other hand, has been used to present visual information for centuries — from Renaissance painting to twentieth-century cinema.

Today, coupled with a computer, the screen is rapidly becoming the main means of accessing any kind of information, be it still images, moving images or text. We are already using it to read the daily newspaper, to watch movies, to communicate with coworkers, relatives and friends, and, most importantly, to work (the screens of airline agents, data entry clerks, secretaries, engineers, doctors, pilots, etc.; the screens of ATM machines, supermarket checkouts, automobile control panels, and, of course, the screens of computers.) We may debate whether our society is a society of spectacle or of simulation, but, undoubtedly, it is the society of a screen. What are the different stages of the screen's history? What are the relationships between the physical space where the viewer is located, his/her body, and the screen space? What are the ways in which computer displays both continue and challenge the tradition of a screen?[87]

A Screen's Genealogy

Let us start with the definition of a screen. Visual culture of the modern period, from painting to cinema, is characterized by an intriguing phenomenon: the existence of <u>another</u> virtual space, another three-dimensional world enclosed by a frame and situated inside our normal space. The frame separates two absolutely different spaces that somehow coexist. This phenomenon is what defines the screen in the most general sense, or, as I will call it, the "classical screen."

What are the properties of a classical screen? It is a flat, rectangular surface. It is intended for frontal viewing — as opposed to, for instance, a panorama. It exists in our normal space, the space of our body, and acts as a window into another space. This other space, the space of representation, typically has a different scale from the scale of our normal space. Defined in this way, a screen describes equally well a Renaissance painting (recall Alberti's formulation referred to above) and a modern computer display. Even proportions have not changed in five centuries, they are similar for a typical fifteenth century painting, a film screen and a computer screen. In this respect it is not accidental that the very names of the two main formats of computer displays point to two genres of painting: a horizontal format is referred to as "landscape mode" while the vertical format is referred to as "portrait mode."

A hundred years ago a new type of screen became popular, which I will call the "dynamic screen." This new type retains all the properties of a classical screen while adding something new: it can display an image changing over time. This is the screen of cinema, television, video. The dynamic screen also brings with it a certain relationship between the image and the spectator — a certain viewing regime, so to speak. This relationship is already implicit in the classical screen but now it fully surfaces. A screen's image strives for complete illusion and visual plenitude while the viewer is asked to suspend disbelief and to identify with the image. Although the screen in reality is only a window of limited dimensions positioned inside the physical space of the viewer, the latter is supposed to completely concentrate on what is seen in this window, focusing attention on the representation and disregarding the physical space outside. This viewing regime is made possible by the fact that, be it a painting, movie screen or television screen, the singular image completely fills the screen. This is why we are so annoyed in a movie theater when the projected image does not precisely coincide with the screen's boundaries: it disrupts the illusion, making us conscious of what exists outside the representation.[88]

Rather than being a neutral medium of presenting information, the screen is aggressive. It functions to filter, to <u>screen out</u>, to take over, rendering non-existent whatever is outside its frame. Of course, the degree of this filtering varies between cinema viewing and television viewing. In cinema viewing, the viewer is asked to completely merge with the screen's space. In television viewing, the screen is smaller, lights are on, conversation between viewers is allowed, and the act of viewing is often integrated with other daily activities. Still, overall this viewing regime remains stable — until recently.

This stability has been challenged by the arrival of the computer screen. On the one hand, rather than showing a single image, a computer screen typically displays a number of coexisting windows. Indeed, the coexistence of a number of overlapping windows is a fundamental principle of modern GUI. No single window completely dominates the viewer's attention. In this sense the possibility of simultaneously observing a few images which coexist within one screen can be compared with the phenomenon of zapping — the quick switching of television channels that allows the viewer to follow more than program.[89] In both instances, the viewer no longer concentrates on a single image. (Some television sets enable a second channel to be watched within a smaller window positioned in a corner of the main screen. Perhaps future TV sets will adopt the window metaphor of a computer.) A window interface has more to do with modern graphic design, which treats a page as a collection of different but equally important blocks of data such as text, images, and graphic elements, than with cinematic screen.

On the other hand, with VR, the screen disappears altogether. VR typically uses a head-mounted display whose images completely fill viewer's visual field. No longer is the viewer looking forward at a rectangular, flat surface located at a certain distance and which acts as a window into another space. Now she is fully situated within this other space. Or, more precisely, we can say that the two spaces, the real, physical space and the virtual simulated space, coincide. The virtual space, previously confined to a painting or a movie screen, now completely encompasses the real space. Frontality, rectangular surface, difference in scale are all gone. The screen has vanished.

Both situations — window interface and VR — disrupt the viewing regime which characterizes the historical period of the dynamic screen. This regime, based on the identification of the viewer with a screen image, reaches its culmination in the cinema which goes to the extreme to enable this identification (the bigness of the screen, the darkness of the surrounding space) while still relying on a screen — a rectangular flat surface.

Thus, the era of the dynamic screen which began with cinema is now ending. And it is this disappearance of the screen — its splitting into many windows in window interface, its complete take over of the visual field in VR — that allows us today to recognize it as a cultural category and begin to trace its history.

The origins of the cinema's screen are well known. We can trace its emergence to the popular spectacles and entertainment of the eighteenth and nineteenth centuries: magic lantern shows, phantasmagoria, eidophusikon, panorama, diorama, zoopraxiscope shows, and so on. The public was ready for cinema and when it finally appeared it was a huge public event. Not by accident the "invention" of cinema was claimed by at least a dozen of individuals from a half-dozen countries.[90]

The origin of the computer screen is a different story. It appears in the middle of this century but it does not become a public presence until much later; and its history has not yet been written. Both of these facts are related to the context in which it emerged: as with all the other elements of modern human-computer interface, the computer screen was developed for military use. Its history has to do not with public entertainment but with military surveillance.

The history of modern surveillance technologies begins at least with photography. From the advent of photography there existed an interest in using it for aerial surveillance. Félix Tournachon Nadar, one of the most eminent photographers of the nineteenth century, succeeded in exposing a photographic plate at 262 feet over Bièvre, France in 1858. He was soon approached by the French Army to attempt photo reconnaissance but rejected the offer. In 1882, unmanned photo balloons were already in the air; a little later, they were joined by photo rockets both in France and in Germany. The only innovation of World War I was to combine aerial cameras with a superior flying platform — the airplane.[91]

Radar became the next major surveillance technology. Massively employed in World War II, it provided important advantages over photography. Previously, military commanders had to wait until the pilots returned from surveillance missions and the film was developed. The inevitable delay between the time of the surveillance and the delivery of the finished image limited its usefulness because by the time the photograph was produced, enemy positions could have changed. However, with radar, as imaging became instantaneous, this delay was eliminated. The effectiveness of radar had to do with a new means of displaying an image — a new type of screen.

Consider the imaging technologies of photography and film. The photographic image is a permanent imprint corresponding to a single referent — whatever was in front of the lens when the photograph was taken. It also corresponds to a limited time of observation — the time of exposure). Film is based on the same principles. A film sequence, composed of a number of still images, represents the sum of referents and the sum of exposure times of these individual images. In either case, the image is fixed once and for all. Therefore the screen can only show past events.

With radar, we see for the first time the mass employment (television is founded on the same principle but its mass employment comes later) of a fundamentally new type of screen, the screen which gradually comes to dominate modern visual culture — video monitor, computer screen, instrument display. What is new about such a screen is that its image can change in real time, reflecting changes in the referent, be it the position of an object in space (radar), any alteration in visible reality (live video) or changing data in the computer's memory (computer screen). The image can be continually updated in real time. This is the third, after classic and dynamic, type of a screen — the screen of real time.

The radar screen changes, tracking the referent. But while it appears that the element of time delay, always present in the technologies of military surveillance, is eliminated, in fact, time enters the real-time screen in a new way. In older, photographic technologies, all parts of an image are exposed simultaneously. Whereas now the image is produced through sequential scanning: circular in the case of radar, horizontal in the case of television. Therefore, the different parts of the image correspond to different moments in time. In this respect, a radar image is more similar to an audio record since consecutive moments in time become circular tracks on a surface.[92]

What this means is that the image, in a traditional sense, no longer exists! And it is only by habit that we still refer to what we see on the real-time screen as "images." It is only because the scanning is fast enough and because, sometimes, the referent remains static, that we see what looks like a static image. Yet, such an image is no longer the norm, but the exception of a more general, new kind of representation for which we don't have a term yet.

The principles and technology of radar were worked out independently by scientists in the United States, England, France and Germany during the 1930s. But, after the beginning of the War only the U.S. had the necessary resources to continue radar development. In 1940, at MIT, a team of scientists was gathered to work in the Radiation Laboratory or the "Rad Lab," as it came to be called. The purpose of the lab was radar research and production. By 1943, the "Rad Lab" occupied 115 acres of floor space; it had the largest telephone switchboard in Cambridge and employed 4,000 people.[93]

Next to photography, radar provided a superior way to gather information about enemy locations. In fact, it provided too much information, more information than one person could deal with. Historical footage from the early days of the war shows a central command room with a large, table-size map of Britain.[94] Small pieces of cardboard in the form of planes are positioned on the map to show the locations of actual German bombers. A few senior officers scrutinize the map. Meanwhile, women in army uniforms constantly change the location of the cardboard pieces by moving them with long sticks as information is transmitted from dozens of radar stations.[95]

Was there a more effective way to process and display information gathered by radar? The computer screen, as well as most other key principles and technologies of modern human-computer interface — interactive control, algorithms for 3D wireframe graphics, bit-mapped graphics — were developed as a way of solving this problem.

The research again took place at MIT. The Radiation Laboratory was dismantled after the end of the War, but soon the Air Force created another secret laboratory in its place — Lincoln Laboratory. The purpose of Lincoln Laboratory was to work on human factors and new display technologies for SAGE — "Semi-Automatic Ground Environment," a command center to control the U.S. air defenses established in the mid-1950s.[96] Historian of technology Paul Edwards writes that SAGE's job "was to link together radar installations around the USA's perimeter, analyze and interpret their signals, and direct manned interceptor jets toward the incoming bee. It was to be a total system, one whose ‘human components' were fully integrated into the mechanized circuit of detection, decision and response."[97]

The creation of SAGE and the development of interactive human-computer interface was largely a result of a particular military doctrine. In the 1950s the American military thought that when the Soviet Union attacked the U.S., it would send a large number of bombers simultaneously. Therefore, it seemed necessary to create a center which could receive information from all U.S. radar stations, track the large number of enemy bombers and coordinate the counterattack. A computer screen and the other components of the modern human-computer interface owe their existence to this particular military idea. (As somebody who was born in the Soviet Union and now woks on the history of new media in the U.S., I find this bit of history truly fascinating.)

The earlier version of the center was called the Cape Cod network since it received information from the radars situated along the coast of New England. The center was operating right out of the Barta Building situated on the MIT campus. Each of 82 Air Force officers monitored his own computer display which showed the outlines of the New England Coast and the locations of key radars. Whenever an officer noticed a dot indicating a moving plane, he would tell the computer to follow the plane. To do this the officer simply had to touch the dot with the special "light pen."[98]

Thus, the SAGE system contained all of the main elements of the modern human-computer interface. The light pen, designed in 1949, can be considered a precursor of the contemporary mouse. More importantly, at SAGE the screen came to be used not only to display information in real time, as in was in radar and television, but also to give commands to the computer. Rather than acting solely as a means to display an image of reality, the screen became the vehicle for directly affecting reality.

Using the technology developed for SAGE, Lincoln researchers created a number of computer graphics programs that relied on the screen as a means to input and output information from a computer. They included programs to display brain waves (1957), simulate planet and gravitational activity (1960), as well as to create 2D drawings (1958).[99] The single most well known of these became a program called Sketchpad. Designed in 1962 by Ivan Sutherland, a graduate student supervised by Claude Shannon, it widely publicized the idea of interactive computer graphics. With Sketchpad, a human operator could create graphics directly on computer screen by touching the screen with a light pen. Sketchpad exemplified a new paradigm of interacting with computers: by changing something on the screen, the operator changed something in the computer's memory. The real-time screen became interactive.

This, in short, is the history of the birth of the computer screen. But even before a computer screen became widely used, a new paradigm emerged — the simulation of an interactive three-dimensional environment without a screen. In 1966, Ivan Sutherland and his colleagues began research on the prototype of VR. The work was cosponsored by ARPA (Advanced Research Projects Agency) and the Office of Naval Research.[100]

"The fundamental idea behind the three-dimensional display is to present the user with a perspective image which changes as he moves," wrote Sutherland in 1968.[101] The computer tracked the position of the viewer's head and adjusted the perspective of the computer graphic image accordingly. The display itself consisted of two six-inch-long monitors which were mounted next to the temples. They projected an image which appeared superimposed over viewer's field of vision.

The screen disappeared. It completely took over the visual field.

The Screen and the Body

I have presented one possible genealogy of the modern computer screen. In my genealogy, the computer screen represents an interactive type, a subtype of the real-time type, which is a subtype of the dynamic type, which is a subtype of the classical type. The discussion of these types relied on two ideas. First, the idea of temporality: the classical screen displays a static, permanent image; the dynamic screen displays a moving image of the past and finally, the real-time screen shows the present. Second, the relationship between the space of the viewer and the space of the representation (I defined the screen as a window into the space of representation which itself exists in our normal space).

Let us now look at the screen's history from another angle — the relationship between the screen and the body of the viewer. This is how Roland Barthes described the screen in "Diderot, Brecht, Eisenstein," written in 1973:

> Representation is not defined directly by imitation: even if one gets rid of notions of the "real," of the "vraisemblable," of the "copy," there will still be representation for as long as a subject (author, reader, spectator or voyeur) casts his gaze towards a horizon on which he cuts out a base of a triangle, his eye (or his mind) forming the apex. The "Organon of Representation" (which is today becoming possible to write because there are intimations of something else) will have as its dual foundation the sovereignty of the act of cutting out [découpage] and the unity of the subject of action... The scene, the picture, the shot, the cut-out rectangle, here we have the very condition that allows us to conceive theater, painting, cinema, literature, all those arts, that is, other than music and which could be called dioptric arts.[102]

For Barthes, the screen becomes the all-encompassing concept which covers the functioning of even non-visual representation (literature), although he does make an appeal to a particular visual model of linear perspective. At any rate, his concept encompasses all types of representational apparatuses I have discussed: painting, film, television, radar and computer display. In each of these, reality is cut by the rectangle of a screen: "a pure cut-out segment with clearly defined edges, irreversible and incorruptible; everything that surrounds it is banished into nothingness, remains unnamed, while everything that it admits within its field is promoted into essence, into light, into view."[103] This act of cutting reality into a sign and nothingness simultaneously doubles the viewing subject who now exists in two spaces: the familiar physical space of his/her real body and the virtual space of an image within the screen. This split comes to the surface with VR, but it already exists with painting and other dioptric arts.

What is the price the subject pays for the mastery of the world, focused and unified by the screen?

The Draughtsman's Contrast, a 1981 film by Peter Greenway, concerns an architectural draftsman hired to produce a set of drawings of a country house. The draughtsman employs a simple drawing tool consisting of a square grid. Throughout the film, we repeatedly see the draughtsman's face through the grid which looks like the prison bars. It is as if the subject who attempts to catch the world, to immobilize it, to fix it within the representational apparatus (here, perspectival drawing), is trapped by this apparatus himself. The subject is imprisoned.

I take this image as a metaphor for what appears to be a general tendency of the Western screen-based representational apparatus. In this tradition, the body must be fixed in space if the viewer is to see the image at all. From Renaissance monocular perspective to modern cinema, from Kepler's camera obscura to nineteenth century camera lucida, the body had to remain still.[104]

The imprisonment of the body takes place on both the conceptual and literal levels; both kinds of imprisonment already appear with the first screen apparatus, Alberti's perspectival window. According to many interpreters of linear perspective, it presents the world as seen by a singular eye, static, unblinking and fixated. As described by Norman Bryson, perspective "followed the logic of the Gaze rather than the Glance, thus producing a visual take that was eternalized, reduced to one 'point of view' and disembodied."[105] Bryson argues that "the gaze of the painter arrests the flux of phenomena, contemplates the visual field from a vantage-point outside the mobility of duration, in an eternal moment of disclosed presence."[106] Correspondingly, the world, as seen by this immobile, static and atemporal Gaze, which belongs more to a statue than to a living body, becomes equally immobile, reified, fixated, cold and dead. Writing about Dürer's famous print of a draftsman drawing a nude through a screen of perspectival threads, Martin Jay notes that "a reifying male look" turns "its targets into stone"; consequently, "the marmoreal nude is drained of its capacity to arouse desire."[107] Similarly, John Berger compares Alberti's window to "a safe let into a wall, a safe into which the visible has been deposited."[108] And in The Draughtsman's Contract, time and again, the draughtsman tries to eliminate all motion, any sign of life from the scenes he is rendering.

With perspectival machines, the imprisonment of the subject also happens in a literal sense. From the onset of the adaptation of perspective, artists and draftsmen have attempted to aid the laborious manual process of creating perspectival images and, between the sixteenth and nineteenth centuries, various "perspectival machines" were constructed.[109] By the first decades of the sixteenth century, Dürer described a number of such machines.[110] Many varieties were invented, but regardless of the type, the artist had to remain immobile throughout the process of drawing.

Along with perspectival machines, a whole range of optical apparatuses was in use, particularly for depicting landscapes and conducting topographical surveys. The most popular optical apparatus was camera obscura.[111] Camera obscura literally means "dark chamber." It was founded on the premise that if the rays of light from an object or a scene pass through a small aperture, they will cross and re-emerge on the other side to form an image on a screen. In order for the image to become visible, however, "it is necessary that the screen be placed in a chamber in which light levels are considerably lower than those around the object."[112] Thus, in one of the earliest depictions of the camera obscura, in Kircher's Ars magna Lucis et umbrae (Rome, 1649), we see the subject enjoying the image inside a tiny room, oblivious to the fact that he had to imprison himself inside this "dark chamber" in order to see the image on the screen.

Later, smaller tent-type camera obscura became popular — a movable prison, so to speak. It consisted of a small tent mounted on a tripod, with a revolving reflector and lens at its apex. Having positioned himself inside the tent which provided the necessary darkness, the draftsman would then spend hours meticulously tracing the image projected by the lens.

Early photography continued the trend toward the imprisonment of the subject and the object of representation. During photography's first decades, the exposure times were quite long. The daguerreotype process, for instance, required exposures of four to seven minutes in the sun and from 12 to 60 minutes in diffused light. So, similar to the drawings produced with the help of camera obscura, which depicted reality as static and immobile, early photographs represented the world as stable, eternal, unshakable. And when photography ventured to represent the living, such as the human subject, s/he had to be immobilized. Thus, portrait studios universally employed various clamps to assure the steadiness of the sitter throughout the lengthy time of exposure. Reminiscent of the torture instruments, the iron clamps firmly held the subject in place, the subject who voluntarily became the prisoner of the machine in order to see her/his own image[113]

Toward the end of the nineteenth century, the petrified world of the photographic image was shattered by the dynamic screen of the cinema. In "The Work of Art in the Age of Mechanical Reproduction," Walter Benjamin expressed his fascination with the new mobility of the visible: “Our taverns and our metropolitan streets, our offices and furnished rooms, our railroad stations and our factories appeared to have us locked up hopelessly. When came the film and burst this prison-world asunder by the dynamite of the tenth of a second, so that now, in the midst of its far-flung ruins and debris, we calmly and adventurously go traveling.”[114]

The cinema screen enabled audiences to take a journey through different spaces without leaving their seats; in the words of film historian Anne Friedberg, it created "a mobilized virtual gaze."[115] However, the cost of this virtual mobility was a new, institutionalized immobility of the spectator. All around the world large prisons were constructed which could hold hundreds of prisoners — movie houses. The prisoners could not neither talk to each other nor move from seat to seat. While they were taken on virtual journeys, their bodies had to remain still in the darkness of the collective camera obscuras.

The formation of this viewing regime took place in parallel with the shift from what film theorists call "primitive" to "classical" film language.[116] An important part of the shift, which took place in the 1910s, was the new functioning of the virtual space represented on the screen. During the "primitive" period, the space of the film theater and the screen space were clearly separated much like those of theater or vaudeville. The viewers were free to interact, come and go, and maintain a psychological distance from the virtual world of the cinematic narrative. In contrast, classical film addressed each viewer as a separate individual and positioned her/him inside its virtual world narrative. As noted by a contemporary in 1913, "they [spectators] should be put in the position of being a 'knot hole in the fence' at every stage in the play."[117] If "primitive cinema keeps the spectator looking across a void in a separate space,"[118] now the spectator is placed at the best viewpoint of each shot, inside the virtual space.

This situation is usually conceptualized in terms of the spectator's identification with the camera eye. The body of the spectator remains in the seat while her/his eye is coupled with a mobile camera. However, it is also possible to conceptualize this differently. We can imagine that the camera does not, in fact, move at all, that it remains stationary, coinciding with the spectator's eyes.

Instead, it is the virtual space as a whole that changes its position with each shot. Using the contemporary vocabulary of computer graphics, we can say that this virtual space is rotated, scaled and zoomed to always give the spectator the best viewpoint. Like a striptease, the space slowly disrobes itself, turning, presenting itself from different sides, teasing, stepping forward and retracting, always leaving something covered, so the spectator will wait for the next shot ... the seductive dance which begins all other with the new scene. All spectator has to do is remain immobile.

Film theorists have taken this immobility to be the essential feature of the institution of cinema. Anne Friedberg wrote: "As everyone from Baudry (who compares cinematic spectation to the prisoners in Plato's cave) to Musser points out, the cinema relies on the immobility of the spectator, seated in an auditorium."[119] Film theoretician Jean-Louis Baudry has probably more than anyone put the emphasis on immobility as the foundation of cinematic illusion. Baudry quoted Plato: "In this underground chamber they have been from childhood, chained by the leg and also by the neck, so that they cannot move and can only see what is in front of them, because the chains will not let them turn their heads."[120] This immobility and confinement, according to Baudry, enables prisoners/spectators to mistake representations for their perceptions, regressing back to childhood when the two were indistinguishable. Thus, rather than a historical accident, according to Baudry's psychoanalytic explanation, the immobility of the spectator is the essential condition of cinematic pleasure.

Alberti's window, Dürer's perspectival machines, camera obscura, photography, cinema — in all of these screen-based apparatuses, the subject had to remain immobile. In fact, as Friedberg perceptively points out, the progressive mobilization of the image in modernity was accompanied by the progressive imprisonment of the viewer: "as the 'mobility' of the gaze became more 'virtual' — as techniques were developed to paint (and then to photograph) realistic images, as mobility was implied by changes in lighting (and then cinematography) — the observer became more immobile, passive, ready to receive the constructions of a virtual reality placed in front of his or her unmoving body."[121]

What happens to this tradition with the arrival of a screen-less representational apparatus — VR? On the one hand, VR does constitute a fundamental break with this tradition. It establishes a radically new type of relationship between the body of a viewer and an image. In contrast to cinema, where the mobile camera moves independent of the immobile spectator, now the spectator has to actually move around the physical space in order to experience the movement in virtual space. The effect is as though the camera is mounted on user's head. So, in order to look up in virtual space, one has to look up in physical space; in order to "virtually" step forward one has to actually step forward and so on.[122] The spectator is no longer chained, immobilized, anesthetized by the apparatus which serves him the ready-made images; now s/he has to work, to speak, in order to see.

At the same time, VR imprisons the body to an unprecedented extent than ever before. This can be seen clearly with the earliest VR system designed by Sutherland and his colleagues in the 1960s which I already mentioned above. According to Howard Rheingold's history of VR, "Sutherland was the first to propose mounting small computer screens in binocular glasses — far from an easy hardware task in the early 1960s — and thus immerse the user's point of view inside the computer graphic world."[123] Rheingold further wrote:

> In order to change the appearance of the computer-generated graphics when the user moves, some kind of gaze-tracking tool is needed. Because the direction of the user's gaze was most economically and accurately measured at that time by means of a mechanical apparatus, and because the HMD [head-mounted display] itself was so heavy, the users of Sutherland's early HMD systems found their head locked into machinery suspended from the ceiling. The user put his or her head into a metal contraption that was known as the 'Sword of Damocles' display.[124]

A pair of tubes connected the display to tracks in the ceiling, "thus making the user a captive of the machine in a physical sense."[125] The user was able to turn around and rotate her/his head in any direction but s/he could not move away from the machine more than few steps. Like today's computer mouse, the body was tied to the computer. In fact, the body was reduced to nothing else — and nothing more — than a giant mouse, or more, precisely, a giant joystick. Instead of moving a mouse, the user had to turn her/his own body. Another comparison which comes to mind is the apparatus built in the late nineteenth century by Etienne-Jules Marey to measure the frequency of the wing movements of a bird. The bird was connected to the measuring equipment by wires which were long enough to enable it to flap its wings in midair but not fly anywhere.[126]

The parodox of VR that requires the viewer to physically move in order to see an image (as opposed to remaining immobile) and at the same time physically ties her/him to a machine is interestingly dramatized in a "cybersex" scene in the movie Lawnmower Man (Brett Leonard, 1992). In the scene, the heroes, a man and a woman, are situated in the same room, each fastened to a separate circular frame which allows the body to freely rotate 360 degrees in all directions. During "cybersex" the camera cuts back and forth between the virtual space (i.e., what the heroes see and experience) and the physical space. In the virtual world represented with psychedelic computer graphics, their bodies melt and morph together disregarding all the laws of physics, while in the real world each of them simply rotates within his/her own frame.

The paradox reaches its extreme in one of the most long standing VR projects — the Super Cockpit developed by the U.S. Air Force in the 1980s.[127] Instead of using his own eyes to follow both the terrain outside of his plane and the dozens of instrument panels inside the cockpit, the pilot wears a head-mounted display that presents both kinds of information in a more efficient way. What follows is a description of the system from Air & Space magazine:

> When he climbed into his F16C, the young fighter jock of 1998 simply plugged in his helmet and flipped down his visor to activate his Super Cockpit system. The virtual world he saw exactly mimicked the world outside. Salient terrain features were outlined and rendered in three dimensions by the two tiny cathode ray tubes focused at his personal viewing distance...His compass heading was displayed as a large band of numbers on the horizon line, his projected flight path a shimmering highway leading out toward infinity.[128]

If in most screen-based representations (painting, cinema, video) as well as in typical VR applications the physical and the virtual worlds have nothing to do with each other, here the virtual world is precisely synchronized to the physical one. The pilot positions himself in the virtual world in order to move through the physical one at a supersonic speed with his representational apparatus which is securely fastened to his body, more securely than ever before in the history of the screen.

Representation versus Simulation

In summary, VR continues the screen's tradition of viewer immobility by fastening the body to a machine, while at the same time it creates an unprecedented new condition, requiring the viewer to move. We may ask whether this new condition is without an historical precedent or whether it fits within some other alternative representational tradition which encourages the movement of the viewer?

I began my discussion of the screen by emphasizing that a screen's frame separates two spaces, the physical and the virtual, which have different scales. Although this condition does not necessarily lead to the immobilization of the spectator, it does discourage any movement on her part: why move when she can't enter the represented virtual space anyway? This was very well dramatized in Alice in Wonderland when Alice struggles to become just the right size in order to enter the other world.

The alternative tradition of which VR is a part can be found whenever the scale of a representation is the same as the scale of our human world so that the two spaces are continuous. This is the tradition of simulation rather than that of representation bound up to a screen. The simulation tradition aims to blend virtual and physical spaces, rather than to separate them. Therefore, the two spaces have the same scale; their boundary is de-emphasized (rather than being marked by a rectangular frame, as in representation tradition); and the spectator is free to move around the physical space.

To further analyze the different logic of the simulation and the representation traditions we may compare their typical representatives: frescoes and mosaics, on the one hand, and the Renaissance painting. The former create an illusionary space that starts behind the surface of an image. Importantly, the frescoes, mosaics, and also wall paintings are inseparable from the architecture. In other words, they can't not be moved anywhere. In contrast, a modern painting, which first makes its appearance during the Renaissance, is essentially mobile. Separate from a wall, it can be transported anywhere. (It is tempting to connect this new mobility of a representation with the tendency of capitalism to make all signs as mobile as possible. I will come back to this idea in "Teleaction" section of the next chapter.)

But, at the same time, an interesting reversal takes place. The interaction with a fresco or a mosaic, which itself can't be moved, does not assume immobility on the part of the spectator, while the mobile Renaissance painting does presuppose such immobility. It is as though the imprisonment of the spectator is the price for the new mobility of the image. This reversal is consistent with the different logic of representation and simulation traditions. Since a fresco or a mosaic are "hardwired" to their architectural setting, this allows the artist to create the continuity between the virtual and the physical space. In contrast, the painting can be put in an arbitrary setting and therefore such continuity can no longer be guaranteed. Responding to this new condition, a painting presents a virtual space which is clearly distinct from the physical space where the painting and the spectator are located. At the same time, its imprisons the spectator through perspective model or other techniques, so she and the painting form one system. Therefore if in the simulation tradition the spectator exists in a single coherent space — the physical space and the virtual space which continues it — in the representational tradition the spectator has a double identity. She simultaneously exists in the physical space and in the space of the representation. This split of the subject is the tradeoff for new mobility of an image as well as for the newly available possibility to represent any arbitrary space, rather than having to simulate the physical space where an image is located.

While representational tradition comes to dominate post-Renaissance culture, the simulation tradition does not disappear. In fact, the nineteenth century, with its obsession with naturalism, pushes simulation to the extreme with the wax museum and the dioramas of natural history museums. Another example of the simulation tradition is a sculpture on a human scale, for instance, Auguste Rodin's "The Burghers of Calais." We think of such sculptures as part of post-Renaissance humanism which puts the human at the center of the universe, when in fact, they are aliens, black holes within our world into another parallel universe, the petrified universe of marble or stone, which exists in parallel to our own world.

VR continues the tradition of simulation. However, it introduces one important difference. Previously, the simulation depicted a fake space which was continuous with and extended from the normal space. For instance, a wall painting created a pseudo landscape which appeared to begin at the wall. In VR, either there is no connection between the two spaces (for instance, I am in a physical room while the virtual space is one of an underwater landscape) or, on the contrary, the two completely coincide (i.e., the Super Cockpit project). In either case, the actual physical reality is disregarded, dismissed, abandoned.

In this respect, nineteenth century panorama can be thought of as a transitional form from classical simulations (wall paintings, human size sculpture, diorama) toward VR. Like VR, panorama creates a 360 degree space. The viewers are situated in the center of this space and they are encouraged to move around the central viewing area in order to see different parts of the panorama.[129] But in contrast to wall paintings and mosaics which, after all, acted as decorations of a real space, the physical space of action, now this physical space is subordinate to the virtual space. In other words, the central viewing area is conceived as a continuation of fake space, rather than vice versa as before — and this is why it is usually empty. It is empty so that we can pretend that it continues the battlefield, or a view of Paris or whatever else the panorama represents.[130] From here we are one step away from VR where the physical space is totally disregarded and all the "real" actions take place in virtual space. The screen disappeared because what was behind it simply took over.

And what about the immobilization of the body in VR which connects it to the screen tradition? Dramatic as it is, this immobilization probably represents the last act in the long history of the body's imprisonment. All around us are the signs of increasing mobility and the miniaturization of communication devices — mobile telephones and electronic organizers; pagers and laptops; phones and watches which offer Web surfing; Gameboy and similar hand held game units. Eventually VR apparatus may be reduced to a chip implanted in a retina and connected by wireless transmission to the Net. From that moment on, we will carry our prisons with us — not in order to blissfully confuse representations and perceptions (as in cinema), but to always "be in touch," always connected, always "plugged-in." The retina and the screen will merge.

This futuristic scenario may never become a reality. For now, we clearly live in the society of a screen. The screens are everywhere: the screens of airline agents, data entry clerks, secretaries, engineers, doctors, pilots, etc.; the screens of ATM machines, supermarket checkouts, automobile control panels, and, of course, the screens of computers. Rather than disappearing, the screen threatens to take over our offices, cities and homes. Both computer and television monitors are getting bigger and flatter; eventually to become wall-size. Architects such as Rem Koolhaus design “Blade Runner” like buildings where the whole façade is turned into a giant screen.[131]

Dynamic, real-time and interactive, a screen is still a screen. Interactivity, simulation, and telepresence: like centuries ago, we are still looking at a flat rectangular surface, existing in the space of our body and acting as a window into another space. Whatever new era we may be entering today, we still have not left the era of a screen.

III. The Operations

Just as there is no "innocent eye," there is no "pure computer." A traditional artist perceives the world through the filters of already existing cultural codes, languages and representational schemes. Similarly, a new media designer or a user approaches the computer through a number of cultural filters. The preceding chapter discussed some of these filters. Human-computer interface models the world in distinct ways; it also imposes its own logic on digital data. Existing cultural forms such as printed word and cinema bring their own powerful conventions of organizing information. These forms further interact with the human-computer interface conventions to create what I called cultural interfaces — new sets of conventions used to organize cultural data. Finally, such constructs as screen (and the corresponding representation tradition along with its counterpart, the simulation tradition) contribute additional layer of conventions.

The metaphor of a series of filters assumes that at each stage, from bare-bones digital data to particular media applications, the creative possibilities are being further restricted. It is important therefore to note that each of these stages can be also seen as progressively more enabling. That is, although the programmer who would directly deal with binary values stored in memory would be as "close to the machine" as possible, it would also take forever to get the computer to do anything. Indeed, the history of software is one of increasing abstraction. By removing the programmer and the user further from the machine, software allows them to accomplish more faster - or, to use the early slogan of Apple, Inc., "the power to be your best." From machine language programmers moved to Assembler, from there — to high level languages such as COBOL, FORTRAN and C, as well as very high level languages designed for programming in a particular area, such Macromedia Director's LINGO and HTML. The use of computers to author media developed along similar lines. If the few artists working with computers in the 1960s and 1970 had to write their own programs in high-level computer languages, beginning with the Macintosh most artists, designers and occasional users came to use menu-based software applications: image editors, paint and layout programs, Web editors. And while each of these programs comes with its built-in commands, default values, metaphors and interface conventions which strongly influence gets produced with their help, the evolution of software towards higher and higher levels of abstraction is fully compatible with the overall trajectory which governs computers development and use: automation.

In this chapter I will take the next step in describing the language of new media. I started by analyzing the properties of computer data (Chapter 1), and then looked at the human-computer interface (Chapter 2). Continuing this bottom-up movement, this chapter takes up the layer of technology which runs on top of the interface after — application software. Software programs enable new media designers and artists to create new media objects — and at the same time they act as yet another filter which shapes their imagination of what is possible to do with a computer. Similarly, software used by end users to access these objects, such as Web browsers, image viewers or media players, shape their understanding of what new media is. For example, digital media players such Windows 98 Media Player or RealPlayer emulate the interfaces of linear media machines such as a VCR. They provide such commands as play, stop, eject, rewind and fast forward. In this way, they make new media simulate old media, hiding its new properties such as random access.

Rather than analyzing particular software programs, I will address more general techniques, or commands, which are common to many of them. Regardless of whether a new media designer is working with quantitative data, text, images, video, 3D space or their combinations, she employs the same techniques: copy, cut, paste, search, composite, transform, filter. The existence of such techniques which are not media specific is another consequence of media status as computer data. I will call these typical techniques of working with computer media operations. This chapter will discuss three examples of operations: selection, compositing, and teleaction.

While the operations are embedded in software, they are not tied up to it. They are employed not only within a computer but also in the social world outside of it. but also outside the computer. They are not only ways of working with computer data but also general ways of working, ways of thinking, and ways of existing in a computer age.

The communication between the larger social world and software use and design is a two way process. As we work with software and use the operations embedded in it, these operations become part of how we understand ourselves, others and the world. The strategies of working with computer data become our general cognitive strategies. At the same time, the design of software and the human-computer interface reflects a larger social logic, ideology, and imaginary of the contemporary society. So if we find particular operations dominating software programs, we may also expect to find them at work in culture at large. In discussing the three operations of selecting, compositing and teleaction in the sections of this chapter I will illustrate this general thesis with particular examples. Other examples of operations which are imbedded in software and hardware and also can be found at work in contemporary culture at large are sampling and morphing.[132]

As I already noted in “Interface” chapter, one of the differences between industrial and information society is that in the latter both work and leisure often involve the use of the same computer interfaces. This new, more close relationship between work and leisure is complimented by a more close relationship authors and readers (or, more generally, between producers of cultural objects and their users). This does not mean that new media completely collapses the difference between producers and users, or that every new media text exemplifies Roland Barthes' concept of "readarly text." Rather, as we shift from industrial society to information society, from old media to new media, the overlapping between producers and users becomes much larger. This holds for software the two groups use, their respective skills and expertise, the structure of typical media objects, and the operations they perform on computer data.

While some software products is aimed at either professional producers or end users, other software is used by both groups: Web browsers and search engines, word processors, media editing applications such as Photoshop (the latter routinely employed in post-production of Hollywood feature films) or Dreamweaver. Further, the differences in functionality and pricing between professional and amateur software are quite small (few hundred dollars or less) compared to the real gap between equipment and formats used by professionals and amateurs before new media. For instance, the differences between 35mm and 8mm film equipment and cost of production, or between professional video (formats such as D-1 and Beta SP; editing decks, switchers, DVE, and other editing hardware) and amateur video (VHS) were in the hundreds of thousands of dollars. Similarly, the gap in skills between professionals and amateurs also got smaller. For instance, while employing Java or DHTML for Web design in the late 1990s was the domain of professionals, many Web users were also able to create a basic Web page using such programs as FrontPage, HomePage or Word..

At the same time, new media does not change the nature of professional-amateur relationship. The gap became much smaller but it still exist. And it will always exist, systematically maintained by the professional producers themselves in order to survive. With photography, film and video, this gap involved three key areas: technology, skills, and aesthetics.[133] With new media, a new area has emerged. As the "professional" technology becomes accessible to amateurs, the new media professionals create new standards, formats and design expectations to maintain their status. Thus, the continuos introduction of new Web design "features" along with the techniques to create them following the public debut of HTML around 1993 — rollover buttons and pull-down menus, DHTML and XML, Javscript scripts and Java applets — can be in part explained as the strategy employed by the professionals to keep themselves ahead of home users

On the level of new media products, the overlapping between the producers and the users can be illustrated by computer games. As I will discuss in more detail in "Navigable Space" section, game companies often release so-called "level editors," the special software to allow the players to create their own game environments for the game they purchased. Other software to add or modify games is released by third parties or written by game fans themselves. This phenomenon is referred to as "game patching." As described the writer and curator Anne-Marie Schleiner, "game patches, (or game add-ons, mods, levels, maps or wads), refer to the alterations of preexisting game source code in terms of graphics, game characters, architrecture, sound and game play. Game patching in the 1990s has evolved into a kind of popular hacker art form with numerous shareware editors available on the Internet for modifying most games."[134]

Every commercial game is also expected to have an extensive "options" area where the player can customize various aspects of the game. Thus, a game player becomes somewhat of a game designer, although her creativity involves not making something from scratch but selecting combinations of different options. I will discuss this concept of creativity as selection in more detail in "Menus, Filters, Plug-ins" section.

While some operations are the domain of new media professionals, and other operations are the domain of end users, the two groups also employ some of the same operations. The examples are copy, cut and paste, sort, search, filter, transcode, rip. The operations discussed in this chapter exemplify these three kinds. "Selection" is the operation employed by both professional designers and end users. "Compositing" is used exclusively belongs exclusively by the designers. The third operation, "teleaction," is an example of operation typically used by users.

Although this chapter focuses on new media operations, the concept of an operation can be used in relation to other technologically-based cultural practices. We can connect it to other more familiar terms such as "procedure," "practice" or "method." At the same time, it would be a mistake to reduce the concept of an operation to such concepts as "tool" or "medium." In fact, one of the assumptions underlying this book is that these traditional concepts do not work very well in relation to new media, and that we need new concepts such as an interface and operations. On the one hand, operations are usually in part automated, the way traditional tools were not. On the other hand, like computer algorithms, they can be written down as series of steps, i.e. they exist as concepts before being materialized in hardware and software. In fact, most of new media operations, from morphing to texture mapping, from searching and matching to hyperlinking, begin as algorithms published in computer science papers; eventually these algorithms become commands of standard software applications. So, for instance, when the user applies a particular Photoshop filter to an image, the main Photoshop programs invokes a separate program which corresponds to this filter. The program reads in the pixel values, performs some actions of them, and writes modified values to the screen.

Thus, operations should be seen as another case of the more general principle of new media — transcoding. Encoded in algorithms and implemented as software commands, operations exist independently from the media data to which they can be applied. The separation between algorithms and data in programming becomes the separation between operations and media data.

As an example of the operations in other areas of culture, consider architectural practice of Peter Eiseman. His projects use diffirent operations provided by CAD programs as the basis of the design of building's exterior and/or interior form. Eiseman systematically utilized the full range of computer operations available: extrusion, twisting, extension, displacement, morphing, warping, shifting, scaling, rotation, and so on.[135]

Another example is provided by clothing design by Iseey Miyake. Each of his designs is a result of a particular conceptual procedure, translated into a technological process.[136] For instance, <u>Just Before</u> (Spring/Summer 1998 collection) is a gigantic role of identical dresses with suggested lines of demarcation already incorporated into the fabric. An individual dress can be cut out from the roll in a variety of possible ways. <u>Dunes</u> (Spring/Summer 1998 collection) is based on the operation of shrinking. A model is cut two times larger than its final size; next patches and pieces of tape are fitted in the key places; finally it is shrinked down to size by dipping it into special solution. This creates a particular wrinkled texture except in the places protected by patches and tapes.

<u>Dunes</u> exemplifies an important feature of operations: they can be combined together in a sequence. The (new media) designer can manipulate the resulting script, removing and adding new operations. This script exists separately from the data to which it can be applied. Thus, the script of <u>Dunes</u> consists from cutting the model; applying patches and tapes to key areas; and shrinking. It can be applied to different designs and fabrics. New media software, designers and users have even more flexibility. New filters can be "plugged into" the program, extending the range of operations available. The script can be edited using special scripting languages. It can be also saved and later applied to a different object. The designers and users can automatically apply the script to a number of objects and even instruct the computer to automatically invoke the script at a particular time or if particular condition as occurred. The example of the former are backup or disk defragmenter programs often designated to start at a particular time at night. The example of the later is filtering email messages in email programs such as Eudora or Microsoft Outlook. While retrieving new email messages from the server, the program can move email messages into a particular folder (or delete them, or raise their priority, etc.) if the message header or address contain a particular string.

Menus, Filters, Plug-ins

The Logic of Selection

Viewpoint Datalabs International is selling thousands 3D geometric models widely used by computer animators and designers. Its catalog describes the models as follows: "VP4370: Man, Extra Low Resolution. VP4369: Man, Low Resolution. VP4752: Man, Muscular in Shorts and Tennis Shoe. VP5200. Man, w/Beard, Boxer Shorts..."[137] Adobe Photoshop 5.0 comes with more than 100 filers which allow the user to modify an image in numerous ways; After Effects 4.0, the standard for compositing moving images, is shipped with 80 effects plug-ins; thousands more are available from third parties.[138] Macromedia Director 7 comes with an extensive library of "behaviors" — ready-to-use pieces of computer code.[139] Softimage|3D (v3.8), the leading 3D modeling and animation software, is shipped with over 400 textures which can be applied to 3D objects.[140] QuickTime 4 from Apple, a format for digital video, comes with 15 built-in filters and 13 built-in video transitions.[141] Geocities Web site, which pioneered the concept of hosting users' Web sites for free in exchange for adding ad banners into users' pages, gives users access to a collection of over 40,000 clip art images for customizing their sites.[142] Index Stock Imagery offers 375,000 stock photos available for use in Web banner ads.[143] Microsoft Word 97 Web Page Wizard lets the user to create a simple Web by selecting from eight pre-determined styles described by such terms as "Elegant," "Festive" and "Professional." Microsoft Chat 2.1 asks the user to specify her avator by choosing among twelth built-in cartoon character. During the online session, the user can further customize the selected character by interpolating between eight values which represent eight fundamental emotions as defined by Microsoft programmers.

These examples illustrate a new logic of computer culture. New media objects are rarely created completely from scratch; usually they are assembled from ready-made parts. Put differently, in computer culture authentic creation has been replaced by selection from a menu. In the process of creating a new media object, the designer selects from libraries of 3D models and texture maps, sounds and behaviors, background images and buttons, filters and transitions. Every authoring and editing software comes with such libraries. In addition, both software manufacturers and third parties sell separate collections which work as "plug-ins," i.e. they appear as additional commands and ready-to-use media elements under software's menus. The Web provides a further source of plug-ins and media elements, with numerous collections available for free.

New media users are similarly asked to select from pre-defined menus of choices when using software to create documents or access various Internet services. Here are few examples: selecting one of pre-defined styles when creating a Web page in Microsoft Word or a similar program; selecting one of "AutoLayouts" when creating a slide in PowerPoint; selecting one of pre-determined avatars on entering a multi-user virtual world such as Palace; selecting one of the pre-determined viewpoints when navigating a VRML world. (Avatar is a character or a graphic icon representing a user in a virtual world.)

All in all, selecting from a library or menu of pre-defined elements or choices is one of the key operations for both professional producers of new media and for the end users. This operation makes production process more efficient for the professionals; and it makes end users feel that they are not just consumers but "authors" creating a new media object or experience. What are the historical origins of this new cultural logic? How can we describe theoretically the particular dynamics of standardization and invention which comes with it? Is the model of authorship it puts forward specific to new media or can we already find it work in old media?

Art historian Ernst Gombrich and Roland Barthes, among others, critiqued the romantic ideal of the artist creating totally from scratch, pulling images directly from his imagination, or inventing new ways to see the world all alone.[144] According to Gombrich, the realist artist can only represent nature by relaying on already established "representational schemes"; the history of illusion in art involves slow and subtle modifications of these schemes over many generations of artists. In his famous essay "The Death of the Author," Barthes offered even more radical criticism of the idea an author as a solitary inventor alone responsible for work's content. As Barthes puts it, "the Text is a tissue of quotations drawn from the innumerable centers of culture."[145] Yet, even though a modern artist may be only reproducing, or, at best, combining in new ways preexisting texts, idioms and schemas, the actual material process of art making supports the romantic ideal. An artist operates like God creating the Universe — she starts with an empty canvas or a blank page. Gradually filling in the details, he brings a new world into existence.

Such a process of art making, manual and painstakingly slow, was appropriate for the age of pre-industrial artisan culture. In the twentieth century, as the rest of the culture moved to mass production and automation, literally becoming a "culture industry" (the term of Theodor Adorno), fine arts continued to insist on its artisan model. Only in the 1910s when some artists began to assemble collages and montages from already existing cultural "parts," the industrial method of production entered the realm of art. Photomontage became the most "pure" expression of this new method. By the early 1920s, photomontage practitioners already created (or rather, constructed) some of the most remarkable images of modern art such as Cut with the Cake-Knife (Hannah Höch, 1919), Metropolis (Paul Citroën, 1923), The Electrification of the Whole Country (Gustav Klutsis, 1920), and Tatlin at Home (Raoul Hausmann, 1920), to mention just a few examples. Yet, although photomontage became an established practice of Dadaists, Surrealists, and Constructivists in the 1920s, and Pop artists in the 1960s, the creation from scratch, as exemplified by painting and drawing, remained the main operation of modern art.

In contrast, electronic art from its very beginning was based on a new principle: modification of an already existing signal. The first electronic instrument designed in 1920 by the Russian scientist and musician Leon Theremin contained a generator producing a sine wave; the performer simply modified its frequency and amplitude.[146] In the 1960s video artists began to build video synthesizers based on the same principle. The artist was no longer a romantic genius generating a new world purely out of his imagination; he became a technician turning a knob here, pressing switch there — an accessory to the machine.

Substitute a simple sine wave by a more complex signal (sounds, rhythms, melodies); add a whole bank of signal generators and you have arrived at a modern music synthesizer, the first instrument which embodies the logic of all new media: selection from a menu of choices.

The first music synthesizers appeared in the 1950s, followed by video synthesizers in the 1960s, followed by DVE (Digital Video Effects) in the late 1970s — the banks of effects used by video editors; followed by computer software such as 1984 MacDraw that came with a repertoire of basic shapes. The process of art making has finally caught up with modern times. It has become synchronized with the rest of modern society where everything is assembled from ready-made parts; from objects to people's identities. The modern subject proceeds through life by selecting from numerous menus and catalogs of items — be it assembling an outfit, decorating the apartment, choosing dishes from a restaurant menu, or choosing which interest groups to join. With electronic and digital media, art making similarly entails choosing from ready-made elements: textures and icons supplied by a paint program; 3D models which come with a 3D modeling program; melodies and rhythms built into a music synthesis program.

While previously the great text of culture from which the artist created her or his own unique "tissue of quotations" was bubbling and shimmering somewhere below the consciousness, now it has become externalized (and greatly reduced in the process) — 2D objects, 3D models, textures, transitions, effects which are available as soon as the artist turns on the computer. The World Wide Web takes this process to the next level: it encourages the creation of texts that completely consist of pointers to other texts that are already on the Web. One does not have to add any original writing; it is enough to select from what already exists. Put differently, now anybody can become a creator by simply providing a new menu, i.e. by making a new selection from the total corpus available.

