MediaArtHistories

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MediaArtHistories

edited by Oliver Grau

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Series Foreword

The arts, science, and technology are experiencing a period of profound change. Explosive challenges to the institutions and practices of engineering, art making, and scientific research raise urgent questions of ethics, craft, and care for the planet and its inhabitants. Unforeseen forms of beauty and understanding are possible, but so too are unexpected risks and threats. A newly global connectivity creates new arenas for interaction between science, art, and technology but also creates the preconditions for global crises. The Leonardo Book series, published by the MIT Press, aims to consider these opportunities, changes, and challenges in books that are both timely and of enduring value.

Leonardo books provide a public forum for research and debate; they contribute to the archive of art-science-technology interactions; they contribute to understandings of emergent historical processes; and they point toward future practices in creativity, research, scholarship, and enterprise.

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Leonardo, the International Society for the Arts, Sciences, and Technology, and the affiliated French organization Association Leonardo have two very simple goals:

1. to document and make known the work of artists, researchers, and scholars interested in the ways that the contemporary arts interact with science and technology; and
2. to create a forum and meeting places where artists, scientists, and engineers can meet, exchange ideas, and, where appropriate, collaborate.

When the journal *Leonardo* was started some forty years ago, these creative disciplines existed in segregated institutional and social networks, a situation dramatized at that time by the "Two Cultures" debates initiated by C. P. Snow. Today we live in a different time of cross-disciplinary ferment, collaboration, and intellectual confrontation enabled by new hybrid organizations, new funding sponsors, and the shared tools of computers and the Internet. Above all, new generations of artist-researchers and researcher-artists are now at work individually and in collaborative teams bridging the art, science, and technology disciplines. Perhaps in our lifetime we will see the emergence of "new Leonardos," creative individuals or teams that will not only develop a meaningful art for our times but also drive new agendas in science and stimulate technological innovation that addresses today's human needs.

For more information on the activities of the Leonardo organizations and networks, please visit our websites at http://www.leonardo.info/ and http://www.olats.org/.

Roger F. Malina
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This book is the fruit of the labors of many colleagues with whom I have had the pleasure to work and get to know on various levels during the past fifteen years. Thanks to all the authors from many disciplines for the highly professional worldwide collaboration which made this book possible. The desire to bring together a collection of thinkers from a variety of fields, all examining media art, is answered in this book as well as by a conference for which I served as chair in 2005. Refresh! The First International Conference on the Histories of Media Art, Science, and Technology was produced by the Database for Virtual Art, Leonardo, and the Banff New Media Institute (where the conference was held) and was a great success for the emerging field of scholars for whom this book is also produced. Though this book is not a direct result of the conference, Refresh! nonetheless definitively influenced our discussions.

I would like to thank the Advisory and Honorary Board of the Refresh! conference, many of whom are contributors to this book, for their engagement in the creation of our emerging field: Rudolf Arnheim, Andreas Broeckmann, Paul Brown, Karin Bruns, Annick Bureaud, Dieter Daniels, Diana Domingues, Felice Frankel, Jean Gagnon, Thomas Gunning, Linda D. Henderson, Manray Hsu, Erkki Huhtamo, Douglas Kahn, Ángel Kalenberg, Martin Kemp, Ryszard Kluszczynski, Machiko Kusahara, W. J. T. Mitchell, Gunalan Nadarajan, Christiane Paul, Louise Poissant, Frank Popper, Jasia Reichardt, Itsuo Sakane, Edward Shanken, Jeffrey Shaw, Barbara Maria Stafford, Tereza Wagner, Peter Weibel, Steven Wilson, and Walter Zanini.

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My deepest thanks to Rudolf Arnheim, whose influence on the field and lifetime of work have been greatly impressed upon my own research.

1

Introduction

Oliver Grau

> The technology of the modern media has produced new possibilities of interaction. . . . What is needed is a wider view encompassing the coming rewards in the context of the treasures left us by the past experiences, possessions and insights.
> —RUDOLF ARNHEIM, SUMMER 2000

Recognizing the increasing significance of media art for our culture, this book will discuss for the first time the history of media art within the interdisciplinary and intercultural contexts of the histories of art. It explores and summarizes the mutual influences and the interactions of art, science, and technology and assesses the status of digital art within the art of our times. To do so, this collection assembles some of the most well-known researchers of this emerging field.

This book discusses questions of historiography, methodology, terminology, and the roles of institutions and inventions in media art. It contains key debates about the function of the machinic, of projection, visuality, automation, of neural networks and mental representation, as well as the prominent role of sound during the last decades, contemporary science theory, and scientific visualization. It will also emphasize themes of collaborative research and pop culture in the histories of media art.

The goal is to open up art history to include media art from recent decades and contemporary art forms. Besides photography, film, video, and the little-known media art history of the 1960s to the '80s, today media artists are

active in a wide range of digital areas (including net art, interactive, genetic, and telematic art). Even in robotics, a-life, and nanotechnology, artists design and conduct experiments.[1] This dynamic process has triggered intense discussion about images in the disciplines of art history, media, cultural studies, and the history of science. The focus will be to view and analyze media art against the backdrop of art history and reflections from neighboring disciplines. This anthology in media art histories offers a basis for attempting an evolutionary history of audiovisual media. It is an evolution with breaks and detours; however, all its stages are distinguished by a close relationship between art, science, and technology.