The same logic applies to branching-type interactive new media objects. In a branching-type interactive program, when the user reaching a particular object, she can select which branch to follow next by clicking a button or on the part of an image or by choosing from a menu. The visual result of making a choice is that is either a whole screen or its part(s) change. A typical interactive program of the 1980s and early 1990s was self-contained, i.e. it run on a computer which was not networked. In contrast to surfing the Web where it is very easy to move from one site to another, the designers of self-contained programs could expect undivided attention from a user. Therefore it was safe to change the whole screen after a user makes a selection. The effect was similar to turning pages in a book. This book metaphor was promoted by first popular hypermedia authoring software — Apple's HyperCard (1987); a good example of its use can be found in the game Myst (Broderbund, 1993). Myst presents the player with still images which fill the screen. When the player clicking on the left or right parts of an image, it is replaced by another image. (For more on navigation in Myst, see "Digital Cinema" and "Navigable Space" sections below.) In the second part of the 1990s, as most interactive documents migrated to the Web and simultaneously became more complex, it became important to give all pages of the site a common identity and also visually display page's position in relation to the site's branching-tree structure. Consequently, with the help of such technologies such as HTML Frames, Dynamic HTML and Flash, interactive designers established a different convention. Now parts of the screen, which typically contain company logo, top-level menus, and page's path, remain constant while other parts changed dynamically. (Microsoft and Macromedia sites provide good examples of this new convention.[147]) But regardless of whether making a selection leads the user to a whole new screen or only changes part(s)of it, the user still navigates through branching structure consisting from pre-defined objects. While more complex types of interactivity can be created by via a computer program which controls and modifies the media object at run time, the majority of interactive media uses fixed branching tree structures.

It is often claimed that a user of a branching interactive program becomes its co-author: by choosing a unique path through the elements of a work, she supposedly creates a new work. But it is also possible to see the same process in a different way. If a complete work is a sum of all possible paths through its elements, then the user following a particular path only accesses a part of this whole. In other words, the user is only activating a part of the total work that already exists. Just as with the example of Web pages which consist from nothing but the links to other pages, here the user does not add new objects to a corpus, but only selects its subset. This is a new type of authorship which corresponds neither to pre-modern (before Romanticism) idea of providing minor modification to the tradition nor to the modern idea (nineteenth and first part of the twentieth centuries) of a creator-genius revolting against it. It does, however, fit perfectly with the logic of advanced industrial and post-industrial societies, where almost every practical act involves choosing from some menu, catalog, or database. In fact, as I already noted when discussing interactivity in "Principles of New Media" section, new media is the best available expression of the logic of identity in these societies: choosing values from a number of pre-defined menus.

How can a modern subject escape from this logic? In a society saturated with brands and labels, people respond by adopting minimalist aesthetics and hard-to-identify clothing style. Writing about an empty loft as an expression of minimalist ideal, architecture critic Herbert Muschamp points out that people "reject exposing the subjectivity when one piece of stuff is prefered to another." The opposition between an the indvidualised inner world and objective, shared, objective, neutral world outside becomes reversed:

> The private living space has taken on the guise of objectivity: neutral, value-free, as if this were a found space, not an impeccably designed one. The world outside, meawhile, has become subjectified, rendered into a changing collage of pesonal whims and fancies. This is to be expected in a culure dominated by the distribution system. That system, exists, after all, not to make things but to sell them, to apeal to individual impulses, tastes, desires. As a result, the public realm has becime a collective repository of dreams and designs from which the self requires refuge.[148]

How can one accomplishing the similar escape in new media? It can only be accomplished by refusing all options and customization, and ultimately refusing all forms of interactivity. Paradoxically, by followng an interactive path one does not construct a unique self but instead adopts already pre-established identitities. Similarly, chossing values from menu or customisng one's desktop or an aplication automatally makes one participate in the "changing collage of personal whims and fancies" mapped out and coded into software by the companies. Thus, short of using command-line interface of UNIX which can be though of an equivalent of minimalist loft in the realm of computing, I would prefer using Microsoft Windows exactly the way it was installed at the factory.

"Postmodernism" and Photoshop

As I noted in this chapter's introduction, computer operations encode existing cultural norms in their design. "The logic of selection" is a good example of this. But what was a set of social and economic practices and conventions now became encoded in the software itself. The result is a new form of control, soft but powerful. Although software does not directly prevent its users from creating from scratch, its design on every level makes it "natural" to follow a different logic: that of selection.

While computer software "naturalizes" the model of authorship as selection from libraries of pre-defined objects, we can already find this model at work with old media, such as magic lantern slides shows.[149] As film historian Charles Musser points out, in contrast modern cinema where the authorship extends from pre-production to post-production but does not cover exhibition (i.e., the theatrical presentation of a film is completely standardized and does not involve making creative decisions), in magic lantern slide shows the exhibition was a highly creative act. Magic lantern exhibitioner was the in fact an artist who skillfully arranged a presentation of slides which he bought from the distributors. This is a perfect example of authorship as selection: an author puts together an object from the elements which she herself did not create. The creative energy of the author goes into selection and sequencing of elements, rather than into their original design.

Although not all modern media arts follow this authorship model, the technological logic of analog media strongly supports it. Stored using industrially manufactured materials such as film stock or magnetic tape, media elements can be more easily copied, isolated and assembled in new combinations. In addition, various media manipulation machines, such as a tape recorder and a film slicer, make the operations of selection and combination easier to perform,. In parallel, we witness the development of archives of various media which enable the authors to draw on already existing media elements rather than always having to record new elements themselves. For instance, in the 1930s German photojournalist Dr. Otto Bettmann started what latter became known as Bettmann Archive; at the time of its acquisition by Bill Gates's Corbis Corporation in 1995 it contained 16 million photographs, including some of most frequently used images of this century. Similar archives were created for film and audio media. Using "stock" photographs, movie clips and audio recording become the standard practice of modern media production.

To summarize: the practice of putting together a media object from already existing and commercially distributed media elements already existed with old media, but new media technology further standardizes it and makes it much easier to perform. What before involved scissors and glue now involves simply clicking on "cut" and "paste. And, by encoding the operations of selection and combination into the very interfaces of authoring and editing software, new media "legitimizes" them. Pulling elements from databases and libraries becomes the default; creating them from scratch becomes an exception. The Web acts as a perfect materialization of this logic. It is one gigantic library of graphics, photographs, video, audio, design layouts, software code and texts; and each and every element is free since it can be saved to user's computer with a single mouse click.

It is not accidental that the development of GUI which legitimized "cut and paste" logic as well as media manipulation software such as Photoshop, which popularized plug-in architecture, took place during the 1980s — the same decade when contemporary culture became "post-modern." In evoking this term I follow Fredric Jameson usage of post-modernism as "a periodizing concept whose function is to correlate the emergence of new formal features in culture with the emergence of a new type of social life and a new economic order."[150] As it became apparent by the early 1980s for critics such as Jameson, culture no longer tried to "make it new." Rather, endless recycling and quoting of the past media content, artistic styles and forms became the new "international style" and the new cultural logic of modern society. Rather than assembling more media recordings of reality, culture is now busy re-working, recombining and analyzing the already accumulated media material. Invoking the metaphor of Plato's cave, Jameson writes that post-modern cultural production "can no longer look directly out of its eyes at the real word but must, as in Plato's cave, trace its mental images of the world on its confining walls."[151] In my view, this new cultural condition found its perfect reflection in the emerging computer software of the 1980s which privileged the selection from already existing media elements over creating them from scratch. And at the same time, to large extent it is this software which made post-modernism possible. The shift of all cultural production to first electronic tools such as switchers and DVEs (1980s) and then to computer-based tools (1990s) greatly eased the practice of relying on old media content in creating new productions. It also made media universe much more self-referential, because when all media objects are designed, stored and distributed using a single machine — computer — it becomes much easier to borrow elements from already existing objects. Here again the Web became the perfect expression of this logic, since new Web pages are routinely created by copying and modifying already existing Web pages. This applies both for home users creating their home pages and for professional Web, hypermedia, and game development companies.

From Object to Signal

Selecting ready-made elements which will become part of the content of a new media object is only one aspect of "logic of selection." While working on the object, the designer also typically selects and applies various filters and "effects." All these filters, be it manipulating image appearance, creating a transition between moving images, or applying a filter to a piece of music, involve the same principle: algorithmically modifying the existing media object or its parts. Since computer media consist from samples which are represented in a computer as numbers, a computer program can access every sample in turn and modify its value according to some algorithm (see “Principles of New Media,” (2) and (3)). Most image filters work in this way. For instance, to add noise to an image, a program such as Photoshop reads in the image file pixel by pixel, adds a randomly generated number to the value of each pixel, and writes out a new image file. Programs can also work on more than one media object at once. For instance, to blend two images together, a program reads in values of corresponding pixels from the two images; it then calculates a new pixel value based on the percentages of existing pixel values; this process is repeated for all the pixels.

Although we can also find precursors to filter operations in old media (for instance, hand colorization of silent film), they really comes into their own with the electronic media technologies. All electronic media technologies of the nineteenth and twentieth century are based on modifying a signal by passing it through various filters. These include technologies for real-time communication such as telephone; broadcasting technologies used for mass distribution of media products such as radio and television; and technologies to synthesize media, such as video and audio synthesizers which originate with the instrument designed by Theremin in 1920.

In retrospect, the shift from a material object to a signal accomplished by electronic technologies represents a fundamental conceptual step towards computer media. In contrast to a permanent imprint in some material, a signal can be modified in real time by passing it through some filter(s). Moreover, in contrast to manual modifications of a material object, an electronic filter can modify the signal all at once. Finally, and most importantly, all machines for electronic media synthesis, recording, transmission and reception include controls for signal modification. As a result, an electronic signal does not have a singular identity — a particular state which is qualitatively different from all other possible states. Consider, for example, loudness control of the radio receiver or brightness control of an analog television set. They don’t have any privileged values. In contrast to a material object, electronic signal is essentially mutable.

This mutability of electronic media is just one step away from “variability” of new media (see “Principles of New Media” section.) As already discussed, a new media object can exist in numerous versions . For instance, in the case of a digital image, we can change its contrast and color, blur or sharpen it, turn it into a 3D shape, use its values to control sound, and so on. But, to a significant extent, an electronic signal is already characterized by similar variability, because it can exist in numerous states. For example, in the case of a sine wave, we can modify its amplitude or frequency; each modification produces a new version of the original signal without affecting its structure. Therefore, in essence, a television or radio signal are already new media. Put differently, in the progression from a material object to an electronic signal to computer media the first shift is more radical than the second. All that happens when we move from analog electronics to digital computers is that the range of variations is greatly expanded. This happens because, firstly, modern digital computers separate hardware and software, and, secondly, because an object is now represented as numbers, i.e. it become computer data which can be modified by software. In short, a media object becomes “soft” — with all the implications contained in this metaphor.

The experimental filmmaker Hollis Frampton whose reputation rests on his remarkable structural films and who, towards the end of his life, came to be interested in computer media, seemed to already understood this fundamental importance of the shift from a material object to an electronic signal.[152] He wrote in one of his essays:

> Since the New Stone Age, all the arts have tended, through accident or design, toward a certain fixity in their object. If Romanticism deferred stabilizing the artifact, it nonetheless placed its trust, finally, in a specialized dream of statis: the 'assembly line' of the Industrial Revolution was at first understood as responsive to copious imagination.
>
> If the television assembly line has by now run riot (half a billion people can watch a wedding as consequential as mine or yours) it has also confuted itself in its own malleability.
>
> We're all familiar with the parameters of expression: Hue, Saturation, Brightness, Contrast. For the adventurous, there remain the twin deities Vertical Hold and Horizontal Hold…and, for those aspiring to the pinnacles, Fine Tuning.[153]

What Frampton calls “malleability” of television signal becomes “variability” of new media. While the analog television set allowed the viewer to modify the signal on just a few dimensions such as brightness and hue, new media technologies give the user much more control. A new media object can be modified on numerous dimensions, and these modifications can be expressed numerically. For instance, the user of a Web browser software can instruct the browser to skip all multimedia elements; tell it to enlarge font size while displaying a page or to completely substitute the original font by a different one. The user can also re-shape the browser window to any size and proportions as well as change the spatial and color resolution of the display itself. Further, a designer can specify that different versions of the same Web site will be displayed depending upon the bandwidth of user’s connection and the resolution of her display. For instance, a user accessing the site via a high-speed connection and a high resolution screen will get a rich multimedia version while the user accessing the same site via a small LCD display of a hand-held electronic will receive just a few lines of text. More radically, a number of completely different interfaces can be constructed to the same data, from a database to a virtual environment. In short, the new media object is something which can exist in numerous versions and numerous incarnations.

To conclude this discussion of selection operation, I would like to invoke a particular cultural figure — a new kind of author for whom this operation is the keys. This author is a DJ who creates music in real-time by mixing already existing music tracks and who is dependent on various electronic hardware devices. In the 1990s DJ acquired a new cultural prestige, becoming a required presence at art openings and book release parties, in hip restaurants and hotels, in the pages of Art Forum and Wired. The rise of this figure can be directly correlated to the rise of computer culture. DJ best demonstrates its new logic: selection and combination of pre-existent elements. DJ also demonstrates the true potential of this logic to create new artistic forms. Finally, DJ example also makes it clear that selection by itself is not sufficient. The essence of DJ's art is the ability to mix the selected elements together in rich and sophisticated ways. In contrast to "paste and cut" metaphor of modern GUI which suggests that selected elements can be simply, almost mechanically combined, the practice of live electronic music demonstrates that true art lies in the "mix."

Compositing

From Image Streams to Modular Media

The movie Wag the Dog (Barry Levinson, 1997) contains an scene in which a Washington spin doctor and a Hollywood producer are editing a fake news footage designed to win public support for the non-existent war. The footage shows a girl, a cat in her arms, running through the destroyed village. If a few decades earlier creating together such a shot required staging and then filming the whole thing on location, the computer tools make it possible to create it in real time. Now, the only live element is the girl, played by a professional actress. The actress is videotaped against a blue screen. The other two elements in the shot, the destroyed village and the car, come from the database of stock footage. Scanning through the database, the producers trying different versions of these elements; a computer updates the composite scene in real time.

The logic of this shot is typical of new media production process, regardless of whether the object being put together is a video or film shot, as in Wag the Dog example; a 2D still image; a sound track; a 3D virtual environment; a computer game scene; or a sound track. In the course of production, some elements are created specifically for the project; others are selected from databases of stock material. Once all the elements are ready, they are composited together into a single object. That is, they are fitted together and adjusted in a such a way that their separate identities become invisible. The fact that they come diverse sources and were created by different people in different times is hidden. The result is a single seamless image, sound, space or a scene.

As used in new media field, the term digital compositing has a particular and well-defined meaning. It refers to the process of combining a number of moving image sequences and possibly stills into a single sequence with the help of special compositing software such as After Effects (Adobe), Compositor (Alias|Wavefront), or Cineon (Kodak). Compositing was formally defined in a paper published in 1984 by two scientists working for Lucasfilm. In describing compositing they make a significant analogy with computer programming:

> Experience has taught us to break dwn large bodies of source code into separate modules in order to save compilation time. An error in one routine forces only the recompilation of its module and the relatively quick reloading of the entire program. Similarly, small errors in coloration or design in one object should not force “recompilation” of the entire image.

Separating the image into elements which can be independently rendered saves enormous time. Each element has an associated matte, coverage information which designates the shape of the element. The compositing of those elements makes use of the mattes to accumulate the final image.[154]

Most often the composited sequence simulates a traditional film shot. That it, it looks like something which took place in real physical space and was filmed by a real film camera. To achieve this, all elements which comprise the finished composite — for example, footage shot on location, referred in the industry as a "live plate," footage of actors shot in front of a blue screen, and 3D computer-generated elements — are aligned in perspective, and modified so they have same contrast and color saturation. To simulate the depth of field of effect, some elements are blurred while others are sharpened. Once all the elements are assembled, a virtual camera move through the simulated space may be added to increase its "reality effect." Finally, such artifacts as film grain or video noise can be added. (See "Illusion" chapter for more detailed discussion of how 3D computer graphics is used in the service of traditional cinematic realism.) In summary, digital compositing can be broken into three conceptual steps:

1. Construction of a seamless 3D virtual space from different elements.
2. Simulation of a camera move(s) through this space (optional).
3. Simulation of the artifacts of a particular media (optional).

If 3D computer animation is used to create a virtual space from scratch, compositing typically uses existing film or video footage. Therefore I need to explain why I claim the result of a composite is a virtual space. Let us consider two different examples of compositing. A compositor may use a number of moving and still images to create a totally new 3D space and then generate a camera move through it. For example, in Cliffhanger (Renny Harlin, 1993) the shot of the main hero, played by Silvester Stallone, which was filmed in the studio against a blue screen, was composited with the shot of a mountain landscape. The resulting shot shows Stallone high in the mountains hanging over an abyss. In other cases, new elements will be added (or removed from) a live action sequence without changing neither its perspective nor the camera move. For example, a 3D computer generated creature can be added to a live action shot of an outdoor location, such as in many dinosaur shots in Jurassic Park (Steven Spielberg, special effects by Industrial Light & Magic, 1993) In the first example it is immediately clear that composited shot represents something which never took place in reality. In other words, the result of the composite is a virtual space. In the second example, it may appear at first that the existing physical space is preserved. However, here as well, the final result is a virtual world which never really existed. Put differently, what existed was a field of grass with trees without dinosaurs.

Digital compositing is routinely used to put together TV commercials and music videos, computer games scenes, shots in feature films and most other moving images in computer culture. Throughout the 1990s, Hollywood directors increasingly came to rely on compositing to assemble larger and larger part of a film. In 1999 George Lucas released Stars Wars: Episode 1 (1999); according to Lucas, %95 of the film was assembled on a computer. As I will discuss below, digital compositing as a technique to create moving images goes back to video keying and optical printing in cinema; but what before was a rather special operation now become a norm for creating moving imagery. Digital compositing also greatly expanded the range of this technique, allowing to control the transparency of individual layers and to combine potentially unlimited number of layers. For instance, a typical special effects shot from a Hollywood film may consist from a few hundred, or even thousands of layers. Although in some situations a few layers can be combined in real time automatically (virtual sets technology), in general compositing is a time consuming and difficult operation. This is one aspect of compositing the scene from Wag the Dog misrepresented; to create the composite shown in this scene would require many hours.

Digital compositing exemplifies a more general operation of computer culture: assembling together a number of elements to create a single seamless object. Thus we can distinguish between compositing in wider sense (i.e., the general operation) and compositing in a narrow sense (assembling movie image elements to create a photorealistic shot). The latter meaning corresponds to the accepted usage of the term compositing. For me, compositing in a narrow sense is a particular case of a more general operation of compositing — a typical operation in assembling any new media object.

As a general operation, compositing is a counterpart of selection. Since a typical new media object is put together from elements which come from different sources, these elements need to be coordinated and adjusted to fit together. Although the logic of these two operations — selection and compositing — may suggest that they always follow one another (first select, then composite), in practice their relationship is more interactive. Once an object is partially assembled, new elements may need to be added; existing elements may need to be re-worked. This interactivity is made possible by modular organization of a new media object on different scales (see “Principles of New Media,” (2)). Throughout the production process, the elements retain their separate identity and therefore they can be easily modified, substituted or deleted. When the object is complete, it can be “output” as a single “stream” in which separate elements no longer are accessible. The example of the operation which “collapses” all elements together is “flatten image” command in Adobe Photoshop 5.0. Another example of “collapsing” elements into a single stream is recording a digitally composited moving image sequence on film, which was a typical procedure in Hollywood film production in the 1980s and 1990s.

Alternatively, the completed object may retain the modular structure when it is distributed. For instance, in computer games the player can interactively control characters, moving them in space. In some games, the user moves 2D images of characters, called sprites, over the background image; in others, everything is represented as 3D objects, including the characters. In either case, during production the elements are adjusted to form a single whole, stylistically, spatially and semantically; during the play the user can move the elements within the programmed limits.

In general, 3D computer graphics representation is more "progressive" than a 2D image because it allows true independence of elements; therefore it may gradually replace image streams, still used by our culture: photographs, 2D drawings, films, video. In other words, 3D computer graphics representation is more modular than 2D still image or 2D moving image stream. This modularity makes it easier for a designer to modify the scene at any time. It also gives the scene additional functionality. For instance, the user may "control" the character, moving him or her around the 3D space. Scene elements can be later reused for new productions. Finally, modularity also allows for a more efficient storage and transmission of a media object. For example, to transmit a video clip over a network all pixels which make up this clip have to be send over; but to transmit a 3D scene only requires sending the coordinates of the objects in it. These is how online virtual worlds, online computer games and networked military simulators work: first the copies of all objects making up a world are downloaded to a user computer, and after this the server only has to keep sending their new 3D coordinates.

If the general trajectory of computer culture is from 2D images towards 3D computer graphics representations, digital compositing represents an intermediary historical step between the two. A composited space which consists from a number of moving image layers is more modular than a single shot of a physical space. The layers can be repositioned against each other and adjusted separately. Yet such a representation is not as modular as a true 3D virtual space, because each of the layers retains its own perspective. (In "Digital Cinema" section below I will discuss the newer post-production method in which digitized film or video sequences are positioned in a virtual computer generated space.) When and were moving image "streams" will be replaced by %100 3D computer generated scenes will depend not only on cultural acceptance of computer scene's look but also on economics. A 3D scene is much more functional than a film or video shot of the same scene but, if it is to contain similar level of detail, it may be much more expensive to generate.

The general evolution of all media types towards becoming more and more modular, and the particular evolution of a moving image in the same direction, can be traced through the history of popular media file formats. QuickTime developers early on specified that a single QuickTime movie may consist from a number of separate tracks, just as a still Photoshop image consists from a number of layers. QuickTime 4 format (1999) included 11 different track types, including video track, sound track, text track and sprite track (graphic objects which can be moved independently of video).[155] By placing different media on different tracks which can be edited and exported independently, QuickTime encourages the designers to think in modular terms. In addition, a movie may contain a number of video tracks which can act as layers in a digital composite. By using alpha channels (masks saved with video tracks) and different modes of track interaction (such as partial transparency), QuickTime user can create complex compositing effects within a single QuickTime movie, without having to resort to any special compositing software. In effect, QuickTime architects embedded the practice of digital compositing in the media format itself. What previously required special software now can be done by simply using the features of QuickTime format itself.

Another example of media format evolving towards more and more data modularity is MPEG.[156] The early version of the format such as MPEG-1 (1992) was defined as "the standard for storage and retrieval of moving pictures and audio on storage media." The format specified a compression scheme for a video and/or audio data conceptualized in a traditional way. In contrast, MPEG-7 (to be approved in 2001) is defined as "the content representation standard for multimedia information search, filtering, management and processing." It is based on different concept of a media composition which consist from a number of a media objects of various types, from video and audio to 3D models and facial expressions, and the information on how these objects are combined. MPEG-7 provides an abstract language to describe such a scene. The evolution of MPEG thus allows us to trace the conceptual evolution in how we understand new media — from a traditional "stream" to a modular composition, more similar in its logic to a structural computer program than a traditional image or a film.

The Resistance to Montage

The connection between aesthetics of post-modernism and the operation of selection also applies to compositing. Together, these two operations reflect and at the same time enable "post-modern" practice of pastiche and quotation. They work in tandem: one operation is used to select elements and styles from the "database of culture"; another is to put them together into new objects. Thus, along with selection, compositing is the key operation of post-modern, or computer-based authorship.

At the same time, we should think of the aesthetic and the technological as aligned but ultimately separate layers, to use the metaphor of digital technology itself. The logic of the 1980s post-modern aesthetics and the logic of the 1990s computer-based compositing are not the same. In the 1980s post-modern aesthetics, historical references and media quotes were kept as distinct elements; the boundaries between elements were well-defined (think of David Salle's paintings, Barbara Kruger's montages and various music videos.) Interestingly, this aesthetics corresponds to electronic and early digital tools of the period, such as video switchers, keyers, DVE (digital video effect devices), and computer graphics card which had limited color resolution. These tools enabled hard-edge "copy and paste" operation but not smooch, multi-layer composites. (A lot can be made out of the fact that one of the key post-modern artists of the 1980s, Richard Prince, who became well-known for his "appropriation" photographs, was operating one of the earliest computer-based photo editing system in the late 1970s as a part of his commercial job, before he started making "appropriation" photographs.) The 1990s compositing supported a different aesthetics characterized by smoothness and continuity. The elements were now blended together, and the boundaries were erased, rather than emphasized. This aesthetics of continuity can be best observed in television spots and special effects sequences of feature films which actually put together through digital compositing (i.e., compositing in the narrow, technical sense). For instance, the computer-generated dinosaurs in Jurassic Park are made to perfectly blend with the landscape, just as the live actors, 3D virtual actors and computer-rendered ship are made to blend together in Titanic (James Cameron, special effects by Digital Domain, 1997). But the aesthetics of continuity can also be found in other areas of new media. Computer-generated morphs allow for a continuos transition between two images which before would be accomplished through a dissolve or a cut.[157] Many computer games also obey the aesthetics of continuity in that, in cinematic terms, they are single-takes. They have no cuts. From beginning to end, they present a single continuos trajectory through a 3D space. This is particularly true for first-person shooters such as Quake. The lack of montage in these games fits in with a first person point of view they employ. These games simulate the continuity of a human experience, guaranteed by the laws of physics. While modern telecommunication, from telegraph, telephone and television to telepresence and World Wide Web allowed us to suspend these laws, moving almost instantly from one virtual location to another with a tog of a switch or a press of a button, in RL (real life) we still obey physics: in order to move from one point to another we have to pass through every point in between. (I will investigate navigation through space as a key form of computer culture in "Navigable Space" section below.)

All these examples — smooth composites, morphing, uninterrupted navigation in games — have one thing in common: where old media relied on montage, new media substitutes the aesthetics of continuity. A film cut is replaced by a digital morph or by a digital composite. Similarly, the instant changes in time and space characteristic of modern narrative, both in literature and in cinema, are replaced by a continuos non-interrupted first-person narrative of games and VR. Computer multimedia also does not use any montage. The desire to correlate between different senses, or, to use new media lingo, different media tracks, which preoccupied many artists throughout the twentieth century such as Kandinsky, Skriabin, Eisenstein, and Godard, to mention just a few well-known names, is foreign to multimedia. Instead it follows the principle of simple addition. The elements in different media are placed next to each other without any attempt to establish contrast, complementarity or dissonance between them. This is best illustrated by Web sites of the 1990s which typically contains JPEG images, QuickTime clips, audio files, and other media elements, side by side.

We can also find strong anti-montage tendencies in modern GUI. In the middle of the 1980s Apple published guidelines for interface design of all Macintosh application software. According to these guidelines, an interface should communicate the same messages through more than one sense. For instance, an alert box appearing on the screen should be accompanied by a sound. This alignment of different senses can be compared to naturalistic use of different media in traditional film language, which was attacked by Eisenstein and other montage activists. Another example of anti-montage tendency in GUI is peaceful co-existence of multiple information objects on the computer screen, exemplified by a number of simultaneously opened windows. Just as with media elements in a Web, the user can add more and more windows without establishing any conceptual tension between them.

The aesthetics of continuity can't be fully deduced from compositing technology, although in many cases it would not be possible without it. Similarly, montage aesthetics which dominated much of modern art and media should not be thought of as a simple result of the available tools; but at the same time these tools, with their possibilities and limitations, contributed to its development. For instance, a film camera enables to shoot film footage of a certain limited length; to create a longer film the separate pieces have to be put together. This is typically in editing were the pieces are trimmed and then glued together. Not surprisingly, the modern film language is built on discontinuities: short shots replace one another; the point of view changes from shot to shot. The Russian montage school pushes such discontinuities to the extreme but, with a very few exceptions such as Andy Warhol's early films and Wavelength by Michael Snow, all film systems are based on them.

In computer culture, montage is no longer dominant aesthetics, as it was throughout the twentieth century, from the avant-garde of the 1920s up until post-modernism of the 1980s. Digital compositing in which different spaces are combined into a single seamless virtual space is a good example of the alternative aesthetics of continuity; however, compositing in general can be understood as a counterpart of montage aesthetics. Montage aims to create visual, stylistic, semantic, and emotional dissonance between different elements. In contrast, compositing aims to blend them into a seamless whole, a single gestalt. Since I already evoked DJ as somebody who exemplifies "authoring by selection," I will use this figure once again as an example of how anti-montage aesthetics of continuity cuts across culture and is not limited to the creation of computer still and moving images and spaces. DJ's art is measured by his ability to seamlessly go from one track to another. A great DJ is thus a compositor and anti-montage artist par excellence. He is able to create a perfect temporal transition from very different musical layers; and he can do this in real time, in front of the dancing crowd.

In discussing selection from a menu, I pointed out that this operation is typical of both new media and culture at large. Similarly, the operation of compositing is not limited to new media. Consider, for instance, the frequent use of one or more layers of semi-transparent materials in contemporary packaging and architecture. The result is a visual composite, since a viewer can see both what is in front and what is behind the layer. It is interesting that one architectural project which explicitly refers to computer culture — The Digital House (Hariri & Hariri, project, 1988) — systematically employs such semi-transparent layers throughout.[158] If in the famous glass house of Mies van de Rohe the inhabitant was looking outside through glass walls, the more complex plan of The Digital House creates the possibility of seeing through a number of interior spaces at once. Thus the inhabitant of the house is constantly faced with complex visual composites.

Having discussed compositing as a general operation of new media and as a counterpart of selection, I will now focus on its particular case — compositing in the narrow sense, i.e. creation of a single moving image sequence from a number of separate sequences and (optionally) stills using special compositing software. Today digital compositing is responsible for an increasing number of moving images: all special effects in cinema, computer games, virtual worlds, most television visuals and even television news (see discussion of virtual sets below). Most often the moving image constructed through compositing presents a fake 3D world. I say "fake" because regardless of whether a compositor creates a totally new 3D space from different elements (Cliffhanger example), or only adds some elements to a live action footage (Jurassic Park example), the resulting moving image shows something which did not exist in reality. Digital compositing thus belongs together with other simulation techniques. These are the techniques used to create fake realities and thus, ultimately, to deceive the viewer: fashion and make up, realist painting, dioramas, military decoys and VR. Why digital compositing acquired such prominence? If we are to create an archeology which will connect digital compositing with previous techniques of visual simulation, there should we locate the essential historical breaks? Or, to ask this question differently: what is the historical logic which drives the evolution of these techniques? Shall we indeed expect computer culture to gradually abandon pure lens-based imaging (still photography, film, video) replacing it instead with composited images and ultimately with 3D computer generated simulations?

Archeology of Compositing: Cinema

I will start my archeology of compositing with Potemkin's Villages. According to the historical myth, at the end of the eighteenth century, Russian ruler Catherine the Great decided to travel around Russia in order to observe first-hand how the peasants lived. The first minister and Catherine's lover, Potemkin, had ordered the construction of special fake villages along her projected route. Each village consisted of a row of pretty facades. The facades faced the road; at the same time, to conceal their artifice, they were positioned at a considerable distance. Since Catherine the Great never left her carriage, she returned from her journey convinced that all peasants lived in happiness and prosperity.

This extraordinary arrangement can be seen as a metaphor for life in the Soviet Union where I grew up in the 1970s. There, the experience of all citizens was split between the ugly reality of their lives and the official shining facades of ideological pretense. However, the split took place not only on a metaphorical but also on a literal level, particularly in Moscow — the showcase Communist city. When prestigious foreign guests visited Moscow, they, like Catherine the Great, were taken around in limousines which always followed few special routes. Along these routes, every building was freshly painted, the shop windows displayed consumer goods, the drunks were removed, having been picked up by the militia early in the morning. The monochrome, rusty, half-broken, amorphous Soviet reality was carefully hidden from the view of the passengers.

In turning selected streets into fake facades, Soviet rulers adopted eighteenth century technique of creating fake reality. But, of course, the twentieth century brought with it a much more effective technology: cinema. By substituting a window of a carriage or a car with a screen showing projected images, cinema opened up new possibilities for simulation.

Fictional cinema, as we know it, is based upon lying to a viewer. A perfect example is the construction of a cinematic space. Traditional fiction film transports us into a space: a room, a house, a city. Usually, none of these exist in reality. What exists are the few fragments carefully constructed in a studio. Out of these disjointed fragments, a film synthesizers the illusion of a coherent space.

The development of the techniques to accomplish this synthesis coincides with the shift in American cinema between approximately 1907 and 1917 from a so-called "primitive" to a "classical" film style. Before the classical period, the space of film theater and the screen space were clearly separated much like in theater or vaudeville. The viewers were free to interact, come and go, and maintain a psychological distance from the cinematic narrative. Correspondingly, the early cinema's system of representation was presentational: actors played to the audience, and the style was strictly frontal.[159] The composition of the shots also emphasized frontality.

In contrast, classical Hollywood film positions each viewer inside the fictional space of the narrative. The viewer is asked to identify with the characters and to experience the story from their points of view. Accordingly, the space no longer acts as a theatrical backdrop. Instead, through new compositional principles, staging, set design, deep focus cinematography, lighting and camera movement, the viewer is situated at the optimum viewpoint of each shot. The viewer is "present" inside a space which does not really exist. A fake space.

In general, Hollywood cinema was always careful to hide the artificial nature of its space, but there is one exception: rear screen projection shots which were introduced in the 1930s. A typical shot shows actors sitting inside a stationary vehicle; a film of a moving landscape is projected on the screen behind car's windows. The artificiality of rear screen projection shots stands in striking contrast against the smooth fabric of Hollywood cinematic style in general.

The synthesis of a coherent space out of distinct fragments is only one example of how fictional cinema fakes reality. A film in general is comprised from separate image sequences. These sequences can come from different physical locations. Two consecutive shots of what looks like one room may correspond to two places inside one studio. They can also correspond to the locations in Moscow and Berlin, or Berlin and New York. The viewer will never know.

This is the key advantage of cinema over older fake reality technologies, be it eighteenth century Potemkin's Villages or nineteenth century Panoramas and Dioramas. Before cinema, the simulation was limited to the construction of a fake space inside a real space visible to the viewer. Examples include theater decorations and military decoys. In the nineteenth century, Panorama offered a small improvement: by enclosing a viewer within a 360-degree view, the area of fake space was expanded. Louis-Jacques Daguerre introduced another innovation by having viewers move from one set to another in his London Diorama. As described by the historian Paul Johnson, its "amphitheater, seating 200, pivoted through a 73-degree arc, from one 'picture' to another. Each picture was seen through a 2,800-square-foot-window."[160] But, already in the eighteenth century, Potemkin had pushed this technique to its limit: he created a giant facade — a Diorama stretching for hundred of miles — along which the viewer (Catherine the Great) passed. In cinema a viewer remains stationary: what is moving is the film itself.

Therefore, if the older simulation technologies were limited by the materiality of a viewer's body, existing in a particular point in space and time, film overcomes these spatial and temporal limitation. It achieves this by substituting recorded images for unmediated human sight and by editing these images together. Through editing, images that could have been shot in different geographic locations or in different times create an illusion of a contiguous space and time.

Editing, or montage, is the key twentieth technology for creating fake realities. Theoreticians of cinema have distinguished between many kinds of montage but, for the purposes of sketching the archeology of the technologies of simulation leading to digital compositing, I will distinguish between two basic techniques. The first technique is temporal montage: separate realities form consecutive moments in time. The second technique is montage within a shot. It is the opposite of the first: separate realities form contingent parts of a single image. The first technique of temporal montage is much more common; this is what we usually mean by montage in film. It defines the cinematic language as we know it. In contrast, the montage within a shot is used more rarely throughout film history. An example of this technique is the dream sequence in The Life of an American Fireman by Edward Porter in 1903, in which an image of a dream appears over a man's sleeping head. Other examples include the split screens beginning in 1908 which show the different interlocutors of a telephone conversation; superimposition of a few images and multiple screens used by the avant-garde filmmakers in the 1920's (for instance, superimposed images in Vertov's Man with a Movie Camera and a three-part screen in Gance Abel's 1927 Napoléon); rear screen projection shots; and the use of deep focus and a particular compositional strategies used to juxtapose close and far away scenes (for instance, a character looking through a window, such as in Citizen Kane, Ivan the Terrible and Rear Window.)[161]

In a fiction film temporal montage serves a number of functions. As I already pointed out, it creates a sense of presence in a virtual space. It is also utilized to change the meanings of individual shots (recall Kuleshov's effect), or, more precisely, to construct a meaning from separate pieces of pro-filmic reality. However, the use of temporal montage extends beyond the construction of an artistic fiction. Montage also becomes a key technology for ideological manipulation, through its employment in propaganda films, documentaries, news, commercials and so on. The pioneer of this ideological montage is once again Vertov. In 1923 Vertov analyzed how he put together episodes of his news program Kino-Pravda (Cinema-Truth) out of shots filmed at different locations and in different times. This is one example of his montage: "the bodies of people's heroes are being lowered into the graves (filmed in Astrakhan' in 1918); the graves are being covered with earth (Kronshtad, 1921); gun salute (Petrograd, 1920); eternal memory, people take down their hats (Moscow, 1922)." Here is another example: "montage of the greetings by the crowd and montage of the greetings by the machines to the comrade Lenin, filmed at different times."[162] As theorized by Vertov, through montage, film can overcome its indexical nature, presenting a viewer with objects which never existed in reality.

Archeology of Compositing: Video

Outside of cinema, montage within a shot becomes a standard technique of modern photography and design (photomontages of Alexander Rodchenko, El Lissitzky, Hannah Höch, John Heartfield and countless other lesser-known twentieth century designers). However, in the realm of a moving image, temporal montage dominates. Temporal montage is cinema's main operation for creating fake realities.

After the World War II a gradual shift takes place from film-based to electronic image recording and editing. This shift brings with it a new technique: keying. One of the most basic techniques used today in any video and television production, keying refers to combining two different image sources together. Any area of uniform color in one video image can be cut out and substituted with another source. Significantly, this new source can be a live video camera positioned somewhere, a pre-recorded tape, or computer generated graphics. The possibilities for creating fake realities are multiplied once again.

With electronic keying becoming a part of a standard television practice in the 1970s, the construction of not only still but also of moving images finally begin to routinely rely on montage within a shot. In fact, rear projection and other special effects shots, which had occupied marginal presence in a classical film, became the norm: weather man in front of a weather map, an announcer in front of footage of a news event, a singer in front of an animation in a music video.

An image created through keying presents a hybrid reality, composed of two different spaces. Television normally relates these spaces semantically, but not visually. To take a typical example, we may be shown an image of an announcer sitting in a studio; behind her, in a cutout, we see news footage of a city street. The two spaces are connected through their meanings (the announcer discusses events shown in a cutout), but visually they are disjoint, as they do not share neither the same scale nor perspective. If classical cinematic montage creates an illusion of a coherent space and hides its own work, electronic montage openly presents the viewer with an apparent visual clash of different spaces.

What will happen if the two spaces seamlessly merge? This operation forms the basis of a remarkable video Steps directed by Polish born filmmaker Zbigniew Rybczynski in 1987. Steps is shot on video tape and uses keying; it also utilizes film footage and makes an inadvertent reference to virtual reality. In this way, Rybczynski connects three generations of fake reality technologies: analog, electronic and digital. He also reminds us that it was the 1920s Soviet filmmakers who first fully realized the possibilities of montage which continue to be explored and expanded by electronic and digital media.

In the video, a group of American tourists is invited into a sophisticated video studio to participate in a kind of virtual reality / time machine experiment. The group is positioned in front of a blue screen. Next, the tourists find themselves literally inside the famous Odessa steps sequence from Sergei Eisenstein's Potemkin (1925). Rybczynski skillfully keys the shots of the people in the studio into the shots from Potemkin creating a single coherent space. At the same time, he emphasizes the artificiality of this space by contrasting the color video images of the tourists with the original grainy black and white Eisenstein's footage. The tourists walk up and down the steps, snap pictures at the attacking soldiers, play with a baby in a crib. Gradually, the two realities begin to interact and mix together: some Americans fall down the steps after being shot by the soldiers from Eisenstein's sequence; a tourist drops an apple which is picked up by a soldier.

The Odessa steps sequence, already a famous example of cinematic montage, becomes just one element in a new ironic re-mix by Rybczynski. The original shots which were already edited by Eisenstein are now edited again with video images of the tourists, using both temporal montage and montage within a shot, the latter done through video keying. A "film look" is juxtaposed with "video look," color is juxtaposed with black and white, the "presentness" of video is juxtaposed with the "always already" of film.

In "Steps" Eisenstein's sequence becomes a generator for numerous kinds of juxtapositions, super-impositions, mixes and re-mixes. But Rybczynski treats this sequence not only as a single element of his own montage but also as a singular, physically existing space. In other words, the Odessa steps sequence is read as a single shot corresponding to a real space, a space which could be visited like any other tourist attraction.

Along with Rybczynski, another filmmaker who systematically experimented with the possibilities of electronic montage within a shot is Jean-Luk Godard. While in the 1960s Godard was actively exploring new possibilities of temporal montage such as jump cut, in later video works such as Scénario du film 'Passion' (1982) and Histore(s) du cinéma (1989-) he developed an unique aesthetics of continuity which relies on electronically mixing a number of images together within a single shot. If Rybczynski's aesthetics is based on the operation of video keying, Godard's aesthetics similarly relies on a single operation available to any video editor: mixing. Godard uses the electronic mixer to create very slow cross-dissolves between images, cross-dissolves which seem never to resolve in a singular image, ultimately becoming the film itself. In Histore(s) du cinéma, Godard mixes together two, three or more images; images gradually fade in and out, but never disappear completely, staying on the screen for a few minutes at a time. This technique can be interpreted as representation of ideas or mental images floating around in our minds, coming in and out of the mental focus. Another variation of the same technique used by Godard is to move from one image to another by oscillating between the two. The images flicker back and forth over and over, until the second image finally replaces the first. This technique can be also interpreted as an attempt to represent mind's movement from one concept, mental image or memory to another — the attempt, in other words, to represent what, according to Locke and other associationist philosophers, is the basis of our mental life — forming associations.

Godard wrote: "There are no more simple images... The whole world is too much for an image. You need several of them, a chain of images..." [163] Accordingly, Godard always multiple images, images cross-dissolved together, coming together and separating. The electronic mixing that replaces both temporal montage and montage within the shot becomes for Godard an appropriate technique to visualize this "vague and complicated system that the whole world is continually entering and watching."[164]

Digital Compositing

The next generation in simulation technologies is digital compositing. On first glance, computers do not bring any conceptually new techniques for creating fake realities. They simply expand the possibilities of joining together different image within one shot. Rather than keying together images from two video sources, we can now composite an unlimited number of image layers. A shot may consist of dozens, hundreds, or thousands of image layers. These image may all have different origins: film shot on location ("live plates"), computer-generated sets or virtual actors, digital matte paintings, archival footage, and so on. Following the success of Terminator 2 and Jurassic Park, most Hollywood films came to utilize digital compositing to create a least some of their shots.

Thus historically, a digitally composed image, like an electronically keyed image, can be seen as a continuation of montage within a shot. But while electronic keying creates disjoined spaces reminding us of the avant-garde collages of Rodchenko or Moholy-Nagy from the 1920s, digital composing brings back the nineteenth century techniques of creating smooth "combination prints" like those of Henry Peach Robinson and Oscar G. Reijlander.

But this historical continuity is deceiving. Digital compositing does represent a qualitatively new step in the history of visual simulation because it allows the creation of moving images of non-existent worlds. Computer generated characters can move within real landscapes; conversely, real actors can move and act within synthetic environments. In contrast to nineteenth century "combination prints" which emulated academic painting, digital composites simulate the established language of cinema and television. Regardless of the particular combination of live action elements and computer-generated elements which make up the composited shot, the camera can pan, zoom, and dolly through it. The interactions of the elements of the virtual world over time between themselves (for instance, the dinosaur attacking the car) along with the ability to look at it from different viewpoints become the guarantee of its authenticity.

These new abilities to create a virtual world which moves — and to be able to move through it —come at a price. Although in the scene from Wag the Dog compositing the fake news footage took place in real time, in reality aligning together numerous elements to create a convincing composite is a time-consuming task. For instance, a 40 second sequence from Titanic in which the camera flies over the computer-generated ship populated by computer-generated characters took many months to produce and its total cost was 1.1 million dollars.[165] In contrast, although images of such complexity were out of reach for video keying, it was possible to use it to combine three image sources in real-time. (This trade-off between image construction time and its complexity is similar to another trade-off I already noted above: between image construction time and its functionality. That is, images created with 3D computer graphics are more functional than image streams recorded by film or video cameras, but in most cases they are much more time consuming to generate.)

If a compositor restricts the composite to just a few images, as it was done with electronic keying, compositing can also be created in real time. The resulting illusion of a seamless space is stronger that what was possible with electronic keying. The example of real-time compositing is Virtual Sets technology which was first introduced in the early 1990s and since them has been making its way into television studios around the world. This technology allows to composite video image and computer-generated three-dimensional elements on the fly. (Actually, because the generation of computer-elements is computation intensive, the final image transmitted to the audience may be a seconds behind the original image picked by television camera.) The typical application of Virtual Sets involves composing an image of an actor over a computer-generated set. The computer reads the position of the video camera and uses this information to render the set in proper perspective. The illusion is made more convincing by generating shadows and/or reflections of the actor and integrating them into the composite. Because of the relatively low resolution of analog television, the resulting effect is quite convincing. A particularly interesting application of Virtual Sets is replacement and insertion of arena-tied advertising messages during live TV broadcasts of sports and entertainment events. Computer-synthesized advertising messages can be inserted onto the playing field or other empty areas in the arena in the proper perspective, as though they were actually present in physical reality.[166]

Digital compositing represents a fundamental break with previous techniques for visual deception yet for another reason. Throughout the history of representation, artists and designers focused on the problem of creating a convincing illusion within a single image, be it a painting, a film frame or a view seen by Catherine the Great through the window of her carriage. Set making, one-point perspective, chiaroscuro, trick photography and other cinematography techniques were all developed to solve this problem. Film montage introduced a new paradigm: creating an effect of presence in a virtual world by joining different images over time. Temporal montage became the dominant paradigm for visual simulation of non-existent spaces.

As the examples of digital composing for film and Virtual Sets applications for television demonstrate, the computer era introduces a different paradigm. This paradigm is concerned not with time but with space. It can be seen as the next step in the development of techniques for creating a single convincing image of non-existent spaces: painting, photography, cinematography. Having mastered this task, the culture came to focus on how to seamlessly join a number of such images into one coherent whole (electronic keying, digital compositing.) Whether it is composing a live video of a newscaster with a 3D computer generated set or composing thousands of elements to create images of "Titanic," the main problem is no longer how to generate convincingly looking individual images but how to blend them together. Consequently, what is important now is what happens on the edges where different images are joined. The borders where different realities come together is the new arena where Potemkins of our era try to outdo one another.

Compositing and New Types of Montage

In the beginning of this section I pointed out that the use of digital compositing to create continuos spaces out of different elements can be seen as an example of larger anti-montage aesthetics of computer culture. Indeed, if in the beginning of the twentieth century cinema discovered that it can simulate a single space through temporal montage — a time-based mosaics of different shots — in the end of the century it came with the technique to accomplish the similar result without montage. In digital compositing, the elements are not juxtaposed but blended, with their boundaries erased rather than foregrounded.

At the same time, by relating digital compositing to theory and practice of film montage, we can better understand how this new key technique of assembling moving images redefines our concepts of a moving image (in “Digital Cinema” I will offer another conceptualization of a digital moving image, arrived at through a different historical trajectory.) While traditional film montage privileges temporal montage over montage within a shot — because technically the later was much more difficult to achieve — compositing makes them equal. More precisely, it erases the strict conceptual and technical separation between the two. Consider, for instance, the interface layout typical of many programs for computer-based editing and digital compositing, such as Adobe Premiere 4.2, a popular editing program, and Alias|Wavefront Composer 4.0, a professional compositing program. In this interface, the horizontal dimension represents time, while the vertical dimension represents spatial order of different image layers making up each image. A moving image sequence appears as a number of blocks staggered vertically, with each block standing for a particular image layer. Thus if Pudovkin, one of Russian film montage theorists and practitioners of the 1920s, conceived of montage as a one-dimensional line of bricks, now it becomes a 2D brick wall. This interface makes montage in time and montage within a shot equal in importance.

If Premiere interface conceptualizes editing as an operation in 2D dimensions, the interface of one of the most popular compositing programs, After Effects 3.0, adds a third dimension. Following the conventions of traditional film and video editing, Premiere assumes that all image sequences are the same size and proportions; in fact, it makes working with images which do not conform to the standard 3 by 4 frame ratio rather difficult. In contrast, the user of After Effects places image sequences of arbitrary sizes and proportions within the larger frame. Breaking with the conventions of old moving image media, the interface of After Effects assumes that the individual elements making up a moving image can freely move, rotate and change proportions over time.

Serge Einstein already used the metaphor of many-dimensional space in his writings on montage, naming one of his articles “The Filmic Forth Dimension” (“Kino cheturekh izmereneii”).[167] However, his theories of montage ultimately focused on one dimension — time. Eisenstein formulated a number of principles, such as counterpoint, which can be used to coordinate the changes in different visual dimensions over time. The examples of visual dimensions he considered are graphic directions, volumes, masses, space, and contrast.[168] When the sound film became a possibility, Eisenstein extended these principles to handle what, in computer language, can be called synchronization of visual and audio tracks; and later he added the dimension of color.[169] Eisenstein also developed a different set of principles (“methods of montage”) according to which different shots can be edited together to form a longer sequence. The examples of “methods of montage” include metric montage which uses absolute lengths of shots to establish a ‘beat,” and rhythmic montage based on pattern of movement within the shots. These methods can be used by themselves to structure a sequence of shots, but they also can be combined within a single sequence.

The new logic of a digital moving image contained in the operation of compositing runs against Einstein's aesthetics with its focus on time. Digital compositing makes the dimensions of space (3D fake space being created by a composite and 2½ D space of all the layers being composited) and frame (separate images moving in 2D within the frame) as important as time. In addition, the possibility of imbedding hyperlinks within a moving sequence introduced in QuickTime 3 and other digital formats adds yet another spatial dimension.[170] The typical use of hyperlinking in digital movies it to link elements of a movie with information displayed outside of it. For instance, when a particular frame is displayed, a specific Web page can be loaded in another window. This practice “spatializes” moving image: no longer completely filling a screen, it is now just one window among others. makes moving image hyperlinking spatial as well.

In summary, if film technology, film practice and film theory privileged the temporal development of a moving image, computer technology spatializes moving image making time just one dimension among a number of others. The new spatial dimensions can be defined as follows:

1. Spatial order of layers in a composite (2 1/2 space).
2. Virtual space constructed trough compositing (3D space).
3. 2D movement of layers in relation to the image frame (2D space).
4. The relationship between moving image and the linked information in the adjustment windows (2D space).

These dimensions should be added to the list of visual and sound dimensions of the moving image, elaborated by Eistenstein and other filmmakers. Their use opens new possibilities for cinema as well as a new challenge for film theory. No longer just a subset of audio-visual culture, digital moving image becomes a part of audio-visual-spatial culture.

Of course, the simple use of these dimensions by itself does not result in montage. Most images and spaces of contemporary culture are juxtaposition of different elements; calling any such juxtaposition montage will render the term meaningless. Media critic and historian Erkki Hutamo suggested that we should reserve the use of the term for “strong” cases, and I will follow his suggestion here.[171] Thus, in order to “qualify” as an example of montage, a new media object should fulfill two conditions: the juxtapositions of elements should follow a particular system; and these juxtapositions should play key role in how the work establishes its meaning, emotional and aesthetic effect. These conditions would also apply to the particular case of new spatial dimensions of a digital moving image. By establishing a logic which controls the changes and the correlation of values on these dimensions, digital filmmakers can create what I will call spatial montage. In the section “New Language of Cinema” below I will continue the discussion of spatial montage by analysing two concrete examples: a CD-ROM and a Web site.

While the dominant use of digital compositing is to create a seamless virtual space, it does not have to be subordinated to this goal. The borders between different worlds do not have to be erased; the different spaces do not have to be matched in perspective, scale and lighting; the individual layers can retain their separate identity rather then being merged into a single space; the different worlds can clash semantically rather than form a single universe. I will conclude this section by invoking a few more works, which, together with videos by Rybczynski and Godard, point at the new aesthetic possibilities of digital compositing if it is not used in the service of simulation. Although all these works were created before digital compositing became available, they explore its aesthetic logic — for compositing is not just a technological but first of all a conceptual operation. I will use these works to introduce two other montage methods based on compositing: ontological montage and stylistic montage.

Rybczynski's film Tango (1982) made when he was still living in Poland uses layering as a metaphor for the particular overcrowdness characteristic of Socialist countries in the second part of the twentieth century, and for human co-habitation in general. A number of people perform various actions moving in loops through the same small room, apparently unaware of each other. Rybczynski offsets the loops in such a way that even though his characters keep moving through the same points in space, they never run into another. Compositing, achieved in Tango through optical printing, allows the filmmaker to superimpose a number of elements, or whole words, within a single space. (In this film each person moving through the room can be said to form a separate world.) As in Steps, these worlds are matched in perspective and scale— and yet the viewer knows that the scene being shown either could not occur in normal human experience at all given the laws of physics, or is highly unlikely to occur given the conventions of human life. In the case of Tango, while the depicted scene could have occurred physically, the probability of it actually occurring is close to zero. Works such as Tango and Steps develop what I will call an ontological montage: the co-existence of ontologically incompatible elements within the same time and space.

The films of Czech filmmaker Konrad Zeman exemplify another montage method based on compositing which I will call stylistic montage. In a career which spanned from the 1940s to the 1980s Zeman used a variety of special effect techniques to create juxtapositions of stylistically diverse images in different media. Zeman juxtaposes different media both in time, cutting from a live action shot to a shot of a model or documentary footage, and within the same shot. For example, a shot may combine filmed human figures, an old engraving used for background, and a model. Of course, such artists as Picasso, Braque, Picabia and Max Ernst were creating similar juxtaposition of elements in different media in still images already before the World War II. However, in the realm of a moving image stylistic montage only came to the surface in the 1990s when the computer became the meeting ground for different generations of media formats used in the twentieth century — 35 mm and 8 mm film, amateur and professional video, and early digital film formats. While previously filmmakers usually worked with a single format throughout the whole film, the accelerated replacement of different analog and digital formats since the 1970s made the co-existence of stylistically diverse elements a norm rather than exemption for new media objects. Compositing can be used to hide this diversity — or it can be used to foreground it, as well as to create it artificially. For instance, the film Forest Gump strongly emphasizes stylistic differences between various shots; this simulation of different film and video artifacts is an important aspect of its narrative system.

In Zeman's films such as Baron Prásil ("Baron Muchhausen," 1961) and Na komete ("On the Comet," 1970), live action footage, etchings, miniatures and other elements are layered together in self-conscious and ironic way. Like Rybczynski, Zeman keeps the coherent perspectival space in his films while making us aware that it is constructed. One of his devices is to superimpose filmed actors over an old etching used as a background. In Zeman's aesthetics neither graphic nor cinematographic dominate; the two are blended together in equal proportion creating a unique visual style. At the same time, Zeman subordinates the logic of feature filmmaking to the logic of animation. That is, the shots in his films which combine live action footage with graphic elements position all elements on parallel planes; the elements move parallel to the screen. This is the logic of an animation stand where the stack of images is arranged parallel to each other, rather than of live action cinema where the camera typically moves through 3D space. As we will see in "Digital Cinema" section, this subordination of live action to animation is the logic of digital cinema in general.

Young St. Petersburg artist Olga Tobreluts, who does use digital compositing, also respects the illusion of a coherent perspectival space, while continuously playing tricks with it. In "Gore ot Uma"(1994; directed by Olga Komarova), a video work based on a famous play written by the nineteenth century Russian writer Aleksandr Griboedov, Tobreluts overlays images representing radically different realities (a close-up of plants; animals in the Zoo) on the windows and walls of various interior spaces. In one shot, two characters converse in front of a window behind which we see a flock of soaring birds taken from Alfred Hitchcock's "The Birds"; in another, a delicate computer- rendered design keeps morphing on the wall behind a dancing couple. In these and similar shots Tobreluts aligns the two realities in perspective but not in scale. The result is an ontological montage — and also a new kind of montage within a shot. Which is to say, if the 1920s avant-garde, and MTV in its wake, juxtaposed radically different realities within a single image, and if Hollywood digital artists use computer compositing to glue different images into a seamless illusionistic space (for instance, synthetic dinosaurs composited against filmed landscape in "Jurassic Park"), Zeman, Rybczynski and Tobreluts explores the creative space between these two extremes. This space in between modernist collage and Hollywood cinematic realism is a new direction for cinema ready to be further explored with the help of digital compositing.

Teleaction

Representation versus Communication

Teleaction, the third operation which I will discuss in this chapter, may appear to be qualitatively different from the first two, selecting and compositing. It is not employed to create new media, but only to access it. Therefore that we may at first think that teleaction does not have a direct effect on the language of new media.

Of course, this operation is made possible by the designers of computer hardware and software. For instance, numerous Web cameras allow the users to observe remote locations; most Web sites also include hyperlinks which allow the user to "teleport" from one remote server to another. At the same time, in the case of many commercial sites, a designers aims to try to prevent a user from leaving the site for as long as possible. To use the industry lingo (circa 1999), a designer wants to make each user "hardcore" (making the user stay on the site); the goal of commercial Web design is to create "stickness" (a measure of how long an individual user stays on a particular Web site), and to increase "eyeball hang time" (Web-site royalty). So while it is the end user who is employing the operation of teleaction, it is the designer who makes it (im)possible. Still, no new media objects are being generated when the user folows a hyperlink to another Web site, or uses telepresence to observe or act in a remote location, or communicates in real time with other users using Internet chat, or just makes a plain old-fashioned telephone call. In short, once we begin dealing with verbs and nouns which start with "tele," we no longer deal with the traditional cultural domain of representation. Instead, we enter a new conceptual space which this book has not explored so far — telecommunication. How can we start navigating it?

When we think of the decade of the 1890s, we think of the birth of cinema. In the preceding decades, and the one which immediately followed the 1890s, most other modern media technologies were developed, enabling the recording of still images of visible reality (photography) and sound (the phonograph), as well as real-time transmission of images, sounds, and text (telegraph, television, the fax, telephone and radio). Yet, more than any of these other inventions, it was the introduction of cinema which impressed itself most strongly on public memory. The year which we remember and celebrate is 1895; it is not 1875 (first television experiments of Carey) or 1907 (the introduction of the fax). Clearly, we are more impressed (or at least, we have been until the Internet) with modern media's ability to record aspects of reality and then use these recordings to simulate it for our senses, than with its real-time communication aspect. If we had a choice to be among the Lumiere's first audience or be the among the first users of the telephone, we would choose the former. Why? The reason is that the new recording technologies led to the development of new arts in the way that real-time communication did not. The fact that aspects of sensible reality can be recorded and that these recordings can be later combined, re-shaped and manipulated — in short, edited — made possible the new media-based arts which were soon to dominate the twentieth century: fiction films, radio concerts and music programs, television serials and news programs. Despite persistent experiments of the avant-garde artists with modern technologies of real-time communication — radio in the 1920s, video in the 1970s, Internet in the 1990s — the ability to communicate over a physical distance in real-time by itself did not seem to inspire fundamentally new aesthetic principles the way film or tape recording did.

Since their beginning in the nineteenth century, modern media technologies have developed along two distinct trajectories. The first is representational technologies: film, audio and video magnetic tape, varios digital storage formats. The second is real-time communication tecnologies, i.e. everything which begins with "tele": telegraph, telephone, telex, television, telepresence. Such new twentieth century cultural forms as radio and later television emerge at the intersections of these two trajectories. In this meeting, the technologies of real-time communication became subordinated to technologies of representation. Telecommunication was used for distribution, as with broadcasting which enabled a twentith century radio listener or television viewer to receive a transmission in real time. But a typical program being broadcast, be it a film, a play or a musical performance, was a traditional aesthetic object, i.e. a construction which utilizes elements of familiar reality and which was created by professionals before the transmission. For instance, although following the adoptation of video tape recorders television retained some live programs such as news and talk shows, the majority of programming came to be pre-recorded.

The attempts of some artists from the 1960s onward to substitute a traditionally defined aesthetic object by other concepts such as "process," "practice," and "concept" only highlight the strong hold of the tradtional concept on our cultural imagination. The concept of an aesthetic object as an <u>object</u>, i.e. as a self-contained structure limited in space and/or time, is fundamental to all modern thinking about aesthetics. For instance, in his <u>Languages of Art</u> (1976), one of the most influential aesthetic theories of the last decades, philosopher Nelson Goodman names the following four symptoms of the aesthetic: syntactic density, semantic density, syntactic repleteness and the ability to exemplify.[172] These characteristics assume a finite object in space and/or time: a literary text, a musical or dance performance, a painting, a work of architecture. For another example of how modern aesthetic theory relies on the concept of a fixed object we can look at the very influential article “From Work to Text” by Roland Barthes. In this article Barthes establisheds an oppositon between a traditional notion of a “work” and a new notion of “text,” about which he advances seven ”propositions.”[173] As can be seen from these propositions, Barthes’s notion of a “text” is an attempt to go beyond traditional aesthetic object understood as something clearly delineated from other objects semantically and physically — and yet ultimately Barthes retains the traditonal concept. Proposition (1) states: “The work can be held in hand, the text is held in language, only exists in the movement of discourse.” “Text” is ruled by metonymy (3) (think of hyperlinking) ; it aims at dissemination of meanings and is fundamentally intertextual (4) (recall another Barthes’s quote already cited in “Selection” section); it does not have a single Author (5); it “requires that one try to abolish (or at the very least to diminish) the distance between writing and reading” (6), the distance which, as Barthes notes, is a recent historical invention. Like a post-serial musical score which makes a performer into its co-author, “text” “asks of the reader a practical collaboration” (6). Given this last proposition in particular, many interactive new media objects qualify as “texts” in Barthes’s definition. Yet his notion of a “text” still assumes a reader “reading,” in most general sense, something which was previously “written.” In short, while a “text” is interactive, hypertextual, distributed, and dynamic (to translate Barthes’s propositions into new media terms), it is still a finite object.

By foregrounding telecommunication, both real-time and asynchronous, as a fundamental cultural activity, Internet asks us to reconsider the very paradigm of what an aesthetic object is. Is it necessary for the concept of the aesthetics to assume representation? Does art necessary involves a finite object? Can telecommunication between users by itself be a subject of an aesthetic? Similarly, can the user’s search for information be understood aesthetically? In short, if a user accessing information and a user telecommunicating with other(s) are as common in computer culture as a user interacting with a representation, can we expand our aesthetic theories to include these two new situations?

I find these to be hard questions; but as a way to begin approaching them, this section will offer an analysis of different kinds of “tele” operations which I summed up by my own term “teleaction.”

Telepresence: Illusion versus Action

In an opening sequence from a movie Titanic (James Cameron, 1997), we see an operator sitting at the controls. The operator is wearing a head-mounted display which shows an image transmitted from a remote location. This allows him to remotely control a small vehicle, and with its help, to explore the insides of the

“Titanic” lying on the bottom of the ocean. In short, the operator becomes "telepresent."

With the rise of the Web, telepresence which until recently was restricted to few specialized industrial and military applications, became more of a familiar experience. The search on Yahoo! for "interesting devices connected to the Net" returns links to a variety of Net-based telepresence applications: coffee machines, robots, interactive model railroad, audio devices and, of course, the ever-popular web cams.[174] Some of these devices, such as most web cams, do not allow for true telepresence — you get images from a remote location but you can't act. Others, however, are true telepresence links, which allow the user to perform actions remotely.

Remote video cameras and remotely navigated devices such as the one shown in Titanic exemplify the notion of being “present” in a physically remote location. At the same time, the experience of daily navigating the Web also involves telepresence on a more basic level. By following hyperlinks, the user “teleports” from one server to another, from one physical location to the next. So if we are still fetishising video-based telepresence as portrayed in “Titanic,” this is only because we are slow to accept the primacy of information space over physical space in computer culture. But in fact the ability to instantly “teleport” from one server to another, to be able to explore a multitude of documents located on computers around the world, all from one location, is much more important that being able to perform physical actions in one remote location.

Following my strategy in “Compositing” section where I focused on digital compositing of moving images as an example of the general operation of compositing, this section will discuss telepresence in its accepted, more narrow meaning: the ability to see and act at a distance. And just as I constructed one possible archeology of digital compositing, here I would like to construct one possible historical trajectory leading to computer-based telepresence. If digital compositing can be placed along with other technologies for creating fake reality such as fashion and make up, realist paintings, dioramas, military decoys and VR, telepresence can be thought of as one example of representational technologies used to enable action, i.e. to allow the viewer to manipulate reality through representations. Other examples of these action-enabling technologies are maps, architectural drawings, and x-rays. All of them allow their user to act over distance. Given this, what are the new possibilities for action offered by telepresence in contrast to these older technologies? This question will guide my discussion of telepresence here.

If we look at the word itself, the meaning of the term telepresence is presence over distance. But presence where? Interactive media designer and theorist Brenda Laurel defines telepresence as "a medium that allows you to take your body with you into some other environment... you get to take some subset of your senses with you into another environment. And that environment may be a computer-generated environment, it may be a camera-originated environment, or it may be a combination of the two."[175] In this definition, telepresence encompasses two different situations: being "present" in a synthetic computer-generated environment (what is commonly referred as virtual reality) and being "present" in a real remote physical location via a live video image. Scott Fisher, one of the developers of NASA Ames Virtual Environment Workstation — the first modern VR system — similarly does not distinguish between being "present" in a computer-generated or a real remote physical location. Describing Ames system, he writes: "Virtual environments at the Ames system are synthesized with 3D computer-generated imagery, or are remotely sensed by user-controlled, stereoscopic video camera configurations."[176] Fisher uses "virtual environments" as all-encompassing term, reserving "telepresence" for the second situation: "presence" in a remote physical location.[177] I will follow his usage here.

Both popular media and the critics have downplayed the concept of telepresence in favor of virtual reality. The photographs of the Ames system, for instance, have been often featured to illustrate the idea of an escape from any physical space into a computer-generated world. The fact that a head-mounted display can also show a televised image of a remote physical location was hardly ever mentioned.

And yet, from the point of view of the history of the technologies of action, telepresence is a much more radical technology than virtual reality, or computer simulations in general. Let us consider the difference between the two.

Like fake reality technologies which preceded it, virtual reality provides the subject with the illusion of being present in a simulated world. Virtual reality adds a new capability: it allows the subject to actively change this world. In other words, the subject is given control over a fake reality. For instance, an architect can modify an architectural model, a chemist can try different molecule configuration, a tank driver can shoot at a model of a tank, and so on. But, what is modified in each case is nothing but data stored in a computer's memory! The user of any computer simulation has power over the virtual world which only exists inside a computer.

Telepresence allows the subject to control not just the simulation but reality itself. Telepresence provides the ability to remotely manipulate physical reality in real time through its image. The body of a teleoperator is transmitted, in real time, to another location where it can act on subject's behalf: repairing a space station, doing underwater excavation or bombing a military base in Baghdad or Yugoslavia.

Thus, the essence of telepresence is that it is anti-presence. I don't have to be physically present in a location to affect reality at this location. A better term would be teleaction. Acting over distance. In real time.

Catherine the Great was fooled into mistaking painted facades for real villages (see “Compositing.”) Today, from thousands of miles away — as it was demonstrated during the Gulf War — we can send missile equipped with a television camera close enough to tell the difference between a target and a decoy. We can direct the flight of the missile using the image transmitted back by its camera, we can carefully fly towards the target. And, using the same image, we blow the target away. All that is needed is to position the computer cursor over the right place in image and to press a button.

Image-Instruments

How new is this use of images?[178] Does it originate with telepresence? Since we are accustomed to consider the history of visual representations in the West in terms of illusion, it may seem that to use images to enable action is a completely new phenomenon. However, French philosopher and sociologist Bruno Latour proposes that certain kinds of images have always functioned as instruments of control and power, power being defined as the ability to mobilize and manipulate resources across space and time.

One example of such image-instruments analyzed by Latour are perspectival images. Perspective establishes the precise and reciprocal relationship between objects and their signs. We can go from objects to signs (two-dimensional representations); but we can also go from such signs to three-dimensional objects. This reciprocal relationship allows us not only to represent reality but also to control it.[179] For instance, we cannot measure the sun in space directly, but we only need a small ruler to measure it on a photograph (the perspectival image par excellence).[180] And even if we could fly around the sun, we would still be better off studying the sun through its representations which we can bring back from the trip — because now we have unlimited time to measure, analyze, and catalog them. We can move objects from one place to another by simply moving their representations: "You can see a church in Rome, and carry it with you in London in such a way as to reconstruct it in London, or you can go back to Rome and amend the picture." Finally, we can also represent absent things and plan our movement through space by working on representations: "One cannot smell or hear or touch Sakhalin Island, but you can look at the map and determine at which bearing you will see the land when you send the next fleet."[181] All in all, perspective is more than just a sign system, reflecting reality

— it makes possible the manipulation of reality through the manipulation of its signs.

Perspective is only one example of image-instruments. Any representation which systematically captures some features of reality can be used as an instrument. In fact, most types of representations which do not fit into the history of illusionism (which includes both representation and simulation traditions as outlined in “Screen” section) — diagrams and charts, maps and x-rays, infrared and radar images — belong to the second history: that of representations as instruments for action.

Telecommunication

Given that images have always been used to affect reality, does telepresence bring anything new? A map, for instance, already allows for a kind of teleaction: it can be used to predict the future and therefore to change it. To quote Latour again, "one cannot smell or hear or touch Sakhalin Island, but you can look at the map and determine at which bearing you will see the land when you send the next fleet."

In my view, there are two fundamental differences. Because telepresence involves electronic transmission of video images, the constructions of representations takes place instantaneously. Making a perspectival drawing or a chart, taking a photograph or shooting film takes time. Now I can use a remote video camera which capture images in real-time, sending these images back to me without any delay. This allows me to monitor any visible changes in a remote location (weather conditions, movements of troops, and so on), adjusting my actions accordingly. Depending upon what information I need, radar can be used instead of a video camera as well. In either case, an image-instrument displayed by a real-time screen (see “Screen” section) is formed in real time.

The second difference is directly related to the first. The ability to receive visual information about a remote place in real time allows us to manipulate physical reality in this place, also in real-time. If power, according to Latour, includes the ability to manipulate resources at a distance, then teleaction provides a new and unique kind of power: real-time remote control. I can drive a toy vehicle, repair a space station, do underwater excavation, operate on a patient or kill — all from a distance.

What technology is responsible for this new power? Since teleoperator typically acts with the help of a live video image (for instance, when remotely operating a moving vehicle such as in the opening sequence of "Titanic"), we may think at first that it is the technology of video, or, more precisely, of television. The original nineteenth century meaning of television was "vision over distance."

Only after 1920s, when television was equated with broadcasting, does this meaning fade away. However, during the preceding half a century (television research begins in the 1870s), television engineers were mostly concerned with the problem of how to transmit consecutive images of a remote location to enable "remote seeing."

If images are transmitted at regular intervals, if these intervals are short enough, and if the images have sufficient detail, the viewer will have enough reliable information about the remote location for teleaction. The early television systems used slow mechanical scanning and the resolution as low as thirty lines. In the case of modern television systems, the visible reality is being scanned at the resolution of a few hundred lines sixty times a second. This provides enough information for most telepresence tasks.

Now, consider the Telegarden project by Ken Goldberg and his associates.[182] In this Web telerobotics project, the Web users operate a robotic arm to plant the seeds in a garden. Instead of continuosly refreshed video, the project uses uses user-driven still images. The image shows the garden from the viewpoint of the video camera attached to the robotic arm. When the arm is moved to a new location, a new still image is transmitted. These still images provide enough information for the particular teleaction in this project — planting the seeds.

As this example indicates, it is possible to teleact without video. More generally, we can say that different kinds of teleaction require different temporal and spatial resolution. If the operator needs an immediate feedback on her actions (the example of remote operation of a vehicle is again appropriate here), frequent update of images is essential. But in the case of planting a garden using a remote robot arm, user-triggered still images are sufficient.

Now, consider another example of telepresence. Radar images are obtained by scanning the surrounding area once every few seconds. The visible reality is reduced to a single point. A radar image does not contain any indications about shapes, textures or colors present in a video image — it only records the position of an object. Yet this information is quite sufficient for the most basic teleaction: to destroy an object.

In this extreme case of teleaction, the image is so minimal it hardly can be called an image at all. However, it is still sufficient for real-time remote action. What is crucial is that the information is transmitted in real time.

If we put the examples of video-based and radar-based telepresence together, the common denominator turns out to be not video but electronic transmission of signals. In other words, the technology which makes teleaction in real time possible is electronic telecommunication. It itself was made possible by two discoveries of the nineteenth century: electricity and electromagnetism. Coupled with a computer used for real time control, electronic telecommunication leads to a new and unprecedented relationship between objects and their signs. It makes instantaneous not only the process by which objects are turned into signs but also the reverse process — manipulation of objects through these signs.

Umberto Eco once defined a sign as something which can be used to tell a lie. This definition correctly describes one function of visual representations — to deceive. But in the age of electronic telecommunication we need a new definition: a sign is something which can be used to teleact.

Distance and Aura

Having analyzed the operation of telepresence in its more narrow and conventional meanings as a physical presence in a remote environment, I now want to come back to a more general sense of telepresence: real-time communication with a physically remote location. This meaning fits all “tele” technologies, from television, radio, fax and telephone to Internet hyperlinking and chat. Again, I want to ask the same question as before: what is different about more recent telecommunication technology as opposed to older onces?

To address this question I will juxtapose the arguments by two key theoreticians of old and new media: Walter Benjamin and Paul Virilio. These arguments come from two essays written half a century apart: Benjamin’s celebrated "The Work of Art in the Age of Mechanical Reproduction" (1936)[183] and Virilio’s "Big Optics" (1992).[184] Benjamin’s and Virilio’s essays focus on the same theme: the disruption caused by a cultural artifact, specifically, new communication technology (film in the case of Benjamin, telecommunication in the case of Virilio) in the familiar patterns of human perception; in short, intervention of technology into human nature. But what is human nature and what is technology? How does one draw the boundary between the two in the twentieth century? Both Benjamin and Virilio solve this problem in the same way. They equate nature with spatial distance between the observer and the observed; and they see technologies as destroying this distance. As we will see, these two assumptions lead them to interpret the prominent new technologies of their times in a very similar way.

Benjamin starts with his now famous concept of aura: the unique presence of a work of art, of a historical or of a natural object. We may think that an object has to be close by if we are to experience its aura but, paradoxically, Benjamin defines aura "as the unique phenomenon of a distance"(224). "If, while resting on a summer afternoon, you follow with your eyes a mountain range on the horizon or a branch which casts its shadow over you, you experience the aura of those mountains, of that branch" (225). Similarly, writes Benjamin, "painter maintains in his work a natural distance from reality" (235). This respect for distance common to both natural perception and painting is overturned by the new technologies of mass reproduction, particularly photography and film. The cameraman, whom Benjamin compares to a surgeon, "penetrates deeply into its [reality] web" (237); his camera zooms in order to "pray an object from its shell" (225). With its new mobility, glorified in such films as "A Man with the Movie Camera," the camera can be anywhere, and, with its superhuman vision, it can obtain a close-up of any object. These close-ups, writes Benjamin, satisfy the desires of the masses "to bring things 'closer' spatially and humanly," "to get hold of an object at very close range" (225). Along with disregarding the scale, the unique locations of the objects are discarded as well as their photographs brought together within a single picture magazine or a film newsreel, the forms which fit in with the demand of mass democratic society for "the universal equality of things."

Writing about telecommunication and telepresence, Virilio also uses the concept of distance to understand their effect. In Virilio's reading, these technologies collapse the physical distances, uprooting the familiar patterns of perception which grounded our culture and politics. Virilio introduces the terms Small Optics and Big Optics to underline the dramatic nature of this change. Small Optics are based on geometric perspective and shared by human vision, painting and film. It involves the distinctions between near and far, between an object and a horizon against which the object stands out. Big Optics is real-time electronic transmission of information, "the active optics of time passing at the speed of light."

As Small Optics are being replaced by Big Optics, the distinctions characteristic of Small Optics era are erased. If information from any point can be transmitted with the same speed, the concepts of near and far, horizon, distance and space itself no longer have any meaning. So, if for Benjamin the industrial age displaced every object from its original setting, for Virilio post-industrial age eliminates the dimension of space altogether. At least in principle, every point on Earth is now instantly accessible from any other point on Earth. As a consequence, Big Optics locks us in a claustrophobic world without any depth or horizon; the Earth becomes our prison.

Virilio asks us to notice "the progressive derealization of the terrestrial horizon,...resulting in an impending primacy of real time perspective of undulatory optics over real space of the linear geometrical optics of the Quattrocento."[185] He mourns the destruction of distance, geographic grandeur, the vastness of natural space, the vastness which guaranteed time delay between events and our reactions, giving us time for critical reflection necessary to arrive at a correct decision. The regime of Big Optics inevitably leads to real time politics, the politics which requires instant reactions to the events transmitted with the speed of light, and which ultimately can only be efficiently handled by computers responding to each other.

Given the surprising similarity of Benjamin's and Virilio's accounts of new technologies, it is telling how differently they draw the boundaries between natural and cultural, between what is already assimilated within the human nature and what is still new and threatening. Writing in 1936, Benjamin uses the real landscape and a painting as examples of what is natural for human perception. This natural state is invaded by film which collapses distances, bringing everything equally close and destroys aura. Virilio, writing half a century later, draws lines quite differently. If for Benjamin film still represented an alien presence, for Virilio it already became part of our human nature, the continuation of our natural sight. Virilio considers human vision, the Renaissance perspective, painting and film as all belonging to Small Optics of geometric perspective in contrast to the Big Optics of instant electronic transmission.

Virilio postulates a historical break between film and telecommunication, between Small Optics and Big Optics. It is also possible to read the movement from the first to the second in terms of continuity — if we are to use the concept of modernization. Modernization is accompanied by the process of disruption of physical space and matter, the process which privileges interchangeable and mobile signs over the original objects and relations. In the words of an art historian Jonathan Crary (who draws on Deleuze and Guattari's Anti-Oedipus and on Marx's Grandrisse), "Modernization is the process by which capitalism uproots and makes mobile that which is grounded, clears away or obliterates that which impedes circulation, and makes exchangeable what is singular."[186] The concept of modernization fits equally well Benjamin's account of film and Virilio's account of telecommunication, the latter just being a more advanced stage in this continual process of turning objects into mobile signs. Before, different physical locations met within a single magazine spread or a film newsreel; now, they meet within a single electronic screen. Of course, the signs now themselves exist as digital data which makes their transmission and manipulation even easier. Also, in contrast to photographs, which remain fixed once they are printed, computer representation makes every image inherently mutable — creating signs which are no longer just mobile but also forever modifiable.[187] Yet, significant as they are, these are ultimately quantitative rather than qualitative differences — with one exception.

As can be seen from my discussion above, in contrast to photography and film, electronic telecommunication can function as two-way communication. Not only can user immediately obtain images of various locations, bringing them together within a single electronic screen, but, via telepresence, she can also be "present" in these locations. In other words, she can affect change on material reality over physical distance in real time.

Film, telecommunication, telepresence. Benjamin's and Virilio's analyses make it possible for us to understand the historical effect of these technologies in terms of progressive diminishing and finally complete elimination of something which both writers see as a fundamental condition of human perception — spatial distance, the distance between the subject who is seeing and the object being seen. This reading of distance involved in (perspectival) vision as something positive, as a necessary ingredient of human culture provides an important alternative for a much more dominant tendency in modern thought to read distance negatively. This negative reading is then used to attack the visual sense as a whole. Distance becomes responsible for creating the gap between the spectator and spectacle, for separating subject and object, for putting the first in the position of transcendental mastery and rendering the second inert. Distance allows the subject to treat the Other as object; in short, it makes objectification possible. Or, as a French fisherman have summarized these arguments to young Lacan who was looking at a sardine can floating on the surface of the sea, years before he became a famous psychoanalyst: "You see the can? Do you see it? Well, it doesn't see you!"[188]

In Western thought, vision has always been understood and discussed in opposition to touch; so, inevitably, the denigration of vision (to use Martin Jay's term[189]) leads to the elevation of touch. Thus criticisim of vision predictably leads to the new theoretical interest in the idea of the haptic. We may be tempted, for instance, to read the lack of distance characteristic of the act of touching as allowing for a different relationship between subject and object. Benjamin and Virilio block this seemingly logical line of argument since they both stress the aggression potentially present in touchin. Rather than understanding touch as a respectful and careful contact or as a caress, they present it as unceremonious and aggressive disruption of matter.

Thus, the standard connotations of vision and touch become reversed. For Benjamin and Virilio, distance guaranteed by vision preserves the aura of an object, its position in the world, while the desire "to brings things 'closer' " destroys objects' relations to each other, ultimately obliterating the material order altogether and rendering the notions of distance and space meaningless. So even if we are to disagree with their arguments about new technologies and to question their equitation of natural order and distance, the critique of vision — touch opposition is something we should retain. Indeed, in contrast to older action enabling representational technologies, real-time image instruments literally allows us to touch us objects over distance, thus making possible their easy destruction as well. The potential aggresivity of looking turns out to be rather innocent than the actual aggression of electronically-enabled touch.

IV. The Illusions

Zeuxis was a legendary Greek painter who lived in the fifth century BC. The story of his competition with Parrhasius exemplifies the concern with illusionism which was to occupy Western art throughout much of its history. According to the story, Zeuxis painted grapes with such a skill that the birds begun to fly down trying to eat from the painted vine.[190]

RealityEngine is a high-performance graphics computer which was manufactured by Silicon Graphics Inc. in the last decade of the twentieth century AC. Optimized to generate real time interactive photorealistic 3D graphics, it is used to create computer games and special effects for feature films and TV, to run scientific visualization models and computer-aided design software. Last but not least, RealityEngine is routinely employed to run high-end VR environments — this latest achievement in West's struggle to outdo Zeuxis.

In terms of the images it can generate RealityEngine may not be superior to Zeuxis. Yet it can do other tricks, unavailable to the Greek painter. For instance, it allows the viewer to move around virtual grapes, touch them, lift them on a palm of a hand. And this ability of a viewer to interact with a representation may be as important in contributing to the overall reality effect as the images themselves. Which makes RealityEngine a formidable contender to Zeuxis.

In the twentieth century art has largely rejected the goal of illusionism, the goal which was so important to it before, and, as a consequence, it lost much of its popular support. The production of illusionistic representations became the domain of mass culture and of media technologies — photography, film and video. The creation of illusions was delegated to optical and electronic machines.

Today, everywhere, these machines are being replaced by new, digital illusion generators — computers. The production of all illusionistic images is becoming the sole province of PCs and Macs, Onyxes and RealityEngines.[191]

This massive replacement is one of the key economic factors which keeps the new media industries expanding. As a consequence, these industries are obsessed with visual illusionism. This obsession is particularly strong in the field of computer imaging and animation. Its annual SIGGRAPH conventions is the competition between Zeuxis and Parrhasius on the industrial scale: about 40,000 people gather on a trade floor around thousands of new hardware and software displays, all competing with each other to deliver the best illusionistic images. The industry frames each new technological advance in image acquisition and display in terms of the ability of computer technologies to catch up and surpass the visual fidelity of analog media technologies. On their side, animators and software engineers are perfecting the techniques for synthesizing photorealistic images of sets and human actors. The quest for a perfect simulation of reality drives the whole field of Virtual Reality (VR). In a different sense, the designers of human-computer interfaces are also concerned with illusion. Many of them believe that their main goal is to make the computer invisible, i.e. to construct an interface which is completely "natural." (In reality, what they usually mean by "natural" is simply older, already assimilated technologies, such as office stationary and furniture, a car, VCR controls, or a telephone.)

Continuing our bottom-up trajectory in examining new media, we have now arrived at the level of appearance. Although industry's obsession with illusionism is not the sole factor responsible for making new media look they way they do, it definitely one of the key. Focusing on the issue of illusionism, the sections of this chapter address different questions raised by it. How is the "reality effect" of a synthetic image different from that of the optical media? Is computer technology redefines our standards of illusionism as determined by our earlier experience with photography, film and video? "Synthetic Realism as Bricolage" and "Synthetic Image and its Subject" provide two possible answers to these questions. These sections investigate the new "internal" logic of a computer-generated illusionistic image by comparing lens-based and computer imaging technologies. The third section, "Illusion, Narrative, and Interactivity," asks how visual illusionism and interactivity work together (as well as against each other), in virtual worlds, computer games, military simulators and other new interactive new media objects and interfaces.

The discussions in these sections do not by any means exhaust the topic of illusionism in new media. "Compositing" and "Digital Cinema" sections in the preceding and last chapter, respectively, deal with this topic from other perspectives. As an example of other interesting questions which the topic of illusionism in new media may generate, I will list three below.

1.A parallel can be established between the gradual turn of computer imaging towards representational and photorealistic (the industry term for synthetic images which look as through they were created using traditional photography or cinematography) images throughout the end of the 1970s — beginning of the 1980s and the similar turn towards representational painting and photography in the art world during the same period.[192] In the art world we witness photorealism, neo-expressionism, "post-modern" "simulation" photography. In computer world, during the same period, we may note the rapid development of the key algorithms for photorealistic 3D image synthesis such as Phong shading, texture mapping, bump mapping, reflection mapping and cast shadows; also the development of first paint programs in mid 1970s which allowed manual creation of representational images and eventually, towards the end of the 1980s, software such as Photoshop which, for a while, made a manipulated photograph the most common type of imagery created on a computer. In contrast, from the 1960s until late 1970s computer imaging was mostly abstract because it was algorithm-driven and the technologies for inputting photographs into a computer were not easily accessible.[193] Similarly, art world was either dominated by non-representational movements, such as conceptual art, minimalism and performance, or at least was approaching representation with a strong sense of irony and distance, in the case of pop art. (Although it is possible to argue that 1980s "simulation" artists also used "appropriated" images ironically, in their case the distance between the media and artists' images became visually very small or non-existent.)

2.In the twentieth century, a very particular looking image created by still photography and cinematography came to dominate modern visual culture. Some of its qualities are linear perspective, depth of field effect (so only a part of 3D space is in focus), particular tonal and color range, and motion blur (rapidly moving objects appear smudged). As I will discuss in the following two sections, considerable research had to be accomplished before it became possible to simulate all these visual artifacts with computers. And even armed with special software, the designer still has to spend significant time manually recreating the look of photography or film. In other words, computer software does not produce such images by default. The paradox of digital visual culture is while all imaging is shifting towards being computer-based, the dominance of photographic and cinematic looking images is becoming even stronger. But rather than being a direct, "natural" result of photo and film technology, these images are constructed on computers. 3D virtual worlds are subjected to depth of field and motion blur algorithms; digital video is run through the special filters which simulate film grain; and so on.

While visually, these computer-generated or filtered images are indistinguishable from traditional photo and film images, on the level of "material," they are quite different as they are made from pixels or represented by mathematical equations and algorithms. In terms of the kinds of operations which can be performed on them, they are also quite different from images of photography and film. These operations, such as "copy and paste," "add," "multiply," "compress," "filter," reflect first of all the logic of computer algorithms and of human-computer interface; only secondly they refer to the dimensions inherently meaningful to human perception. (In fact, we can think of these operations as well as HCI in general as balancing between the two poles of computer logic and human logic, by which I mean the everyday ways of perception, cognition, causality and motivation — in short, human everyday existence.)

Other aspects of the new logic of computer images can be derived from the general principles of new media (see "Principles of New Media): many operations involved in their synthesis and editing are automated; they typically exist in many versions; they include hyperlinks; they act as interactive interfaces (thus an image is something we expect to enter rather than to stay on its surface); and so on. To summarize, the visual culture of a computer age is cinematographic in its appearance, digital on the level of its material, and computational (i.e., software driven) in its logic. What are the interactions between these three levels? Can we expect that cinematographic images (I use this phrase here to include images of both traditional analog and computer-simulated cinematography and photography) will be at some point replaced by some very differently images whose appearance will be more in tune with their underlying computer-based logic?

My own feeling is that the answer to this question is no. Cinematographic images are very efficient for cultural communication. Since they share many qualities with natural perception, they are easily processed by the brain. Their similarity to "the real thing" allows the designers to provoke emotions in viewers, as well as effectively visualize non-existent objects and scenes. And since computer representation turns these images into numerically coded data which is discrete (pixels) and modular (layers), they become subject to all economically beneficial effects of computerization: algorithmic manipulation, automation, variability and so on. A digitally-coded cinematographic image thus has two identities, so to speak: one satisfies the demands of human communication, another makes it suitable for computer-based practices of production and distribution.

3. The available theories and histories of illusion in art and media, from Gombrich's Art and Illusion and Andre Bazin's "The Myth of Total Cinema" to Stephen Bann's The True Vine, only deal with the visual dimensions.[194] In my view, most of these theories have three arguments in common. These arguments concern three different relationships, respectively: between an image and physical reality (1); between an image and natural perception (2); between present and past images (3):

1. Illusionistic images share some features with the represented physical reality (for instance, the number of an object's angles).
2. Illusionistic images share some features with human vision (for instance, linear perspective).
3. Each period offers some new "features" which are perceived by audiences as "improvement" over of the previous period (for instance, the evolution of cinema from silent to sound to color).[195]

Until the arrival of computer media these theories were sufficient since the human desire to simulate reality indeed focused on its visual appearance (although not exclusively — think, for instance, of the tradition of automata). Today, while still useful, the traditional analysis of visual illusionism needs to be supplemented by new theories. The reason is that the reality effect in many areas of new media such only partially depends on image's appearance. Such areas of new media as computer games, motion simulators, virtual worlds and VR, in particular, exemplify how computer-based illusionism functions differently. Rather than utilizing the single dimension of visual fidelity, they construct the reality effect on a number of dimensions, of which visual fidelity is just one. These new dimensions include active bodily engagement with a virtual world (for instance, the user of VR moves the whole body); the involvement of other senses beside vision (spatialized audio in virtual worlds and games; use of touch in VR; joysticks with force feedback; special vibrating and moving chairs for computer games play and motion rides), and the accuracy of the simulation of physical objects, natural pnenomena, anthropomorhic characters and humans.

This last dimension, in particular, calls for an extensive analysis, because of the variety of methods and subjects of simulation. If the history of illusionism in art and media largely revolves around the simulation of how things look, for computer simulation this is one goal among many. Besides their visual appearance, simulation in new media aims to realistically model how objects and humans act, react, move, grow, evolve, think and feel. Physically-based modeling is used to simulate the behavior of inanimate objects and their interactions such as a ball bouncing of the floor or a glass being shattered. Computer games extensively use physical modeling to simulate collisions between objects and vehicle behavior — for instance, a car being bounced against the walls of the racing tracks, or behavior of a plane in a flight simulation. Other methods such as AL, formal grammars, fractal geometry and various applications of the complexity theory (popularly referred to as "chaos theory") are used to simulate natural phenomena such as such as waterfalls and ocean waves, and animal behavior (flocking birds, school of fish). Yet another important area of simulation which also relies on many different methods is virtual characters and avatars, extensively used in movies, games, virtual worlds and human-computer interfaces. The examples are enemies and monsters in Quake; army units in WarCraft and similar games; human-like creatures in Creatures and other AL games and toys; and anthropomorphic interfaces such as Microsoft Office Assistant in Windows 98 — an animated character which periodically pops out in a small window offering help and tips. The goal of human simulation in itself can be further broken into a set of various sub-goals: simulation of human psychological states, human behavior, motivations, and emotions. (Thus, ultimately, the fully "realistic" simulation of a human being requires not only completely fulfilling the vision of the original AI paradigm but also going beyond it — since original AI was solely aimed at simulating human perception and thinking processes but not emotions and motivations.) Yet another kind of simulation involve modeling the dynamic behavior over time of whole systems composed from organic and/or non-organic elements (for instance, popular series of Sim games such as SimCity or SimAnts which simulate a city and an ant colony, respectively)

And even on the visual dimension — the one dimension which new media "reality engines" share with the traditional illusionistic techniques — things work very differently. New media changes our concept of what an image is — because it turns a viewer into an active user. As a result, a illusionistic image is no longer something a subject simply looks at, comparing it with her memories of represented reality in order to judge the reality effect of this image. The new media image is something the user actively goes into, zooming in or clicking on individual parts with the assumption that they contain hyperlinks (for instance, imagemaps in Web sites). Moreover, new media turns most images into image-interfaces and image-instruments (on the concept of image as interface, see "Cultural Interfaces" section; on image-instrument, see "Teleaction" section.) Image becomes interactive, i.e. it now functions as an interface between a user and a computer or other devices. The user emplys Image-interface to control a computer, asking it to zoom into the image or display another one, start a software application, connect to the Internet, and so on. The user employs image-instruments to directly affect reality:, move a robotic arm in a remote location, fire a missile, change the speed of the car and set the temperature, and so on. To evoke the term often used in film theory, new media moves us from identification to action. What kinds of actions can be performed via an image, how easily they can be accomplished, their range — all this plays part in user's assessment of the reality effect of the image.

Synthetic Realism and its Discontents

"Realism" is the concept which inevitably accompanies the development and assimilation of 3D computer graphics. In media, trade publications and research papers, the history of technological innovation and research is presented as a progression toward realism — the ability to simulate any object in such a way that its computer image is indistinguishable from a photograph. At the same time, it is constantly pointed out that this realism is qualitatively different from the realism of optically based image technologies (photography, film), for the simulated reality is not indexically related to the existing world.

Despite this difference, the ability to generate three-dimensional stills does not represent a radical break in the history of visual representation of the multitude comparable to the achievements of Giotto. A Renaissance painting and a computer image employ the same technique (a set of consistent depth cues) to create an illusion of space — existent or imaginary. The real break is the introduction of a moving synthetic image — interactive 3D computer graphics and computer animation. With these technologies, a viewer has an experience of moving around the simulated 3D space — something one can't do with an illusionistic painting.

In order to better understand the nature of "realism" of the synthetic moving image it is relevant to consider a contiguous practice of the moving image — the cinema. I will approach the problem of "realism" in 3D computer animation starting from the arguments advanced in film theory in regard to cinematic realism.

This section considers finished 3D computer animations which are created beforehand and then incorporated in a film, a television program, a Web site or a computer game. In the case of animations which are being generated by a computer in real-time, and thus are dependent not only on available software but also on hardware capabilities, somewhat different logic applies. The example of a new media object from the 1990s which uses both types of animation is a typical computer game. The interactive parts of the game are animated in real time. Periodically, the game switches to a "full motion video" mode. "Full motion video" is either a digital video sequence or a 3D animation which was pre-rendered and therefore has higher level of detail — and thus "realism" — than the animations done in real time. The last section of this chapter, "Image, Narrative and Illusion" considers how such temporal shifts which are not limited to games but are typical of interactive new media objects in general, affects their "realism."

Technology and Style in Cinema

The idea of cinematic realism is first of all associated with André Bazin, for whom cinematic technology and style move toward a "total and complete representation of reality."[196] In "The Myth of Total Cinema" Bazin claims that the idea of cinema existed long before the medium had actually appeared and that the development of cinema technology "little by little made a reality out of original 'myth'."[197] In this account, the modern technology of cinema is a realization of an ancient myth of mimesis, just as the development of aviation is a realization of the myth of Icarus. In another influential essay, "The Evolution of the Language of Cinema," Bazin reads the history of film style in similar teleological terms: the introduction of depth of field style in the end of 1930s and the subsequent innovations of Italian neorealists in 1940s gradually bring a spectator "into a relation with the image closer to that which he enjoys with reality." The essays differ not only in that the first interprets film technology while the second concentrates on film style, but also in their distinct approaches to the problem of realism. In the first essay realism stands for the approximation of phenomenological qualities of reality, "the reconstruction of a perfect illusion of the outside world in sound, color and relief."[198] In the second essay Bazin emphasizes that a realistic representation should also approximate the perceptual and cognitive dynamics of natural vision. For Bazin, this dynamics involves active exploration of visual reality. Consequently, he interprets the introduction of depth of field as a step toward realism, because now the viewer can freely explore the space of film image.[199]

Against Bazin's "idealist" and evolutionary account, Jean-Louis Comolli proposes a "materialist" and fundamentally non-linear reading of the history of cinematic technology and style. The cinema, Comolli tells us, "is born immediately as a social machine...from the anticipation and confirmation of its social profitability; economic, ideological and symbolic."[200] Comolli thus proposes to read history of cinema techniques as an intersection of technical, aesthetic, social and ideological determinations; however, his analyses clearly privilege an ideological function of the cinema. For Comolli, this function is "'objective' duplication of the 'real' itself conceived as specular reflection" (133). Along with other representational cultural practices, cinema works to endlessly reduplicate the visible thus sustaining the illusion that it is the phenomenal forms (such as the commodity form) which constitute the social "real" — rather than "invisible" to the eye relations of productions. To fulfill its function, cinema must maintain and constantly update its "realism." Comolli sketches this process using two alternative figures — addition and substitution.

In terms of technological developments, the history of realism in the cinema is one of additions. First, additions are necessary to maintain the process of disavowal, which for Comolli defines the nature of cinematic spectatorship

(132). Each new technological development (sound, panchromatic stock, color) points to the viewers just how "un-realistic" the previous image was and also reminds them that the present image, even though more realistic, will be superseded in the future — thus constantly sustaining the state of disavowal. Secondly, since cinema functions in a structure with other visual media, it has to keep up with their changing level of realism. For instance, by 1920s the spread of photography with its finely gradated image made cinematic image seem harsh by comparison, and film industry was forced to change to the panchromatic stock to keep up with the standard of photographic realism (131). This example is a good illustration of Comolli's reliance on Althusserian structuralist Marxism. Unprofitable economically for the film industry, this change is "profitable" in more abstract terms for the social structure as a whole, helping to sustain the ideology of the real/visible.

In terms of cinematic style, the history of realism in cinema is one of the substitutions of cinematic techniques. For instance, while the change to panchromatic stock adds to the image quality, it leads to other losses. If earlier cinematic realism was maintained through the effects of depth, now "depth(perspective) loses its importance in the production of 'reality effects' in favor of shade, range, color" (131). So theorized, realistic effect in the cinema appears as a constant sum in an equation with a few variables which change historically and have equal weight: if more shading or color is "put in," perspective can be "taken out." Comolli follows the same logic of substitution/substraction in sketching the development of cinematic style in its first two decades: the early cinematographic image announces its realism through an abundance of moving figures and the use of deep focus; later these devices fade away and others, such as fictional logic, psychological characters, coherent space-time of narration, take over (130).

While for Bazin realism functions as an Idea (in a Hegelian sense), for Comolli it plays an ideological role (in a Marxist sense); for David Bordwell and Janet Staiger, realism in film is first of all connected with the industrial organization of cinema. Put differently, Bazin draws the idea of realism from mythological utopian thinking. For him, realism is found in the space between reality and a transcendental spectator. Comolli sees it as an effect, produced between the image and the historical viewer and continuously sustained through the ideologically determined additions and substitutions of cinematic technologies and techniques. Bordwell and Staiger locate realism within the institutional discourses of film industries, implying that it is a rational and pragmatic tool in industrial competition.[201] Emphasizing that cinema is an industry like any other, Bordwell and Staiger attribute the changes in cinematic technology to the factors shared by all modern industries — efficiency, product differentiation, maintenance of a standard of quality (247). One of the advantages of adopting an industrial model is that it allows the authors to look at specific agents —

manufacturing and supplying firms and professional associations (250). The latter are particularly important since it is in their discourses (conferences, trade meetings and publications) that the standards and goals of stylistic and technical innovations are articulated.

Bordwell and Staiger agree with Comolli that the development of cinematic technology is not linear, however, they claim that it is not random either, as the professional discourses articulate goals of the research and set the limits for permissible innovations (260). According to Bordwell and Staiger, realism is one of these goals. They believe that such definition of a realism is specific to Hollywood:

> “Showmanship,” realism, invisibility: such cannons guided the SMPE [Society of Motion Picture Engineers] members toward understanding the acceptable and unacceptable choices in technical innovations, and these too became teleological. In another industry, the engineer's goal might be an unbreakable glass or a lighter alloy. In the film industry, the goals were not only increased efficiency, economy, and flexibility but also spectacle, concealment of artifice, and what Goldsmith [1934 president of SMPE] called “the production of an acceptance semblance of reality.” (258)

Bordwell and Staiger are satisfied with Goldsmith's definition of realism as "the production of an acceptance semblance of reality." However, such general and transhistorical definition does not seem to have any specificity for Hollywood and thus can't really account for the direction of technological innovation. Moreover, although they claim to have successfully reduced realism to a rational and a functional notion, in fact they have not managed to eliminate Bazin's idealism. It reappears in the comparison between the goals of innovation in film and other industries. "Lighter alloy" is used in aviation industry which can be thought of as the realization of the myth of Icarus; and is there not something mythical and fairy tale-like about "unbreakable glass"?

Technology and Style in Computer Animation

How can these three influential accounts of cinematic realism be used to approach the problem of realism in 3D computer animation? Bazin, Comolli, and Bordwell and Staiger offer us three different strategies, three different starting points. Bazin builds his argument by comparing the changing quality of the cinematic image with the phenomenological impression of visual reality. Comolli's analysis suggests a different strategy: to think of the history of computer graphics technologies and the changing stylistic conventions as a chain of substitutions functioning to sustain the reality effect for audiences. Finally, to follow Bordwell and Staiger's approach is to analyze the relationship between the character of realism in computer animation and the particular industrial organization of the computer graphics industry. (For instance, we can ask how this character is affected by the cost difference between hardware and software development.) Further, we should pay attention to professional organizations in the field and their discourses which articulate the goals of research and where we may expect to find "admonitions about the range and nature of permissible innovations" (Bordwell and Staiger, 260). I will try the three strategies in turn.

If we follow Bazin's approach and compare images drawn from the history of 3D computer graphics with the visual perception of natural reality, his evolutionary narrative appears to be confirmed. During the 1970s and the 1980s, computer images progressed towards fuller and fuller illusion of reality: from wireframe displays to smooth shadows, detailed textures, aerial perspective; from geometric shapes to moving animal and human figures; from Cimabue to Giotto to Leonardo and beyond. Bazin's idea that deep focus cinematography allowed the spectator a more active position in relation to film image, thus bringing cinematic perception closer to real life perception, also finds a recent equivalent in interactive computer graphics, where the user can freely explore the virtual space of the display from different points of view. And with such extensions of computer graphics technology as virtual reality, the promise of Bazin's "total realism" appears to be closer than ever, literally within arms reach of VR's user.

The history of the style and technology of computer animation can also be seen in a different way. Comolli reads the history of realistic media as a constant trade-off of codes, a chain of substitutions producing the reality effect for audiences, rather than as an asymptotic movement toward the axes labeled "reality." His interpretation of the history of film style is first of all supported by the shift he observes between the cinematic style of the 1900s and the 1920s, the example I have already mentioned. Early film announces its realism by excessive representations of deep space achieved through every possible means: deep focus, moving figures, frame compositions which emphasize the effect of linear perspective. In the 1920s, with the adaptation of panchromatic film stock, "depth (perspective) loses its importance in the production of 'reality effects' in favor of shade, range, color" (Comolli, 131). A similar trade-off of codes can be observed during the short history of commercial 3D computer animation which begins around 1980. Initially, the animations were schematic, cartoon-like because the objects could only be rendered in wireframe or facet shaded form. Illusionism was limited to the indication of objects's volumes. To compensate for this limited illusionism in the representation of objects, computer animations of the early 1980s ubiquitously showed deep space. This was done by emphasizing linear perspective (mostly, through the excessive use of grids) and by building animations around rapid movement in depth in the direction perpendicular to the screen. These strategies are exemplified by computer sequences of Disney movie Tron released in 1982. Toward the end of the 1980s, with commercial availability of such techniques as smooth shading, texture mapping and cast shadows, the representation of objects in animations approached much closer the ideal of photorealism. At this time, the codes by which early animation signaled deep space started to disappear. In place of rapid in-depth movements and grids, animations begun to feature lateral movements in shallow space.

The observed substitution of realistic codes in the history of 3D computer animation seems to confirm Comolli's argument. The introduction of new illusionistic techniques dislodges old ones. Comolli explains this process of sustaining reality effect from the point of view of audiences. Following Bordwell and Staiger's approach, we can consider the same phenomenon from the producers' point of view. For the production companies, the constant substitution of codes is necessary to stay competitive. As in every industry, the producers of computer animation stay competitive by differentiating their products. To attract clients, a company has to be able to offer some novel effects and techniques. But why do the old techniques disappear? The specificity of industrial organization of the computer animation field is that it is driven by software innovation. (In this, the field is closer to the computer industry as a whole, rather than film industry or graphic design.) New algorithms to produce new effects are constantly developed. To stay competitive, a company has to quickly incorporate the new software into their offerings. The animations are designed to show off the latest algorithm. Correspondingly, the effects possible with older algorithms are featured less often — available to everybody else in the field, they no longer signal "state of the art." Thus, the trade-off of codes in the history of computer animation can be related to the competitive pressure to quickly utilize the latest achievements of software research.

While commercial companies employ programmers capable of adopting published algorithms for the production environment, the theoretical work of developing these algorithms mainly takes place in academic computer science departments and in research groups of top computer companies such as Microsoft or SGI (formerly Silicon Graphics). To further pursue the question of realism we need to ask about the direction of this work. Do computer graphics researches share a common goal?

In analyzing the same question for film industry, Bordwell and Staiger claim that realism "was rationally adopted as an engineering aim" (258). They attempt to discover the specificity of Hollywood's conception of realism in the discourses of the professional organizations such as SMPE. For the computer graphics industry, the major professional organization is SIGGRAPH (Special Interest Group on Computer Graphics of the Association for Computing Machinery). Its annual conventions, attended by tenths of thousands, combine a trade show, a festival of computer animation and a scientific conference where the best new research work is presented. The conferences also serve as the meeting place for the researchers, engineers and commercial designers. If the research has a common direction, we can expect to find its articulations in SIGGRAPH proceedings.

Indeed, a typical research paper includes a reference to realism as the goal of investigations in computer graphics field. For example, a 1987 paper presented by three highly recognized scientists offers this definition of realism:

> Reys is an image rendering system developed at Lucasfilm Ltd. and currently in use at Pixar. In designing Reys, our goal was an architecture optimized for fast high-quality rendering of complex animated scenes. By fast we mean being able to compute a feature-length film in about a year; high quality means virtually indistinguishable from live action motion picture photography; and complex means as visually rich as real scenes.[202]

In this definition, achieving synthetic realism means attaining two goals: the simulation of codes of traditional cinematography and the simulation of the perceptual properties of real life objects and environments. The first goal, the simulation of cinematographic codes, was in principle solved early on as these codes are well-defined and few in number. Every current professional computer animation system incorporates a virtual camera with variable length lens, depth of field effect, motion blur and controllable lights which simulate the lights available to a traditional cinematographer.

The second goal, the simulation of "real scenes," turned out to be more complex. Creating computer time-based representation of an object involves solving three separate problems: the representation of an object's shape, the effects of light on its surface, and the pattern of movement. To have a general solution for each problem requires the exact simulation of underlying physical properties and processes. This is impossible because of the extreme mathematical complexity. For instance, to fully simulate the shape of a tree would involve mathematically "growing" every leaf, every brunch, every piece of bark; and to fully simulate the color of a tree's surface a programmer has to consider every other object in the scene, from grass to clouds to other trees. In practice, computer graphics researchers have resorted to solving particular local cases, developing a number of unrelated techniques for simulation of some kinds of shapes, materials, lighting effects and movements.

The result is a realism which is highly uneven. Of course, one may suggest that this is not an entirely new development and that it can already be observed in the history of twentieth century optical and electronic representational technologies, which allows for more precise rendering of certain features of visual reality at the expense of others. For instance, both color film and color television were designed to assure acceptable rendering of human flesh tones at the expense of other colors. However, the limitations of synthetic realism are qualitatively different.

In the case of optically-based representation, the camera records already existing reality. Everything which exists can be photographed. Camera artifacts, such as depth of field, film grain, and the limited tonal range, affects the image as a whole.

In the case of 3D computer graphics the situation is quite different. Now reality itself has to be constructed from scratch before it can be photographed by a virtual camera. Therefore, the photorealistic simulation of "real scenes" is practically impossible as techniques available to commercial animators only cover the particular phenomena of visual reality. The animator using a particular software package can, for instance, easily create a shape of human face, but not the hair; the materials such as plastic or metal but not cloth or leather; the flight of a bird but not the jumps of a frog. The realism of computer animation is highly uneven, reflecting the range of problems which were addressed and solved.

What determines which particular problems received priority in research? To a large extent, this was determined by the needs of the early sponsors of this research — the Pentagon and Hollywood. I am not concerned here to fully trace the history of these sponsorships. What is important for my argument is that the requirements of military and entertainment applications led the researchers to concentrate on simulation of the particular phenomena of visual reality, such as landscapes and moving figures.

One of the original motivations behind the development of photorealistic computer graphics was its application for flight simulators and other training technology.[203] And since simulators require synthetic landscapes, a lot of research went into the techniques to render clouds, rugged terrain, trees, aerial perspective. Thus, the work which led to the development of the famous technique to represent natural shapes, such as mountains, using fractal mathematics was done at Boeing.[204] Other well-known algorithms to simulate natural scenes and clouds were developed by the Grumman Aerospace Corporation.[205] The latter technology was used for flight simulators and also was applied to pattern recognition research in target tracking by a missile.[206]

Another major sponsor was the entertainment industry, lured by the promise of lowering the costs of film and television production. In 1979 Lucasfilm, Ltd., George Lucas's company, organized a computer animation research division. It hired the best computer scientists in the field to produce animations for special effects. The research for the effects in such films as <u>Star Trek II: The Wrath of Khan</u> (Nicholas Meyer, Paramount Pictures, special effects by Industrial Light & Magic,1982) and <u>Return of the Jedi</u> (Richard Marquand, Lucasfilm Ltd., special effects by Industrial Light & Magic,1983) have led to the development of important algorithms which became widely used.[207]

Along with creating particular effects for films such as star fields and explosions, a lot of research activity has been dedicated to the development of moving humanoid figures and synthetic actors. This is not surprising since commercial film and video productions center around human characters. Significantly, the first time computer animation was used in a feature film (Looker, Michael Cricton, Warner Brothers,1981) was to create a three-dimensional model of an actress. One of the early attempt to simulate human facial expressions featured synthetic replicas of Marilyn Monroe and Humphrey Bogart.[208] In another early acclaimed 3D animation, produced by Kleiser-Wolczak Construction Company in 1988, a synthetic human figure was humorously casted as Nestor Sextone, a candidate for the presidency in the Synthetic Actors Guild.

The task of creating fully synthetic human actors has turned out to be more complex than was originally anticipated. Researchers continue to work on this problem. For instance, the 1992 SIGGRAPH conference presented a session on "Humans and Clothing" which featured such papers as "Dressing Animated Synthetic Actors with Complex Deformable Clothes"[209] and "A Simple Method for Extracting the Natural Beauty of Hair."[210] Meanwhile, Hollywood has created a new genre of films (Terminator 2, Jurassic Park, Casper, Flubber, etc.) structured around "the state of the art" in digital actor simulation. In computer graphics it is still easier to create the fantastic and extraordinary then to simulate ordinary human beings. Consequently, each of these films is centered around an unusual character which in fact, consists of a series of special effects — morphing into different shapes, exploding into particles, and so on.

The preceding analysis applies to the period during which the techniques of 3D animation were undergoing continuos development: from the middle 1970s to the middle 1990s. By the end of this period the software tools became relatively stable; at the same time, the dramatically decreased cost of hardware led to the significant reduction of time it takes to render complex animations. Put differently, the animators were now able to use more complex geometric and rendering models, thus achieving stronger reality effect. Titanic (1997) featured hundreds of computer animated “extras” while %95 of Stars Wars: Episode 1 (1999) were constructed on a computer. However, the dynamics which characterized the early period of pre-rendered computer animation returned in new areas of new media: computer games and virtual worlds (such as VRML and Active Worlds scenes) which all use computer animation being generated in real-time. Here Bazinian evolution towards fuller and fuller realism which characterized the development of computer animation in the 1970s and the 1980s was replayed once again at a accelerated speed. As the speed of CPUs and graphics card kept increasing, computer games moved from flat shading of the original Doom (1993) to the more detailed world of Unreal (Epic Games, 1997) which featured shadows, reflections and transparency. In the area of virtual worlds which were designed to run on typical computers without specialized graphics accelerators, the same evolution proceeded at a much slower pace.

The icons of mimesis

While the privileging of certain areas in research can be attributed to the needs of the sponsors, other areas received consistent attention for a different reason. To support the idea of progress of computer graphics toward realism, researchers privilege particular subjects that culturally connote the mastery of illusionistic representation.

Historically, the idea of illusionism has been connected with the success in representation of certain subjects. The original episode in the history of Western painting, which I already invoked, is the story of the competition of Zeuxis and Parrhasiuss. The grapes painted by Zeuxis symbolize his skill to create living nature out of inanimate matter of paint. Further examples in the history of art include the celebration of the mimetic skill of those painters who were able to simulate another symbol of living nature — the human flesh. Not surprisingly, throughout the history of computer animation, the simulation of a human figure served as a yardstick used to measure the progress of the whole field.

While the painting tradition had its own iconography of subjects connoting mimesis, moving image media relied on different set of subjects. 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."[211] Computer graphics researchers resort to similar subjects to signify the realism of animation. "Moving nature" presented at SIGGRAPH conferences have included animations of smoke, fire, sea waves, and moving grass.[212] These privileged signs of realism overcompensate for the inability of computer graphics researches to fully simulate "real scenes."

In summary, the differences between cinematic and synthetic realism begin on the level of ontology. New realism is partial and uneven, rather than analog and uniform. The artificial reality which can be simulated with 3D computer graphics is fundamentally incomplete, full of gaps and white spots.

Who determines what will be filled and what will remain a gap in the simulated world? As I already noted, the available computer graphics techniques reflect particular military and industrial needs which paid for their developments. The ability of certain subjects to connote mastery of illusionism also makes researchers pay more attention to some areas on the “map” and ignore others. In addition, as computer graphics techniques migrate from specialized markets towards mass consumers, they become biased in yet another way.

The amount of labor involved in constructing reality from scratch in a computer makes it hard to resist the temptation to utilize pre-assembled, standardized objects, characters and behaviors readily provided by software manufacturers — fractal landscapes, checkerboard floors, complete characters, and so on. As discussed in "selection" section, every program comes with libraries of ready-to-use models, effects or even complete animations. For instance, a user of the Dynamation program (a part of the popular Alias|Wavefront 3D software) can access complete pre-assembled animations of moving hair, rain, a comet's tail or smoke, with a single mouse click. If even professional designers rely on ready-made objects and animations, the end users of virtual worlds on the Internet, who usually don't have graphic or programming skills, have no other choice. Not surprisingly, VRML software companies and Web virtual world providers encourage users to choose from the libraries of 3D objects and avatars they supply. Worlds Inc., the provider of Worlds software used to create online virtual 3D chat environments, provides its users with a library of 100 3D avatars.[213] The Active Worlds which offers "3D community based environments on the Internet" allows its over one million users (April 1999 data) to choose from over 1000 different worlds, some of which are provided by a company and others were built by the users themselves.[214] As the complexity of these words increases, we can expect a whole market for detailed virtual sets, characters with programmable behaviors, and even complete environments (a bar with customers, a city square, a famous historical episode, etc.) from which a user can put together her or his own "unique" virtual world. And although companies such as Active Worlds provide end users with software which allows them to quickly build and customize their virtual dwellings, avatars and whole virtual universes, each of these constructs has to adhere to standards established by the company. Thus behind the freedom on the surface lies standardization on a deeper level. While a hundred years ago the user of a Kodak camera was asked just to push a button, she still had the freedom to point the camera at anything. Now, "you push the button, we do the rest" has become "you push the button, we create your world."

I hope that this section demonstrated that the accounts of realism developed in film theory can be usefully employed to talk about realism in new media. But that does not mean that the question of computer realism is exhausted. In the twentieth century, new technologies of representation and simulation replace each other in rapid succession, therefore creating a perpetual lag between our experience of their effects and our understanding of this experience. Reality effect of a moving image is a case in point. As film scholars were producing increasingly detailed studies of cinematic realism, film itself was already being undermined by 3D computer animation. Indeed, consider the following chronology.

Bazin's Evolution of the Language of Cinema is a compilation of three articles written between 1952 and 1955. In 1951 the viewers of the popular television show "See it Now" for the first time saw a computer graphics display, generated by MIT computer Whirlwind, built in 1949. One animation was of a bouncing ball, another of a rocket's trajectory.[215]

Comolli's Machines of the Visible was given as a paper at the seminal conference on the cinematic apparatus in 1978. The same year saw the publication of a crucial paper for the history of computer graphics research. It presented a method to simulate bump textures which is still one of the most powerful techniques of synthetic photorealism.[216]

Bordwell and Staiger's chapter Technology, Style and Mode of Production forms a part of the comprehensive The Classical Hollywood Cinema: Film Style & Mode of Production to 1960, published in 1985. By this year, most of the fundamental photorealistic techniques were discovered and turnkey computer animation systems were already employed by media production companies.

As 3D synthetic imagery is used more and more widely in contemporary visual culture, the problem of realism has to be studied afresh. And while many theoretical accounts developed in relation do cinema do hold when applied to synthetic imaging, we can't assume that any concept or model can be taken for granted. Redefining the very concepts of representation, illusion and simulation, new media challenges us to understand in new ways how visual realism functions.

Synthetic Image and its Subject

As we saw, the achievement of photorealism is the main goal of research in the field of computer graphics. The field defines photorealism as the ability to simulate any object in such a way that its computer image is indistinguishable from its photograph. Since this goal was articulated in the end of the 1970s, a significant progress has been made towards getting closer to this goal: compare, for instance, the computer images of Tron (1982) with those of Star Wars: Episode 1 (1999). Yet the common opinion still holds that synthetic 3D images generated by computer graphics are not yet (or perhaps will never be) as "realistic" in rendering visual reality as images obtained through a photographic lens. In this section I will suggest that this common opinion is mistaken. Such synthetic photographs are already more "realistic" than traditional photographs. In fact, they are too real.

This, at first sight, paradoxical argument will become less strange once we place the current preoccupation with photorealiasm in a longer historical framework, considering not only the present and recent past (computer imaging and analog film, respectively) but also both more distant past and the future of visual illusionism. For while the computer graphics field tries desperately to replicate the particular kind of images created by twentieth century film technology, these images represent only one episode in a longer history of visual culture. We should not assume that the history of illusion ends with 35 mm frames projected on the screen across the movie hall — even if a film camera is substituted by computer software, a film projector is substituted by a digital projector and the film reel itself is substituted by data transmitted over computer network.

Georges Méliès, the father of computer graphics

When a future historian will write about the computerization of cinema in the 1990s, she will highlight such movies as Terminator 2 and Jurassic Park. Along with a few others, these films by John Cameron and George Lucas were responsible for turning Hollywood around: from still being highly skeptical about computer animation in the early 1990s to fully embracing it by the middle of the decade. These two movies, along with the host of others which followed, Titanic, Star Wars: Episode 1 and so on, dramatically demonstrated that total synthetic realism seemed to be in sight. Yet, they also exemplified the triviality of what at first may appear to be an outstanding technical achievement — the ability to fake visual reality. For what is faked is, of course, not reality but photographic reality,

reality as seen by the camera lens. In other words, what computer graphics has (almost) achieved is not realism, but only photorealism — the ability to fake not our perceptual and bodily experience of reality but only its photographic image.[217] This image exists outside of our consciousness, on a screen — a window of limited size which presents a still imprint of a small part of outer reality, filtered through the lens with its limited depth of field, and then filtered through film's grain and its limited tonal range. It is only this film-based image which computer graphics technology has learned to simulate. And the reason we may think that computer graphics has succeeded in faking reality is that we, over the course of the last hundred and fifty years, has come to accept the image of photography and film as reality.

What is faked is only a film-based image. Once we came to accept the photographic image as reality the way to its future simulation was open. What remained were small details: the development of digital computers (1940s) followed by a perspective-generating algorithm (early 1960s), and then working out how to make a simulated object solid with shadow, reflection and texture (1970s), and finally simulating the artifacts of the lens such as motion blur and depth of field (1980s). So, while the distance from the first computer graphics images circa 1960 to the synthetic dinosaurs of Jurassic Park in the 1990s is tremendous, we should not be too impressed. For, conceptually, photorealistic computer graphics had already appeared with Félix Nadar's photographs in the 1840s and certainly with the first films of Georges Méliès in the 1890s. Conceptually, these are the inventors of 3D photorealistic computer graphics.

In saying this I do not want to negate the human ingenuity and the tremendous amount of labor which today goes into creating computer-generated special effects. Indeed, if our civilization has any equivalent to Medieval cathedrals, it is special effects Hollywood films. They are truly epic both in their scale and the attention to detail. Assembled by thousands of highly skilled craftsmen over the course of years, each such movie is the ultimate display of collective craftsmanship we have today. But if Medieval masters left after themselves the material wonders of stone and glass inspired by religious faith, today our craftsmen leave just the pixel sets to be projected on movie theater screens or played on computer monitors. These are immaterial cathedrals made of light; and appropriately, they often still have religious references, both in the stories (consider for example Christian references in Star Wars: Episode 1: Skywalker was conceived without a father, etc.) and in the grandeur and transcendence of virtual sets.

Jurassic Park and Socialist Realism

Consider one of these immaterial cathedrals: George Lucas's Jurassic Park. This triumph of computer simulation took more than two years of work by dozens of designers, animators, and programmers of Industrial Light and Magic (ILM), one of the premier company specializing in the production of computer animation for feature films in the world today. Because a few seconds of computer animation often requires months and months of work, only the huge budget of a Hollywood blockbuster could pay for such extensive and highly detailed computer generated scenes as seen in Jurassic Park. Most of the 3D computer animation produced today has a much lower degree of photorealism and this photorealism, as I shown in the previous section, is uneven, higher for some kinds of objects and lower for others. And even for ILM photorealistic simulation of human beings, the ultimate goal of computer animation, still remains impossible. (Some scenes in 1997 Titanic feature hundreds of synthetic human figures, yet they appear for a few seconds and are quite small, being far away from the camera.)

Typical images produced with 3D computer graphics still appear unnaturally clean, sharp, and geometric looking. Their limitations especially stand out when juxtaposed with a normal photograph. Thus one of the landmark achievements of Jurassic Park was the seamless integration of film footage of real scenes with computer simulated objects. To achieve this integration, computer-generated images had to be degraded; their perfection had to be diluted to match the imperfection of film's graininess.

First, the animators needed to figure out the resolution at which to render computer graphics elements. If the resolution were too high, the computer image would have more detail than the film image and its artificiality would become apparent. Just as Medieval masters guarded their painting secrets now leading computer graphics companies carefully guard the resolution of image they simulate.

Once computer-generated images are combined with film images additional tricks are used to diminish their perfection. With the help of special algorithms, the straight edges of computer-generated objects are softened. Barely visible noise is added to the overall image to blend computer and film elements. Sometimes, as in the final battle between the two protagonists in Terminator 2, the scene is staged in a particular location (in this example, a smoky factory) which justifies addition of smoke or fog to further blend the film and synthetic elements together.

So, while we normally think that synthetic photographs produced with computer graphics are inferior to real photographs, in fact, they are too perfect. But beyond that we can also say that paradoxically they are also too real.

The synthetic image is free of the limitations of both human and camera vision. It can have unlimited resolution and an unlimited level of detail. It is free of the depth-of-field effect, this inevitable consequence of the lens, so everything is in focus. It is also free of grain — the layer of noise created by film stock and by human perception. Its colors are more saturated and its sharp lines follow the economy of geometry. From the point of view of human vision it is hyperreal. And yet, it is completely realistic. Synthetic image is a result of a different, more perfect than human, vision.

Whose vision is it? It is the vision of a computer, a cyborg, a automatic missile. It is a realistic representation of human vision in the future when it will be augmented by computer graphics and cleansed from noise. It is the vision of a digital grid. Synthetic computer-generated image is not an inferior representation of our reality, but a realistic representation of a different reality.

By the same logic, we should not consider clean, skinless, too flexible, and in the same time too jerky, human figures in 3D computer animation as unrealistic, as imperfect approximation to the real thing — our bodies. They are perfectly realistic representation of a cyborg body yet to come, of a world reduced to geometry, where efficient representation via a geometric model becomes the basis of reality. The synthetic image simply represents the future. In other words, if a traditional photograph always points to the past event, a synthetic photograph points to the future event.

Is this a totally new situation? Was there already an aesthetics which consistently pointed to the future? In order to help us locate this aesthetics histroically, I will invoke a painting by Russian-born conceptual artists Komar and Melamud. Called "Bolsheviks Returning Home after a Demonstration" (1981-1982), it depicts two workers, one carrying a red flag, who came across a tiny dinosaur, smaller than a human hand, standing in the snow. Part of "Nostalgic Socialist Realism" series, this painting was created a few years after the painters arrived to the United States, well before Hollywood embraced computer-generated visuals. Yet it seems to comment on such movies as Jurassic Park and on Hollywood as a whole, connecting its fictions with the fictions of Soviet history as depicted by Socialist Realism, the official style of Soviet art from the early 1930s until the late 1950s.

Taking the hint from this panting, we are now in a position to characterize the aesthetics of Jurassic Park. This aesthetic is one of Soviet Socialist Realism. Socialist Realism wanted to show the future in the present by projecting the perfect world of future socialist society on a visual reality familiar to the viewer — streets, interiors and faces of Russia in the middle of the twentieth century — tired and underfed, scared and exhausted from fear, unkempt and gray. Socialist realism had to retain enough of then everyday reality while showing how that reality would look in the future when everyone's body will be healthy and muscular, every street modern, every face transformed by the spirituality of communist ideology. This is its difference from pure science fiction which does not have to carry any feature of today reality into the future. In contrast, Socialist realism had to superimpose future into the present, projecting the Communist ideal into the very different reality familiar to the viewers. Importantly, Socialist Realism never depicted this future directly: there is not a single Socialist Realist work of art set in the future. Science fiction as a genre did not exist from early

1930s until Stalin's death. The idea was not to make the workers dream about the perfect future closing their eyes to imperfect reality, but rather to make them see the signs of this future in the reality around them. This is one of the meanings behind Vertov's notion of "communist decoding of the world." To decode the world in such a way means to recognize the future all around you.

The same superimposition of future onto the present happens in Jurassic Park. It tries to show the future of sight itself — the perfect cyborg vision which is free of noise and capable of grasping infinite details. This vision is exemplified by the original computer graphics images before they were blended with film images. But just as Socialist Realist paintings blended the perfect future with the imperfect reality, Jurassic Park blends the future super-vision of computer graphics with the familiar vision of film image. In Jurassic Park, the computer image bends down before the film image, its perfection is undermined by every possible means and is also masked by the film's content. As I already described, computer generated images, originally clean and sharp, free of focus and grain, are degraded in a variety of ways: resolution is reduced, edges are softened, depth of field and grain effect are artificially added. Additionally, the very content of the film — the prehistoric dinosaurs which came to life — can be interpreted as another way to mask the potentially disturbing reference to our cyborg future. The dinosaurs are present to tell us that computer images belong safely to the past long gone — even though we have every reason to believe that they are messengers from the future still to come.

In that respect Jurassic Park and Terminator 2 are the opposites. If in Jurassic Park the dinosaurs function to convince us that computer imagery belongs to the past, the Terminator in Terminator 2 is more "honest." He himself is a messenger from the future. Accordingly, he is a cyborg who can take on the human appearance. His true from is that of a futuristic alloy. In perfect correspondence with this logic, this form is represented with computer graphics. While his true body perfectly reflects its surrounding reality, the very nature of these reflection shows to us the future of human and machine sight. The reflections are extra-sharp and clean, without any blur. This is indeed the look produced by the reflection mapping algorithm, one of the standard techniques to achieve photorealism. Thus, to represent the Terminator who came from the future the designers used the standard computer graphics techniques without degrading them; in contrast, in Jurassic Park the dinosaurs which came from the past were created by systematically degrading computer images. What of course is the past in this movie is the film medium itself: its grain, its depth of focus, its motion blur, its low resolution.

This is, then, the paradox of 3D photorealistic computer animation. Its images are not inferior to the visual realism of traditional photography. They are perfectly real — all too real.

Illusion, Narrative and Interactivity

Having analyzed computer illusionism from the points of view of its production and the longer history of visual illusion, I now want to look at it from a different perspective. While the existing theories of illusionism assume that the subject acts strictly a viewer, the new media more often than not turns the subject into the user. The subject is expected to interact with a representation: click on menus or the image itself, making selections and decisions. What effect does interactivity has on reality effect of an image? Is the fidelity of simulation of physical laws or human motivation more important for "realism" of a representation than its purely visual qualities? For instance, is a racing game which uses a more precise collision model but poor visuals feels more real than the game which has richer images but less precise model? Or do the simulation dimensions and visual dimensions support each other, adding up to create a total effect?

In this section I will focus on a particular aspect of this more general question: production of illusionism in interactive computer objects. The aspect which I will consider has to do with time. Web sites, virtual worlds, computer games and many other types of hypermedia applications are characterized by a peculiar temporal dynamic: constant, repetitive shifts between an illusion and its suspense. These new media objects keep reminding us about their artificiality, incompleteness, and constructedness. They present us with a perfect illusion only to reveal the underlying machinery next.

Web surfing in the 1990s provides a perfect example. A typical user may be spending equal time looking at a page and waiting for the next page to download. During waiting periods, the act of communication itself — bits traveling through the network — becomes the message. The user keeps checking whether the connection is being made, glancing back and forth between the animated icon and the status bar. Using Roman Jakobson's model of communication functions, we can say that communication comes to be dominated by contact, or phatic function — it is centered around the physical channel and the very act of connection between the addresser and the addressee.[218]

Jakobson writes about verbal communication between two people who, in order to check whether the channel works, address each other: "Do you hear me?," "Do you understand me?" But in Web communication there is no human addresser, only a machine. So as the user keeps checking whether the information is coming, she actually addresses the machine itself. Or rather, the machine addresses the user. The machine reveals itself, it reminds the user of its existence — not only because the user is forced to wait but also because she is forced to witness how the message is being constructed over time. A page fills in part by part, top to bottom; text comes before images; images arrive in low resolution and are gradually refined. Finally, everything comes together in a smooth sleek image — the image which will be destroyed with the next click.

Interaction with most 3D virtual worlds is characterized by the same temporal dynamic. Consider the technique called "distancing" or "level of detail," which for years has been used in VR simulations and later was adapted to 3D games and VRML scenes. The idea is to render the models more crudely when the user is moving through virtual space; when the user stops, details gradually fill in. Another variation of the same technique involves creating a number of models of the same object, each with progressively less detail. When the virtual camera is close to an object, a highly detailed model is used; if the object is far away, a lesser detailed version is substituted to save unnecessary computation.

A virtual world which incorporates these techniques has a fluid ontology that is affected by the actions of the user. As the user navigates through space the objects switch back and forth between pale blueprints and fully fleshed out illusions. The immobility of a subject guarantees a complete illusion; the slightest movement destroys it.

Navigating a QuickTime VR movie is characterized by a similar dynamic. In contrast to the nineteenth century panorama that it closely emulates, QuickTime VR continuously deconstructs its own illusion. The moment you begin to pan through the scene, the image becomes jagged. And, if you try to zoom into the image, all you get are oversized pixels. The representational machine keeps hiding and revealing itself.

Compare this dynamic to traditional cinema or realist theater which aims at all costs to maintain the continuity of the illusion for the duration of the performance. In contrast to such totalizing realism, new media aesthetics has a surprising affinity to twentieth century leftist avant-garde aesthetics. Playwright Bertold Brecht's strategy to reveal the conditions of an illusion's production, echoed by countless other leftist artists, has become embedded in hardware and software themselves. Similarly, Walter Benjamin's concept of "perception in the state of distraction"[219] has found a perfect realization. The periodic reappearance of the machinery, the continuous presence of the communication channel in the message prevent the subject from falling into the dream world of illusion for very long, making her alternate between concentration and detachment.

While virtual machinery itself already acts as an avant-garde director, the designers of interactive media, such as games, DVD titles, interactive cinema, and interactive television programs, often consciously attempt to structure the subject's temporal experience as a series of periodic shifts. The subject is forced to oscillate between the roles of viewer and user, shifting between perceiving and acting, between following the story and actively participating in it. During one segment the computer screen presents the viewer with an engaging cinematic narrative. Suddenly the image freezes, menus and icons appear and the viewer is forced to act: make choices; click; push buttons. The most pure example of such cyclical organization of user's experience is the computer games which alternate between FMV (full motion video) segments and the segments which require user's input, such as Wing Commander series. Moscow media theorist Anatoly Prokhorov described these shifts in terms of two different identities of a computer screen: transparent and opague. The screen keeps shifting from being transparent to being opaque — from a window into a fictional 3D universe to a solid surface, full of menus, controls, text and icons.[220] Three-dimensional space becomes surface; a photograph becomes a diagram; a character becomes an icon. To use the opposition introduced in "Cultural Interfaces" section, we can say that the screen keeps alternates between the dimensions of representation and control. What at one moment was a fictional universe becomes a set of buttons which demand action.

The effect of these shifts on the subject is hardly one of liberation and enlightenment. While modernist avant-garde theater and film directors deliberately highlighted machinery and conventions involved in producing and keeping the illusion in their works — for instance, having actors directly address the audience or pulling away the camera to show the crew and the set — the systematic "auto-deconstruction" performed by computer objects, applications, interfaces and hardware does not seem to distract the user from giving in to the reality effect. The cyclical shifts between illusion and its destruction appear to neither distract from it nor support it. It is tempting to compare these temporal shifts to shot / counter-shot structure in cinema and to understand them as a new kind of suturing mechanism. By having periodically to complete the interactive text through active participation the subject is interpolated in it. Thus, if we adopt the notion of suture, it would follow that the periodic shifts between illusion and its suspension are necessary to fully involve the subject in the illusion.[221]

Yet clearly we are dealing with something which goes beyond old-style realism of analog era. We can call this new realism meta-realism since it incorporates its own critique inside itself. It emergence can be related to a larger cultural change. Old realism corresponded to the functioning of ideology during modernity: totalization of a semiotic field, "false consciousness," complete illusion. But today ideology functions differently: it continuously and skillfully deconstructs itself, presenting the subject with countless "scandals" and "investigations." The leaders of the middle of the twentieth century were presented as invincible; as being always right, and, in the case of Stalin and Hitler, as true saints not capable of any human sin. Today we expect to learn about the scandals involving our leaders, and these scandals do not really diminish their credibility. Similarly, contemporary television commercials often make fun of themselves and advertising in general; this does not prevent them from selling whatever they are designed to sell. Auto-critique, scandal, revelation of its machinery became a new structural component of modern ideology: witness the 1998 episode when MTV created an illusion on its Web site that somebody hacked it. The ideology does not demand that the subject blindly beliefs it, as it did early in the twentieth century; rather, it puts the subject in a master position of somebody who knows very well that she is being fooled, and generously lets her be fooled. You know, for instance, that creating a unique identity through a commercially mass produced style is meaningless — but anyway you buy the expensively styled clothes, choosing from a menu: "military," "bohemian," "flower child," "inner city, " clubbing," and so on. The periodic shifts between illusion and its suspension in interactive media, described here, can be seen as another example of the same general phenomenon. Just as classical ideology, classical realism demanded that the subject completely accepted the illusion for as along as it lasted. In contrast, the new meta-realism is based on oscillation between illusion and its destruction, between immersing a viewer in illusion and directly addressing her. In fact, the user is even put in much stronger position of mastery when she ever is by "auto-deconstructing" commercials, newspaper reports of "scandals" and other traditional non-interactive media. Once illusion stops, the user can make choices, re-direct game narrative or get additional information from other Web sites conveniently linked by the designers. The user invests into illusion precisely because she is given control over it.

If this analysis is correct, the counter-arguments that this oscillation is simply an artifact of the current technology and that the advances in hardware will eliminate it, would not work. The oscillation analyzed here is not an artifact of computer technology but a structural feature of modern society, present not just in interactive media but in numerous other social realms and on many different levels.

This may explain the popularity of this particular temporal dynamics in interactive media, but it does not address another question: does it work aesthetically? Can Brett and Hollywood be married? Is it possible to create a new temporal aesthetics, even a language, based on cyclical shifts between perception and action? In my view, the most successful example of such an aesthetics already in existence is a military simulator, the only mature form of interactive narrative. It perfectly blends perception and action, cinematic realism and computer menus. The screen presents the subject with an illusionistic virtual world while periodically demanding quick actions: shooting at the enemy; changing the direction of a vehicle; and so on. In this art form, the roles of a viewer and a actant are blended perfectly — but there is a price to pay. The narrative is organized around a single and clearly defined goal: staying alive.

The games modeled after simulators — first of all, first person shooters such as Doom, Quake and Tomb Rider, but also flight and racing simulators — have been also quite successful. In contrast to interactive narratives such as Wing Commander, Myst, Riven, or Bad Day on the Midway which are based on temporal oscillation between two distinct states, non-interactive movie-like presentation and interactive game play, in these games these two states — which are also two states of the subject (perception and action) and the two states of a screen (transparent and opaque) — co-exist together. As you run through the corridors shooting at enemies or control the car on the racetrack, you also keep your eyes on the readouts which tell about the "health" of your character, the damage level of your vehicle, the availability of ammunition, and so on.

As a conclusion, I would like to offer a different interpretation of the temporal oscillation in new media which will relate it not to the social realm outside of new media but to other similar effects specific to new media itself. The oscillation between illusionary segments and interactive segments forces the user to switch between different mental sets — different kinds of cognitive activity. These switches are typical of using modern computer use in general. The user analyses the quantitative data; next she is using a search engine; next she starts a new application; next she navigates through space in a computer game; next she may go back to using a search engine; and so on. In fact, the modern HCI which allows the user to run a number of programs at the same time and to keep a number of windows open on the screen at once posits multi-tasking as the social and cognitive norm. This multi-tasking demands from the user "cognitive multi-tasking" — rapidly alternating between different kinds of attention, problem solving and other cognitive skills. All in all, modern computing requires from a user intellectual problem solving, systematic experimentation and the quick learning of new tasks. Thus, just as any particular software application is embedded, both metaphorically and literally, within the larger framework of the operating system, new media embeds cinema-style illusions within the larger framework of an interactive control surface. Illusion is subordinated to action; depth to surface; a window into an imaginary universe to a control panel. From commanding a dark movie theater, this twentieth century illusion and therapy machine par exellance, a cinema image becomes just a small window on a computer screen; one stream among many others coming to us through the network; one file among numerous others on our hard drives.

V. The Forms

August 5, 1999. I am sitting in the lobby of Razorfish Studios, which was named by Adweek among 10 top interactive agencies in the world for 1998.[222] The company's story is Silicon Alley legend. It was founded in 1995 by two partners in their East Village loft; by 1997 it had 45 employees; by 1999 the number grew to 600 (this includes a number of companies around the world Razorfish acquired). Razorfish projects range from screen savers to Charles Shwabb online trading Web site. At the time of my visit, the studios are housed in two floors of a building on Grand Street in Soho, between Broadway and Mercer, a few blacks from Prada, Hugo Boss and other designer shops. Open space houses loosely positioned workspaces occupied mostly by 20-something (although I notice a busy programmer who can't be older then 18). The design of the space functions (intentionally so) as a metaphor for computer culture's key themes: interactivity, lack of hierarchy, modularity. In contrast to traditional office architecture were the reception area acts as a getaway between the visitor and the company, here this desk looks like just another workstation, set aside from the entrance. On entering the space you can go the reception desk or you can directly make your way to any workstation on the floor. Stylishly dressed 20-somethings of both genders appear and disappear in the elevator at regular intervals. It is pretty quite, except the little noises made by numerous computers as they save and retrieve files. One of the co-founders, still in his early 30s, gives me a quick tour of the place. Although Razorfish is the established design leader in the virtual world of computer screens and networks, our tour is focused on the physical world. He proudly points out that the workers are scattered around the open space regardless of their job titles: a programmer next to interface designer next to Web designer. He notes that the reception area composed of a desk and two semi-circular sofas mimics the image — Razorfish logo. He talks about Razorfish plans to venture into product design. "Our goal is to provide total user experience. Right now a client thinks that if he needs the design for buttons on the screen, he hires Razorfish; but if he needs real buttons, he goes to another shop. We want to change this."

The original 1970s paradigm of Graphical User Interface (GUI) emulated familiar physical interfaces: a file cabinet, a desk, a trash can, a control panel. After leaving Razorfish Studios, I stop at Venus by Patricia Field, a funky store on West Broadway where I buy an orange and blue valet which has two plastic buttons on its cover, an emulation of forward and reverse buttons of a Web browser. The buttons do not do anything (yet); they simply signify "computer." Over the course of twenty years, the culture came full circle. If, with GUI, the physical environment migrated into computer screen, now the conventions of GUI are migrating back into our physical reality. The same trajectory can be traced in relation to other conventions, or forms, of computer media. A collection of documents and a navigable space, these traditional methods to organize both data and human experience of the world itself, became two of these forms which today can be found in most areas of new media. The first form is a database, used to store any kind of data — from financial records to digital movie clips; the second form is a virtual interactive 3D space, employed in computer games, motion rides, VR, computer animation, and human-computer interfaces. In migrating to a computer environment, a collection and navigable space were not left unchanged; on the contrary, they came to incorporate computer's particular techniques for structuring and accessing data, such as modularity, as well as its fundamental logic: that of computer programming. So, for instance, a computer database is quite different from a traditional collection of documents: it allows to quickly access, sort and re-organize millions of records; it can contain different media types, and it assumes multiple indexing of data, since each record besides the data itself contains a number of fields with user-defined values.

Today, in a perfect illustration of the transcoding principle (see Chapter 1), these two computer-based forms migrate back into culture at large, both literally and conceptually. A library, a museum, in fact, any large collection of cultural data are being substituted by a computer database. At the same time, a computer database becomes a new metaphor which we use to conceptualize individual and collective cultural memory, a collection of documents or objects, and other phenomena and experiences. Similarly, computer culture uses 3D navigable space to visualize any kind of data — molecules and historical records, files in a computer, the Internet as a whole, and the semantics of human language. (For instance, the software from plumbdesign renders English thesaurus as a structure in 3D space.[223]) And, with many computer games, the human experience of being in a world and the narrative itself are being represented as continuos navigation through space (think, for example, of Tomb Rider). In short, a computer database and 3D computer-based virtual space became true cultural forms — general ways used by culture to represent the human experience, the world, and human existence in this world.

Why does computer culture privilege these forms over other possibilities?[224] We may associate the first genre with work (post-industrial labor of information processing) and the second with leisure and fun (computer games), yet this very distinction is no longer valid in computer culture. As I already noted in the introduction to "Interface" chapter, increasingly the same metaphors and interfaces are used at work and at home, for business and for entertainment. For instance, the user navigates through a virtual space both to work and to play, whether analyzing scientific data or killing enemies in Quake.

We may arrive at a better explanation if we look at how these two forms are used in new media design. From one perspective, all new media design can be reduced to these two approach. That is, creating works in new media can be understood as either constructing the right interface to a multimedia database or as defining navigation methods through spatialized representations. The first approach is typically used in self-contained hypermedia and Web sites — in short, whenever the main goal is to provide an interface to data. The second approach is used in most computer games and virtual worlds. What is the logic here? Web sites and hypermedia programs usually aim to give user efficient access to information, while games and virtual worlds aim to psychologically "submerge" the user in an imaginary universe. It is appropriate that database has emerged as perfect vehicle for the first goal while navigable space meets the demands of the second. It accomplishes the same effects which before were created by literary and cinematic narrative.

Sometimes either of these two goals, information access and psychological engagement with an imaginary world, solely shapes the design of a new media object. The example of the former would be a search engine site; the example of a later would be games such as Riven or Unreal. However in general these two goals should be thought of as extreme cases of a single conceptual continuum. Such supposedly "pure" example of an information-oriented object as a Yahoo, Hotbot or other search sites aim to "immerse" the user in its universe, prevent her from going to other sites. And such supposedly pure "psychological immersion" objects as Riven or Unreal have a strong "information processing" dimension. This dimension makes playing these games more like reading a detective story or playing chess then being engaged with traditional literary and film fictional narrative. Gathering clues and treasures; constantly updating a mental map of the universe of the game, including the positions of pathways, doors, places to avoid and so on; keeping track of one's ammunition, health and other levels — all this aligns playing a computer game with other "information processing" tasks typical of computer culture, like searching Internet, scanning through news groups, pulling records from a database, using a spreadsheet, or data mining large data stores.

Often, the two goals of information access and psychological engagement compete within the same new media object. Along with surface versus depth, the opposition between information and "immersion" can be thought of as particular expression of the more general opposition characteristic of new media: between action and representation. And just as it is the case with surface and depth opposition, discussed in "Cultural Interfaces" and "Illusion, Narrative and Interactivity" sections, the results of this competition are often awkward and uneasy. For instance, an image which embeds within itself a number of hyperlinks offers neither a true psychological "immersion" nor easy navigation since the user has to search for hyperlinks. Appropriately, games such as Jonny Mnemonic (SONY, 1995) which inspired to become true interactive movies, chosen to avoid either imbedding hyperlinks or displaying controls on the screen altogether, instead relying on a keyboard the sole source of interactive control.

Narratology, the branch of modern literary theory devoted to the theory of narrative, distinguishes between narration and description. Narration are parts of the narrative which move the plot forward; description are the parts which do not. The examples of description are passages which describe the landscape, or a city, or character's apartment In short, to use the language of information age, description passages present the reader with descriptive information. As its name itself implies, narratology paid most attention to narration and hardly any to description. But in the information age narration and description has changed roles. If traditional cultures provided people with well-defined narratives (myths, religion) and little "stand-alone" information, today we have too much information and too few narratives which can tie it all together. For better or worse, information access become a key activity of a computer age. Therefore, we need something which can be called "info-aesthetics" — a theoretical analysis of the aesthetics of information access as well creation of new media objects which "aestheticize" information processing. In the age when all design became "information design," and, to paraphrase the title of the famous book by the architectural historian Sigfried Giedion[225], "search engine takes command," information access is no longer just a key form of work but also a new key category of culture. Thus it demands that we deal with it theoretically, aesthetically and symbolically.

Database

The Database Logic

After the novel, and subsequently cinema privileged narrative as the key form of cultural expression of the modern age, the computer age introduces its correlate — database. Many new media objects do not tell stories; they don't have beginning or end; in fact, they don't have any development, thematically, formally or otherwise which would organize their elements into a sequence. Instead, they are collections of individual items, where every item has the same significance as any other.

Why does new media favor database form over others? Can we explain its popularity by analyzing the specificity of the digital medium and of computer programming? What is the relationship between database and another form, which has traditionally dominated human culture — narrative? These are the questions I will address in this section.

Before proceeding I need to comment on my use of the word database. In computer science database is defined as a structured collection of data. The data stored in a database is organized for fast search and retrieval by a computer and therefore it is anything but a simple collection of items. Different types of databases — hierarchical, network, relational and object-oriented — use different models to organize data. For instance, the records in hierarchical databases are organized in a treelike structure. Object-oriented databases store complex data structures, called "objects," which are organized into hierarchical classes that may inherit properties from classes higher in the chain.[226] New media objects may or may not employ these highly structured database models; however, from the point of view of user's experience a large proportion of them are databases in a more basic sense. They appear as a collections of items on which the user can perform various operations: view, navigate, search. The user experience of such computerized collections is therefore quite distinct from reading a narrative or watching a film or navigating an architectural site. Similarly, literary or cinematic narrative, an architectural plan and database each present a different model of what a world is like. It is this sense of database as a cultural form of its own which I want to address here. Following art historian Ervin Panofsky's analysis of linear perspective as a "symbolic form" of the modern age, we may even call database a new symbolic form of a computer age (or, as philosopher Jean-Francois Lyotard called it in his famous 1979 book Postmodern Condition, "computerized society"),[227] a new way to structure our experience of ourselves and of the world. Indeed, if after the death of God (Nietzche), the end of grand

Narratives of Enlightenment (Lyotard) and the arrival of the Web (Tim Berners-Lee) the world appears to us as an endless and unstructured collection of images, texts, and other data records, it is only appropriate that we will be moved to model it as a database. But it is also appropriate that we would want to develops poetics, aesthetics, and ethics of this database.

Let us begin by documenting the dominance of database form in new media. The most obvious examples of this are popular multimedia encyclopedias, which are collections by their very definition; as well as other commercial CD-ROM titles which are collections as well — of recipes, quotations, photographs, and so on.[228] The identity of a CD-ROM as a storage media is projected onto another plane, becoming a cultural form of its own. Multimedia works which have "cultural" content appear to particularly favor the database form. Consider, for instance, the "virtual museums" genre — CD-ROMs which take the user on a "tour" through a museum collection. A museum becomes a database of images representing its holdings, which can be accessed in different ways: chronologically, by country, or by artist. Although such CD-ROMs often simulate the traditional museum experience of moving from room to room in a continuous trajectory, this "narrative" method of access does not have any special status in comparison to other access methods offered by a CD-ROM. Thus the narrative becomes just one method of accessing data among others. Another example of a database form is a multimedia genre which does not has an equivalent in traditional media — CD-ROMs devoted to a single cultural figure such as a famous architect, film director or writer. Instead of a narrative biography we are presented with a database of images, sound recordings, video clips and/or texts which can be navigated in a variety of ways.

CD-ROMs and other digital storage media (floppies, DVD) proved to be particularly receptive to traditional genres which already had a database-like structure, such as a photo-album; they also inspired new database genres, like a database biography. Where the database form really flourished, however, is on the Internet. As defined by original HTML, a Web page is a sequential list of separate elements: text blocks, images, digital video clips, and links to other pages. It is always possible to add a new element to the list — all you have to do is to open a file and add a new line. As a result, most Web pages are collections of separate elements: texts, images, links to other pages or sites. A home page is a collection of personal photographs. A site of a major search engine is a collection of numerous links to other sites (along with a search function, of course). A site of a Web-based TV or radio station offers a collections of video or audio programs along with the option to listen to the current broadcast; but this current program is just one choice among many other programs stored on the site. Thus the traditional broadcasting experience, which consisted solely of a real-time transmission, becomes just one element in a collection of options. Similar to the CD-ROM medium, the Web offered fertile ground to already existing database genres (for instance, bibliography) and also inspired the creation of new ones such as the sites devoted to a person or a phenomenon (Madonna, Civil War, new media theory, etc.) which, even if they contain original material, inevitably center around the list of links to other Web pages on the same person or phenomenon.

The open nature of the Web as medium (Web pages are computer files which can always be edited) means that the Web sites never have to be complete; and they rarely are. The sites always grow. New links are being added to what is already there. It is as easy to add new elements to the end of list as it is to insert them anywhere in it. All this further contributes to the anti-narrative logic of the Web. If new elements are being added over time, the result is a collection, not a story. Indeed, how can one keep a coherent narrative or any other development trajectory through the material if it keeps changing?

Commercial producers have experimented with ways to explore the database form inherent to new media, with offerings ranging from multimedia encyclopedias, to collections of software, to collections of pornographic images. In contrast, many artists working with new media at first uncritically accepted the database form as a given. Thus they became blind victims of database logic. Numerous artists' Web sites are collections of multimedia elements documenting their works in other media. In the case of many early artists' CD-ROMs as well, the tendency was to fill all the available storage space with different material: the main work, documentation, related texts, previous works and so on.

As the 1990s progressed, artists increasingly begun to approach database more critically.[229] A few examples of projects investigating database politics and possible aesthetics.are Chris Marker's "IMMEMORY," Olga Lialina's "Anna Karenina Goes to Paradise,"[230] Stephen Mamber's "Digital Hitchcock," and Fabian Wagmister's "...two, three, many Guevaras." The artist who have explored possibilities of a database most systematically is George Legrady. In a series of interactive multimedia works ("The Anecdoted Archive," 1994; "[the clearning]," 1994; "Slippery Traces, 1996; "Tracing," 1998) he used diffirent types of databases to create “an information structure where stories/things are organized according to mutiple thematic connections."[231]

Data and Algorithm

Of course not all new media objects are explicitly databases. Computer games, for instance, are experienced by their players as narratives. In a game, the player is given a well-defined task — winning the match, being first in a race, reaching the last level, or reaching the highest score. It is this task which makes the player experience the game as a narrative. Everything which happens to her in a game, all the characters and objects she encounters either take her closer to achieving the goal or further away from it. Thus, in contrast to the CD-ROM and Web databases, which always appear arbitrary since the user knows that additional material could have been added without in any way modifying the logic of the database, in a game, from a user's point of view, all the elements are motivated (i.e., their presence is justified).[232]

Often the narrative shell of a game ("you are the specially trained commando who has just landed on a Lunar base; your task is to make your way to the headquarters occupied by the mutant base personnel...") masks a simple algorithm well-familiar to the player: kill all the enemies on the current level, while collecting all treasures it contains; go to the next level and so on until you reach the last level. Other games have different algorithms. Here is an algorithm of the legendary "Tetris": when a new block appears, rotate it in such a way so it will complete the top layer of blocks on the bottom of the screen making this layer disappear. The similarity between the actions expected from the player and computer algorithms is too uncanny to be dismissed. While computer games do not follow database logic, they appear to be ruled by another logic — that of an algorithm. They demand that a player executes an algorithm in order to win.

An algorithm is the key to the game experience in a different sense as well. As the player proceeds through the game, she gradually discovers the rules which operate in the universe constructed by this game. She learns its hidden logic, in short its algorithm. Therefore, in games where the game play departs from following an algorithm, the player is still engaged with an algorithm, albeit in another way: she is discovering the algorithm of the game itself. I mean this both metaphorically and literally: for instance, in a first person shooter, such as "Quake," the player may eventually notice that under such and such condition the enemies will appear from the left, i.e. she will literally reconstruct a part of the algorithm responsible for the game play. Or, in a different formulation of the legendary author of Sim games Will Wright, "Playing the game is a continuos loop between the user (viewing the outcomes and inputting decisions) and the computer (calculating outcomes and displaying them back to the user). The user is trying to build a mental model of the computer model."[233]

What we encountered is another example of the general principle of transcoding discussed in Chapter 1: the projection of the ontology of a computer onto culture itself. If in physics the world is made of atoms and in genetics it is made of genes, computer programming encapsulates the world according to its own logic. The world is reduced to two kinds of software objects which are complementary to each other: data structures and algorithms. Any process or task is reduced to an algorithm, a final sequence of simple operations which a computer can execute to accomplish a given task. And any object in the world — be it the population of a city, or the weather over the course of a century, a chair, a human brain — is modeled as a data structure, i.e. data organized in a particular way for efficient search and retrieval.[234] Examples of data structures are arrays, linked lists and graphs. Algorithms and data structures have a symbiotic relationship. The more complex the data structure of a computer program, the simpler the algorithm needs to be, and vice versa. Together, data structures and algorithms are two halves of the ontology of the world according to a computer.

The computerization of culture involves the projection of these two fundamental parts of computer software — and of the computer's unique ontology — onto the cultural sphere. If CD-ROMs and Web databases are cultural manifestations of one half of this ontology — data structures, then computer games are manifestations of the second half — algorithms. Games (sports, chess, cards, etc.) are one cultural form which required algorithm-like behavior from the players; consequently, many traditional games were quickly simulated on computers. In parallel, new genres of computer games came into existence such as a first person shooter ("Doom," "Quake"). Thus, as it was the case with database genres, computer games both mimic already existing games and create new game genres.

It may appear at first sight that data is passive and algorithm is active — another example of passive-active binary categories so loved by human cultures. A program reads in data, executes an algorithm, and writes out new data. We may recall that before "computer science" and "software engineering" became established names for the computer field, it was called "data processing." This name remained in use for a few decades during which computers were mainly associated with performing calculations over data. However, the passive/active distinction is not quite accurate since data does not just exist — it has to be generated. Data creators have to collect data and organize it, or create it from scratch. Texts need to written, photographs need to be taken, video and audio need to be recorded. Or they need to be digitized from already existing media. In the 1990's, when the new role of a computer as a Universal Media Machine became apparent, already computerized societies went into a digitizing craze. All existing books and video tapes, photographs and audio recordings started to be fed into computers at an ever increasing rate. Steven Spielberg created the Shoah Foundation which videotaped and then digitized numerous interviews with Holocaust survivors; it would take one person forty years to watch all the recorded material. The editors of Mediamatic journal, who devoted a whole issue to the topic of "the storage mania" (Summer 1994) wrote: "A growing number of organizations are embarking on ambitious projects. Everything is being collected: culture, asteroids, DNA patterns, credit records, telephone conversations; it doesn't matter."[235] In 1996, financial company T. Rowe Price stored 800 gigabytes of data; by the Fall of 1999 this number rose to 10 terabytes.[236]

Once it is digitized, the data has to be cleaned up, organized, indexed. The computer age brought with it a new cultural algorithm: reality-> media->data-

>database. The rise of the Web, this gigantic and always changing data corpus, gave millions of people a new hobby or profession: data indexing. There is hardly a Web site which does not feature at least a dozen links to other sites, therefore every site is a type of database. And, with the rise of Internet commerce, most large-scale commercial sites have become real databases, or rather front-ends to company databases. For instance, in the Fall of 1998, Amazon.com, an online book store, had 3 million books in its database; and the maker of leading commercial database Oracle has offered Oracle 8i, fully integrated with the Internet and featuring unlimited database size, natural-language queries and support for all multimedia data types.[237] Jorge Luis Borges's story about a map which was equal in size to the territory it represented became re-written as the story about indexes and the data they index. But now the map has become larger than the territory. Sometimes, much larger. Porno Web sites exposed the logic of the Web to its extreme by constantly re-using the same photographs from other porno Web sites. Only rare sites featured the original content. On any given date, the same few dozen images would appear on thousands of sites. Thus, the same data would give rise to more indexes than the number of data elements themselves.

Database and Narrative

As a cultural form, database represents the world as a list of items and it refuses to order this list. In contrast, a narrative creates a cause-and-effect trajectory of seemingly unordered items (events). Therefore, database and narrative are natural enemies. Competing for the same territory of human culture, each claims an exclusive right to make meaning out of the world.

In contrast to most games, most narratives do not require algorithm-like behavior from their readers. However, narratives and games are similar in that the user, while proceeding through them, must uncover its underlying logic — its algorithm. Just like a game player, a reader of a novel gradually reconstructs an algorithm (here I use it metaphorically) which the writer used to create the settings, the characters, and the events. From this perspective, I can re-write my earlier equations between the two parts of the computer's ontology and its corresponding cultural forms. Data structures and algorithms drive different forms of computer culture. CD-ROMs, Web sites and other new media objects which are organized as databases correspond to the data structure; while narratives, including computer games, correspond to the algorithms.

In computer programming, data structures and algorithms need each other; they are equally important for a program to work. What happens in a cultural sphere? Do databases and narratives have the same status in computer culture?

Some media objects explicitly follow database logic in their structure while others do not; but behind the surface practically all of them are databases. In general, creating a work in new media can be understood as the construction of an interface to a database. In the simplest case, the interface simply provides the access to the underlying database. For instance, an image database can be represented as a page of miniature images; clicking on a miniature will retrieve the corresponding record. If a database is too large to display all of its records at once, a search engine can be provided to allow the user to search for particular records. But the interface can also translate the underlying database into a very different user experience. The user may be navigating a virtual three-dimensional city composed from letters, as in Jeffrew Shaw's interactive installation "Legible City."[238] Or she may be traversing a black and white image of a naked body, activating pieces of text, audio and video embedded in its skin (Harwood's CD-ROM "Rehearsal of Memory.")[239] Or she may be playing with virtual animals which come closer or run away depending upon her movements (Scott Fisher et al, VR installation, "Menagerie.")[240] Although each of these works engages the user in a set of behaviors and cognitive activities which are quite distinct from going through the records of a database, all of them are databases. "Legible City" is a database of three-dimensional letters which make up the city. "Rehearsal of Memory" is a database of texts and audio and video clips which are accessed through the interface of a body. And "Menagerie" is a database of virtual animals, including their shapes, movements and behaviors.

Database becomes the center of the creative process in the computer age. Historically, the artist made a unique work within a particular medium. Therefore the interface and the work were the same; in other words, the level of an interface did not exist. With new media, the content of the work and the interface become separate. It is therefore possible to create different interfaces to the same material. These interfaces may present different versions of the same work, as in David Blair's WaxWeb.[241] Or they may be radically different from each other, as in Moscow WWWArt Centre.[242] This is one of the ways in which the already discussed principle of variability of new media manifests itself. But now we can give this principle a new formulation. The new media object consists of one or more interfaces to a database of multimedia material. If only one interface is constructed, the result will be similar to a traditional art object; but this is an exception rather than the norm.

This formulation places the opposition between database and narrative in a new light, thus redefining our concept of narrative. The "user" of a narrative is traversing a database, following links between its records as established by the database's creator. An interactive narrative (which can be also called "hyper-narrative" in an analogy with hypertext) can then be understood as the sum of multiple trajectories through a database. A traditional linear narrative is one, among many other possible trajectories; i.e. a particular choice made within a hyper-narrative. Just as a traditional cultural object can now be seen as a particular case of a new media object (i.e., a new media object which only has one interface), traditional linear narrative can be seen as a particular case of a hyper-narrative.

This "technical," or "material" change in the definition of narrative does not mean that an arbitrary sequence of database records is a narrative. To qualify as a narrative, a cultural object has to satisfy a number of criteria, which cultural theorist Mieke Bal, the author of a standard textbook on narrative theory, defines as follows: it should contain both an actor and a narrator; it also should contain three distinct levels consisting of the text, the story, and the fabula; and its "contents" should be "a series of connected events caused or experienced by actors."[243] Obviously, not all cultural objects are narratives. However, in the world of new media, the word “narrative” is often used as all-inclusive term, to cover up the fact that we have not yet developed a language to describe these new strange objects. It is usually paired with another over-used word — interactive. Thus, a number of database records linked together so that more than one trajectory is possible, is assumed to be constitute "interactive narrative." But to just create these trajectories is of course not sufficient; the author also has to control the semantics of the elements and the logic of their connection so that the resulting object will meet the criteria of narrative as outlined above. Another erroneous assumption frequently made is that by creating her own path (i.e., choosing the records from a database in a particular order) the user constructs her own unique narrative. However, if the user simply accesses different elements, one after another, in a usually random order, there is no reason to assume that these elements will form a narrative at all. Indeed, why should an arbitrary sequence of database records, constructed by the user, result in "a series of connected events caused or experienced by actors"?

In summary, database and narrative do not have the same status in computer culture. In the database / narrative pair, database is the unmarked term.[244] Regardless of whether new media objects present themselves as linear narratives, interactive narratives, databases, or something else, underneath, on the level of material organization, they are all databases. In new media, the database supports a range of cultural forms which range from direct translation (i.e., a database stays a database) to a form whose logic is the opposite of the logic of the material form itself — a narrative. More precisely, a database can support narrative, but there is nothing in the logic of the medium itself which would foster its generation. It is not surprising, then, that databases occupy a significant, if not the largest, territory of the new media landscape. What is more surprising is why the other end of the spectrum — narratives — still exist in new media.

Paradigm and Syntagm

The dynamics which exist between database and narrative are not unique in new media. The relation between the structure of a digital image and the languages of contemporary visual culture is characterized by the same dynamics. As defined by all computer software, a digital image consists of a number of separate layers, each layer containing particular visual elements (see "Compositing" section for a discussion of moving image compositing and its use to simulate cinematographic look). Throughout the production process, artists and designers manipulate each layer separately; they also delete layers and add new ones. Keeping each element as a separate layer allows the content and the composition of an image to be changed at any point: deleting a background, substituting one person for another, moving two people closer together, blurring an object, and so on. What would a typical image look like if the layers were merged together? The elements contained on different layers will become juxtaposed resulting in a montage look. Montage is the default visual language of composite organization of an image. However, just as database supports both the database form and its opposite — narrative, a composite organization of an image on the material level (and compositing software on the level of operations) support two opposing visual languages. One is modernist-MTV montage — two-dimensional juxtaposition of visual elements designed to shock due to its impossibility in reality. The other is the representation of familiar reality as seen by a photo of film camera (or its computer simulation, in the case of 3D graphics). During the 1980s and 1990s all image making technologies became computer-based thus turning all images into composites. In parallel, a Renaissance of montage took place in visual culture, in print, broadcast design and new media. This is not unexpected — after all, this is the visual language dictated by the composite organization. What needs to be explained is why photorealist images continue to occupy such a significant space in our computer-based visual culture.

It would be surprising, of course, if photorealist images suddenly disappeared completely. The history of culture does not contain such sudden breaks. Similarly, we should not expect that new media would completely substitute narrative by database. New media does not radically break with the past; rather, it distributes weight differently between the categories which hold culture together, foregrounding what was in the background, and vice versa. As Frederick Jameson writes in his analysis of another shift, from modernism to post-modernism: "Radical breaks between periods do not generally involve complete changes but rather the restructuration of a certain number of elements already given: features that in an earlier period of system were subordinate became dominant, and features that had been dominant again become secondary."[245]

Database — narrative opposition is the case in point. To further understand how computer culture redistributes weight between the two terms of opposition in computer culture I will bring in a semiological theory of syntagm and paradigm. According to this model, originally formulated by Ferdinand de Saussure to describe natural languages such as English and later expanded by Roland Barthes and others to apply to other sign systems (narrative, fashion, food, etc.), the elements of a system can be related on two dimensions: syntagmatic and paradigmatic.[246] As defined by Barthes, "the syntagm is a combination of signs, which has space as a support." To use the example of natural language, the speaker produces an utterance by stringing together the elements, one after another, in a linear sequence. This is the syntagmatic dimension. Now, lets look at the paradigm. To continue with an example of a language user, each new element is chosen from a set of other related elements. For instance, all nouns form a set; all synonyms of a particular word form another set. In the original formulation of Saussure, "the units which have something in common are associated in theory and thus form groups within which various relationships can be found."[247] This is the paradigmatic dimension.

The elements on a syntagmatic dimension are related *in praesentia*, while the elements on a paradigmatic dimension are related *in absentia*. For instance, in the case of a written sentence, the words which comprise it materially exist on a piece of paper, while the paradigmatic sets to which these words belong only exist in writer's and reader's minds. Similarly, in the case of a fashion outfit, the elements which make it, such as a skirt, a blouse, and a jacket, are present in reality, while pieces of clothing which could have been present instead — different skirt, different blouse, different jacket — only exist in the viewer's imagination. Thus, syntagm is explicit and paradigm is implicit; one is real and the other is imagined.

Literary and cinematic narratives work in the same way. Particular words, sentences, shots, scenes which make up a narrative have a material existence; other elements which form an imaginary world of an author or a particular literary or cinematic style and which could have appeared instead exist only virtually. Put differently, the database of choices from which narrative is constructed (the paradigm) is implicit; while the actual narrative (the syntagm) is explicit.

New media reverses this relationship. Database (the paradigm) is given material existence, while narrative (the syntagm) is de-materialised. Paradigm is privileged, syntagm is downplayed. Paradigm is real, syntagm is virtual. To see this, consider the new media design process. The design of any new media object begins with assembling a database of possible elements to be used. (Macromedia Director calls this database "cast," Adobe Premiere calls it "project", ProTools calls it a “session," but the principle is the same.) This database is the center of the design process. It typically consists from a combination of original and stock material distributed such as buttons, images, video and audio sequences; 3D objects; behaviors and so on. Throughout the design process new elements are added to the database; existing elements are modified. The narrative is constructed by linking elements of this database in a particular order, i.e. designing a trajectory leading from one element to another. On the material level, a narrative is just a set of links; the elements themselves remain stored in the database. Thus the narrative is more virtual than the database itself. (Since all data is stored as electronic signals, the word "material" seem to be no longer appropriate. Instead we should talk about different degrees of virtuality.)

The paradigm is privileged over syntagm in yet another way in interactive objects presenting the user with a number of choices at the same time — which is what typical interactive interfaces do. For instance, a screen may contain a few icons; clicking on each icon leads the user to a different screen. On the level of an individual screen, these choices form a paradigm of their own which is explicitly presented to the user. On the level of the whole object, the user is made aware that she is following one possible trajectory among many others. In other words, she is selecting one trajectory from the paradigm of all trajectories which are defined.

Other types of interactive interfaces make the paradigm even more explicit by presenting the user with an explicit menu of all available choices. In such interfaces, all of the categories are always available, just a mouse click away. The complete paradigm is present before the user, its elements neatly arranged in a menu. This is another example of how new media makes explicit the psychological processes involved in cultural communication. Other examples include the already discussed shift from creation to selection, which externalizes and codifies the database of cultural elements existing in the creator's mind; as well as the very phenomena of interactive links. As I noted in Chapter 1, new media takes "interaction" literally, equating it with a strictly physical interaction between a user and a computer, at the sake of psychological interaction. The cognitive processes involved in understanding any culltural text are erroneously equated with an objectively existing structure of interactive links.

Interactive interfaces foreground the paradigmatic dimension and often make explicit paradigmatic sets. Yet, they are still organized along the syntagmatic dimension. Although the user is making choices at each new screen, the end result is a linear sequence of screens which she follows. This is the classical syntagmatic experience. In fact, it can be compared to constructing a sentence in a natural language. Just as a language user constructs a sentence by choosing each successive word from a paradigm of other possible words, a new media user creates a sequence of screens by clicking on this or that icon at each screen. Obviously, there are many important differences between these two situations. For instance, in the case of a typical interactive interface, there is no grammar and paradigms are much smaller. Yet, the similarity of basic experience in both cases is quite interesting; in both cases, it unfolds along a syntagmatic dimension.

Why does new media insist on this language-like sequencing? My hypothesis is that it follows the dominant semiological order of the twentieth century — that of cinema. As noted in the previous chapter, cinema replaced all other modes of narration with a sequential narrative, an assembly line of shots which appear on the screen one at a time. For centuries, a spatialized narrative where all images appear simultaneously dominated European visual culture; then it was delegated to "minor" cultural forms as comics or technical illustrations. "Real" culture of the twentieth century came to speak in linear chains, aligning itself with the assembly line of an industrial society and the Turing machine of a post-industrial era. New media continues this mode, giving the user information one screen at a time. At least, this is the case when it tries to become "real" culture (interactive narratives, games); when it simply functions as an interface to information, it is not ashamed to present much more information on the screen at once, be it in the form of tables, normal or pull-down menus, or lists. In particular, the experience of a user filling in an on-line form can be compared to pre-cinematic spatialized narrative: in both cases, the user is following a sequence of elements which are presented simultaneously.

A Database Complex

To what extent is the database form intrinsic to modern storage media? For instance, a typical music CD is a collection of individual tracks grouped together. The database impulse also drives much of photography throughout its history, from William Henry Fox Talbot's "Pencil of Nature" to August Sander's monumental typology of modern German society "Face of Our Time," to the Bernd and Hilla Becher's equally obsessive cataloging of water towers. Yet, the connection between storage media and database forms is not universal. The prime exception is cinema. Here the storage media supports the narrative imagination.[248] Why then, in the case of photography storage media, does technology sustain database, while in the case of cinema it gives rise to a modern narrative form par excellence? Does this have to do with the method of media access? Shall we conclude that random access media, such as computer storage formats (hard drives, removable disks, CD-ROMs), favors database, while sequential access media, such as film, favors narrative? This does not hold either. For instance, a book, this perfect random-access medium, supports database forms, such as photo-albums, and narrative forms, such as novels.

Rather than trying to correlate database and narrative forms with modern media and information technologies, or deduce them from these technologies, I prefer to think of them as two competing imaginations, two basic creative impulses, two essential responses to the world. Both have existed long before modern media. The ancient Greeks produced long narratives, such as Homer's epic poems The Iliad and The Odyssey; they also produced encyclopedias. The first fragments of a Greek encyclopedia to have survived were the work of Speusippus, a nephew of Plato. Diderot wrote novels — and also was in charge of monumental Encyclopédie, the largest publishing project of the 18th century. Competing to make meaning out of the world, database and narrative produce endless hybrids. It is hard to find a pure encyclopedia without any traces of a narrative in it and vice versa. For instance, until alphabetical organization became popular a few centuries ago, most encyclopedias were organized thematically, with topics covered in a particular order (typically, corresponding to seven liberal arts.) At the same time, many narratives, such as the novels by Cervantes and Swift, and even Homer's epic poems — the founding narratives of the Western tradition — traverse an imaginary encyclopedia.

Modern media is the new battlefield for the competition between database and narrative. It is tempting to read the history of this competition in dramatic terms. First the medium of visual recording — photography — privileges catalogs, taxonomies and lists. While the modern novel blossoms, and academicians continue to produce historical narrative paintings all through the nineteenth century, in the realm of the new techno-image of photography, database rules. The next visual recording medium — film — privileges narrative. Almost all fictional films are narratives, with few exceptions. Magnetic tape used in video does not bring any substantial changes. Next storage media — computer controlled digital storage devices (hard drives, removable drives, CD-ROMs, DVD) privilege database once again. Multimedia encyclopedias, virtual museums, pornography, artists' CD-ROMs, library databases, Web indexes, and, of course, the Web itself: database is more popular than ever before.

Digital computer turns out to be the perfect medium for the database form. Like a virus, databases infect CD-ROMs and hard drives, servers and Web sites. Can we say that database is the cultural form most characteristic of a computer? In her 1978 article "Video: The Aesthetics of Narcissism," probably the single most well-known article on video art, art historian Rosalind Krauss argued that video is not a physical medium but a psychological one. In her analysis, "video's real medium is a psychological situation, the very terms of which are to withdraw attention from an external object — an Other — and invest it in the Self."[249] In short, video art is a support for the psychological condition of narcissism.[250] Does new media similarly function to play out a particular psychological condition, something which can be called a database complex? In this respect, it is interesting that database imagination has accompanied computer art from its very beginning. In the 1960s, artists working with computers wrote programs to systematically explore the combinations of different visual elements. In part they were following art world trends such as minimalism. Minimalist artists executed works of art according to pre-existent plans; they also created series of images or objects by systematically varying a single parameter. So, when minimalist artist Sol LeWitt spoke of an artist's idea as "the machine which makes the work," it was only logical to substitute the human executing the idea by a computer.[251] At the same time, since the only way to make pictures with a computer was by writing a computer program, the logic of computer programming itself pushed computer artists in the same directions. Thus, for artist Frieder Nake a computer was a "Universal Picture Generator," capable of producing every possible picture out of a combination of available picture elements and colors.[252] In 1967 he published a portfolio of 12 drawings which were obtained by successfully multiplying a square matrix by itself. Another early computer artist Manfred Mohr produced numerous images which recorded various transformations of a basic cube.

Even more remarkable were films by John Witney, the pioneer of computer filmmaking. His films such as "Permutations" (1967), "Arabesque" (1975) and others systematically explored the transformations of geometric forms obtained by manipulating elementary mathematical functions. Thus they substituted successive accumulation of visual effects for narrative, figuration or even formal development. Instead they presented the viewer with databases of effects. This principle reaches its extreme in Witney's earlier film which was made using analog computer and was called "Catalog." In his important book on new forms of cinema of the 1960s entitled Expanded Cinema (1970) critic Gene Youngblood writes about this remarkable film: "The elder Whitney actually never produced a complete, coherent movie on the analog computer because he was continually developing and refining the machine while using it for commercial work... However, Whitney did assemble a visual catalogue of the effects he had perfected over the years. This film, simply titled Catalog, was completed in 1961 and proved to be of such overwhelming beauty that many persons still prefer Whitney's analogue work over his digital computer films."[253] One is tempted to read "Catalog" as one of the founding moments of new media. As discussed in "Selection" section, today all software for media creation arrives with endless "plug-ins" — the banks of effects which with a press of a button generate interesting images from any input whatsoever. In parallel, much of the aesthetics of computerised visual culture is effects driven, especially when a new techno-genre (computer animation, multimedia, Web sites) is just getting established. For instance, countless music videos are variations of Witney's "Catalog" — the only difference is that the effects are applied to the images of human performers. This is yet another example of how the logic of a computer — in this case, the ability of a computer to produce endless variations of elements and to act as a filter, transforming its input to yield a new output — becomes the logic of culture at large.

Database Cinema: Greenaway and Vertov

Although database form may be inherent to new media, countless attempts to create "interactive narratives" testify to our dissatisfaction with the computer in the sole role of an encyclopedia or a catalog of effects. We want new media narratives, and we want these narratives to be different from the narratives we saw or read before. In fact, regardless of how often we repeat in public that the modernist notion of medium specificity ("every medium should develop its own unique language") is obsolete, we do expect computer narratives to showcase new aesthetic possibilities which did not exist before digital computers. In short, we want them to be new media specific. Given the dominance of database in computer software and the key role it plays in the computer-based design process, perhaps we can arrive at new kinds of narrative by focusing our attention on how narrative and database can work together. How can a narrative take into account the fact that its elements are organized in a database? How can our new abilities to store vast amounts of data, to automatically classify, index, link, search and instantly retrieve it lead to new kinds of narratives?

Peter Greenaway, one of the very few prominent film directors concerned with expanding cinema's language, complained that "the linear pursuit — one story at a time told chronologically — is the standard format of cinema." Pointing out that cinema lags behind modern literature in experimenting with narrative, he asked: "Could it not travel on the road where Joyce, Eliot, Borges and Perec have already arrived?"[254] While Greenaway is right to direct filmmakers to more innovative literary narratives, new media artists working on the database — narrative problem can learn from cinema "as it is." For cinema already exists right in the intersection between database and narrative. We can think of all the material accumulated during shooting forming a database, especially since the shooting schedule usually does not follow the narrative of the film but is determined by production logistics. During editing the editor constructs a film narrative out of this database, creating a unique trajectory through the conceptual space of all possible films which could have been constructed. From this perspective, every filmmaker engages with the database-narrative problem in every film, although only a few have done this self-consciously.

One exception is Greenaway himself. Throughout his career, he has been working on a problem of how to reconcile database and narrative forms. Many of his films progress forward by recounting a list of items, a catalog which does not have any inherent order (for example, different books in Prospero's Books). Working to undermine a linear narrative, Greenaway uses different systems to order his films. He wrote about this approach: "If a numerical, alphabetic color-coding system is employed, it is done deliberately as a device, a construct, to counteract, dilute, augment or compliment the all-pervading obsessive cinema interest in plot, in narrative, in the 'I'am now going to tell you a story school of film-making."[255] His favorite system is numbers. The sequence of numbers acts as a narrative shell which "convinces" the viewer that she is watching a narrative.

In reality the scenes which follow one another are not connected in any logical way. By using numbers, Greenaway "wraps" a minimal narrative around a database. Although Greenaway's database logic was present already in his "avant-garde" films such as The Falls (1980), it has also structured his "commercial" films from the beginning. Draughtsman's Contract (1982) is centered around twelve drawings being made by the draftsman. They do not form any order; Greenaway emphasizes this by having draftsman to work on a few drawings at once. Eventually, Greenaway's desire to take "cinema out of cinema" led to his work on a series of installations and museum exhibitions in the 1990s. No longer having to conform to the linear medium of film, the elements of a database are spatialized within a museum or even the whole city. This move can be read as the desire to create a database at its most pure form: the set of elements not ordered in any way. If the elements exist in one dimension (time of a film, list on a page), they will be inevitably ordered. So the only way to create a pure database is to spatialise it, distributing the elements in space. This is exactly the path which Greenaway took. Situated in three-dimensional space which does not have an inherent narrative logic, a 1992 installation "100 Objects to Represent the World" in its very title proposes that the world should be understood through a catalog rather than a narrative. At the same time, Greenaway does not abandon narrative; he continues to investigate how database and narrative can work together. Having presented "100 Objects" as an installation, Greenaway next turned it into an opera set. In the opera, the narrator Thrope uses the objects to conduct Adam and Eve through the whole of human civilization, thus turning a 100 objects into a sequential narrative.[256] In another installation "The Stairs-Munich-Projection" (1995) Greenaway put up a hundred screens — each for one year in the history of cinema — throughout Munich. Again, Greenaway presents us with a spatialized database — but also with a narrative. By walking from one screen to another, one follows cinema’s history. The project uses Greenaway's favorite principle of organization by numbers, pushing it to the extreme: the projections on the screens contain no figuration, just numbers. The screens are numbered from 1895 to 1995, one screen for each year of cinema's history. Along with numbers, Greenaway introduces another line of development. Each projection is slightly different in color.[257] The hundred colored squares form an abstract narrative of their own which runs in parallel to the linear narrative of cinema’s history. Finally, Greenaway superimposes yet a third narrative by dividing the history of cinema into five sections, each section staged in a different part of the city. The apparent triviality of the basic narrative of the project — one hundred numbers, standing for one hundred years of cinema’s history — "neutralizes" the narrative, forcing the viewer to focus on the phenomenon of the projected light itself, which is the actual subject of this project.

Along with Greenaway, Dziga Vertov can be thought of as a major "database filmmaker" of the twentieth century. Man with a Movie Camera is perhaps the most important example of database imagination in modern media art. In one of the key shots repeated few times in the film we see an editing room with a number of shelves used to keep and organize the shot material. The shelves are marked "machines," "club," "the movement of a city," "physical exercise," "an illusionist," and so on. This is the database of the recorded material. The editor — Vertov's wife, Elizaveta Svilova — is shown working with this database: retrieving some reels, returning used reels, adding new ones.

Although I pointed out that film editing in general can be compared to creating a trajectory through a database, in the case of Man with a Movie Camera this comparison constitutes the very method of the film. Its subject is the filmmaker's struggle to reveal (social) structure among the multitude of observed phenomena. Its project is a brave attempt at an empirical epistemology which only has one tool — perception. The goal is to decode the world purely through the surfaces visible to the eye (of course, its natural sight enhanced by a movie camera). This is how the film's co-author Mikhail Kaufman describes it:

> An ordinary person finds himself in some sort of environment, gets lost amidst the zillions of phenomena, and observes these phenomena from a bad vantage point. He registers one phenomenon very well, registers a second and a third, but has no idea of where they may lead... But the man with a movie camera is infused with the particular thought that he is actually seeing the world for other people. Do you understand? He joins these phenomena with others, from elsewhere, which may not even have been filmed by him. Like a kind of scholar he is able to gather empirical observations in one place and then in another. And that is actually the way in which the world has come to be understood.[258]

Therefore, in contrast to standard film editing which consists in selection and ordering of previously shot material according to a pre-existent script, here the process of relating shots to each other, ordering and reordering them in order to discover the hidden order of the world constitutes the film's method. Man with a Movie Camera traverses its database in a particular order to construct an argument. Records drawn from a database and arranged in a particular order become a picture of modern life — but simultaneously an argument about this life, an interpretation of what these images, which we encounter every day, every second, actually mean.[259]

Was this brave attempt successful? The overall structure of the film is quite complex, and on the first glance has little to do with a database. Just as new media objects contain a hierarchy of levels (interface — content; operating system — application; web page — HTML code; high-level programming language — assembly language — machine language), Vertov's film consists of at least three levels. One level is the story of a cameraman filming material for the film. The second level is the shots of an audience watching the finished film in a movie theater. The third level is this film, which consists from footage recorded in Moscow, Kiev and Riga and is arranged according to a progression of one day: waking up — work — leisure activities. If this third level is a text, the other two can be thought of as its meta-texts.[260] Vertov goes back and forth between the three levels, shifting between the text and its meta-texts: between the production of the film, its reception, and the film itself. But if we focus on the film within the film (i.e., the level of the text) and disregard the special effects used to create many of the shots, we discover almost a linear printout, so to speak, of a database: a number of shots showing machines, followed by a number of shots showing work activities, followed by different shots of leisure, and so on. The paradigm is projected onto syntagm. The result is a banal, mechanical catalog of subjects which one can expect to find in the city of the 1920s: running trams, city beach, movie theaters, factories...

Of course watching Man with a Movie Camera is anything but a banal experience. Even after the 1990s during which computer-based image and video-makers systematically exploited every avant-garde device, the original still looks striking. What makes its striking is not its subjects and the associations Vertov tries to establish between them to impose "the communist decoding of the world" but the most amazing catalog of the film techniques contained within it. Fades and superimpositions, freeze-frames, acceleration, split screens, various types of rhythm and intercutting, different montage techniques[261] — what film scholar Annette Michelson called "a summation of the resources and techniques of the silent cinema"[262] — and of course, a multitude of unusual, "constructivist" points of view are stringed together with such density that the film can't be simply labeled avant-garde. If a "normal" avant-garde film still proposes a coherent language different from the language of mainstream cinema, i.e. a small set of techniques which are repeated, Man with a Movie Camera never arrives at anything like a well-defined language. Rather, it proposes an untamed, and apparently endless unwinding of cinematic techniques, or, to use contemporary language, "effects," as cinema's new way of speaking.

Traditionally, a personal artistic language or a style common to a group of cultural objects or a period requires the stability of paradigms and consistent expectations as to which elements of paradigmatic sets may appear in a given situation. For example, in a case of classical Hollywood style, a viewer may expect that a new scene will begin with an establishing shot or that a particular lighting convention such as high key or low key will be used throughout the film. (David Bordwell defines a Hollywood style in terms of paradigms which are ranked in terms of probabilities.[263])

The endless new possibilities provided by computer software hold the promise of new cinematic languages, but in the same time they prevent such languages from coming into being. (I am using the example of film but the same logic applies to all other areas of computer-based visual culture.) Since every software comes with numerous sets of transitions, 2D filters, 3D transformations and other effects and “plug-ins,” the artist, especially the beginner, is tempted to use many of them in the same work. In such a case a paradigm becomes the syntagm. That is, rather than making singular choices from the sets of possible techniques, or, to use the term of Russian formalists, devices, and then repeating them throughout the work (for instance, using only cuts, or only cross-dissolves), the artist ends up using many options in the same work. Ultimately, a digital film becomes a list of different effects, which appear one after another. Witney’s Catalog is the extreme expression of this logic.

The possibility of creating a stable new language is also subverted by the constant introduction of new techniques over time. Thus the new media paradigms not only contain many more options than in the old media but they also keep growing over time. And in culture ruled by the logic of fashion, i.e., the demand for constant innovation, the artists tend to adopt newly available options while simultaneously dropping the already familiar ones. Every year, every month new effects found their way into the media works, displacing the previously prominent ones and destabilizing any stable expectations which viewers could have begin to form.

And this is why Vertov’s film has a particular relevance to new media. It proves that it is possible to turn “effects” into a meaningful artistic language. Why in the case of Witney's computer films and music videos are the effects just effects, while in the hands of Vertov they acquire meaning? Because in Vertov's film they are motivated by a particular argument, this being that the new techniques to obtain images and manipulate them, summed up by Vertov in his term "kino-eye," can be used to decode the world. As the film progresses, "straight" footage gives way to manipulated footage; newer techniques appear one after one, reaching a roller coaster intensity by the film's end, a true orgy of cinematography. It is as though Vertov re-stages his discovery of the kino-eye for us. Along with Vertov, we gradually realize the full range of possibilities offered by the camera. Vertov's goal is to seduce us into his way of seeing and thinking, to make us share his excitement, his gradual process of discovery of film's new language. This process of discovery is film's main narrative and it is told through a catalog of discoveries being made. Thus, in the hands of Vertov, a database, this normally static and "objective" form, becomes dynamic and subjective. More importantly, Vertov is able to achieve something which new media designers and artists still have to learn — how to merge database and narrative merge into a new form.

Navigable space

Doom and Myst

Looking at the first decade of new media — the 1990s — one can point at a number of objects which exemplify new media's potential to give rise to genuinely original and historically unprecedented aesthetic forms. Among them, two stand out. Both are computer games. Both were published in the same year, 1993. Each became a phenomenon whose popularity has extended beyond the hard core gaming community, spilling into sequels, books, TV, films, fashion and design. Together, they defined the new field and its limits. These games are Doom (id Software, 1993) and Myst (Cyan, 1993).

In a number of ways, Doom and Myst are completely different. Doom is fast paced; Myst is slow. In Doom the player runs through the corridors trying to complete each level as soon as possible, and then moves to the next one. In Myst, the player is moving through the world literally one step at a time, unraveling the narrative along the way. Doom is populated with numerous demons lurking around every corner, waiting to attack; Myst is completely empty. The world of Doom follows the convention of computer games: it consists of a few dozen levels. Although Myst also contains four separate worlds, each is more like a self-contained universe than a traditional computer game level. While the usual levels are quite similar to each other in structure and the look, the worlds of Myst are distinctly different.

Another difference lies in the aesthetics of navigation. In Doom's world, defined by rectangular volumes, the player is moving in straight lines, abruptly turning at right angles to enter a new corridor. In Myst, the navigation is more free-form. The player, or more precisely, the visitor, is slowly exploring the environment: she may look around for a while, go in circles, return to the same place over and over, as though performing an elaborate dance.

Finally, the two objects exemplify two different types of cultural economy. With Doom, id software pioneered the new economy which the critic of computer games J.C. Herz summarizes as follows: "It was an idea whose time has come. Release a free, stripped-down version through shareware channels, the Internet, and online services. Follow with a spruced-up, registered retail version of the software." 15 million copies of the original Doom game were downloaded around the world.[264] By releasing detailed descriptions of game files formats and a game editor, id software also encouraged the players to expand the game, creating new levels. Thus, hacking and adding to the game became its essential part, with new levels widely available on the Internet for anybody to download. Here was a new cultural economy which transcended the usual relationship between producers and consumers or between “strategies” and “tactics” (de Certeau): the producers define the basic structure of an object, and release few examples and the tools to allow the consumers to build their own versions, shared with other consumers. In contrast, the creators of Myst followed an older model of cultural economy. Thus, Myst is more similar to a traditional artwork than to a piece of software: something to behold and admire, rather than to take apart and modify. To use the terms of the software industry, it is a closed, or proprietary system, something which only the original creators can modify or add to.

Despite all these differences in cosmogony, gameplay, and the underlying economic model, the two games are similar in one key respect. Both are spatial journeys. The navigation though 3D space is an essential, if not the key component, of the gameplay. Doom and Myst present the user with a space to be traversed, to be mapped out by moving through it. Both begin by dropping the player somewhere in this space. Before reaching the end of the game narrative, the player must visit most of it, uncovering its geometry and topology, learning it logic and its secrets. In Doom and Myst — and in a great many other computer games — narrative and time itself are equated with the movement through 3D space, the progression through rooms, levels, or words. In contrast to modern literature, theater, and cinema which are built around the psychological tensions between the characters and the movement in psychological space, these computer games return us to the ancient forms of narrative where the plot is driven by the spatial movement of the main hero, traveling through distant lands to save the princess, to find the treasure, to defeat the Dragon, and so on. As J.C. Herz writes about the experience of playing a classical text-based adventure game Zork, "you gradually unlocked a world in which the story took place, and the receeding edge of this world carried you through to the story's conclusion."[265] Stripping away the representation of inner life, psychology and other modernist nineteenth century inventions, these are the narratives in the original Ancient Greek sense, for, as Michel de Certau reminds us, "In Greek, narration is called 'diagesis': it establishes an itinerary (it 'guides) and it passes through (it 'transgresses").[266]

In the introduction to this chapter I invoked the opposition between narration and dsecription from narratology. As stated by Mieke Bal, the standard theoretical premise of narratology was that “descriptions interrupt the line of fabula.”[267] For me this opposition, in which description was defined negatively, as absence of narration, was always problematic. It automatically privileged certain types of narrative (myths, fairy tales, detective stories, classical Hollywood cinema), while making it difficult to think about other forms where actions of characters do not dominate the narrative (for instance, films by Andrey Tarkovskiy and Hirokazu Kore-eda, the director of Maborosi and After Life).[268] Games structured around first-person navigation through space further challenge narration-description opposition.

Instead of narration and description, we may be better off thinking about games in terms of narrative actions and exploration. Rather than being narrated to, the player herself has to perform actions to move narrative forward: talking to other characters she encounters in the game world, picking up objects, fighting the enemies, and so on. If the player does not do anything, the narrative stops. From this perspective, movement through the game world is one of the main narrative actions. But this movement also serves a self-sufficient goal of exploration. Exploring the game world, examining its details and enjoying its images is as important for the success of games such as Myst and its followers, as progressing through the narrative. Thus while from one point of view game narratives can be aligned with ancient narratives which also were structured around movement through space, from another perspective they are the exact opposite. The movement through space allows the player to progress through the narrative; but it is also valuable in itself. It is a way for the player to explore the environment.

Narratology's analysis of description can be a useful start in thinking about exploration of space in computer game and other new media objects. Bal states that descriptive passages in fiction are motivated by speaking, looking and acting. Motivation by looking works as follows: "A character sees an object. The description of reproduction of what it sees." Motivation by acting means that "The actor carries out an action with an object. The description is then made fully narrative. The example of this is the scene in Zola's La Bête in which Jacques polishes [strokes] every individual component of his beloved locomotive."[269]

In contrast to modern novel, action oriented games do not have that much dialog, but looking and acting are indeed the key activities performed by a player. And if in modern fiction looking and acting are usually separate activities, in games they more often than note occur together. As the player comes across a door leading to another level, a new passage, ammunition for his machine gun, an enemy, or a "health potion" he immediately acts on these objects: opens a door, picks up ammunition or "health potion," fires at the enemy. Thus narrative action and exploration are closely linked together.

The central role of navigation through space, both as a tool of narration and of exploration, is acknowledged by the games' designers themselves. Robyn Miller, one of the two co-designers of Myst pointed out that "We' are creating environments to just wonder around inside of. People have been calling it a game for lack of anything better, and we've called it a game at times. But that's not what it really is; it's a world."[270] Richard Garriott, the designer of classical RPG Ultima series, contrasts game design and fiction writing: "A lot of them [fiction writers] develop their individual characters in detail, and they say what is their problem in the beginning, and what they are going to grow to learn in the end. That's not the method I've used... I have the world. I have the message. And then the characters are there to support the world and the message."[271]

Structuring the game as a navigation through space is common to games across all the game genres. This includes adventure games (for instance, Zork, 7th Level, The Journeyman Project, Tomb Raider, Myst), strategy games (Command and Conquer) role-playing games (Diablo, Final Fantasy), flying, driving, and other simulators (Microsoft Flight Simulator), action games (Hexen, Mario), and, of course, first person shooters which have followed in Doom's steps (Quake, Unreal). These genres follow different conventions. In adventure games, the user is exploring an universe, gathering resources. In strategy games, the user is engaged in allocating and moving resources and in risk management. In RPGs (role playing games), the user is building a character, acquiring the skills; the narrative is one of self-improvement. The genre conventions by themselves do not make it necessary for these games to employ a navigable space interface. Therefore, the fact that they all consistently do use it suggests to me that navigable space represents a larger cultural form. In other words, it is something which transcends computer games, and in fact, as we will see later, computer culture as well. Just like a database, navigable space is a form which already exists before computers; however, the computer becomes its perfect medium.

Indeed, the use of navigable space is common to all areas of new media. During the 1980s, numerous 3D computer animations were organized around a single, uninterrupted camera move through a complex and extensive set. In a typical animation, a camera would fly over mountain terrain, or move through a series of rooms, or maneuver past geometric shapes. In contrast to both ancient myths and computer games, this journey had no goal, no purpose. In short, there was no narrative. Here was the ultimate "road movie" where the navigation through the space was sufficient in itself.

In the 1990s, these 3D fly-throughs have come to constitute the new genre of post-computer cinema and location-based entertainment — the motion simulator.[272] By using the first person point of view and by synchronizing the movement of the platform housing the audience with the movement of a virtual camera, motion simulators recreate the experience of traveling in a vehicle. Thinking about the historical precedents of a motion simulator, we begin to uncover some places where the form of navigable space already manifested itself. They include *Hale's Tours and Scenes of the World*, a popular film-based attraction which debuted at the St. Louis Fare in 1904; roller-coaster rides; flight, vehicle and military simulators, which used a moving base since the early 1930s; and the fly-through sequences in *2001: A Space Odyssey* (Kubrick, 1968) and *Star Wars* (Lucas, 1977). Among these, *A Space Odyssey* plays particularly important role; Douglas Trumbull, who since the late 1980s produced some of the most well-known motion simulator attractions and was the key person behind the rise of the whole motion simulator phenomenon begun his career by creating ride sequences for this film.

Along with providing a key foundation for new media aesthetics, navigable space also became a new tool of labor. It is now a common way to visualize and work with any data. From scientific visualization to walk-throughs of architectural designs, from models of a stock market performance to statistical datasets, the 3D virtual space combined with a camera model is the accepted way to visualize all information (see the section "The Language of Cultural Interfaces"). It is as accepted in computer culture as charts and graphs were in a print culture.[273]

Since navigable space can be used to represent both physical spaces and abstract information spaces, it is only logical that it also emerged as an important paradigm in human-computer interfaces. Indeed, on one level HCI can be seen as a particular case of data visualization, the data being computer files rather than molecules, architectural models or stock market figures. The examples of 3D navigable space interfaces are the Information Visualizer (Xerox Parc) which replaces a flat desktop with 3D rooms and planes rendered in perspective;[274] T_Vision (ART+COM) which uses a navigable 3D representation of the earth as its interface;[275] and The Information Landscape (Silicon Graphics) in which the user flies over a plane populated by data objects.[276]

The original (i.e. the 1980's) vision of cyberspace called for a 3D space of information to be traversed by a human user, or, to use the term of William Gibson, a "data cowboy."[277] Even before Gibson's fictional descriptions of cyberspace were published, cyberspace was visualized in the film *Tron* (Disney, 1982). Although *Tron* takes place inside a single computer rather than a network, its vision of users zapping through the immaterial space defined by lines of light is remarkably similar to the one articulated by Gibson in his novels. In an article which appeared in the 1991 anthology <u>Cyberspace: First Steps</u> Marcos Novak still defined cyberspace as "a completely spatialized visualization of all information in global information processing systems."[278] In the first part of the 1990s, this vision has survived among the original designers of VRML (The Virtual Reality Modeling Language). In designing the language, they aimed to "create a unified conceptualization of space spanning the entire Internet, a spatial equivalent of WWW."[279] They saw VRML as a natural stage in the evolution of the Net from an abstract data network toward a "'perceptualized' Internet where the data has been sensualized," i.e., represented in three dimensions.[280]

The term cyberspace itself is derived from another term— cybernetics. In his 1947 book <u>Cybernetics</u> mathematician Norbert Wiener has defined it as "the science of control and communications in the animal and machine." Wiener conceived of cybernetics during World War II when he was working on problems concerning gunfire control and automatic missile guidance. He derived the term cybernetics from the ancient Greek word *kybernetikos* which refers to the art of the steersman and can be translated as “good at steering.” Thus, the idea of navigable space lies at the very origins of computer era. The steersman navigating the ship and the missile traversing space on its way to the target have given rise to a whole number of new figures: the heroes of William Gibson, the “data cowboys” moving through the vast terrains of cyberspace; the "driver" of a motion simulator; a computer user, navigating through the scientific data sets and computer data structures, molecules and genes, earth's atmosphere and the human body; and last but not least, the player of Doom, Myst and their endless imitations.

From one point of view, navigable space can be legitimately seen as a particular kind of an interface to a database, and thus something which does not deserve a special focus. I would like, however, to also think of it as a cultural form of its own, not only because of its prominence across the new media landscape and, as we will see later, its persistence in new media history, but also because, more so than a database, it is a new form which may be unique to new media. Of course both the organization of space and its use to represent or visualize something else have always been a fundamental part of human culture. Architecture and ancient mnemonics, city planing and diagramming, geometry and topology are just some of the disciples and techniques which were developed to harness space's symbolic and economic capital.[281] Spatial constructions in new media draw on all these existing traditions — but they are also fundamentally different in one key respect. For the first time, space becomes a media type. Just as other media types — audio, video, stills, and text — it can be now instantly transmitted, stored and retrieved, compressed, reformatted, streamed, filtered, computed, programmed and interacted with. In other words, all operations which are possible with media as a result of its conversion to computer data can also now apply to representations of 3D space.

Recent cultural theory has paid increasing attention to the category of space. The examples are Henri Lefebvre's work on the politics and anthropology of everyday space; Michel Foucault's analysis of the Panopticon's topology as a model of modern subjectivity; the writings of Frederick Jameson and David Harvey on the post-modern space of global capitalism; Edward Soja’s work on political geography.[282] At the same time, new media theoreticians and practitioners have come with many formulations of how cyberspace should be structured and how computer-based spatial representations can be used in new ways.[283] What received little attention, however, both in cultural theory and in new media theory, is a particular category of navigation through space. And yet, this category characterizes new media as it actually exists; in other words, new media spaces are always spaces of navigation. At the same time, as we will see later in this section, this category also fits a number of developments in other cultural fields such as anthropology and architecture.

To summarize, along with a database, navigable space is another key form of new media. It is already an accepted way for interacting with any type of data; an interface of computer games and motion simulators and, potentially, of any computer in general. Why does computer culture spatialize all representations and experiences (the library is replaced by cyberspace; narrative is equated with traveling through space; all kinds of data are rendered in three dimensions through computer visualization)? Shall we try to oppose this spatialization (i.e., what about time in new media?) And, finally, what are the aesthetics of navigation through virtual space?

Computer Space

The very first coin-op arcade game was called Computer Space. The game simulated the dogfight between a spaceship and a flying saucer. Released in 1971, it was a remake of the first computer game Spacewar programmed on PDP-1 at MIT in 1962.[284] Both of these legendary games included the word space in their titles; and appropriately, space was one of the main characters in each of them. In the original Spacewar the player was navigating two spaceships around the screen while shooting torpedoes at one another. The player also had to be careful in maneuvering the ships to make sure they would not get too close to the star in the center of the screen which pulled them towards it. Thus, along with the spaceships, the player also had to interact with space itself. And although, in contrast to such films as *2001*, *Star Wars,* or *Tron*, the space of Spacewar and Computer Space was not navigable — one could not move through it — the simulation of gravity made it truly an active presence. Just as the player had to engage with the spaceships, he had to engage with the space itself.

This active treatment of space is an exception rather than the rule in new media. Although new media objects favor the use of space for representations of all kinds, most often virtual spaces are not true spaces but collections of separate objects. Or, to put this in a slogan: there is no space in cyberspace.

To explore this thesis further we can borrow the categories developed by art historians early in this century. Alois Riegl, Heinrich Wölfflin, and Erwin Panofsky, the founders of modern art history, defined their field as the history of the representation of space. Working within the paradigm of cyclic cultural development, they related the representation of space in art to the spirit of entire epochs, civilizations, and races. In his 1901 Die Spätrömische Kunstindustrie ("The late-Roman art industry"), Riegl characterized mankind's cultural development as the oscillation between two ways of understanding space, which he called haptic and optic. Haptic perception isolates the object in the field as a discrete entity, while optic perception unifies objects in a spatial continuum. Riegl's contemporary, Heinrich Wölfflin, similarly proposed that the temperament of a period or a nation expresses itself in a particular mode of seeing and representing space. Wölfflin's Principles of Art History (1913) plotted the differences between Renaissance and baroque styles along five axes: linear/painterly; plane/recession; closed form/open form; multiplicity/unity; and clearness/unclearness.[285] Erwin Panofsky, another founder of modern art history, contrasted the "aggregate" space of the Greeks with the "systematic" space of the Italian Renaissance in his famous essay Perspective as Symbolic Form (1924-25).[286] Panofsky established a parallel between the history of spatial representation and the evolution of abstract thought. The former moves from the space of individual objects in antiquity, to the representation of space as continuous and systematic in modernity. Correspondingly, the evolution of abstract thought progresses from ancient philosophy's view of the physical universe as discontinuous and "aggregate", to the post-Renaissance understanding of space as infinite, homogeneous, isotropic, and with ontological primacy in relation to objects — in short, as systematic.

We don't have to believe in grand evolutionary schemes in order to usefully retain such categories. What kind of space is virtual space? At first glance the technology of 3D computer graphics exemplifies Panofsky's concept of systematic space, which exists prior to the objects in it. Indeed, the Cartesian coordinate system is built into computer graphics software and often into the hardware itself.[287] A designer launching a modeling program is typically presented with an empty space defined by a perspectival grid; the space will be gradually filled by the objects created. If the built-in message of a music synthesizer is a sine wave, the built-in world of computer graphics is an empty Renaissance space: the coordinate system itself.

Yet computer-generated worlds are actually much more haptic and aggregate than optic and systematic. The most commonly used computer-graphics technique of creating 3D worlds is polygonal modeling. The virtual world created with this technique is a vacuum containing separate objects defined by rigid boundaries. What is missing from computer space is space in the sense of medium: the environment in which objects are embedded and the effect of these objects on each other. This is what Russian writers and artists call prostranstvennaya sreda. Pavel Florensky, a legendary Russian philosopher and art historian has described it in the following way in the early 1920s: "The space-medium is objects mapped onto space... We have seen the inseparability of Things and space, and the impossibility of representing Things and space by themselves."[288] This understanding of space also characterizes a particular tradition of modern painting which stretches from Seurat to Giacommetti and De Kooning. These painters tried to eliminate the notions of a distinct object and an empty space as such. Instead they depicted a dense field that occasionally hardens into something which we can read as an object. Following the example of Gilles

Deleuze's analysis of cinema as activity of articulating new concepts, akin to philosophy,[289] it can be said that modern painters which belong to this tradition worked to articulate the particular philosophical concept in their painting — that of space-medium. This concept is something mainstream computer graphics still has to discover.

Another basic technique used in creating virtual worlds also leads to aggregate space. It involves superimposing animated characters, still images, digital movies, and other elements over a separate background. Traditionally this technique was used in video and computer games. Responding to the limitations of the available computers, the designers of early games would limit animation to a small part of a screen. 2D animated objects and characters called sprites were drawn over a static background. For example, in Space Invaders the abstract shapes representing the invaders would fly over a blank background, while in Pong the tiny character moved across the picture of a maze. The sprites were essentially animated 2D cutouts thrown over the background image at game time, so no real interaction between them and the background took place. In the second half of the 1990s much faster processors and 3D graphics cards made it possible for games to switch to real-time 3D rendering. This allowed for modeling of visual interactions between the objects and the space they are in, such as reflections and shadows. Consequently, the game space became more of a coherent, true 3D space, rather than a set of 2D planes unrelated to each other. However, the limitations of earlier decades returned in another area of new media — online virtual worlds. Because of the limited bandwidth of the 1990s Internet, virtual world designers have to deal with constraints similar to and sometimes even more severe than the games designers two decades earlier. In online virtual worlds, a typical scenario may involve an avatar — a 2D or 3D graphic representing the user — animated in real time in response to the user's commands. The avatar is superimposed on a picture of a room, in the same way as in video games the sprites were superimposed over the background. The avatar is controlled by the user; the picture of the room is provided by a virtual-world operator. Because the elements come from different sources and are put together in real time, the result is a series of 2D planes rather than a real 3D environment. Although the image depicts characters in a 3D space, it is an illusion since the background and the characters do not "know" about each other, and no interaction between them is possible.

Historically, we can connect the technique of superimposing animated sprites over the background to traditional cell animation. In order to save labor, animators similarly divide the image between a static background and animated characters. In fact the sprites of computer games can be thought of as reincarnated animation characters. Yet the use of this technique did not prevent Fleischer and Disney animators from thinking of space as space-medium (to use Floresky's term), although they created this space-medium in a different way than the modern painters. (Thus while the masses run away from the serious and "difficult" abstract art to enjoy the funny and figurative images of cartoons, what they saw was not that different from Giacommetti's and De Kooning's canvases.) Although all objects in cartoons have hard edges, the total anthropomorphism of the cartoon universe breaks the distinctions both between subjects and objects and objects and space. Everything is subjected to the same laws of stretch and squash, everything moves and twists in the same way, everything is alive to the same extent. It is as though everything — the character's body, chairs, walls, plates, food, cars and so on — is made from the same bio-material. This monism of the cartoon worlds stands in opposition to the binary ontology of computer worlds in which the space and the sprites — characters appear to be made from two fundamentally different substances.

In summary, although 3D computer-generated virtual worlds are usually rendered in linear perspective, they are really collections of separate objects, unrelated to each other. In view of this, the common argument that 3D computer simulations return us to Renaissance perspective and therefore, from the viewpoint of twentieth-century abstraction, should be considered regressive, turns out to be ungrounded. If we are to apply the evolutionary paradigm of Panofsky to the history of virtual computer space, we must conclude that it has not reached its Renaissance stage yet. It is still at the level of ancient Greece, which could not conceive of space as a totality.

Computer space is also aggregate yet in another sense. As I already noted using the example of Doom, traditionally the world of a computer game is not a continuous space but a set of discrete levels. In addition, each level is also discrete — it is a sum of rooms, corridors, and arenas built by the designers. Thus, rather conceiving space as a totality, one is dealing with a set of separate places. The convention of levels is remarkably stable, persisting across genres and numerous computer platforms.

If the World Wide Web and original VRML are any indications, we are not moving any closer toward systematic space; instead, we are embracing aggregate space as a new norm, both metaphorically and literally. The space of the Web in principle can't be thought of as a coherent totality: it is a collection of numerous files, hyperlinked but without any overall perspective to unite them. The same holds for actual 3D spaces on the Internet. A 3D scene as defined by a VRML file is a list of separate objects that may exist anywhere on the Internet, each created by a different person or a different program. A user can easily add or delete objects without taking into account the overall structure of the scene.[290] Just as, in the case of a database, the narrative is replaced by a list of items, here a coherent 3D scene becomes a list of separate objects.

With its metaphors of navigation and home steading, The Web has been compared to the American Wild West. The spatialized Web envisioned by VRML (itself a product of California) reflects the treatment of space in American culture generally, in its lack of attention to any zone not functionally used. The marginal areas that exist between privately owned houses, businesses and parks are left to decay. The VRML universe, as defined by software standards and the default settings of software tools, pushes this tendency to the limit: it does not contain space as such but only objects that belong to different individuals. Obviously, the users can modify the default settings and use the tools to create the opposite of what the default values suggest. In fact, the actual muti-user spaces built on the Web can be seen precisely as the reaction against the anti-communal and discrete nature of American society, the attempt to substitute for the much discussed disappearance of traditional community by creating virtual ones. (Of course, if we are to follow the nineteenth century sociologist Ferdinand Tönnies, the shift from traditional close-knit scale community to modern impersonal society already took place in the nineteenth century and is an inevitable side-effect as well as a prerequisite for modernization.[291]) However, it is important that the ontology of virtual space as defined by software itself is fundamentally aggregate, a set of objects without a unifying point of view.

If art historians, literary and film scholars have traditionally analyzed the structure of cultural objects as reflecting larger cultural patterns (for instance, Panofsky's reading of perspective), in the case of new media we should look not only at the finished objects but first of all at the software tools, their organization and default settings.[292] This is particularly important because in new media the relation between the production tools and the products is one of continuity; in fact, it is often hard to establish the boundary between them. Thus, we may connect the American ideology of democracy with its paranoid fear of hierarchy and centralized control with the flat structure of the Web, where every page exists on the same level of importance as any other and where any two sources connected through hyperlinking have equal weight. Similarly, in the case of virtual 3D spaces on the Web, the lack of a unifying perspective in U.S. culture, whether in the space of an American city, or in the space of an increasingly fragmented public discourse, can be correlated with the design of VRML, which substitutes a collection of objects for a unified space.

The Poetics of Navigation

In order to analyze the computer representations of 3D space, I have used theories from early art history; but it would not be hard to find other theories which can work as well. However, navigation through space is a different matter. While art history, geography, anthropology, sociology and other disciplines have came up with many approaches to analyze space as a static, objectively existing structure, we don’t have the same wealth of concepts to help us think about the poetics of navigation through space. And yet, if I am right to claim that the key feature of computer space is that it is navigable, we need to be able to address this feature theoretically.

As a way to begin, we may take a look at some of the classical navigable computer spaces. The 1978 project Aspen Movie Map, designed at the MIT Architecture Machine Group, headed by Nicholas Negroponte (which later expanded into MIT Media Laboratory) is acknowledged as the first publicly shown interactive virtual navigable space, and also as the first hypermedia program. The program allowed the user to "drive" through the city of Aspen, Colorado. At each intersection the user was able to select a new direction using a joystick. To construct this program, the MIT team drove through Aspen in a car taking pictures every three meters. The pictures were then stored on a set of videodiscs. Responding to the information from the joystick, the appropriate picture or sequence of pictures was displayed on the screen. Inspired by a mockup of an airport used by the Israeli commandos to train for the Entebbe hostage-freeing raid of 1973,Aspen Movie Map was a simulator and therefore its navigation modeled the real-life experience of moving in a car, with all its limitations.[293] Yet its realism also opened a new set of aesthetic possibilities which, unfortunately, later designers of navigable spaces did not explore further. All of them relied on interactive 3D computer graphics to construct their spaces. In contrast, Aspen Movie Map utilized a set of photographic images; in addition, because the images were taken every three meters, this resulted in an interesting sampling of three dimensional space. Although in the 1990s Apple's QuickTime VR technology made this technique itself quite accessible, the idea of constructing a large-scale virtual space from photographs or a video of a real space was never tried out systematically again, although it opens up unique aesthetic possibilities not available with 3D computer graphics.

Jeffrew Shaw's Legible City (1988-1991), another well-known and influential computer navigable space, is also based on the exiting city.[294] As in Aspen Movie Map, the navigation also simulates a real physical situation, in this case driving a bicycle. Its virtual space, however, is not tied to the simulation of physical reality: it is an imaginary city made from 3D letters. In contrast to most navigable spaces whose parameters are chosen arbitrarily, in Legible City (Amsterdam and Karlsruhe versions) every value of its virtual space is derived from the actual existing physical space it replaces. Each 3D letter in the virtual city corresponds to an actual building in a physical city; the letter's proportions, color and location are derived from the building it replaces. By navigating through the space, the user reads the texts composed by the letters; these texts are drawn from the archive documents describing the city history. Through this mapping Jeffrew Shaw foregrounds, or, more precisely, "stages," one of the fundamental problematics of new media and the computer age as a whole: the relation between the virtual and the real. In his other works Shaw systematically "staged" other key aspects of new media such as the interactive relation between the viewer and the image, or the discrete quality of all computer-based representations. In the case of Legible City, it functions not only as a unique navigable virtual space of its own, but also as a comment on all the other navigable spaces. It suggests that instead of creating virtual spaces which have nothing to do with actual physical spaces, or the spaces which are closely modeled after existing physical structures, such as towns or shopping malls, (this holds for most commercial virtual worlds and VR works), we may take a middle road. In Legible City, the memory of the real city is carefully preserved without succumbing to illusionism; the virtual representation encodes the city's genetic code, its deep structure rather than its surface. Through this mapping Shaw proposes an ethics of the virtual. Shaw suggests that the virtual can at least preserve the memory of the real it replaces, encoding its structure, if not aura, in a new form.

While Legible City was a landmark work in that it presented a symbolic rather than illusionistic space, its visual appearance in many ways reflected the default real-time graphics capability of SGI workstations on which it was running: flat-shaded shapes attenuated by a fog. Char Davies and her development team at SoftImage have consciously addressed the goal of creating a different, more painterly aesthetic for the navigable space in their interactive VR installation Osmose (1994-1995).[295] From the point of view of history of modern art the result hardly represented an advancement. Osmose simply replaced the usual hard-edge polygonal Cézanne-like look of 3D computer graphics look with a softer, more atmospheric, Renoir or late Monet-like environment made of translucent textures and flowing particles. Yet in the context of other 3D virtual worlds it was an important advance. The "soft" aesthetic of Osmose is further supported through the use of slow cinematic dissolves between its dozen or so worlds. Like in Aspen Movie Map and in Legible City, the navigation in Osmose is modeled on a real-life experience, in this case, of scuba diving. The "immersant" is controlling navigation by breathing: breathing in sends the body upward, while breathing out makes it fall. The resulting experience, according to the designers, is one of floating, rather than flying or driving, typical of virtual worlds. Another important aspect of Osmose's navigation is its collective character. While only one person can be "immersed" at a time, the audience can witness her or his journey through the virtual worlds as it unfolds on a large projection screen. At the same size, another translucent screen enables the audience to observe the body gestures of the "immersant" as a shadow-silhouette. The "immersant" thus becomes a kind of ship captain, taking the audience along on a journey; like the captain, she occupies a visible and symbolically marked position, being responsible for the audience's aesthetic experience.

Tamás Waliczky's The Forest (1993) liberated the virtual camera from its typical enslavement to the simulation of humanly possible navigation, be it walking, driving a car, pedaling a bicycle or scuba diving. In The Forest the camera slides through the endless black and white forest in a series of complex and melancholic moves. If modern visual culture exemplified by MTV can be thought of as a Mannerist stage of cinema, its perfected techniques of cinematography, mise-en-scene and editing self-consciously displayed and paraded for its own sake, Waliczky's film presents an alternative response to cinema's classical age, which is now behind us. In this meta-film, the camera, part of cinema's apparatus, becomes the main character (in this we may connect The Forest to another meta-film, A Man with a Movie Camera). On first glance, the logic of camera movements can be identified as the quest of a human being trying to escape from the forest (which, in reality, is just a single picture of a tree repeated over and over). Yet, just as in some of the Brothers Quay animated films such as The Street of Crocodiles, the virtual camera of The Forest neither simulates natural perception nor does it follow the standard grammar of cinema's camera; instead, it establishes a distinct system of its own. In The Street of Crocodiles the camera suddenly takes off, rapidly moving in a straight line parallel to an image plane, as though mounted on some robotic arm, and just as suddenly stops to frame a new corner of the space. The logic of these movements is clearly non-human; this is the vision of some alieean creature. In contrast, in The Forest the camera never stops at all, the whole film being one uninterrupted camera trajectory. The camera system of The Forest can be read as a comment on a fundamentally ambiguous nature of computer space. On the one hand, not indexically tied up to physical reality or human body, computer space is isotropic. In contrast to human space, in which the verticality of the body and the direction of the horizon are two dominant directions, computer space does not privilege any particular axis. In this way it is similar to the space of El Lissitzky's Prouns and Kazimir Malevich's suprematist compositions — an abstract cosmos, unencumbered by either Earth's gravity or the weight of a human body. (Thus the game Spacewar with its simulated gravity got it wrong!) William Gibson's term "matrix' which he used in his novels to refer to cyberspace, captures well this isotropic quality. But, on the other hand, computer space is also a space of a human dweller, something which is used and traversed by a user, who brings her own anthropological framework of horizontality and verticality. The camera system of The Forest foregrounds this double character of computer space. While no human figures or avatars appear in the film and we never get to see either the ground or the sky, it is centered around the stand-in for the human subject — a tree. The constant movements of the camera along the vertical dimension throughout the film — sometimes getting closer to where we imagine the ground plane is located, sometimes moving towards (but again, never actually showing) the sky — can be interpreted as an attempt to negotiate between isotropic space and the space of human anthropology, with its horizontality of the ground plane and the horizontal and vertical dimension of human bodies. The navigable space of The Forest thus mediates between human subjectivity and the very different and ultimately alien logic of a computer — the ultimate and omnipresent Other of our age.

While the works discussed so far all created virtual navigable spaces, George's Legrady interactive computer installation Transitional Spaces (1999) moves back from virtual into physical. Legrady locates already existing architectural navigable space (Siemens headquarters building in Munich) and makes it into an "engine" which triggers three cinematic projections. As regular office stuff and vistors move through the main entrance section and second level exit/entrance passage ways, their motions are picked up cameras and are used to control the projections. Legrady writes in his installation proposal:

> As the speed, location, timing, and number of individuals in the space control the sequence and timing of pojection sequences, the audience will have the opportunity to "play" the system, that is, engage consciously by interacting with the camera sensing to conrol the narrative flow of the installation.
>
> All three projections will comment on the notion of "transitional space" and narrative development. Images sequences will represent transitional states: from noise covered to clear, from empty to full, from open to close, from dark to light, from out of focus to in-focus.[296]

Legrady's installtion begins to explore one element in the "vocabulary" of navigable space "althabet": transition from one state to another. (Other potential elements, or rather dimensions, include the character of a trajectory; the pattern of user's movement — for instance, rapid geometric momevement in Doom versus wondering in Myst — the possible interactions between user and the space, such as the character acting as a center of perspective in Waliczky's The Garden (1992); and, of course, the architecture of space itself). While the definition of narrative by Mieke Bal which I invoked earlier may be too restrictive in relation to new media, Legrady quotes another, much broader defintion by literary theorist Tzvetan Todorov. According to him minimal narrative involves the passage from "one equilibium to another" (or, in diffirent words, from one state to another.) Legrady's installation suggests that we can think of subject's movement from one "stable" point in space to another (for insance, moving from an lobby to a building to an office) like a narrative; by analogy, we may also think of a transition from on state of a new media object to another (for instance, from a noisy image to a noise-free image) as a minimal narrative. For me, the second equisation is more problematic than the first, because, in contrast to literara narrative, it is hard to say what constitues a "state of equilibrium" in a typical new media object. Neththeless, rather than concluding that in Legrady's installation does not really create narratives, we should recognize it instead is an important example of a whole trend among new media artists: to explore the minimal condition of a narrative. In the later section “New Temporality: Loop as a Narrative Engine” I will discuss these investigations in relation to another new media convention: the loop.

The computer spaces just discussed, from Aspen Movie Map to Forest, each establish a distinct aesthetic of their own. However, the majority of navigable virtual spaces mimic existing physical reality without proposing any coherent aesthetic programs. What artistic and theoretical traditions can the designers of navigable spaces draw upon to make them more interesting? One obvious candidate is modern architecture. From Melnikov, Le Corbusier and Frank Lloyd Wright to Arhigram and Bernard Tschumi, modern architects elaborated a variety of schemes for structuring and conceptualizing space to be navigated by users. Using a few examples from these architects, we can look at the 1925 USSR Pavilion (Melnikov,), Villa Savoye (Le Corbusier), Walking City (Arhigram), and Parc de la Villette (Tschumi).[297] Even more relevant is the tradition of "paper architecture" — the designs which were not intended to be built and whose authors therefore felt unencumbered by the limitations of materials, gravity and budgets.[298] Another highly relevant tradition is film architecture.[299] As discussed in the "Theory of Cultural Interfaces" section, the standard interface to computer space is the virtual camera modeled after a film camera, rather than a simulation of unaided human sight. After all, film architecture is The architecture designed for navigation and exploration by a film camera.

Along with different architectural traditions, designers of navigable spaces can find a wealth of relevant ideas in modern art. They may consider, for instance, the works of modern artists which exist between art and architecture and which, like projects of paper architects, display spatial imagination not tied up to the questions of utility and economy: warped worlds of Jean Dubuffet, mobiles by Alexander Calder, earth works by Robert Smithson, moving text spaces by Jenny Holzer. While many modern artists felt compelled to create 3D structures in real spaces, others were satisfied with painting their virtual worlds: think, for, instance, of melancholic cityscapes by Giorgio de Chirico, biomorphic worlds by Yves Tanguy, economical wireframe structures by Alberto Giacometti, existential landscapes by Anselm Kiefer. Besides providing us with many examples of imaginative spaces, both abstract and figurative, modern painting is relevant to the design of virtual navigable spaces in two additional ways. First, since new media is most often experienced, like painting, via a rectangular frame (see “The Screen and the User”), virtual architects can study how painters organized their spaces within the constraints of a rectangle. Second, modern painters who belong to what I call the “space-medium” tradition elaborated the concept of space as a homogeneous dense field, where everything is made from the same “stuff” — in contrast to architects which always have to work with a basic dichotomy between the build structure and the empty space. And although virtual spaces realized until now, with the possible exception of Osmose, follow the same dichotomy between rigid objects and a void between them, on the level of material organization they are intrinsically related to the monistic ontology of modern painters such as Matta, Giacometti, or Pollock, for everything in them is also made from the same material — pixels, on the level of surface; polygons or voxels, on the level of 3D representation). Thus virtual computer space is structurally closer to modern painting than to architecture.

Along with painting, a genre of modern art which has a particular relevance to the design of navigable virtual spaces is installation. Seen in the context of new media, many installations can be thought of as dense multimedia information spaces. They combine images, video, texts, graphics and 3D elements within a spatial layout. While most installations leave it up to the viewer to determine the order of "information access" to their elements, one of the most well-known installation artists, Ilya Kabakov, elaborated a system of strategies to structure the viewer's navigation through his spaces.[300] According to Kabakov, in most installations "the viewer is completely free because the space surrounding her and the installation remain completely indifferent to the installation it encloses."[301] In contrast, by creating a separate enclosed space with carefully chosen proportions, colors and lighting within the larger space of a museum or a gallery, Kabakov aims to completely "immerse" the viewer inside his installation. He calls this installation type a "total installation."

For Kabakov, "total" installation has a double identity. On the one hand, it belongs to plastic arts designed to be viewed by an immobile spectator — painting, sculpture, architecture. On the other hand, it also belongs to time-based arts such as theater and cinema. We can say the same about virtual navigable spaces. Another concept of Kabakov's theory which is directly applicable to virtual space design is his distinction between the spatial structure of an installation and its dramaturgy, i.e. the time-space structure created by the movement of a viewer through an installation.[302] Kabakov's strategies of dramaturgy include dividing the total space of an installation into two or more connected spaces; creating a well-defined path through the space which does not preclude the viewer from wandering on her own, yet prevents her from feeling being lost and being bored. To make such a path, Kabakov constructs corridors and abrupt openings between objects, he also places objects in strange places to obstruct passage where one expects to discover a clear pathway. Another strategy of "total installation" is the choice of particular kinds of narratives which lead themselves to spatialization. These are the narratives which take place around a main event which becomes the center of an installation: "the beginning [of the installation] leads to the main event [of the narrative] while the last part exists after the event took place." Yet another strategy involves the positioning of text within the space of an installation as a way to orchestrate the attention and navigation of the viewer. For instance, placing two to three pages of texts at a particular point in the space creates a rhythmic stop in the navigation rhythm.[303] Finally, Kabakov "directs" the viewer to keep alternating between focusing her attention on particular details and the installation as a whole. He describes these two kinds of spatial attention (which we can also correlate with haptic and optic perception as theorized by Riegl and others) as follows: "wandering, total ("summarnaia") orientation in space — and active, well-aimed 'taking in' of partial, small, the unexpected."[304]

All these strategies can be directly applied to the design of virtual navigable spaces (and interactive multimedia in general). In particular, Kabakov is very successful in making the viewers of his installations carefully read significant amounts of text included in them — something which represents a constant challenge for new media designers. His constant emphasis on always thinking about the viewer's attention and reaction to what she will encounter — "the reaction of the viewer during her movement through the installation is the main concern of her designer… The loss of the viewer's attention is the end of the installation"[305] — is also an important lesson to new media designers who often forgot that what they are designing is not an object in itself but a viewer's experience in time and space.

I have used the word "strategy" to refer to Kabakov's techniques on purpose. To evoke the terminology of The Practice of Everyday Life by French writer Michel de Certeau, Kabakov uses strategies to impose a particular matrix of space, time, experience and meaning on his viewers; they, in their turn, use "tactics" to create their own trajectories (this is a term actually used by de Certeau) within this matrix. If Kabakov is perhaps the most accomplished architect of navigable spaces, de Certeau can very well be their best theoretician. Like Kabakov, he never dealt with computer media directly, and yet his The Practice of Everyday Life has a multitude of ideas directly applicable to new media. His general notion of how a user's "tactics" which create their own trajectories through the spaces defined by others (both metaphorically, and, in the case of spatial tactics, literally) is a good model to think about computer users navigating through computer spaces they did not design:

> Although they are composed with the vocabularies of established languages (those of television, newspapers, supermarkets of established sequences) and although they remain subordinated to prescribed syntactical forms (temporal modes of schedules, paradigmatic orders of spaces, etc.), the trajectories trace out the rules of other interests and desires that are neither determined**,** nor captured by**,** the system in which they develop.[306]

The Navigator and the Explorer

Why is navigable space such a popular construct in new media? What are the historical origins and precedents of this form?

In his famous 1863 essay "The Painter of Modern Life", Charles Baudelaire documented the new modern male urban subject — the flâneur.[307] (Recent history of visual culture, film theory, cultural history and writings on cyberculture has already invoked the figure of the flâneur much too often; my justification for invoking it once again here is that I hope to use it in new ways.) An anonymous observer, the flâneur navigates through the space of a Parisian crowd, recording and immediately erasing the faces and the figures of the passers-by in his memory. From time to time, his gaze meets the gaze of a passing woman, engaging her in a split-second virtual affair, only to be unfaithful to her with the next female passer-by. The flâneur is only truly at home in one place — moving through the crowd. Baudelaire writes: "To the perfect spectator, the impassioned observer, it is an immense joy to make his domicile amongst numbers, amidst fluctuation and movement, amidst the fugitive and infinite… To be away from home, and yet to feel at home; to behold the world, to be in the midst of the world and yet to remain hidden from the world." There is a theory of navigable virtual spaces hidden here, and we can turn to Walter Benjamin to help us in articulating it. According to Benjamin, the flâneur's navigation transforms the space of the city: "The Crowd is the veil through which the familiar city lures the flâneur like a phantasmargonia. In it the city is now a landscape, now a room."[308] The navigable space thus is a subjective space, its architecture responding to the subject's movement and emotion. In the case of the flâneur moving through the physical city, this transformation of course only happens in the flâneur's perception, but in the case of navigation through a virtual space, the space can literally change, becoming a mirror of the user's subjectivity. The virtual spaces built on this principle can be found in such films as Waliczky's <u>The Garden</u> and <u>The Dark City</u> (Alex Proyas, 1998).

Following European tradition, the subjectivity of the flâneur is determined by his interaction with a group — even though it is a group of strangers. In place of a close-knit community of a small-scale traditional society (Gemeinschaft) we now have an anonymous association of a modern society (Gesellshaft).[309] We can interpret the flâneur's behavior as a response to this historical shift. It is as though he is trying to compensate for the loss of a close relationship with his group by inserting himself into the anonymous crowd. He thus exemplifies the historical shift from Gemeinschaft to Gesellshaft, and the fact that he only feels at home in the crowd of strangers shows the psychological price paid for modernization. Still, the subjectivity of the flâneur is, in its essence, intersubjectivity: the exchange of glances between him and the other human beings.

A very different image of a navigation through space — and of subjectivity — is presented in the novels of nineteenth century American writers such as James Fenimore Cooper (1789-1851) or Mark Twain (1835-1910). The main character of Cooper's novels, the wilderness scout Natty Bumppo, alias Leatherstocking, navigates through spaces of nature rather than culture. Similarly, in Twain's Huckleberry Finn, the narrative is organized around the voyage of the two boy heroes down the Mississippi River. Instead of the thickness of the urban human crowd which is the milieu of a Parisian flâneur, the heroes of these American novels are most at home in the wilderness, away from the city. They navigate forests and rivers, overcoming obstacles and fighting enemies. The subjectivity is constructed through the conflicts between the subject and nature, and between the subject and his enemies, rather than through interpersonal relations within a group. This structure finds its ultimate expression in the unique American form, the Western, and its hero, the cowboy — a lonely explorer who only occasionally shows up in town to get a drink at the bar. Rather than providing the home for the cowboy, as it does for the flâneur, the town is a hostile place, full of conflict, which eventually erupts into the inevitable showdown.

Both the flâneur and the explorer find their expression in different subject positions, or phenotypes, of new media users. Media theoretician and activist Geert Lovink describes the figure of the present-day media user and Net surfer whom he calls the Data Dandy. Although Lovink's reference is Oscar Wilde rather than Baudelaire, his Data Dandy exhibits the behaviors which also qualify him to be called a Data Flâneur. "The Net is to the electronic dandy what the metropolitan street was for the historical dandy."[310] A perfect aesthete, the Data Dandy loves to display his private and totally irrelevant collection of data to other Net users. "Wrapped in the finest facts and the most senseless gadgets, the new dandy deregulates the time economy of the info = money managers... if the anonymous crowd in the streets was the audience of the Boulevard dandy, the logged-in Net-users are that of the data dandy."[311] While displaying his dandyism, the data dandy does not want to be above the crowd; like Baudelaire's flâneur, he wants to lose himself in its mass, to be moved by the semantic vectors of mass media icons, themes and trends. As Lovink points out, a data dandy "can only play with the rules of the Net as a non-identity. What is exclusivity in the age of differentiation?...Data dandyism is born of an aversion of being exiled into a subculture of one's own."[312] Although Lovink positions Data Dandy exclusively in data space ("Cologne and pink stockings have been replaced by precious Intel"), the Data Dandy does have a dress code of his own. This look is popular with new media artists of the 1990s: no labels, no distinct design, no bright colors or extravagant shapes — a non-identity which is nevertheless paraded as style and which in fact is carefully constructed (as I learned while shopping in Berlin in

1997 with Russian net.artist Alexei Shulgin.) The designers who exemplify this style in the 1990s are Hugo Boss and Prada, whose restrained no-style style contrasts with the opulence of Versace and Gucci, the stars of the 1980s era of exess. The new style of non-identity perfectly corresponds to the rise of the Net, where endless mailing lists, newsgroups, and sites delude any single topic, image or idea — "On the Net, the only thing which appears as a mass is information itself... Today's new theme is tomorrow's 23 newsgroups."[313]

If the Net surfer, who keeps posting to mailing lists and newsgroups and accumulating endless data, is a reincarnation of Baudelaire's flâneur, the user navigating a virtual space assumes the position of the nineteenth century explorer, a character from Cooper and Twain. This is particularly true for the navigable spaces of computer games. The dominance of spatial exploration in games exemplifies the classical American mythology in which the individual discovers his identity and builds character by moving through space. Correspondingly, in many American novels and short stories (O'Henry, Hemingway) narrative is driven by the character's movements in the outside space. In contrast, in the 19th century European novels there is not much movement in physical space, because the action takes place in a psychological space. From this perspective, most computer games follow the logic of American rather than European narrative. Their heroes are not developed and their psychology is not represented. But, as these heroes move through space, defeating enemies, acquiring resources and, more importantly, skill, they are "building character." This is particularly true for Role Playing Games (RPG) whose narrative is one of self-improvement. But it also holds for other game genres (action, adventure, simulators) which put the user in command of a character (Doom, Mario, Tomb Rider). As the character progresses through the game, the user herself or himself acquires new skills and knowledge. She learns how to outwit the mutants lurking in Doom levels, how to defeat the enemies with just a few kicks in Tomb Rider, how to solve the secrets of the playful world in Mario, and so on.[314]

While movement through space as a means of building character is one theme of American frontier mythology, another is exploring and "culturing" unknown space. This theme is also reflected in computer games' structure. A typical game begins at some point in a large unknown space; in the course of the game, the player has to explore this space, mapping out its geography and unraveling its secrets. In the case of games organized into discrete levels such as Doom, the player has to systematically investigate all the spaces of a given level before he can move to the next level. In other game which takes place over one large territory, the game play gradually involves larger and larger parts of this territory (Adventure, War Craft).

This is one possible theory, one historical trajectory: from flâneur to Net surfer; from nineteenth century American explorer to the explorer of navigable virtual space. Although this section focuses on navigating a space in a literal sense, i.e. moving through a 3D virtual space, this concept is also a key metaphor used to conceptualize new media. From the 1980s concept of cyberspace to the 1990s software such as Netscape Navigator, interacting with computerized data and media has been consistently framed in spatial terms. Computer scientists adopted this metaphor as well: they use the term navigation to refer to different methods of organizing and accessing hypermedia, even though a 3D virtual space interface is not at all the most common method. For instance, in his Elements of Hypermedia Design Peter Gloor lists "seven design concepts for navigation in dataspace": linking, searching, sequentialization, hierarchy, similarity, mapping, guides and agents.[315] Thus, "navigating the Internet" includes following the hyperlinks, using menus commonly provided by Web sites, as well as using search engines. If we accept this spatial metaphor, both the nineteenth century European flâneur and the American explorer find their reincarnation in the figure of the net surfer. We may even correlate these two historical figures with the names of two most popular Web browsers: the flâneur of Baudelaire — Netscape Navigator; an explorer of Cooper, Twain and Hemingway — Internet Explorer. Of course, names apart, these two browsers are functionally quite similar. However, given that they both focus on a single user navigating through the Web sites rather than more communal experiences, such as newsgroups, mailing lists, text-based chat and IRC, we can say that they privilege the explorer rather than the flâneur — single user navigating through an unknown territory rather than a member of a group, even is this group is a crowd of strangers. And although different software solutions have been developed to make Internet navigation more of a social experience — for instance, allowing remote users to simultaneously navigate the same Web site together; or allowing the user to see who already accessed a particular document — an individual navigation through the "history-free" data stilled remained the norm at the end of the 1990s.

Kino-Eye and Simulators

It is also possible to construct a different trajectory which will lead from the Parisian flaneurie to navigable computer spaces. In Window Shopping film historian Anne Friedberg presents an archeology of a mode of perception which, according to her, characterizes modern cinematic, televisual, and cyber cultures and which she calls a "mobilized virtual gaze."[316] This mode combines two conditions: "a received perception mediated through representation" and a travel "in an imaginary flanerie through an imaginary elsewhere and an imaginary elsewhen."[317] According to Friedberg's archeology, this mode emerged when a new nineteenth century technology of virtual representation — photography — merged with the mobilized gaze of tourism, urban shopping and flanerie.[318] As can be seen, Friedberg connects Baudelaire's flâneur with a range of other modern practices: “The same impulses which send flâneurs through the arcades, traversing the pavement and wearing thin their shoe leather, sent shoppers into the department stores, tourists to exhibitions, spectators into the panorama, diaroma, wax museum, and cinema.”[319] The flâneur occupies the privileged position among these practices because he embodied most strongly the desire to combine perception with motion through a space. All that remained in order to arrive at a “mobilized virtual gaze” was to virtualize this perception — something which cinema accomplished in the last decade of the nineteenth century.

While Friederg’s account ends with television and does consider new media, the form of navigable virtual space fits well in her historical trajectory. Navigation through a virtual space, whether in a computer game, a motion simulator, data visualizations or a 3D human-computer interface, follows the logic of a “virtual mobile gaze.” Instead of Parisian streets, shopping windows and the faces of the passers-by, the virtual flâneur travels through virtual streets, highways and planes of data; the eroticism of a split-second virtual affair with a passer-by of the opposite sex is replaced with the excitement of locating and opening a particular file or zooming into the virtual object. Just as the original flâneur of Baudelaire, the virtual flâneur is happiest on the move, clicking from one object to another, traversing room after room, level after level, data volume after data volume.

Thus, just as a database form can be seen as an expression of ‘database complex,’ an irrational desire to preserve and store everything, navigable space is not just a purely functional interface. Ii is also an expression and gratification of psychological desire; a state of being; a subject position — or rather, a subject’s trajectory. If the subject of modern society was looking for refuge from the chaos of the real world in the stability and balance of the static composition of a painting, and later in cinema’s image, the subject of the information society finds peace in the knowledge that she can slide over endless fields of data, locating any morsel of information with the click of a button, zooming through file systems and networks. She is comforted not by the equilibrium of shapes and colors, but by the variety of data manipulation operations at her control.

Does this mean that we have reached the end of the trajectory described by Friederg? While still enjoying a privileged place in computer culture, flanerie now shows its age. Here we can make an analogy with the history of GUI (Graphical User Interface). Developed at Xerox Park in the 1970s and commercialized by Apple in the early 1980s, it was appropriate when a typical user’s hard drive contained dozens or even hundreds of files. But for the next stage of Net-based computing in which the user is accessing millions of files it is no longer sufficient.[320] Bypassing the ability to display and navigate the files graphically, the user resorts to a text-based search engine. Similarly, while a “mobilized virtual gaze,” described by Friederg, was a significant advancement over earlier more static methods of data organization and access (static image, text, catalog, library), in the information age its "bandwidth" is too limited. Moreover, a simple simulation of movement through a physical space defeats a computer's new capabilities of data access and manipulation. Thus, for a virtual flâneur such operations as search, segmentation, hyperlinking and visualization and data mining are more satisfying than just navigating through a simulation of a physical space.

In the 1920s Dziga Vertov already understood this very well. A Man with a Movie Camera is an important point in the trajectory which leads from Baudelaire's flanerie to Aspen Movie Map, Doom and VRML worlds not simply because Vertov's film is structured around the camera's active exploration of city spaces, and not only because it fetishizes the camera's mobility. Vertov wanted to overcome the limits of human vision and human movement through space to arrive at more efficient ways of data access. However, the data he worked with is raw visible reality — not reality digitized and stored in computer's memory as numbers. Similarly, his interface was a film camera, i.e. an anthropomorphic simulation of human vision — not computer algorithms. Thus Vertov stands half-way between Baudelaire's flâneur and computer user: no longer just a pedestrian walking through a street, but not yet Gibson's data cowboy who zooms through pure data armed with data mining algorithms.

In his research on what can be called "kino-eye interface," Vertov systematically tried different ways to overcome what he thought were the limits of human vision. He mounted cameras on the roof of a building and a moving automobile; he slowed and speed up film speed; he superimposed a number of images together in time and space (temporal montage and montage within a shot). A Man with a Movie Camera is not only a database of city life in the 1920s, a database of film techniques, and a database of new operations of visual epistemology, but it is also a database of new interface operations which together aim to go beyond a simple human navigation through a physical space.

Along with A Man with a Movie Camera, another key point in the trajectory, from the navigable space of a nineteenth century city to the virtual navigable computer space, is flight simulators. At the same time when Vertov was working on his film, young American engineer E.A. Link, Jr. developed the first commercial flight simulator. Significantly, Link's patent for his simulator filed in 1930 refers to it as a "Combination Training Device for Student Aviators and Entertainment Apparatus."[321] Thus, rather than being an after-thought, the adaptation of flight simulator technology to consumer entertainment which took place in the 1990s was already envisioned by its inventor. Link's design was a simulation of a pilot's cockpit with all the controls, but, in contrast to a modern simulator, it had no visuals. In short, it was a motion ride without a movie. In the 1960s, visuals were added by using new video technology. A video camera was mounted on a movable arm positioned over a room size model of an airport. The movement of the camera was synchronized with the simulator controls; its image was transmitted to a video monitor in the cockpit. While useful, this approach was limited because it was based on physical reality of an actual model set. As we saw in the "Compositing" section, a filmed and edited image is a better simulation technology than a physical construction; and a virtual image controlled by a computer is better still. Not surprisingly, soon after interactive 3D computer graphics technology was developed, it was applied to produce visuals for the simulators by one of his developers. In 1968, Ivan Sutherland, who already pioneered interactive computer-aided design ("Sketchpad," 1962) and virtual reality (1967), formed a company to produce computer-based simulators. In the 1970s and 1980s simulators were one of the main applications of real-time 3D computer graphics technology, thus determining to a significant degree the way this technology was developed (see "Synthetic Realism as Bricolage.") For instance, simulation of particular landscape features which are typically seen by a pilot, such as flat and mountain terrain, sky with clouds, and fog, all became important research problems.[322] The application of interactive graphics for simulators has also shaped the imagination of researchers regarding how this technology can be used. It naturalized a particular idiom: flying through a simulated spatial environment.

Thus, one of the most common forms of navigation used today in computer culture — flying through spatialized data — can be traced back to the 1970s military simulators. From Baudelaire's flâneur strolling through physical streets we move to Vertov's camera mounted on a moving car and then to the virtual camera of a simulator which represents the viewpoint of a military pilot. Although it was not an exclusive factor, the end of the Cold War played an important role in the extension of this military mode of perception into general culture. Until 1990, such companies as Evans and Sutherland, Boeing and Lockheed were busy developing multi-million simulators. As the military orders dried up, they had to look for consumer applications of their technology. During the 1990s, these and other companies converted their expensive simulators into arcade games, motion rides and other forms of location-based entertainment. By the end of the decade, Evans and Sutherland's list of products included image generators for use in military and aviation simulators; a virtual set technology for use in television production; Cyber Fighter, a system of networked game stations modeled after networked military simulators; and Virtual Glider, an immersive location-based entertainment station.[323] As the military budgets continued to diminish and entertainment budgets soared, entertainment and military often came to share the same technologies and to employ the same visual forms. Probably the most graphic example of the ongoing circular transfer of technology and imagination between the military and the civilian sector in new media is the case of <u>Doom</u>. Originally developed and released over the Internet as a consumer game in 1993 by id software, it was soon picked by the U.S. Marine Corps who customized it into a military simulator for group combat training.[324] Instead of using multi-million dollar simulators, the Army could now train soldiers on a $50 game. The Marines, who were involved in the modifications, then went on to form their own company in order to market the customized Doom as a commercial game.

The discussion of the military origins of navigable space form would be incomplete without acknowledging the pioneering work of Paul Virilio. In his brilliant 1984 book War and Cinema Virilio documented numerous parallels between military and film cultures of the twentieth century, including the use of a mobile camera moving through space in film in military aerial surveillance and cinematography.[325] Virilio went on to suggest that while space was the main category of the nineteenth century, the main category of the twentieth century was time. As already discussed in "Teleaction," for Virilio, telecommunication technology eliminates the category of space altogether as it makes every point on Earth as accessible as any other — at least in theory. This technology also leads to real time politics, which require instant reactions to the events transmitted at the speed of light, and ultimately can only be handled efficiently by computers responding to each other without human intervention. From a post-Cold War perspective, Virilio's theory can be seen as another example of the imagination transfer from the military to civilian sector. In this case, techno-politics of the Cold War nuclear arms equilibrium between the two super powers, which at any moment were able to strike each other at any point on Earth, came to be seen by Virilio as a fundamentally new stage of culture, where real time triumphs over space.

Although Virilio did not write on computer interface, the logic of his books suggests that the ideal computer interface for a culture of real time politics would be the War Room in Dr. Strangelove or: How I Learned to Stop Worrying and Love the Bomb (Stanley Kubrick, 1964) with its direct lines of communication between the generals and the pilots; or DOS command lines with their military economy of command and response, rather than the more spectacular but inefficient VRML worlds. Yet, uneconomical and inefficient as it may be, navigable space interface is thriving across all areas of new media. How can we explain its popularity? Is it simply a result of cultural inertia? A left-over from the nineteenth century? A way to make the ultimately Alien space of a computer compatible with humans by anthropomorphizing it, superimposing a simulation of a Parisian flanerie over abstract data? A relic of Cold War culture?

While all these answers make sense, it would be unsatisfactory to see navigable space as only the end of a historical trajectory, rather than as a new beginning. The few computer spaces discussed here point toward some of the aesthetic possibilities of this form; more possibilities are contained in the works of modern painters, installation artists and architects. Theoretically as well, navigable space represents a new challenge. Rather than only considering topology, geometry and logic of a static space, we need to take into account the new way in which space functions in computer culture: as something traversed by a subject, as a trajectory rather than an area. But computer culture is not the only field where the use of the category of navigable space makes sense. I will now briefly look at two other fields — anthropology and architecture — where we find more examples of "navigable space imagination."

In his book Non-places. Introduction to an Anthropology of Supermodernity French anthropologist Marc Auge advances the hypothesis that "supermodernity produces non-places, meaning spaces which are not themselves anthropological places and which, unlike Baudelairean modernity, do not integrate with earlier places."[326] Place is what anthropologists have studied traditionally; it is characterized by stability, and it supports stable identity, relations and history.[327] Auge's main source for his distinction between place and space, or non-place, is Michel de Certeau: "Space, for him, is a 'frequent place,' 'an intersection of moving bodies': it is the pedestrians who transform a street (geometrically defined as a place by town planners) into a space"; it is an animation of a place by the motion of a moving body.[328] Thus, from one perspective we can understand place as a product of cultural producers, while non-places are created by users; in other words, non-place is an individual trajectory through a place. From another perspective, in supermodernity, traditional places are replaced by equally institutionalized non-places, a new architecture of transit and impermanence: hotel chains and squats, holiday clubs and refugee camps, supermarkets, airports and highways. Non-place becomes the new norm, the new way of existence.

It is interesting that as the subject who exemplifies the condition of supermodernity, Auge picks up the counterpart to the pilot or a user of a flight simulator — an airline passenger. "Alone, but one of many, the user of a non-place has contractual relations with it." This contract relieves the person of his usual determinants. "He becomes no more than what he does or experiences in the role of passenger, customer or driver."[329] Auge concludes that "as anthropological places create the organically social, so non-places create solitary contractuality," something which he sees as the very opposite of a traditional object of sociology: "Try to imagine a Durkheimian analysis of a transit lounge at Roissy!"[330]

Architecture by its very definition stands on the side of order, society and rules; it is thus a counterpart of sociology as it deals with regularities, norms and "strategies" (to use de Certeau's term). Yet the very awareness of these assumptions underlying architecture led many contemporary architects to focus their attention on the activities of users who through their "speech acts" "reappropriate the space organized by the techniques of sociocultural production" (de Certeau).[331] Architects come to accept that the structures they design will be modified by users' activities, and that these modifications represent an essential part of architecture. They also took up the challenge of "a Durkheimian analysis of a transit lounge at Roissy," putting their energy and imagination into design of non-places such as an airport (Kansai International Airport in Osaka by Renzo Piano), a train terminal (Waterloo International Terminal in London by Nicholas Grimshaw) or a highway control station (Steel Cloud or Los Angeles West Coast Gateway by Asymptote Architecture group).[332] Probably the ultimate in non-place architecture has been one million square meter Euralille project which redefined the existing city of Lille, France as the transit zone between the Continent and London. The project attracted some of the most interesting contemporary architects: Rem Koolhaas designed the masterplan while Jean Nouvel built Centre Euralille containing a shopping center, a school, a hotel, and apartments next to the train terminal. Centered around the entrance to the Chunnel, the underground tunnel for cars which connects the Continent and England, and the terminal for the high speed train which travels between Lille, London, Brussels and Paris, Euralille is a space of navigation par excellence; a mega-non-place. Like the network players of Doom, Euralille users emerge from trains and cars to temporarily inhabit a zone defined through their trajectories; an environment "to just wander around inside of" (Robyn Miller); "an intersection of moving bodies" (de Certeau).

EVE and Place

We have come a long way since Spacewar (1962) and Computer Space (1971) — at least, in terms of graphics. The images of these early computer games seem to have more in common with abstract paintings of Malevich and Mondrian than with the photorealistic renderings of Quake (1996) and Unreal (1997). But whether this graphics evolution was also accompanied by a conceptual evolution is another matter. Given the richness of modern concepts of space developed by artists, architects, filmmakers, art historians and anthropologists, our computer spaces have a long way to go.

Often the way to go forward is to go back. As this section suggested, the designers of virtual spaces may find a wealth of relevant ideas by looking at twentieth century art, architecture, film and other arts. Similarly, some of the earliest computer spaces, such as Spacewar and Aspen Movie Map, contained aesthetic possibilities which are still waiting to be explored. As a conclusion, I will discuss two more works by Jeffrey Shaw who draws upon various cultural traditions of space construction and representation probably more systematically more than any other new media artist.

While Friedberg's concept of virtual mobile gaze is useful in allowing us to see the connections between a number of technologies and practices of spatial navigation, such as Panorama, cinema and shopping, it can also make us blind to the important differences between them. In contrast, Shaw's EVE (1993 —) and Place: A User' Manual (1995) emphasize both similarities and differences between various technologies of navigation.[333] In these works, Shaw evokes the navigation methods of Panorama, cinema, video and VR. But rather than collapsing different technologies into one, Shaw "layers" them on side by side. That is, he literally encloses the interface of one technology within the interface of another. For instance, in the case of EVE the visitors find themselves inside a large semi-sphere reminiscent of the 19th century Panorama. The projectors located in the middle of the sphere throw a rectangular image on the inside surface of the semi-sphere. In this way, the interface of cinema (an image enclosed by a rectangular frame) is placed inside the interface of Panorama (a semi-spherical enclosed space). In Place: A User' Manual a different "layering" takes place: Panorama interface is placed inside a typical computer space interface. The user navigates a virtual landscape using first-person perspective characteristic of VR, computer games and navigable computer spaces in general. Inside this landscape are eleven cylinders with photographs mapped on them. Once the user moves inside one of these cylinders, she switches to a mode of perception typical of Panorama tradition.

By placing interfaces of different technologies next to each other within a single work, Shaw foregrounds the unique logic of seeing, spatial access and user's behavior characteristic of each technology. The tradition of the framed image , i.e. a representation which exists within the larger physical space which contains the viewer (painting, cinema, computer screen), meets the tradition of the "total" simulation, or "immersion,' i.e. a simulated space which encloses the viewer (Panorama, VR).

Another historical dichotomy staged for us by Shaw is between the traditions of collective and individualized viewing in screen-based arts. The first tradition spans from magic lantern shows to twentieth century cinema. The second passes from the camera obscura, stereoscope and kinescope to head-mounted displays of VR. Both have their dangers. In the first tradition, individual's subjectivity can be dissolved in a mass-induced response. In the second, subjectivity is being defined through the interaction of isolated subject with an object at the expense of intersubjective dialogue. In the case of viewers' interactions with computer installations, as I already noted when talking about Osmose, something quite new begins to emerge: a combination of individualized and collective spectatorship. The interaction of one viewer with the work (via a joystick, a mouse, or a head mounted sensor) becomes in itself a new text for other viewers, situated within the work's arena, so to speak. This affects the behavior of this viewer who acts as a representative for the desires of others, and who is now oriented both to them and to the work.

EVE rehearses the whole Western history of simulation, functioning as a kind of Plato's cave in reverse: visitors progress from the real world inside the space of simulation where instead of mere shadows they are presented with technologically enhanced (via stereo) images, which look more real than their normal perceptions.[334] At the same time, EVE's enclosed round shape refers us back to the fundamental modern desire to construct a perfect self-sufficient utopia, whether visual (the nineteenth-century panorama) or social. (For instance, after 1917 Russian Revolution architect G.I. Gidoni designed a monument to the Revolution in the form of a semi-transparent globe which could hold several thousand spectators.) Yet, rather than being presented with a simulated world which has nothing to do with the real space of the viewer (as in typical VR), the visitors who enter EVE's enclosed space discover that EVE's apparatus shows the outside reality they just left. Moreover, instead of being fused in a single collective vision (Gesamtkunstwerk, cinema, mass society) the visitors are confronted with a subjective and partial view. The visitors only see what one person wearing a head mounted sensor chooses to show them, i.e. they are literally limited by this person's point of view. In addition, instead of a 360^{o} view they see a small rectangular image — a mere sample of the world outside. The one visitor wearing a sensor, and thus literally acting as an eye for the rest of the audience, occupies many positions at once — a master subject, a visionary who shows the audience what is worth seeing and at the same time just an object, an interface between them and outside reality, i.e., a tool for others; a projector, a light and a reflector all at once.

Having examined the two key forms of new media — database and navigable space — it is tempting to see their privileged role in computer culture as a sign of a larger cultural change. If we use Auge's distinction between modernity and supermodernity, the following scheme can be established:

- modernity — "supermodernity"
- narrative (= hierarchy) — database, hypermedia, network (= flattening of hierarchy)
- space — navigable space (trajectory through space)
- static architecture — "liquid architecture."[335]
- geometry and topology as theoretical models for cultural and social analysis — trajectory, vector, flow as theoretical categories

As can seen from this scheme, the two "supermodern" forms of database and navigable space are complimentary in their effects on the forms of modernity. On the one hand, a narrative is "flattened" into a database. A trajectory through events and/or time becomes a flat space. On the other hand, a flat space of architecture or topology is narrativized, becoming a support for individual users' trajectories.

But this is only one possible scheme. What is, however, clear, is that we have left modernity for something else. We are still searching for names to describe it. Yet the names which we come up with — "supermodernity," "transmodernity," "second modern" – all seems to reflect the sense of the continuity of this new stage with the old. If the 1980s concept of "post-modernism" implied a break with modernity, we now seem to prefer to think of cultural history continuos trajectory through a single conceptual and aesthetic space. Having lived through the twentieth century we learned all too well the human price of "breaking with the past," "building from scratch," "making new" and other similar claims — be it in the case of an aesthetic, moral or a social systems. The claim that new media should be totally new is only one in the long list of such claims.

Such notion of a continuos trajectory is more compatible with human anthropology and phenomenology. Just as a human body moves through physical space in a continuos trajectory, the notion of history as a continuos trajectory is, in my view, preferable to the one which postulates epistemological breaks or paradigms shifts from one era to the next. This notion of Michel Foucault and Thomas Kuhn articulated in the 1960s belong to the aesthetics of modernist montage of Eisenstein and Godard rather than to our own era of the aesthetics of continuity as exemplified by compositing, morphing and navigable spaces.[336]

They also seem to have projected onto a diachronic plane of history the traumatic synchronic division of their time — the split between the Capitalist West and the Communist East. But, with the official (although not necessary actual) collapse of this split in the 1990, we have seen how history reasserted its continuity in powerful and dangerous ways. The comeback of nationalism and religion; the desire to erase everything associated with the Communist regime and to return to the pre-1917 or pre-1945 (in the case of Russia and Eastern Europe, respectively) are only some of the more dramatic signs of this process. The price of radical break with the past is that the historical trajectory suddenly stopped in its development simply keeps accumulating potential energy until one day its reasserts itself with new force, breaking up into the open and crushing whatever new was created while it was stopped.

In this book I have chosen to emphasize the continuities between the new media and the old, the interplay between historical repetition and innovation. I wanted to show how new media appropriates old forms and conventions of different media, in particular cinema. Like a river, cultural history can't suddenly change its course; its movement is that of a spline rather than a set of straight lines between points. In short I wanted to create trajectories through the space of cultural history which would pass through new media thus grounding it in what came back before.

VI. What is Cinema?

It is useful to think about the relations between cinema and new media in terms of two main vectors. The first vector goes from cinema to new media, and it constitutes the backbone of this book. Chapters I — V used history and theory of cinema to map out the logic which drives the technical and stylistic development of new media. I also traced the key role which cinematic language is placing in new media interfaces — both traditional HCI (interface of the operating system and software applications) and what I called “cultural interfaces” — the interfaces between the human user and cultural data.

The second vector goes in the opposite direction: from computers to cinema. How does computerization affects our very concept of a moving images? Does if offer new possibilities for film language? Did it led to the development of totally new forms of cinema? This last chapter is devoted to these questions. In part I already started dealing them in “Compositing” section and in “Illusion” chapter. Since the main part of this chapter focused on the new identity of a still 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 of the summary of how (at the time of writing — 1999) I think about the effects of computerization on cinema proper:

1. Use of computer techniques in traditional filmmaking:
   1.1. 3D computer animation / digital composing. Example: "Titanic" (James Cameron, 1997); “"The City of Lost Children" (Marc Caro and J.P. Jeunet, 1995).
   1.2. Digital painting. Example: "Forest 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 Trumball.
   2.2. “Typographic cinema”: film + graphic design + typography. Examples: 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 5 MG.

2.4. Hypermedia interfaces to a film which allows non-linear access at different scales. Examples: "WaxWeb" (David Blair, 1994-1999); Stephen Mamber's database interface to Hitchock's "Psycho" (Mamber, 1996-).

2.5. Interactive movies and games which are structured around film-like sequences. These sequences can be created using traditional film techniques (example: "Jonny Mnemonic" game) or computer animation (example: "Blade Runner" game). (The pioneer of interactive cinema is experimental filmmaker Graham 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 which may not use traditional film sequences yet follow many other conventions of film language in their structure. From this perspective, the majority of 1990s computer games can be actually considered interactive movies.

2.6. Animated, filmed, simulated or hybrid sequences which 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) opening in Tomb Rider and many other games.

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.[337]

Note that this list does not include such new production technologies as DV (digital video) or 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 growing number of Web sites devoted to distribution of films.[338] Although all these developments will undoubtedly have important effect on the economics of film production and distribution, they do not appear to have a direct effect of film language, which is my main concern here.

My second, and a 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 already noted in Chapter 1, I feel that it is important to pay attention not only to the new properties of a computer image which 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 reflect the typical usage of images, rather some "essential" properties it may have because of its digital status. It is also legitimate to think of some of these qualities as particular consequences of the oppositions which define a concept of representation, summarized in the Introduction:

1. Computer-based image is discrete, since 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. Computer-based image is modular, since it typically consists from a number of layers whose contents often correspond to meaningful parts of the image.
3. Computer-based image consists from 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 the dialog with other cultural objects. In terms of its code, an image exist on the same conceptual plane as other computer objects. (The surface-code pain can be related to signifier — signified, base — superstructure, unconscious — conscious pairs. So, just as a signifier exists in a structure with other signifiers of a language, a "surface" of an image, i.e. its "contents" enters in dialog with all other images in a culture.)
4. Computer-based images are typically compressed using lossy compression techniques, such as JPEG. Therefore, presence of noise (in a 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 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 Carrol's Alice. 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 is 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 learn how to combine these two competing roles of an image.
7. Visually, this conceptual opposition translates into the opposition between a depth and surface, between a window into a fictional universe and a control panel.
8. Along with functioning as image-interfaces, computer images also functions as image-instruments. If image-interface controls a computer, an image-instrument allows the user to remotely affect physical reality in real time. This ability not just to act but to "teleact" distinguishes new computer-based image-instrument from old image-instruments. Additionally, if before image-instruments such as maps were clearly distinguished from illusionistic images, such as paintings (although recall Alpers's argument that classical Dutch painting combines both concepts), 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, directs the user outside of itself towards 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, using a computer program a designer 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 which represented 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 of a film the way Blow-up focuses on zooming into a photograph. From this perspective, it is interesting that fifteen years later Blade Runner still applies “old” cinematic logic in relation to a computer-based image. In a well-known scene the hero uses voice commands to direct a futuristic computer device to pan and zoom into an image. In reality already since the 1950s military used different computer techniques for image analysis to automatically identify objects represented in an image, detect changes in images over time, etc. which relied on databases of images.[339]) Any unique image you may desire probably already exists on the Internet or in some database. As I already noted, today the problem is no longer how to create the right image, but how to find already existing one.

Since a computer-based moving image, just as 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 compared it with other types of modern images commonly used before it — drawing, a map, a painting and most importantly, a still photograph. It would be logical to begin discussion of the computer-based moving image by also relating it to two most common types of moving images it replaces in its turn — the film image and an animated image. The first section, “Digital Cinema and the History of a Moving Image” does precisely this. It asks how the shift to computer-based representation and production processes redefines the identity of a moving image and the relationship between cinema and animation. This section also invokes 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 the examples of some of the new directions for film language — or, more generally, the language of moving images — opened up by computerization. My examples come from different areas where computer-based moving image 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 which will let cinema tell its stories in a new way. Yet as exciting as the ideas of a viewer participating in a story, choosing different paths through the narrative space and interacting with characters may be, they only address one aspect of cinema which is neither unique nor, as many will argue, essential to it: narrative.

The challenge which computer media poses to cinema extends far beyond the issue of narrative. Computer media redefines the very identity of cinema. In a symposium which 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."[340] As these terms accurately suggest, what used to be cinema's defining characteristics have become just the default options, with many others available. When one can "enter" a virtual three-dimensional space, to view flat images projected on the screen is hardly the only option. When, given enough time and money, almost everything can be simulated in a computer, to film physical reality is just one possibility.

This "crisis" of cinema's identity also affects the terms and the 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 'super-genre' ['sur-genre']."[341] In identifying fictional films 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 <u>live action</u> films, i.e. they largely consist of unmodified photographic recordings of real events which took place in real physical space. Today, in the age of photorealistic 3D computer animation and digital compositing, invoking this characteristic becomes crucial in defining the specificity of twentieth century 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 significance than this common feature: that they relied on lens-based recordings of reality. This section is concerned with the effect of computerization on cinema as defined by its "super genre" as fictional live action film.[342]

During cinema's history, a whole repertoire of techniques (lighting, art direction, the use of different film stocks and lens, etc.) was developed to modify the basic record obtained by a film apparatus. And yet behind even the most stylized cinematic images we can discern the bluntness, the sterility, the 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 which 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 lay in its ability to record reality. Once, during a public discussion in Moscow sometime in the 1970s he was asked the question as to 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 in a computer using 3D computer animation; to modify individual frames or whole scenes with the help a digital paint program; to cut, bend, stretch and stitch digitized film images into something which has perfect photographic credibility, although 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 nineteenth century pre-cinematic practices, 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 the 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 sub-genre 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 which are currently replacing traditional film technology. Seen together, these features and metaphors suggest a 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 which already use digital moving images — Hollywood films, music videos, CD-ROM-based games and other stand-alone hypermedia — in order 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 which finally succeeded in creating a convincing illusion of dynamic reality. If we approach cinema in this way (rather than the art of audio-visual narrative, or the art of a projected image, or the art of collective spectatorship, etc.), we can see it superseding previous techniques for creating and displaying moving images.

These earlier techniques shared a number of common characteristics. First, they all relied on hand-painted or hand-drawn images. The magic lantern slides were painted at least until the 1850s; so 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 after the photographs.[343]

Not only were the images created manually, they were also manually animated. In Robertson's Phantasmagoria, which premiered in 1799, magic lantern operators moved behind the screen in order to make projected images appear to advance and withdraw.[344] More often, an exhibitor used only his hands, rather than his whole body, to put the images into motion. One animation technique involved using mechanical slides consisting of a number of layers. An exhibitor would slide the layers to animate the image.[345] Another technique was to slowly move a long slide containing separate images 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 their automatic projection were finally combined. A mechanical eye became coupled with a mechanical heart; photography met the motor. As a result, cinema — a very particular regime of the visible — was born. Irregularity, non-uniformity, the accident and other traces of the human body, which previously inevitably accompanied moving image exhibitions, were replaced by the uniformity of machine vision.[346] A machine, which like a conveyer belt, was now spitting out images, all sharing the same appearance, all 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).[347] 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 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 which could animate more than just a few images became increasingly popular. All of them — the Zootrope, the Phonoscope, the Tachyscope, the Kinetoscope — were based on loops, sequences of images featuring complete actions which can be played repeatedly. The Thaumatrope (1825), in which a disk with two different images painted on each face was rapidly rotated by twirling a strings attached to it, was in its 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.[348] 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.[349] Even Edison's Kinetoscope (1892-1896), the first modern cinematic machine to employ film, continued to arrange images in a loop.[350] 50 feet of film translated to an approximately 20 second long 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 which characterized moving pictures before the twentieth century — the manual construction of images, loop actions, the discrete nature of space and movement — all of this was delegated to cinema's bastard relative, its supplement, its 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 which we see could have been constructed rather than recorded. It denies that the reality it shows often does not exist outside of the film image, the image which was arrived at by photographing an already impossible space, itself put together with the use of models, mirrors, and matte paintings, and which was then combined with other images through optical printing. It pretends to be a simple recording of an already existing reality — both to a viewer and to itself.[351] 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.[352] Rear projection and blue screen photography, matte paintings and glass shots, mirrors and miniatures, push development, optical effects and other techniques which allowed filmmakers to construct and alter the 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.[353]

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 which computer generated special effects have come to play in Hollywood industry in the 1990s. Many blockbusters have been driven by special effects; feeding on their popularity. Hollywood has even created a new-mini genre of "The Making of..." videos and books which reveal how special effects are created.

I will use special effects from 1990s Hollywood films for 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 which are equally valid for individual or collective film productions, regardless of whether they are using the most expensive professional hardware and software or its amateur equivalents.

Consider, then, the following principles of digital filmmaking:

1. Rather than filming physical reality it is now possible to generate film-like scenes directly in a computer with the help of 3D computer animation. Therefore, live action footage is displaced from its role as the only possible material from which the finished film is constructed.
2. Once live action footage is digitized (or directly recorded in a digital format), it loses its privileged indexical relationship to pro-filmic reality. The computer does not distinguish between an image obtained through the photographic lens, an image created in a paint program or an image synthesized in a 3D graphics package, since they are 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 reduced to be just another graphic, no different than images which were created manually.[354]
3. If live action footage was left intact in traditional filmmaking, now it functions as raw material for further compositing, animating and morphing. As a result, while retaining visual realism unique to the photographic process, film obtains the plasticity which 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 <u>Forest Gump</u> (Robert 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.[355] The result: a new kind of realism, which can be described as "something which looks is intended to look exactly as if it could have happened, although it really could not."
4. Previously, editing and special effects were strictly separate activities. An editor worked on ordering sequences of images together; 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 of differences of scale. So, re-ordering 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 + 2D computer animation + 3D computer animation

Live action material can either be recorded on film or video or directly in a digital format.[356] 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 post-production in cinema) no longer applies to digital cinema, since each image, regardless of its origin, goes through a number of programs before making it to the final film.[357]

Let us summarize these principles. Live action footage is now only raw material to be manipulated by hand: animated, combined with 3D 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 which uses live action footage as one of its many elements.

This can be re-read 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 re-appear 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 boundary, only to become one particular case of animation in the end.

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

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 (George Lucas, 1999) was done in just 65 days. The post-production, however, stretched over two years, since ninety-five percent of the film (approximately 2,000 shots out of the total 2,200) was constructed on a computer.[358]

Here are two more examples to further illustrate the shift from re-arranging reality to re-arranging 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 (Universal Studious, 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 3D planes to create a virtual set which was animated to match a 180-degree dolly movement of a camera following a rising rocket.[359]

The last example brings us to another conceptualization of digital cinema — as painting. In his book-length study of digital photography, William J. Mitchell focuses our attention on what he calls the inherent mutability of a 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."[360] 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. With an artist being able to easily manipulate digitized footage either as a whole or frame by frame, a film in a general sense becomes a series of paintings.[361]

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, it opens itself towards the painterly. It is also the most obvious example of the return of cinema to its nineteenth century origins — in this case, to hand-crafted images of magic lantern slides, the Phenakistiscope, the Zootrope.

We usually think of computerization as automation, but here the result is the reverse: what was previously automatically recorded by a camera now has to be painted one frame at a time. But not just a dozen images, as in the nineteenth century, but thousands and thousands. We can draw another parallel with the practice, common in the early days of silent cinema, of manually tinting film frames in different colors according to a scene's mood.[362] Today, some of the most visually sophisticated digital effects are often achieved using the same simple method: painstakingly altering by hand thousands of frames. The frames are painted over either to create mattes ("hand drawn matte extraction") or to directly change the images, as, for instance, in Forest Gump, where President Kennedy was made to speak new sentences by altering the shape of his lips, one frame at a time.[363] In principle, given enough time and money, one can create what will be the ultimate digital film: 90 minutes, i.e., 129600 frames completely painted by hand from scratch, but indistinguishable in appearance from live photography.

The concept of digital cinema as painting can be also 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 early Renaissance. A painter making fresco has limited time before the paint dries; and once it is dried, no further changes to the image are possible. Similarly, a traditional filmmaker has limited means to modify images once they are recorded on film. In the case of Medieval tempera painting, this can be compared to the practice of special effects during the analog period of cinema. A painter working with tempera could modify and re-work the image, but the process was quite painstaking and slow. Medieval and early Renaissance masters would spend up to six months on a painting 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 Tician) 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 even 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 the 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 post-production, 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 3D virtual space. This gives the director the ability to freely move the virtual camera through this space, dolling and panning. Thus cinematography is subordinated to 3D computer animation. We may think of this method as an extension of multiplane animation camera. However, if the camera mounted over a multiplane stand could only move perpendicular to the images, now it can move in a arbitrary trajectory. The example of a commercial film which rely on this newer method which one day may become the standard of filmmaking (because it gives the director most flexibility) is Disney's Alladin; the example of an independent work which fully explores the new aesthetic possibilities of this method without subordinating it to the traditional cinematic realism is The Forest by Tamas Waliczky (1994).

In discussing digital compositing in "Compositing" section I pointed out that it can be thought off as an intermediary step from 2D images to 3D computer representation. The newer post-production method represents the next logical step towards %100 3D computer generated scenes. Instead of 2D space of “traditional” composite, we now have the layers of moving images positioned in a virtual 3D space.

The reader who followed my analysis of the new possibilities of digital cinema may wonder why I have stressed the parallels between digital cinema and the pre-cinematic techniques of the nineteenth century but did not mention 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 later extensively covering shot footage with dots, scratches, splattered paint, smears and lines in an attempt to turn his films into equivalents of Abstract Expressionst painting. More generally, one of the major impulses in all of 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 be 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 became embedded in the commands and interface metaphors of computer software.[364] In short, <u>the avant-garde became materialized in a computer</u>. Digital cinema technology is a case in point. The avant-garde strategy of collage reemerged as a "cut and paste" command, the most basic operation one can perform on digital data. The idea of painting on film became embedded in 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 single all-in-one packages. Finally, another move to combine a number of film images together within one frame (for instance, in Leger's 1924 <u>Ballet Mechanique</u> or in <u>A Man with a Movie Camera</u>) also become legitimized by technology, since all editing software, including Photoshop, Premiere, After Effects, Flame, and Cineon, by default assumes that a digital image consists of a number of separate image layers. All in all, what used to be exceptions for traditional cinema became the normal, intended techniques of digital filmmaking, embedded in technology design itself.[365]

From Kino-Eye to Kino-Brush

In the twentieth century, cinema has played two roles at once. As a media technology, cinema's role was to capture and to store visible reality. The difficulty of modifying images once they were recorded was exactly what gave cinema its value as a document, assuring its authenticity. The same rigidity of the film image has defined the limits of cinema as I defined it earlier, i.e. the super-genre of live action narrative. Although it includes within itself a variety of styles — the result of the efforts of many directors, designers and cinematographers — these styles share a strong family resemblance. They are all children of the recording process which uses lens, 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 a 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.[366]

The privileged role played by the manual construction of images in digital cinema is one example of a larger trend: the return of pre-cinematic moving images techniques. Marginalized by the twentieth century institution of live action narrative cinema which relegated them to the realms of animation and special effects, these techniques reemerge as the foundation of digital filmmaking. What was supplemental to cinema becomes its norm; what was at its boundaries comes into the center. Computer media returns to us the repressed of the cinema.

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

New Language of Cinema

Cinematic and Graphic: Cinegratography

3D animation, compositing, mapping, paint retouching: in commercial cinema, these radical new techniques are mostly used to solve technical problems while traditional cinematic language is preserved unchanged. Frames are hand-painted to remove wires which supported an actor during shooting; a flock of birds is added to a landscape; a city street is filled with crowds of simulated extras. Although most Hollywood releases now involve digitally manipulated scenes, the use of computers is always carefully hidden.[367]
Appropriately, in Hollywood the practice of simulating traditional film language received a name "invisible effects," defined as "computer-enchanced scenes that fool the audience into believing the sots were produced with live actors on location, but are really composed of a mélange of digital and live action footage."[368]

Commercial narrative cinema still continues to hold on to the classical realist style where images function as un-retouched photographic records of some events which took place in front of the camera. So when Hollywood cinema uses computers to create fantastic, impossible reality, this is done through the introduction of various non-human characters such as aliens, mutants and robots. We never notice the pure arbitrariness of their colorful and mutating bodies, of the beams of energy emulating from their eyes, of the whirlpools of particles emulating from their wings, because they are made perceptually consistent with the set, i.e. they look like something which could have existed in a three-dimensional space and therefore could have been photographed.

But how do filmmakers motivate turning familiar reality such as a human body or a landscape into something phsically impossible in our world? Such transformations are motivated by the movie's narrative. The shiny metallic body of Terminator in Terminator 2 is possible because the Terminator is a cyborg send from the future; the rubber-like body of Jim Carrey in The Mask (Russell, 1994) is possible because his character wears a mask with magical powers. Similarly, in What Dreams May Come (PolyGram Filmed Entertainment, Ward, special effects by Mass.Illusions and others, 1998) the fantastic landscape made of swirling brushstrokes where the main hero is transported after his death is motivated by the unique status of this location.

While embracing computers as a productivity tool, cinema refuses to give up its unique cinema-effect, an effect which, according to film theorist Christian Metz's penetrating analysis made in the 1970s, depends upon narrative form, the reality effect and cinema's architectural arrangement all working together.[369] Towards the end of his essay, Metz wonders whether in the future non-narrative films may become more numerous; if this happens, he suggests that cinema will no longer need to manufacture its reality effect. Electronic and digital media have already brought about this transformation. Beginning in the 1980s, new cinematic forms have emerged which are not linear narratives, which are exhibited on a television or a computer screen, rather than in a movie theater — and which simultaneously give up cinematic realism.

What are these forms? First of all, there is the music video. Probably not by accident, the genre of music video came into existence exactly at the time when electronic video effects devices were entering editing studios. Importantly, just as music videos often incorporate narratives within them, but are not 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 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 a aesthetic strategy. The genre of music video has been a laboratory for exploring numerous new possibilities of manipulating photographic images made possible by computers — the numerous points which exist in the space between the 2D and the 3D, 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 music video, 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. However, for the next 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. Secondly, the computer would 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, in twentieth century animation, and in 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 a 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 adopt 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 have merged in a new hybrid language which can be called “cinegratography.”.

We can trace the development of this language by analyzing a few well-known CD-ROM titles. The best selling game Myst (Broderbund, 1993) unfolds its narrative strictly through still images, a practice which takes us back to magic lantern shows (and to Chris Marker's La Jetée).[370] 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 a 3D 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 3D 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 nineteenth century pro-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 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, it 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 a space between cinema and collage.

It would be not entirely inappropriate to read this short history of the digital moving image as a teleological development which replays the emergence of cinema a hundred years earlier. Indeed, as computers' speed keeps increasing, the 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 nineteenth century progression: from sequences of still images (magic lantern slides presentations) to moving characters over static backgrounds (for instance, in Reynaud's Praxinoscope Theater) to full motion (the Lumieres' 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 the images approximately two by three inches in size, both called for private viewing rather than collective exhibition. The two technologies appear to play the 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 which turned a computer in a film projector, however imperfect.[371] Finally, the Lumieres' first film screenings of 1895 which shocked their audiences with huge moving images found their parallel in 1995 CD-ROM titles where the moving image finally fills the entire computer screen (for instance, in Jonny 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 towards only one possible language, or as a progression towards more and more accurate verisimilitude. Rather, we have come to see its history 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.[372] Similarly, instead of dismissing visual strategies of early multimedia titles as a result of technological limitations, we may want to think of them as an alternative to traditional cinematic illusionism, as a 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 and the end of the twentieth centuries: if cinema was developing towards the still open horizon of many possibilities, the development of commercial multimedia, and of corresponding computer hardware (compression boards, storage formats such as DVD), is driven by a clearly defined goal: the exact duplication of cinematic realism. So if a computer screen, more and more, emulates cinema's screen, this not an accident but a result of conscious planning by the computer and entertainment industry. But this drive to turn new media into a simulation of classical film language, which paralles the encoding of cinema’s techniques in software interfaces and hardare itself, described in “Cultural Interfaces” section, is just one direction for new media dvelopment among numerous others. I will next examine a number of new media and old media objects which point towards other possible trajectories.

New Temporality: 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, and in particular cinema, we can find many strategies and techniques relevant to new media design. Put differently, in order to develop new aesthetics of new media we should pay as much attention to the cultural history as to computer’s new unique possibilities to generate, organize, manipulate and distribute data.

As we scan through 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:

- when an earlier interesting strategy or technique was abandoned or forced into “underground” without fully developing its potential;
- when an earlier strategy can be understood as a response to the technological constrains (I am using this more technical term on purpose instead of more ideologically loaded “limitations”) similar to the constrains of new media;
- when an earlier strategy was used in a situation similar to a particular situation faced by new media designers. For instance, montage was a strategy to deal with modularity of a film (how do you join separate shots?) as well as with a problem of coordinating diffirent media types such as images and sound. Both of these simutaions are being faced once again today by new media designers.

I already used these principles in discussing the parallels between nineteenth century pro-cinematic techniques and the language of new media; they also guided me in thinking about animation (the “underground” of 20th century cinema) as the basis for digital cinema new language. I will now use a particular parallel between early cinematic and new media technology to highlight another older technique useful to new media: a loop. Characterically, many new media products, be it 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 it as a source of new possibilities for new media.[373]

As already mentioned in the previous section, all nineteenth century pro-cinematic devices, up to 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, the pornographic peep-show and the animated cartoon. In contrast, narrative cinema has avoided repetitions; as modern Western fictional forms in general, it put 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 A 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 an 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 which 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 re-stages the terror which Lumieres's 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 nineteenth century pro-cinematic devices. This is probably why the loop playback function was built into QuickTime interface, thus giving it the same weight as the VCR-style "play forward" 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 in real time every character, the designers stored short loops of character's motion — for instance, an enemy soldier or a monster walking back and forth — which would be recalled at the appropriate times in the game. Internet pornography also heavily relied on loops. Many sites featured numerous "channels" which 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 will be cut into a number of short loops which would become the content of 100, 500 or 1000 channels.[374]

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

The similar logic applies to loops. Earlier QuickTime movies and computer games heavily relied 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 it provides a cheap (in terms of bandwidth and computation) way of adding some signs of "life" to their geometric-looking environments.[375] Similarly, we may expect that when digital videos will appear on small displays in our cellular phones, personal managers such as Palm Pilot or other wireless communication devices, they will once again will 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?[376] 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 a loop as its conveyer belt.

As the practice of computer programming illustrates, the loop and the sequential progression do not have to be thought as being mutually exclusive. A computer program progresses from start to end by executing a series of loops. Another illustration of how these two temporal forms can work together is Möbius House by Dutch team UN Studio/Van Berkel & Bos.[377] In this house a number of functionally different areas are arranged one after another in the form of a Möbius strip, thus forming a loop. As the narrative of the day progresses from one activity to the next, the inhabitants move from area to area.

Traditional cell animation similarly combines a narrative and a loop. In order to save labor, animators arrange many actions, such as movements of characters' legs, eyes and arms, into short loops and repeat them over and over. Thus, as already discussed in the previous section, in a typical twentieth century cartoon a large proportion of motions involves loops. This principle is taken to the extreme in Rybczynski's Tango. Subjecting live action footage to the logic of animation, Rybczynski arranges the trajectory of every character through space as a loop. These loops are further composited together resulting in a complex and intricate time-based structure. At the same time, the overall "shape" of this structure is governed by a number of narratives. The film begins in an empty room; next the loops of character's trajectories through this room are added, one by one. The end of the film mirrors its beginning as the loops are "deleted" in a reverse order, also one by one. This metaphor for a progression of a human life (we are born alone, gradually forms relations with other humans, and eventually die alone) is also supported by another narrative: the first character to appear in the room is a young boy, the last one is an old woman.

The concept of a loop as an "engine" which puts the narrative in motion becomes a foundation of a brilliant interactive TV program Akvaario (aquarium) by a number of graduate students at Helsinki's University of Art and Design (Professor and Media Lab coordinator: Minna Tarrka).[378] In contrast to many new media objects which combine the conventions of cinema, print and HCI, Akvaario aims to preserve the continuos flow of traditional cinema, while adding interactivity to it. Along with an earlier game Jonny Mnemonic (SONY, 1995), as well as the pioneering interactive laserdisk computer installations by Graham Weinbren done in the 1980s, this project is a rare example of a new media narrative which does not rely on the oscillation between non-interactive and interactive segments (see "Illusion, Narrative and Interactivity" section for the analysis of this temporal ossicilation.)

Using the already familiar convention of such games such as Tamagotchi (1996-), the program asks TV viewers to "take charge" of a fictional human character.[379] Most shots which we see show this character engaged in different activities in his apartment: eating dinner, reading a book, starring into space. The shots replace each other following standard conventions of film and TV editing. The result is something which looks at first like a conventional, although very long, movie (the program was projected to run for three hours every day over the course of a few months), even though the shots are selected in real time by a computer porgram from a database of a few hundreds diffirent shots.

By choosing one of the four buttons which are always present on the bottom of the screen, the viewers control character's motivation. When a button is pressed, a computer program selects a sequence of particular shots to follow the shot which plays currently. Because of visual, spatial and referential discontinuity between shots typical of standard editing, the result is something which the viewer interprets as a conventional narrative. A film or television viewer viewer does not expect that any two shots which follow one another have to display the same space or subsequent moments of time. Therefore in Akvaario a computer program can "weave" an endless narrative by choosing from a database of different shots. What gives the resulting "narrative: a suficient continuity is that almost all shots show the same character.

Akvaario is one of the first examples of what in previous chapter I called a "database narrative." It is, in other words, a narrative which fully utilizes many features of database organization of data. It relies on our abilities to classify database records according to different dimensions, to sort through records, to quickly retrieve any record, as well as to “stream” a number of different records continuously one after another.

In Akvaario the loop becomes the way to bridge linear narrative and interactive control. When the program begins, a few shots keep following each other in a loop. After users choose character’s motivation by pressing a button, this loop becomes a narrative. Shots stop repeating and a sequence of new shots is displayed. If no button pressed again, the narrative turns back into a loop, i.e. a few shots start repeating over and over. In Akvaario a narrative is born from a loop and it returns back to a loop. The historical birth of modern fictional cinema out of the loop returns as a condition of cinema’s rebirth as an interactive form. Rather than being an archaic leftover, a reject from cinema’s evolution, the use of loop in Akvaario suggests a new temporal aesthetics for computer-based cinema.

Jean-Louis Boissier's Flora petrinsularis realizes some of the possibilities contained in the loop form in a diffirent way.[380] This CD-ROM is based on Rousseau's Confessions. It opens with a white screen, containing a numbered list. Clicking on each item leads us to a screen containing two windows, positioned side by side. Both windows show the same video loop made from a few diffirent 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 which also contains two windows, each showing loop of a rhythmically vibrating water surface. The loops of water surfaces can be thought of as two sign waves offset in phase. This structure, then, functions as a “meta-text” of a structure in the first screen. In other words, the loops of water surface act as a diagram of the loop structure which controls the correlations between shots in the first screen, similar to how Marey and the Gibsons diagrammed human motion in their film studies in the beginning of the twentieth century.

As each mouse click reveals another loop, the viewer becomes an editor, but not in a traditional sense. Rather than constructing a singular narrative sequence and discarding material which is not used, here the viewer brings to the forefront, one by one, numerous layers of looped actions which seem to be taking place all at once, a multitude of separate but co-existing temporalities. The viewer is not cutting but re-shuffling. In a reversal of Vertov's sequence where a loop generated a narrative, 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 using montage theory. From this perspective, the repetition of images in two adjoint windows can be interpreted as an example of what Eisenstein called rhythmical montage. At the same time, Boissier takes montage apart, so to speak. The shots which in traditional temporal montage would follow each in time here appear next to each 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.

At the same time, it is possible to find more traditional temporal montage in this work as well — for instance, the move from first screen which shows 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 a 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 is again one of co-existence rather than that of replacement, typical of cinema (see my discussion of spatial montage below).

The loop which structures Flora petrinsularis on a number of levels becomes a metaphor for human desire which can never achieve resolution. It can be also read as a comment on cinematic realism. What are the minimal conditions necessary to create the impression of reality? As Boissier demonstrates, in the case of a field of grass, a close-up of a plant or a stream, just a few looped frames become 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."[381] 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 grades shifting slightly back and forth, rhythmically responding to the blow of non-existent wind which is 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

Along with taking on a loop, Flora petrinsularis can also be seen as a step towards what I will call a spatial montage. Instead of a traditional singular frame of cinema, Boissier uses two images at once, positioned side by side. This can be thought of a simplest case of a spatial montage. In general, spatial montage would involve a number of images, potentially of different sizes and proportions, appearing on the screen at the same time. This by itself of course does not result in montage; it up to the filmmaker to construct a logic which drives which images appear together, when they appear and what kind of relationships they enter with each 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 a set of repetitive, sequential, and simple activities. The same principle made computer programming possible: a computer program breaks a tasks 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 which appear on the screen one at a time. A sequential narrative turned out to be particularly incompatible with a spatial narrative which 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, be it the fictional space of a painting or the physical space which can be taken by the viewer all in 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 which formed one narrative but they separated by time were depicted within a single painting. More often, the painting's subject became an excuse to show a number of separate "micro-narratives" (for instance, works by Hiëronymous Bosch and Peter Bruegel). All in all, in contrast to cinema's sequential narrative, in spatial narrative all the "shots" were accessible to a viewer at one. Like nineteenth century animation, spatial narrative did not disappear completely in the 20th century; but just as animation, it 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 sequential mode of narration coincided with the rise of 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 the decline in spatial imagination and the spatial mode of social analysis.[382] According to Soja, it is only in the last decades of the twentieth century that this mode made a powerful comeback, as exemplified by the growing importance of such concepts as "geopolitics" and "globalisation" as well as by the key role analysis of space played in theories of post-modernism. Indeed, although some of the best thinkers of the twentieth century such as Freud, Panofsky and Foucault were able to combine historical and spatial mode of analysis in their theories, they probably represent an exemption rather than the norm. The same holds for film theory, which, from Eisenstein in the 1920s to Deleuse in the 1980s, focused on temporal rather than spatial structures of film.

Twentieth century film practice has elaborated complex techniques of montage between different images replacing each other in time; but the possibility of what can be called "spatial montage" between simultaneously co-exiting images was not explored as systematically. (Thus cinema also given to historical imagination at the expense of spatial one.) The notable exemptions include the use of split screen by Hans Abel in Napoléon in the 1920s and also by the American experimental filmmaker Stan Van der Beek in the 1960s; also some other works, or rather, events, of the 1960s "expanded cinema" movement, and, last but not least, the legendary multi-image multimedia presentation shown in the Chech Pavilion at the1967 World Expo. Emil Radok's Diaolyektan consisted from 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, since this project nobody tried again to create a spatial montage of this complexity in any technology.

Traditional film and video technology were designed to completely fill a screen with a single image; thus to explore spatial montage a filmmaker had to work "against" the technology. This in part explains why so few tried to do this. But when, in the 1970s, the screen became a bit-mapped computer display, with individual pixels corresponding to memory locations which can be dynamically updated by a computer program, one image/ one screen logic was broken. Since the Xerox Park Alto workstation, GUI 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 Golden Eye (Nintendo/Rare, 1997) already used multiple windows to present the same action simultaneously from different viewpoints. We may expect that computer-based cinema will eventually have to follow the same direction — especially when the limitations of communication bandwidth will disappear, while the resolution of displays will significantly increase, from the typical 1-2K in 2000 to 4K, 8K or beyond. I believe that the next generation of cinema — broadband cinema — will add multiple windows to its language. When this happen, the tradition of spatial narrative which twentieth century cinema suppressed will re-emerge one again.

Looking back at visual culture and art of the previous centuries gives many ideas for how spatial narrative can be further developed in a computer; but what about spatial montage? In other words, what will happen if we combine two different cultural traditions: informationally dense visual narratives of Renaissance and Baroque painters with "attention demanding" shot juxtapositions of twentieth century film directors? "My boyfriend came back from war!," a Web-based work by the young Moscow artist Olga Lialina, can be read as an exploration of this direction.[383] Using the capability of HTML to create frames within frames, Lialina leads us through a narrative which begins with an 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 of a constantly blinking window remain on the left part of screen. These two images enter into new combinations with texts and images on the right part which 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, movement) we now have a new dimension: the position of the 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 one image which 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 co-existence. Time becomes spatialized, distributed over the surface of the screen. In spatial montage, nothing is potentially 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 cinema's screen, which primarily functioned as a record of perception, here computer screen functions as a record of memory.

As I already noted, spatial montage can also be seen as an aesthetics appropriate for the user experience of muli-tasking 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 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…”[384] 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 the 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 with presents the user with multiple icons which are all simultaneously and continuously “active” (since they all can be clicked at any time) follows the same logic of “simultaneity” and of “side-by-side.” On the level of computer programming, this logic corresponds to object-oriented programming. Instead of a single program which, like Ford’s assembly line, is executed one statement at a time, in object-oriented paradigm a number of objects send messages to each other. These objects are all active simultaneously. Object-oriented paradigm and multiple windows of GUI work together; object-oriented approach was in fact used to program the original Macintosh GUI which 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 this logic of simultaneity of modern GUI. 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, changing the overall "state" of the computer environment, the user of Lialina's site can activate different hyperlinks which are all simultaneously present. Each action either changes the contents of a single frame or creates new frame(s). In either case, the "state" of the screen as a whole is affected. The result is a new cinema where syncronic dimension is no longer privileged to the diacronic dimension, space is no longer privileged to time, the simultaneity is no longer privileged to sequence, montage within a shot is no longer privileged to montage in time.

Cinema as an Information Space

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

Yet another way to think about new media interfaces in relation to cinema is to interpret the later as information space. <u>If HCI is an interface to computer data, and a book is interface to text, cinema can be thought of an interface to events taking place in 3D space</u>. Just as painting before it, cinema presented 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. The examples of the former are paintings by Morandi and shots in <u>Late Spring</u> (Yasujiro Ozu, 1949); the examples of the later are paintings by Bosch and Bruegel (and much of Northern Renaissance painting in general), and many shots in <u>A Man with a Movie Camera</u>.[385] It would be 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 dozens commands at once. Can the contemporary information designers learn from information displays of the past — particular films, paintings and other visual forms which follow the aesthetics of density?

In making such a connection I rely on work of art historian Svetlana Alpers who claimed that in contrast to Italian Renaissance painting primarily concerned with narration, Dutch painting of the Seventeenth century is focused on description.[386] While the Italians subordinated details to the narrative action, creating clear hierarchy of viewer's attention, in Dutch paintings particular details and, consequently, viewer's attention, are more evenly distributed throughout the whole image. While functioning as a window into an illusionary space, the Dutch painting also is a loving catalog of numerous objects, different material surfaces and light effects painted in minute detail (works by Vermeer, for instance.) The dense surfaces of these paintings can be easily related to contemporary interfaces; in addition, they can be also related to the future aesthetics of a moving image, when the digital displays will move much beyond the resolution of analog television and film.

The trilogy of computer films by Paris-based filmmaker Christian Boustani, develops such an aesthetics of density. Taking his inspiration from Renaissance Dutch painting as well as from classical Japanese art, Boustani uses digital compositing to achieve unprecedented. for film, information density. While this density was typical for old art he draws on, it was never before achieved in cinema. In Brugge (1995) Boustani recreates the images typical of winter landscape scenes in Dutch seventeenth century painting. His next film A Viagem (The Voyage, 1998) achieves even higher information density; some shots of the film use as many as 1600 separate layers.

This new cinematic aesthetics of density seems to be highly appropriate for out age. If, from a city street to a Web page, we are surrounded by highly dense information surfaces, it is appropriate to expect from cinema similar logic. (In a same fashion, we may think of spatial montage as reflecting another contemporary daily experience: working with a number of different applications at once on a computer. If we are now used to distribute and rapidly switch our attention from one program to another, from one set of windows and command to another set, we may find multiple streams of audio-visual information presented simultaneously more satisfying than a single stream of traditional cinema.)

It is appropriate that some of the most dense shots of A Viagem recreates a Renaissance marketplace, this symbol of emerging capitalism which was probably responsible for the new density of Renaissance painting (think, for instance, of Dutch still-lives which function as a kind of store display window aiming to overwhelm the viewer and seduce her into making a purchase). In the same way, in the 1990s the commercialization of the Internet was responsible for the new density of Web pages. By the end of the decade all home pages of big companies and Internet portals became indexes containing dozens of entries in a small type. If every small area of the screen can potentially contain a lucrative add or a link to a page with one, this leaves no place for the aesthetics of emptiness and minimalism. Thus it is not surprising that commercialized Web joined the same aesthetics of information density and competing signs and images which characterizes visual culture in a capitalist society in general.

If Lialina's spatial montage relies on HTML frames and actions of the user to activate images appearing in these frames, Boustani's spatial montage is more purely cinematic and painterly. He combines mobility of camera and movement of objects characteristic of cinema which the "hyper-realism" of old Dutch painting which presented everything "in focus." In analog cinema, the inevitable "depth of field" artifact acted as a limit to the information density of an image. The achievement of Boustani is to create images where every detail is in focus and yet the overall image is easily readable. This could only be done through digital compositing. By reducing visible reality to numbers the computer makes possible for us to literally see in a new way. If, according to Benjamin, early twentieth century cinema used close-up "to bring things 'closer' spatially and humanly," "to get hold of an object at very close range," and, as a result, destroyed their aura, digital composites of Boustani can be said to bring objects close to a viewer without "extracting" them away from their places in the word. (Of course also an opposite interpretation is possible: we can say that Boustani's digital eye is super-human. Similar to the argument in "Synthetic Image and its subject" section, his vision can be interpreted as the gaze of a cyborg or computer vison system which can see things equally well at any distance.)

Scrutinizing the prototypical perceptual spaces of modernity — the factory, the movie theater, the shopping arcade — Walter Benjamin insisted on the contiguity between the perceptual experiences in the workplace and outside of it:

> Whereas Poe's passers-by cast glances in all directions which still appeared to be aimless, today's pedestrians are obliged to do so in order to keep abreast of traffic signals. Thus technology has subjected the human sensorium to a complex kind of training. There came a day when a new and urgent need for stimuli was met by the film. In a film, perception in the form of shocks was established as a formal principle. That which determines the rhythm of production on a conveyer belt is the basis of the rhythm of reception in the film.[387]

For Benjamin, the modern regime of perceptual labor, where the eye is constantly asked to process stimuli, equally manifests itself 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 the users with similarly structured perceptual experiences at work and at home, on a computer screen and outside of it. Indeed, as I already noted, we now use the same interfaces for work and for leisure, the 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 Gulf War as "video game war.") But if Benjamin appears to regret that the subjects of an industrial lost pre-modern freedom of perception, now regimented by factory, modern city and film, we may instead think of information density of our own workspaces as a new aesthetic challenge, something to explore rather than to condemn. Similarly, we should explore the aesthetic possibilities of all aspects of user's experience with a computer, this key experience of modern life: dynamic windows of GUI, multi-tasking, 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 will arrive, what will they look like? How would we even know they are here? Would future films look like a "data shower" from the movie "Matrix"? Is the famous fountain at Xerox Park in which the strength of the water stream reflects the behavior of the stock market, with stock data arriving in real time over Internet, represents the future of public sculpture?

We don't 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 a computer code.[388]

It is worthwhile to relate Cosic's films to both Zuse's "found footage movies" from the 1930s, which I invoke 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.[389] Zuse superimposes digital code over the film images. Lucas follows the opposite logic: in his film, digital code "lies under" his images. That is, given that most images in the film were put together on computer workstations, during the post-production process they were pure digital data. The frames were made up from numbers rather than bodies, faces, and landscapes. The Phantom Menace is, therefore, can be called the first feature-length commercial abstract film: two hours worth of frames made up from 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, in ASCII films the code and the image coexist.

Like VinylVideo project by Gebhard Sengmüller which records TV programs and films on old vinyl disks,[390] Cosic's ASCII initiative[391] 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. The artists noticed this new logic of culture early on: in the 1960s, Roy Lichtenstein and Andy Warhol already made media translation the basis of their art. Sengmuller and Cosic understand that the only way to deal with built-in media obsolescence of a modern society is by ironically resurrecting dead media. Sengmuller translates old TV programs into vinyl disks; Cosic translates old films into ASCII images.[392]

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. I was surprised that in 1999 I still was able to 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 early days of computing is not unique to Cosic but 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[393]; a Russian net.artist Alexei Shulgin has performed music in the late 1990s using old 386PC.[394] 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 an abbreviation 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, which were then transmitted over communications lines to a receiving system, which 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.[395]

ASCII code was itself an extension of an earlier code invented by Jean-Maurice-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. And so on.

The history of ASCII code compresses a number of technological and conceptual developments which lead to (but I am sure will not stop at) a 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” in these images many key issues of computer culture and new media art.

As this book has argued, in 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 interfaces and defaults of software programs and hardware itself. Yet, while on the one hand new media strengthens existing cultural forms and languages, including the language of cinema, it simultaneously “opens” them up for redefinition. The elements of their interfaces become separated from the types of data they were traditionally connected to. Further, what was previously in the background, on the margins, comes into the center. For instance, animation comes to challenge live cinema; spatial montage comes to challenge temporal montage, database comes to challenge narrative; search engine comes to challenge encyclopedia; and, last but not least, online distribution of culture challenges traditional “off-line” formats. To use a metaphor from computer culture, new media turns all culture and cultural theory into “open source.” This “opening up” of all cultural techniques, conventions, forms and concepts is ultimately the most positive cultural effect of computerization — the opportunity to see the world and the human being anew, in ways which were not available to <u>A Man with a Movie Camera</u>.

NOTES

[1] http://www.nettime.org

[2] http://www.rhizome.org

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

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

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

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

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

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

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

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

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

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

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

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

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

[15] Eames, A Computer Perspective, 120.

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

[17] Kerlov and Rosebush, Computer Graphics, 21.

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

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

[20] http://www.mrl.nyu.edu/improv/, accessed June 29, 1999.

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

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

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

[24] See http://www.virage.com/products, accessed June 29, 1999.

[25] http://agents.www.media.mit.edu/groups/agents/projects/, accessed June 29, 1999.

[26] See my “Avant-Garde as Software,” in Ostranenie, edited by Stephen Kovats (Frankfurt and New York: Campus Verlag, 1999.). (http://visarts.ucsd.edu/~manovich)

[27] For an experiment in creating diffirent multimedia interfaces to the same text, see my Freud-Lissitzky Navigator (http://visarts.ucsd.edu/~manovich/FLN).

[28] http://jefferson.village.virginia.edu/wax/, accessed October 24, 1999.

[29] Frank Halacz and Mayer Swartz, “The Dexter Hypertext Reference Model,” Communication of the ACM (New York: ACM, 1994), 30.

[30] Noam Chomsky, Syntactic Structures, reprint edition (Peter Lang Publishing, 1978).

[31] “How Marketers ‘Profile’ Users,” USA Today (November 9, 1999), 2A.

[32] See http://www.three.org. Our conversations helped me to clarify my ideas, and I am very grateful to Jon for the ongoing exchange.

[33] Marcos Novak, lecture at “Interactive Frictions” conference, University of Southern Californa, Los Angeles, June 6, 1999.

[34] Graame Weinbren, In the Ocean of Streams of Story, Millennium Film Journal 28 (Spring 1995), http://www.sva.edu/MFJ/journalpages/MFJ28/GWOCEAN.HTML.

[35] Rick Moody, Demonology, first published in Conjunctions, reprinted in The KGB Bar Reader, qtd. in Vince Passaro, “Unlikely Stories,” Harper’s Magazine vol. 299, no. 1791 (August 1999), 88-89.

[36] Albert Abramson, Electronic Motion Pictures. A History of Television Camera (Berkeley: University of California Press, 1955), 15-24.

[37] Charles Musser, The Emergence of Cinema: The American Screen to 1907 (Berkeley: University of California Press, 1994), 65.

[38] Mitchell, The Reconfigured Eye (Cambridge, Mass.: The MIT Press, 1982), 6.

[39] Mitchell, The Reconfigured Eye, 6.

[40] Mitchell, The Reconfigured Eye, 49.

[41] Ernst Gombrich analses "the beholder's share" in decoding the missing information in visual images in his classic Art and Illusion. A Study in the Psychology of Pictorial Representation (Princeton: Princeton University Press, 1960).

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

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

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

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

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

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

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

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

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

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

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

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

[54] George Lakoff, "Cognitive Linguistics," Versus 44/45 (1986): 149.

[55] Philip Johnson-Laird, Mental Models: Towards a Cognitive Science of Language, Inference, and Consciousness (Cambridge: Cambridge University Press, 1983).

[56] Louis Alhusser introduced his influential notion of ideological interpellation in his "Ideology and Ideological State Apparatuses (Notes Towards an Investigation), in Lenin and Philosophy, trans. by Ben Brewster (New York: Monthly Review Press, 1971).

[57] Stephen Johnson’s Interface Culture makes a claim for the cultural significance of computer interface.

[58] Other examples of cultural theories which rely on “non-transparency of the code” idea are Yuri Lotman’s theory of secondary modeling systems, George Lakoff’s cognitive linguistics, Jacques Derrida’s critique of logocentrism and Marshall McLuhan’s media theory.

[59] http://www.ntticc.or.jp/permanent/index_e.html, accessed July 15, 1999.

[60] Brad. A. Myers, "A Brief History of Human Computer Interaction Technology," technical report CMU-CS-96-163 and Human Computer Interaction Institute Technical Report CMU-HCII-96-103 (Pittsburgh, Pennsylvania: Carnegie Mellon University, Human-Computer Interaction Institute, 1996).

[61] http://www.xanadu.net/the.project, accessed December 1, 1997.

[62] XML which is promoted as the replacement for HTML enables any user to create her customized markup language. Thus, the next stage in computer culture may involve authoring not simply new Web documents but new languages. For more information on XML, see http://www.ucc.ie/xml., accessed December 1, 1997.

[63] http://www.hotwired.com/rgb/antirom/index2.html, accessed December 1, 1997.

[64] See, for instance, Mark Pesce, "Ontos, Eros, Noos, Logos," keynote address for ISEA (International Symposium on Electronic Arts) 1995, http://www.xs4all.nl/~mpesce/iseakey.html, accessed December 1, 1997.

[65] http://www.backspace.org/iod, accessed July 15, 1999.

[66] http://www.netomat.net, accessed July 15, 1999.

[67] Roman Jakobson, "Deux aspects du langage et deux types d'aphasie", in Temps Modernes, no. 188 (January 1962).

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

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

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

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

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

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

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

[75] http://webspace.sgi.com/WebSpace/Help/1.1/index.html, accessed December 1, 1997.

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

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

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

[79] Dungeon Keeper (Bullfrog Productions, 1997).

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

94 Ibid.

[95] Ibid.

[96] On SAGE, see exellent social history of early computing by Paul Edwards, The Closed World: Computers and the Politics of Discourse in Cold War America (MIT Press, 1996). For a shorter sumary of his argument, see Paul Edwards, "The Closed World. Systems discourse, military policy and post-World War II U.S. historical consciousness," in Cyborg Worlds: The Military Information Society, eds. Les Levidow and Kevin Robins (London: Free Association Books, 1989). See also Howard Rheingold, Virtual Reality (New York: Simon & Schuster, Inc., 1991), 68-93.

[97] Edwards (1989), 142.

[98] "Retrospectives II: The Early Years in Computer Graphics at MIT, Lincoln Lab, and Harvard," in SIGGRAPH '89 Panel Proceedings (New York: The Association for Computing Machinery, 1989), 22-24.

[99] Ibid., 42-54.

[100] Rheingold, 105.

[101] Qtd. in Rheingold, 104.

[102] Roland Barthes, "Diderot, Brecht, Eisenstein," in Images-Music-Text, ed. Stephen Heath (New York: Farrar, Straus and Giroux, 1977), 69-70.

[103] Ibid.

[104] While in the following I discuss the immobility of the subject of a screen in the context of the history of representation, we can also relate this condition to the history of communication. In Ancient Greece, communication was understood as an oral dialogue between people. It was also assumed that physical movement stimulated dialogue and the process of thinking. Aristotle and his pupils walked around while discussing philosophical problems. In the Middle Ages, a shift occured from a dialogue between subjects to communication between a subject and an information storage device, i.e., a book. A Medieval book chained to a table can be considered a precursor to the screen which “fixes” its subject in space.

[105] As summarized by Martin Jay, "Scopic Regimes of Modernity," in Vision and Visuality, edited by Hal Foster (Seattle: Bay Press, 1988), 7.

[106] Qtd. in Ibid, 7.

[107] Ibid, 8.

[108] Qtd. in Ibid., 9.

[109] For a survey of perspectival instruments, see Martin Kemp, The Science of Art (New Haven: Yale University Press, 1990), 167-220.
[110] Ibid., 171-172.
[111] Ibid., 200.
[112] Ibid.
[113] Anesthesiology emerges approximately at the same time.
[114] Walter Benjamin, "The Work of Art in the Age of Mechanical Reproduction," in Illuminations, ed. Hannah Arendt (New York: Schochen Books, 1969), 238.
[115] Anne Friedberg, Window Shopping: Cinema and the Postmodern (Berkeley: University of California Press, 1993), 2.
[116] See, for instance, David Bordwell, Janet Steiger and Kristin Thompson, The Classical Hollywood Cinema (New York: Columbia University Press, 1985).
[117] Qtd. in Ibid., 215.
[118] Ibid., 214.
[119] Friedberg, 134. She refers to Jean-Louis Baudry, "The Apparatus: Metapsychological Approaches to the Impression of Reality in the Cinema," in Narrative, Apparatus, Ideology, ed. Philip Rosen (New York: Columbia University Press, 1986) and Charles Musser, The Emergence of Cinema: The American Screen to 1907 (New York: Charles Scribner and Sons, 1990).
[120] Qtd. in Baudry, 303.
[121] Friedberg, 28.
[122] A typical VR system adds other ways of moving around, for instance, the ability to move forward in a single direction by simply pressing a button on a joystick. However, to change the direction the user still has to change the position of his/her body.
[123] Rheingold, 104.
[124] Ibid., 105.
[125] Ibid., 109.
[126] Marta Braun, Picturing Time: The Work of Etienne-Jules Marey (1830-1904) (Chicago: The University of Chicago Press, 1992), 34-35.
[127] Rheingold, 201-209.
[128] Qtd. in Ibid., 201.

[129] Here I disagree with Friedberg who writes, "Phantasmagorias, panoramas, diaramas — devices that concealed their machinery — were dependent on the relative immobility of their spectators." (23)

[130] In some nineteenth century panoramas the central area was occupied by the simulation of a vehicle consistent with the subject of the panorama, such as a part of the ship. We can say that in this case virtual space of the simulation completely takes over the physical space. That is, physical space has no identity of its own – not even such minimal negative identity as emptiness. It completely serves the simulation.

[131] I am refering here to Rem Koolhaus unrealized project for a new building for ZKM in Karlsruhe, Germany. See Rem Koolhaaus and Bruce Mau, S, M, L, XL (Penguin, 1998).

[132] Sampling across media is the subject of the Ph.D. dissertation (in progress) by Tarleton Gillespie (Department of Communication, University of California, San Diego); morping is the subject of Vivian Sobcack, ed., Meta-Morphing: Visual Transformation and the Culture of Quick-Change (University of Minnesota Press, 1999).

[133] See my article "'Real' Wars: Esthetics and Professionalism in Computer Animation," Design Issues 6, no. 1 (Fall 1991): 18-25.

[134] Switch 5, no. 2 (http://switch.sjsu.edu/CrackingtheMaze).

[135] Peter Eiseman, Diagram Diaries (New York: Universe Publishing, 1999), 238-239.

[136] Issey Miyake Making Things, an exhibition at Foundation Cartier, Paris, October 13, 1998 – January 17, 1999.

[137] http://www.viewpoint.com

[138] http://www.adobe.com

[139] http://www.macromedia.com

[140] htpp://www.aw.sgi.com

[141] http://www.apple.com/quicktime/authoring/tutorials.tml, accessed September 26, 1999.

[142] http://geocities.yahoo.com

[143] http://www.turneupheat.com, acessed August 4, 1999.

[144] E.H. Gombrich, Art and Illusion; Roland Barthes, "The Death of the Author," in Image, Music, Text, ed. Stephen Heath (New York: Farrar, Straus and Giroux, 1977).

[145] Barthes, "The Death of the Author," 142.

[146] Bulat Galeyev, Soviet Faust. Lev Theremin — Pioneer Of Electronic Art (in Russian) (Kazan, 1995), 19.

[147] http://www.microsoft.com; http://www.macromedia.com, accessed September 22, 1999.

[148] Herbert Muschamp, "Blueprint: The Shock of the Familiar, The New York Times Magazine (December 13, 1998), 66.

[149] Musser, The Emergence of Cinema.

[150] Fredric Jameson, "Postmodernism and Consumer Society," in Postmodernism and its Discontents, edited by E. Ann Kaplan (London and New York: Verso, 1988): 15

[151] Jameson, "Postmodernism and Consumer Society," 20.

[152] Peter Lunenfeld discusses the relevance of Frampton to new media in his Snap to the Grid (Cambridge, Mass.: The MIT Press, forthcoming).

[153] Hollis Frampton, "The Withering Away of the State of the Art," in Circles of Confusion (Rochester: Visual Studies Workshop), 169.

[154] Thomas Porter and Tom Duff, "Compositing Digital Images," Computer Graphics vol. 18, no. 3 (July 1984): 253-259.

[155] http://www.apple.com/quicktime/resources/qt4/us/help/QuickTime%20Help.htm, accessed Septermebr 26, 1999.

[156] http://drogo.cset.it/mpeg, accessed September 26, 1999.

[157] For an exellent theoretical analysis of morphing, see Vivian Sobchack, "'At the Still Point of the Turning World': Meta-Morphing and Meta-Stasis, in Vivian Sobchack, ed., Meta-Morphing: Visual Transformation and the Culture of Quick-Change (University of Minnesota Press, 1999).

[158] Terence Riley, The Un-private House (New York: The Museum of Modern Art,1999).

[159] On presentational system of early cinema, see Charles Musser, The Emergence of Cinema: The American Screen to 1907 (Berkeley: University of California Press, 1990), 3.

[160] Paul Johnson, The Birth of the Modern: World Society 1815-1830 (London: Orion House, 1992), 156.

[161] The examples of Citizen Kane and Ivan the Terrible are from Aumont et al., Aesthetics of Film (Austin: Texas University Press, 1992), 41.

[162] Dziga Vertov, "Kinoki. Perevorot" (Kinoki. A revolution), LEF 3 (1923): 140.
[163] Jen-Luc Godard, Son + Image, edited by Raymond Bellour (New York: the Museum of Modern Art, 1992) p. 171.
[164] Ibid.
[165] See Paula Parisi, "Lunch on the Deck on the Titanic," Wired 6.02 (February 1998).
[166] IMadGibe. Virtual Advertising for Live Sport Events. A promotional flyer by ORAD, P.O. Box 2177, Kfar Saba 44425, Israel, 1998.
[167] Sergei Eisenstein, "The Filmic Forth Dimension," in Film Form, trans. by Jay Leyda (San Diedo, New York, London: Harcourt Brace & Company, 1949).
[168] Eisenstein, "A Dialectical Approach to Film Form," in Film Form.
[169] Eisenstein, "Statement," in Film Fom, and "Synchronization of Senses," in Film Sense, trans. by Jay Leyda (San Diedo, New York, London: Harcourt Brace & Company, 1942).
[170] For an exellent theoretical analysis of QuickTime and digital moving image in general, see Vivian Sobchack, "Nostalgia for a Digital Object: Regrets on the Quickening of QuickTime."
[171] Private communication, Helsinki, October 4, 1999.
[172] Nelson Goodman, Languages of Art, second edition (Indianapolis and Camrbridge: Hackett Publishing Company, 1976), 252-253.
[173] Roland Barthes, "From Work to Text," trans. Stephen Heath, in Image-Music-Text (New York: Hill and Wang, 1977).
[174] www. yahoo.com, accessed March 27, 1999.
[175] Brenda Laurel, quoted in Rebecca Coyle, "The Genesis of Virtual Reality," in Future Visions: New Technologies of the Screen," edited by Philip Hayward and Tana Wollen (London: British Film Institute, 1993), 162.
[176] Fisher, 430. Emphasis mine — LM.
[177] Fisher defines telepresence as "a technology which would allow remotely situated operators to receive enough sensory feedback to feel like they are really at a remote location and are able to do diffirent kinds of tasks." Scott Fisher, "Visual Interface Environments," in The Art of Human-Computer Interface Design, edited by Brenda Laurel (Reading, Mass.: Addison-Wesley Publishing Company, Inc., 1990), 427.

[178] I am grateful to Thomas Elsaesser for suggesting the term "image-instrument" and also making a number of other suggestions regarding "Teleaction" section as a whole.

[179] Bruno Latour, "Visualization and Cognition: Thinking with Eyes and Hands," Knowledge and Society: Studies in the Sociology of Culture Past and Present 6 (1986): 1-40.

[180] Ibid., 22.

[181] Ibid., 8.

[182] http://telegarden.aec.at, accessed March 27, 1999.

[183] Walter Benjamin, "The Work of Art in the Age of Mechanical Reproduction," in Illuminations, ed. Hannah Arendt (New York: Schochen Books, 1969).

[184] Paul Virilio, "Big Optics," in On Justifying the Hypothetical Nature of Art and The Non-Identicality Within The Object World, ed. Peter Weibel (Köln, 1992). Virilio's argument can also be found in his other texts, for instance, "Speed and Information: Cyberspace Alarm!" in CTHEORY (www.ctheory.com/a30-cyberspace_alarm.html) and Open Sky, trans. by Julie Rose (London and New York: Verso, 1997).

[185] Virilio, "Big Optics," 90.

[186] Jonathan Crary, Techniques of the Observer: On Vision and Modernity in the Nineteenth Century (Cambridge: The MIT Press, 1990), 10.

[187] This point is argued in Mitchell, The Reconfigured Eye.

[188] Jacques Lacan, The Four Fundamental Concepts of Psycho-Analysis, ed. Jacques-Alain Miller (New York and London: W.W.Norton, 1978), 95.

[189] Martin Jay, Downcast Eyes: The Denigration of Vision in Twentieth-Century French Thought (Berkeley: University of California Press, 1993).

[190] For a detailed analysis of this story, see Stephen Bann, The True Vine. On Western Representation and the Western Tradition (Cambridge: Cambridge University Press, 1989).

[191] Onyx is a faster version or RealityEngine which was also manufactured by Silicon Graphics. See www.sgi.com

[192] I am grateful to Peter Lunenfeld for pointing out this connection to me.

[193] For an overview of the early history of computer art which includes the discussion of the “turn to illusionism,” see Frank Dietrich, "Visual Intelligence: The First Decade of Computer Art," in Computer Graphics, 1985.

[194] Andre Bazin, What is Cinema? (Berkeley: University of California Press, 1967-71); Stephen Bann, The True Vine: on Visual Representation and the Western Tradition (Camridge, England, and New York: Cambridge University Pres, 1989).

[195] On the history of illusionism in cinema, see the influential theoretical analsis by Jean-Louis Comolli, "Machines of the Visible, The Cinematic Apparatus, edited by Teresa De Lauretis and Steven Health (New York: St. Martin Press), 1980. I discuss Comolli argument in more detail in “Synthetic Realism as Brickolage” section below.

[196] André Bazin, What is Cinema? Vol. 1 (Berkeley: University of California Press, 1967), 20.

[197] Bazin, What is Cinema? Vol. 1, 21.

[198] Bazin, What is Cinema? Vol. 1, 20.

[199] Bazin, What is Cinema? Vol. 1, 36-37.

[200] Jean-Louis Comolli, "Machines of the Visible,” 122

[201] Bordwell, David and Janet Staiger. "Technology, Style and Mode of Production," in David Bordwell, Janet Staiger and Kristin Thompson, The Classical Hollywood Cinema, 243-261.

[202] Cook, R., L. Carpenter and E. Catull. "The Reys Image Rendering Architecture." Computer Graphics. 21.4 (1987): 95. Emphasis mine - L.M.

[203] Cynthia Goodman, Digital Visions (New York: Harry N. Abrams, Inc., 1987), 22, 102.

[204] Carpenter, L., A. Fournier and D. Fussell. "Fractal Surfaces." Communications of the ACM. 1981.

[205] Gardner, Geoffrey Y. "Simulation of Natural Scenes Using Textured Quadric Surfaces." Computer Graphics. 18.3 (1984): 21-30.
Gardner, Geoffrey Y. "Visual Simulation of Clouds." Computer Graphics. 19.3 (1985): 297-304.

[206] Gardner (1984), 19.

[207] Reeves, William T. "Particle Systems — A Technique for Modeling a Class of Fuzzy Objects." ACM Transactions on Graphics. 2.3 (1983): 91-108.

[208] Magnenat-Thalman, Nadia and Daniel Thalman. "The Direction of Synthetic Actors in the Film 'Rendezvous a Montreal'." IEEE Computer Graphics and Applications. December 1987.

[209] Carignan, M., Yang, Y., Thalmann, N., and Thalmann, D. "Dressing Animated Synthetic Actors with Complex Deformable Clothes." Computer Graphics. 26.2 (1992 ??): 99-104.

[210] Anjyo, K., Usami, Y., and Kurihara, T. "A Simple Method for Extracting the Natural Beauty of Hair." Computer Graphics. 26.2 (1992): 111-120.

[211] Steve Neale,.Cinema and Technology (Bloomington: Indiana University Press, 1985), 52.

[212] The folllowing are just a few well-known “classics” in the field devoted to this research: Nelson Max,."Vectorized procedure models for natural terrain: waves and islands in the sunset" Computer Graphics 15.3 (1981); Ken Perlin,."An Image Synthesizer," Computer Graphics. 19.3 (1985): 287-296; William T.Reeves, "Particle Systems — A Technique for Modeling a Class of Fuzzy Objects" ACM Transactions on Graphics 2.3 (1983): 91-108; William T. Reeves and Ricki Blau, "Approximate and Probabilistic Algorithms for Shading and Rendering Structured Particle Systems" Computer Graphics 19.3 (1985): 313-322.

[213] http://www.worlds.com, accessed September 9, 1999.

[214] http://www.activeworlds.com, accessed September 9, 1999.

[215] Cynthia Goodman, Digital Visions, 18-19.

[216] J. F Blinn,."Simulation of Wrinkled Surfaces," Computer Graphics (August 1978): 286-92.

[217] The research in VR aims to go beyond the screen image in order to simulate both the perceptual and bodily experience of reality.

[218] See Roman Jakobson, "Closing Statement: Linguistics and Poetics," in Style In Language, ed. Thomas Sebeok (Cambridge, Mass.: The MIT Press, 1960).

[219] Walter Benjamin, "The Work of Art in the Age of Mechanical Reproduction," in Illuminations, ed. Hannah Arendt (New York: Schochen Books, 1969).

[220] Private communication, September 1995, St. Petersburg.

[221] On theories of suture in relation to cinema, see chapter 5 of Kaja Silverman, The Subject of Semiotics (New York: Oxford University Press, 1983).

[222] www.adweek.com, January 18, 1999.

[223] http://www.plumbdesign.com/thesaurus/, accessed May 14, 1999.

[224] According to Janet Murray, digital environments have four essential properties: they are procedural, participatory, spatial and encyclopedic. As can be seen, spatial and encyclopedic can be correlated with the two forms I describe here: navigable space and a database. Janet Murray, Hamlet on the Holodeck – The Future of Narrative in Cyberspace (Cambridge, Mass.: The MIT Press, 1997), 73.

[225] Sigfried Giedion, Mechanization Takes Command, a Contribution to Anonymous History (New York: Oxford University Press, 1948).

[226] "database" Britannica Online. <http://www.eb.com:180/cgi-bin/g?DocF=micro/160/23.html> Accessed 27 November 1998.

[227] Jean-Francois Lyotard, The Postmodern Condition: A Report on Knowledge, trans. Geoff Bennington and Brian Massumi (Minneapolis: University of Minnesota Press, 1984), 3.

[228] As early as 1985 Grolier, Inc. issued text-only "Academic American Encyclopedia" on CD-ROM. First multimedia encyclopedia was "Compton's MultiMedia Encyclopedia" published in 1989.

[229] See AI and Society 13.3, special issue on database aesthetics, edited by Victria Vesna (http://arts.ucsb.edu/~vesna/AI_Society/); SWITCH, The Database Issue (http://switch.sjsu.edu/), forthcoming spring 2000.

[230] http://www.teleportacia.org/anna

[231] George Legrady, personal communication, September 16, 1998.

[232] David Bordwell and Kristin Thompson define motivation in cinema in the following way: "Because films are human constructs, we can expect that any one element in a film will have some justification for being there. This justification is the motivation for that element." Here are some examples of motivation: "When Tom jumps from the balloon to chase a cat, we motivate his action by appealing to notions of how dogs are likely to act when cats are around." "The movement of a character across a room may motivate the moving of the camera to follow the action and keep the character within a frame." David Bordwell and Kristin Thompson, Film Art: an Introduction. 5th Edition, 80.

[233] Chris McGowan and Jim McCullaugh, Entertainment in the Cyber Zone (New York: Random House, 1995), 71.

[234] This is true for a procedural programming paradigm. In a object-oriented programming paradigm, represented by such computer langaugues as Java and C++, algorithms and data structures are modeled together as objects.

[235] Mediamatic 8, no. 1 (Summer 1994), 1860.

[236] Bob Laird, "Information Age Loosing Memory," USA TODAY, Monday, October 25, 1999.
[237] http://www.amazon.com/exec/obidos/subst/misc/company-info.html/, http://www.oracle.com/database/oracle8i/, accessed Nov. 28, 1998;
[238] http://artnetweb.com/guggenheim/mediascape/shaw.html
[239] Harwood, Rehearsal of Memory, CD-ROM (London: Artec and Bookworks, 1996.)
[240] http://www.telepresence.com/MENAGERIE, accessed October 22, 1998.
[241] http://jefferson.village.virginia.edu/wax/, accessed September 12, 1998.
[242] http://www.cs.msu.su/wwwart/, accessed October 22, 1998.
[243] Mieke Bal, Naratology: Introduction to the Theory of Narrative (Toronto: University of Toronto Press, 1985), 8.
[244] The theory of marketdness was first developed by linguists of the Prague School in relation to phonology but subsequently applied to all levels of linguistic analysis. For example, "bitch" is the marked term and "dog" is unmarked term. Whereas the "bitch" is used only in relation to females, "dog" is applicable to both males and females.
[245] Fredric Jameson, "Postmodernism and Consumer Society," in The Anti-Aesthetic. Essays on Postmodern Culture, ed. Hal Foster (Seattle: Bay Press, 1983), 123.
[246] Roland Barthes, The Elements of Semiology (New York: Hill and Wang, 1968), 58.
[247] Qtd. in ibid., 58.
[248] Christian Metz, "The Fiction Film and its Spectator: A Metapsychological Study," in Apparatus, edited by Theresa Hak Kyung Cha (New York: Tanam Press, 1980), p. 402.
[249] Rosalind Krauss, "Video: The Aesthetics of Narcissism," in John Hanhardt, ed., Video Culture (Rochester: Visual Studies Workshop, 1987), 184.
[250] This analysis can be also applied to many interactive computer installation. The user of such an installtion is presented with her own image; the user is given the possibility to play with this image and also observe how her movements trigger various effects. In a diffirent sense, most of new media regardless of whether it represents to the user her image or not can be said to activate the narcissistic condition because it represents to the user her actions and their results. In other words, it functions as a new kind of mirror which reflects not just the

human image but her activities. This is a diffirent kind of Narcissism: not a passive contemplation but action. The user moves the cursor around the screen; clicks on icons; presses the keys on the keyboard and so on. The computer screen acts as a mirror of these activities. Often, this mirror not simply reflects but greatly amplifies user's actions. This is the second diffirence from traditional Narcissism. For instance, clicking on a folder icon activates an animation accompanied by sound; pressinng a button on a game pad sends the character to climb the mountain; and so on. But even without this amplification the modern GUI functions as a mirror, always representing the image of the user in the form of a cursor moving around the screen.

[251] Qtd. in Sam Hunter and John Jacobus, Modern Art: Painting, Sculpture and Architecture, 3rd ed. (New York: Abrams, 1992), 326.

[252] Frank Dietrich, "Visual Intelligence: The First Decade of Computer Art (1965 — 1975)," IEEE Computer Graphics and Applications (July 1985), 39.

[253] Gene Youngblood, Expanded Cinema (New York: E.P. Dutton & Co,Inc., 1970), 210.

[254] Peter Greenaway, The Stairs—Munich—Projection 2 (London: Merrell Holberton Publishers, 1995), 21.

[255] Qtd. in David Pascoe, Peter Greenaway: Museums and Moving Images (London: Reaktion Books, 1997), 9-10.

[256] http://www.tem-nanterre.com/greenaway-100objects/, accesed November 3, 1998.

[257] Greenaway, The Stairs—Munich—Projection 2, 47-53.

[258] Mikhail Kaufman, "An Interview," October 11 (Winter 1979): 65.

[259] It can be said that Vertov uses "the Kuleshov's effect" to give the meaning to the database records by placing them in a particular order.

[260] Linguistics, semiotics and philosophy use the concept of metalanguage. Metalanguage is the language used for the analysis of object language. Thus, a metalanguage may be thought of as a language about another language. A metatext is a text in metalanguage about a text in object language. For instance, an article in a fashion magazine is a metatext about the text of cloves. Or, HTML file is a metatext which desribes the text of a Web page.

[261] We should remember that various temporal montage techniques were still a novelty in the 1920s; for a contemporary viewer, they had the same status as "special effects" such as 3D characters are the viewer of the 1990s. Therefore, the original viewers of Vertov's film probably experienced it as one long special effects sequence.

262 Ibid., 55.
263 David Bordwell, "Classical Hollywood Film," in Philip Rosen, Narrative, Apparatus, Ideology: A Film Theory Reader (Columbia University Press, 1987).
264 J.C.Hertz, Joystick Nation (Boston: Little, Brown and Company, 1997), 90, 84.
265 Ibid., 150.
266 Michel de Certeau, The Practice of Everyday Life, trans. Steven Rendall (Berkely, University of California Press, 1984), 129.
267 Bal, Narratology, 130. Bal defines fabula as "a series of logically and chronologically related events that are caused or expeienced by actors" (5).
268 In Understanding Comics Scott McLoud notes how, in contrast to Western comics, Japanese comics spend much more time on "description" which is not directly motivated by the narrative development. The same opposition holds between the language of classical Hollywood cinema and many films from the "east," such as the works of Tarkovsky and Kore-eda. Although I recognize the danger of such a generalization, it is tempting to connect narration – description opposition to a much larger opposition between traditionally Western and Eastern ways of existence and philosophies: the drive of a Western subject to know and conquer the world outside versus Buddhist emphasis on meditation and stasis. Scott McLoud, Understanding Comics: The Invisible Art (Harper Perennial, 1994).
269 Bal, Narratology, 130-132.
270 Chris McGoman and Jim McCullaugh, Entertainment in the Cyber Zone (New York: Random House, 1995), 120.
271 Qtd. in J.C.Hertz, Joystick Nation, 155-156.
272 For critical anaylsis of motion simulator phenomenon, see Erkki Huhtamo, "Phantom Train to Technopia," in Minna Tarkka, ed., ISEA '94. The 5fth International Symposium on Electronic Art Catalogue (Helsinki: University of Art and Design, 1994); "Encapsulated Bodies in Motion: Simulators and the Quest for Total Immersion," in Simon Penny, ed., Critical Issues in Electronic Media (State University of New York Press, 1995).
273 See www.cybergeography.com, accessed October 7, 1999.
274 Stuart Card, George Robertson, Jock Mackingly, "The Information Visualizer, an Information Workplace," in CHI'91: Human Factors in Computing Systems Conference Proceedings (New York: ACM, 1991) , 181-186; available online at

http://www.acm.org/pubs/articles/proceedings/chi/108844/p181-card/p181-card.pdf, accessed June 18, 1999.

[275] http://www.artcom.de/projects/t_vision/, accessed Dec. 26, 1998.

[276] http://www.acm.org/sigchi/chi95/proceedings/panels/km_bdy.htm, accessed Dec. 26, 1998.

[277] William Gibson, Neuromancer (New York: Ace Books, 1984).

[278] Marcos Novak, "Liquid Architecture in Cyberspace," in Michael Benedict, ed., Cyberspace: First Steps (Cambridge, Mass.: The MIT Press, 1991).

[279] Mark Pesce, Peter Kennard and Anthony Parisi, "Cyberspace," 1994. Http://www.hyperreal.org/~mpesce/www.html, accessed June 17, 1999.

[280] Ibid.

[281] Michael Bendedict explores the relevance of some of these disciplines to the concept of cyberspace in the introduction to his groundbreaking anthology Cyberspace: First Steps, which remains one of the best books on the topic of cyberspace. Michael Benedict, ed., Cyberspace: First Steps (Cambridge, Mass.: The MIT Press, 1991).

[282] Henri Lefebvre, The Production of Space (Oxford: Blackwell Publishers, 1991); Michel Foucault, Discipline and Punish: the Birth of the Prison (New York: Pantheon Books, 1977); Fredric Jameson, The Geopolitical Aesthetic: Cinema and Space in the World System (Bloomington: Indiana University Press, 1992); David Harvey, The Condition of Postmodernity (Oxford, England: Blackwell, 1989); Edward Soja, Postmodern Geographies: the Reassertion of Space in Critical Social Theory (London: Verso, 1989).

[283] See, for instance, Benedict, Cyberspace: First Steps; the articles of Marcos Novak (http://www.aud.ucla.edu/~marcos).

[284] http://icwhen.com/the70s/1971.html, accessed November 21, 1998.

[285] Heinrich Wölfflin, Principles of Art History, translated by M. D. Hottinger (New York, Dover Publications, 1950).

[286] Erwin Panofsky, Perspective as Symbolic Form, translated by Christopher S. Wood (New York: Zone Books, 1991).

[287] See my article "Mapping Space: Perspective, Radar and Computer Graphics."

[288] Quoted in Alla Efimova and Lev Manovich, "Object, Space, Culture: Introduction," in Tekstura: Russian Essays on Visual Culture, eds. Alla Efimova and Lev Manovich (Chicago: University of Chicago Press, 1993), xxvi.

[289] Gilles Deleuse, Cinema (Minneapolis: University of Minessota Press, 1986-1989).
[290] Jed Hatman and Josie Werneke, The VRML 2.0 Handbook (Reading, Mass.: Addison-Wesley Publishing Company, 1996).
[291] See Ferdinand Tönnies, Community and Society, trans. Charles P. Loomis (East Lansing, Michigan State University Press, 1957).
[292] One importance exeption was the Apparatus theory developed by film theoreticians in the 1970s.
[293] Stewart Brand, The Media Lab (New York: Penguin Books, 1988), 141.
[294] Manuela Abel, ed., Jeffrew Shaw - a User's Manual (Kalsuhe, Germany: ZKM, 1997), 127 - 129. Three difirent versions of Legible City were created based on the plans of Manhattan, Amsterdam and Karlsruhe, Germany.
[295] http://www.softimage.com/Projects/Osmose/
[296] George Legrady, Transitional Spaces, exhibition catalog (Munich: Siemens Kultur Programm, 1999), 5.
[297] For a discussion of Archigram group in the context of computer-based virtual spaces, see Hans-Peter Schwarz, Media-Art-History. Media Museum (Munich: Prestel-Verlag, 1997), 74-76.
[298] See, for instance, Visionary Architects: Boullee, Ledoux, Lequeu (Houston: University of St. Thomas, 1968); Heinrich Klotz, ed., Paper architecture: New Projects from the Soviet Union (Frankfurt: Deutsches Architekturmuseum, 1988).
[299] See, for instance, Dietrich Neumann, ed., Film architecture: Set Designs from Metropolis to Blade Runner (Munich: Prestel, 1996).
[300] Ilya Kabakov, On the "Total Installation" (Bonn: Cantz Verlag, 1995).
[301] Ibid., 125. This and the following translations from Russian text of Kabakov are mine — L.M.
[302] Ibid., 200.
[303] Ibid., 200-208.
[304] Ibid., 162.
[305] Ibid., 162.
[306] De Certeau, The Practice of Everyday Life, XVIII.
[307] Charles Baudelaire, "The Painter of Modern Life," in My Heart Laid Bare and Other Prose Writings (London: Soho Book Company, 1986).
[308] Walter Benjamin, "Paris, Capital of the Nineteenth Century," in Reflections

(New York: Schocken Books, 1986), 156.

[309] The distinction between Gemeinschaft and Gesellshaft was developed by Tönnies in Community and Society.

[310] Adilkno, The Media Archive (Brooklyn, New York: Autnomedia,1998), 99.

[311] Ibid., 100.

[312] Ibid.

[313] Ibid.

[314] This narrative of maturation can be also seen as a particular case of an initiation ceremony, something which traditionally was a part of every human society.

[315] Peter Gloor, Elements of Hypermedia Design (Boston, Basel, Berlin: Birkhäuser, 1997).

[316] Anne Friedberg, Window Shopping, 2.

[317] Ibid.

[318] Ibid., 184.

[319] Ibid., 94.

[320] See Don Gentner and Jakob Nielson, "The Anti-Mac Interface," Communications of the ACM 39, no. 8 (August 1996), 70-82. Available online at http://www.acm.org/cacm/AUG96/antimac.htm.

[321] Benjamin Wooley, Virtual Worlds (Oxford, UK and Cambridge, USA: Blackwel, 1992), 39, 43.

[322] For more on the history of 3-D computer graphics, see my article "Mapping Space: Perspective, Radar and Computer Graphics."

[323] http://www.es.com/product_index.html, accessed January 27, 1999.

[324] Elizabeth Sikorovsky, "Training spells Doom for Marines," Federal Computer Week, July 15, 1996, available online at http://www.fcm.com/pubs/fcw/0715/guide.htm.

[325] Paul Virilio, War and Cinema (London and New York: Verso, 1989).

[326] Marc Auge, Non-places. Introduction to an Anthropology of Supermodernity, translated by John Howe (London and New York: Verso, 1995), 78.

[327] Ibid., 53-53.

[328] Ibid., 79-80.

[329] Ibid., 101, 103.

[330] Ibid., 94.
[331] De Certeau, The Practice of Everyday Life, XIV.
[332] Jean-Claude Dubost and Jean-Francois Gonthier, eds., Architecture for the Future (Paris: Éditions Pierre Terrail, 1996), 171.
[333] Abel, Jeffrey Shaw, 138-139; 142-145.
[334] Here I am describing the particular application of EVE which I saw at "Multimediale 4" exhibition, Karlsruhe, Germany, May 1995.
[335] See Marcos Novak, Liquid Architectures in Cyberspace, in Cyberspace: The First Steps.
[336] Another notion which belongs to this paradigm of discontinuity is René Thom's catastrophe theory. See his Structural Stability and Morphogenesis (Reading, Mass.: W.A. Benjamin, 1975).
[337] The phenomenon of motion rides has been already discussed in detail by Finish new media theoretician and historian Erki Huhtamo.
[338] 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.
[339] On the history of computer-based image analysis, see my article "Automation of Sight from Photography to Computer Vision."
[340] Scott Billups, presentation during "Casting from Forest Lawn (Future of Performers) panel at "The Artists Rights Digital Technology Symposium '96," Los Angeles, Directors Guild of America, February 16 1996. Billups was a major figure in bringing Hollywood and Silicon Valley together by way of the American Film Institute's Apple Laboratory and Advanced Technologies Programs in the late 1980s and ealy 1990s. See Paula Perisi, "The New Hollywood Silicon Stars," Wired 3.12 (December, 1995), 142-145; 202-210.
[341] Christian Metz, "The Fiction Film and its Spectator: A Metaphychological Study," in Apparatus, edited by Theresa Hak Kyung Cha (New York: Tanam Press, 1980), 402.
[342] Cinema as defined by its "super-genre" of fictional live action film belongs to media arts which, in contrast to traditional arts, rely on recordings of reality as their basis. Another term which is not as popular as "media arts" but perhaps is more precise is "recording arts." For the use of this term, see James Monaco, How to Read a Film, revised edition (New York and Oxford: Oxford University Press, 1981), 7.

[343] Charles Musser, The Emergence of Cinema: The American Screen to 1907 (Berkeley and Los Angeles: University of California Press, 1990), 49-50.
[344] Musser, The Emergence of Cinema, 25.
[345] C.W. Ceram, Archeology of the Cinema (New York: Harcourt, Brace & World, Inc., 1965), 44-45.
[346] The birth of cinema in the 1890s is accompanied by an interesting transformation: while the body as the generator of moving pictures disappears, it simultaneously becomes their new subject. Indeed, one of the key themes of early films produced by Edison is a human body in motion: a man sneezing, a famous bodybuider Sandow flexing his muscles, an athlete performing somesault, a woman dancing. Films of boxing matches play a key role in the commercial development of Kinetoscope. See Musser, The Emergence of Cinema, 72-79; David Robinson, From Peep Show to Palace: the Birth of American Film (New York: Columbia University Press, 1996), 44-48.
[347] Robinson, From Peep Show to Palace, 12.
[348] This arrangement was previously used in magic lantern projections; it is described in the second edition of Althanasius Kircher's Ars magna (1671). See Musser, The Emergence of Cinema, 21-22.
[349] Ceram, Archeology of the Cinema, 140.
[350] Musser, The Emergence of Cinema, 78.
[351] The extent of this lie is made clear by the films of Andy Warhol from the first part of the 1960s — perhaps the only real attempt to create cinema without a language.
[352] I have borrowed this definition of special effects from David Samuelson, Motion Picture Camera Techniques (London: Focal Press, 1978).
[353] The following examples illustrate this disavowal of special effects; other examples can be easily found. The first example is from popular discourse on cinema. A section entitled "Making the Movies" in Kenneth W. Leish Cinema (New York: Newsweek Books, 1974) contains short stories from the history of the movie industry. The heroes of these stories are actors, directors and producers; special effects artists are mentioned only once. The second example is from an academic source: the authors of the authoritative Aesthetics of Film (1983) state that "the goal of our book is to summarize from a synthetic and didactic perspective the diverse theoretical attempts at examining these empirical notions [terms from the lexicon of film technicians], including ideas like frame vs. shot, terms from production crews' vocabularies, the notion of identification produced by critical vocabulary, etc." The fact that the text never mentions special effects

techniques reflects the general lack of any historical or theroretical interest in the topic by film scholars. Bordwell and Thompson's Film Art: An Introduction which is used as a standard textbook in undergraduate film classes is a little better as it devotes three pages out of its five hundred pages to special effects. Finally, a relevant piece of statistics: a library of University of California, San Diego contains 4273 titles catalogued under the subject "motion pictures" and only 16 tiles under "special effects cinematography." For the few important works addressing the larger cultural significance of special effects by film theoreticians see Vivian Sobchack and Scott Bukatman. Norman Klein is currently working on a history of special effects environments.
Kenneth W. Leish Cinema (New York: Newsweek Books, 1974); Jacques Aumont, Alain Bergala, Michel Marie and Marc Vernet, Aesthetics of Film, trans. Richard Neupert (Austin: University of Texas Press, 1992), p. 7; David Bordwell and Kristin Thompson, Film Art: an Introduction, 4th ed. (New York: McGraw-Hill, Inc., 1993); Vivian Sobchack Screening Space: The American Science Fiction Film, 2nd ed. (New York: Ungar, 1987); Scott Bukatman, "The Artificial Infinite," in Visual Display, eds. Lynne Cooke and Peter Wollen (Seattle: Bay Press, 1995).

[354] For a discussion of the subsumption of the photographic to the graphic, see Peter Lunenfeld, "Art Post-History: Digital Photography and Electronic Semiotics," Photography After Photography, eds. v. Amelunxen, Stefan Iglhaut, Florian Rötzer, 58-66. Münhen: Verlag der Kunst, 1995.

[355] For a complete list of people at ILM who worked on this film, see SIGGRAPH '94 Visual Proceedings (New York: ACM SIGGRAPH, 1994), 19.

[356] In this respect 1995 can be called the last year of digital media. At 1995 National Association of Broadcasters convention Avid showed a working model of a digital video camera which records not on a video cassette but directly onto a hard drive. Once digital cameras become widely used, we will no longer have any reason to talk about digital media since the process of digitization will be eliminated.

[357] Here is another, even more radical definition: digital film = f (x, y, t). This definition would be greeted with joy by the proponents of abstract animation. Since computer breaks down every frame into pixels, a complete film can be defined as a function which, given horizontal, vertical and time location of each pixel, returns its color. This is actually how a computer represents a film, a representation which has a surprising affinity with a certain well-known the avant-garde vision of cinema! For a computer, a film is an abstract arrangement of colors changing in time, rather than something structured by "shots," "narrative," "actors" and so on.

[358] Paula Parisi, “Grand Illusion,” Wired 7.05 (May 1999), 137.
[359] See Barbara Robertson, "Digital Magic: Appolo 13," Computer Graphics World (August 1995), 20.
[360] Mitchell, The Reconfigured Eye, 7.
[361] The full advantage of mapping time into 2-D space, already present in Edison's first cinema apparatus, is now realized: one can modify events in time by literally painting on a sequence of frames, treating them as a single image.
[362] See Robinson, From Peep Show to Palace, 165.
[363] See "Industrial Light & Magic alters history with MATADOR," promotion material by Parralax Software, SIGGRAPH 95 Conference, Los Angeles, August 1995.
[364] See my “Avant-Garde as Software,” in Ostranenie, edited by Stephen Kovats (Frankfurt and New York: Campus Verlag, 1999.). (http://visarts.ucsd.edu/~manovich)
[365] For the experiments in painting on film by Lye, McLaren and Brackage, see Robert Russett and Cecile Starr, Experimental Animation (New York: Van Nostrand Reinhold Company, 1976), pp. 65-71, 117-128; P. Adams Smith, Visionary Film, 2nd ed. (Oxford: Oxford University Press), 230, 136-227.
[366] Dziga Vertov coined the term "kino-eye" in the 1920s to describe the cinematic apparatus's ability "to record and organize the individual characteristics of life's phenomena into a whole, an essence, a conclusion." For Vertov, it was the presentation of film "facts," based as they were on materialist evidence, that defined the very nature of the cinema. See Kino-Eye: The Writings of Dziga Vertov, ed. Annette Michelson, trans. Kevin O'Brien (Berkely: University of California Press, 1984). The quotation above is from "Artistic Drama and Kino-Eye," originally published in 1924, pages 47-49, 47.
[367] Reporting in December 1995 issue of Wired, Paula Parise writes: "A decade ago, only an intrepid few, led by George Lucas's Industrial Light and Magic, were doing high-quality digital work. Now computer imaging is considered an indespensable production tool for all films, from the smallest drama to the largest visual extravaganza." (Perisi, "The New Hollywood Silicon Stars," 144.)
[368] Mark Frauenfelder, “Hollywood’s Head Case, “ Wired 7.08 (August 1999), 112.
[369] Metz, "The Fiction Film and its Spectator: A Metaphychological Study."

370 This 28 minute film, made in 1962, is composed almost exclusively of still frames. For documentation, see Chris Marker, La Jetée: Ciné-roman (New York: Zone Books, 1992).

371 These parallels are further investigated in my “Little Movies” (http://visarts.ucsd.edu/~manovich/little-movies).

372 Kuhn, The Structure of Scientific Revolutions.

373 “Little Movies” explorers the aesthetics of digital cinema and draws paralels between the early cinema of the 1990s, the structuralist filmmaking of the 1960s and the new media of the 1990s.

374 http://www.danny.com, accessed September 9, 1999.

375 http://www.activeworlds.com, accessed September 9, 1999.

376 Natalie Bookchin’s CD-ROM “Databank of the Everyday” (1996) investigates the loop as a structure of everyday life. Since I did the larger part of cinematography and some interface design for this project, I do not discuss it in the main text.

377 Terence Riley, The Un-private House (New York: The Museum of Modern Art,1999).

378 http://www.mlab.uiah.fi/

379 My analysis is based on a project ptototype which I saw in October of 1999. The completed project is projected to have a male and a female character.

380 Flora petrinsularis (1993) is included in the compilation CD-ROM, Artintact 1 (Karlsruhe, Germany: ZKM/Center for Art and Media, 1994). These are other ZKM publications are available at www.zkm.de.

381 Steven Neale, Cinema and Technology (Bloomington: Indiana University Press, 1985), 52.

382 Edward Soja, keynote lecture at “History and Space” conference, University of Turku, Turku, Finland, October 2, 1999.

383 http://www.telepolis.de/tp/deutsch/kunst/3040?1.html, accessed accessed September 16, 1999. Liliana’s other net.art projects can be found at http://www.teleportacia.org.

384 Michel Foucault, Dits et ecrits. Selections, vol. 1 (New York: New Press, 1997).

385 Anne Hollander’s Moving Pictures presents paralells compositional and scenographic strategies in painting and cinema, and it can be a useful source for further thinking about both as precursors to contemporary information design.

Anne Hollander, Moving Pictures, reprint edition (Harvard University Press, 1991). Another useful study which also systematically comparises between compositional and sceneographic strategies of the two media is Jacques Aumont, The Image, translated by Claire Pajackowska (London: British Film Institite, 1997).

[386] Alpers, The Art of Describing.

[387] Walter Benjamin, "On Some Motives in Baudelaire," in Illuminations, ed. Hannah Arendt (New York: Schochen Books, 1969), 175.

[388] http:www.vuk.org/ascii, accessed May 29, 1999.

[389] The reason that I refer to Stars Wars: Episode 1, The Phantom Menace as the first all-digital film, as opposed to reserving this title for Toy Story a first feature length animation by Pixar (1995) is that the former relies on human actors and real sets, supplementing those with computer animation. It is, in other words, a traditional live action film simulated on computers, in contrast to Toy Story whose reference is cartoons and the tradition of computer animation.

[390] http://www.onlineloop.com/pub/VinulVideo.

[391] www.vuk.org/ascii/aae.html

[392] See also Bruce Sterling's Dead Media Project http://eff.bilkent.edu.tr/pub/Net_culture/Folklore/Dead_Media_Project/.

[393] www.jodi.org.

[394] www.easylife.org/386dx.

[395] "teleprinter" Encyclopaedia Britannica Online <http://www.eb.com:180/bol/topic?thes_id=378047> Accessed May 27, 1999.