This is what it's about: hundreds of names of artists, thousands of artworks, art trends, theory of media art in keywords, presented in an enormous circle-diagram (fig. 1.1). Thirty-two slices are offered as a subdivision into themes, such as representation, emotion and synesthesia, the material issue in art, atmosphere, games, therapy, mission, and art as spatial experience through which we find glimpses of a history of media art.[2] Over the last thirty years

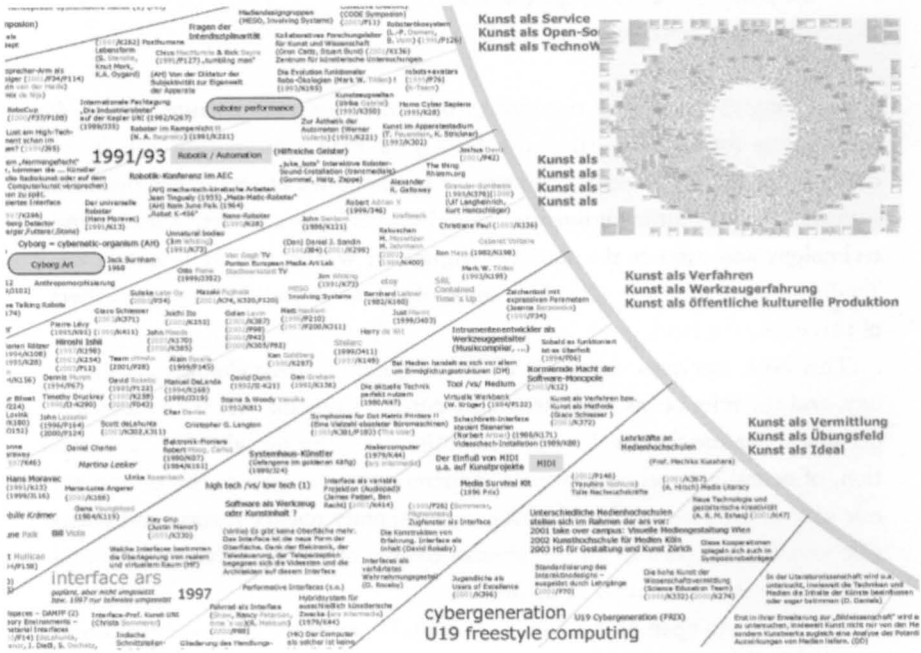

Figure 1.1 Gerhard Dirmoser, *Ars Concept Cluster*, 2004. By kind permission of the author.

media art has evolved into a vital factor of the contemporary artistic scene. Digital art has become the art of our times, yet it has not "arrived" in the cultural institutions of our societies. It is still rarely collected, it is not included or supported under the auspices of art history or other academic disciplines, and it is almost inaccessible for the non-north-Western public and their scholars. To change this is our goal! What is needed is a wider view encompassing media art in the context of the treasures left us by past experiences, possessions, and insights.

On the path leading toward installation-based virtual art, Charlotte Davies transports us with *Osmose* or *Éphémère*—already classics—into a visually powerful simulation of a lush mineral-vegetable sphere, which we can explore via an intimate interface (fig. 1.2).[3] Japanese-flavored interaction is observed with Hiroo Iwata's *Floating Eye* (2000; fig. 1.3), in which a camera on a blimp replaces one's normal vision with a panoramic spherical screen, so that one can observe oneself from above. Operating in both the scientific and artistic arena, Karl Sims's artificial life research can be found at the Centre Pompidou

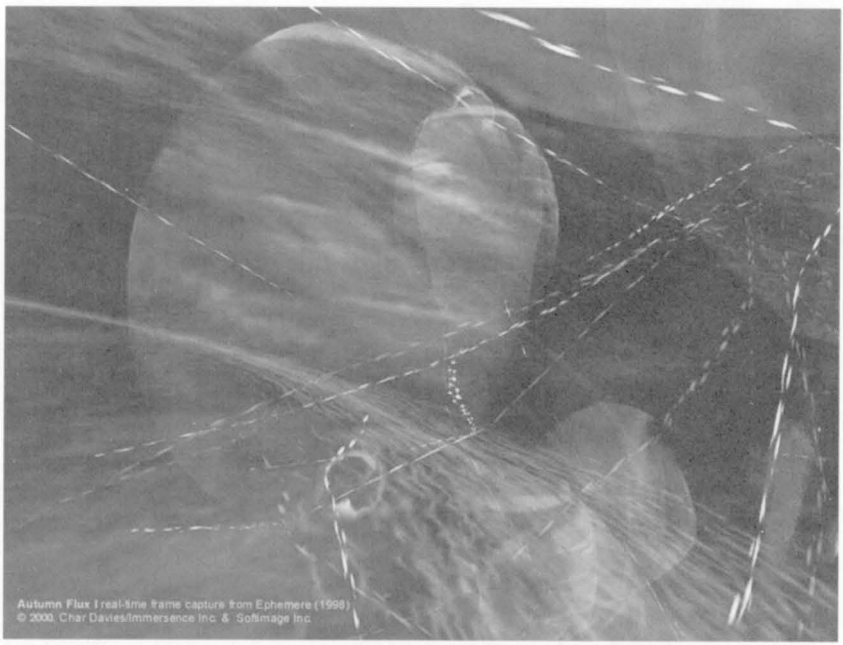

Figure 1.2 Char Davies, *Éphémère*, 1998. See plate 1. By kind permission of the artist.

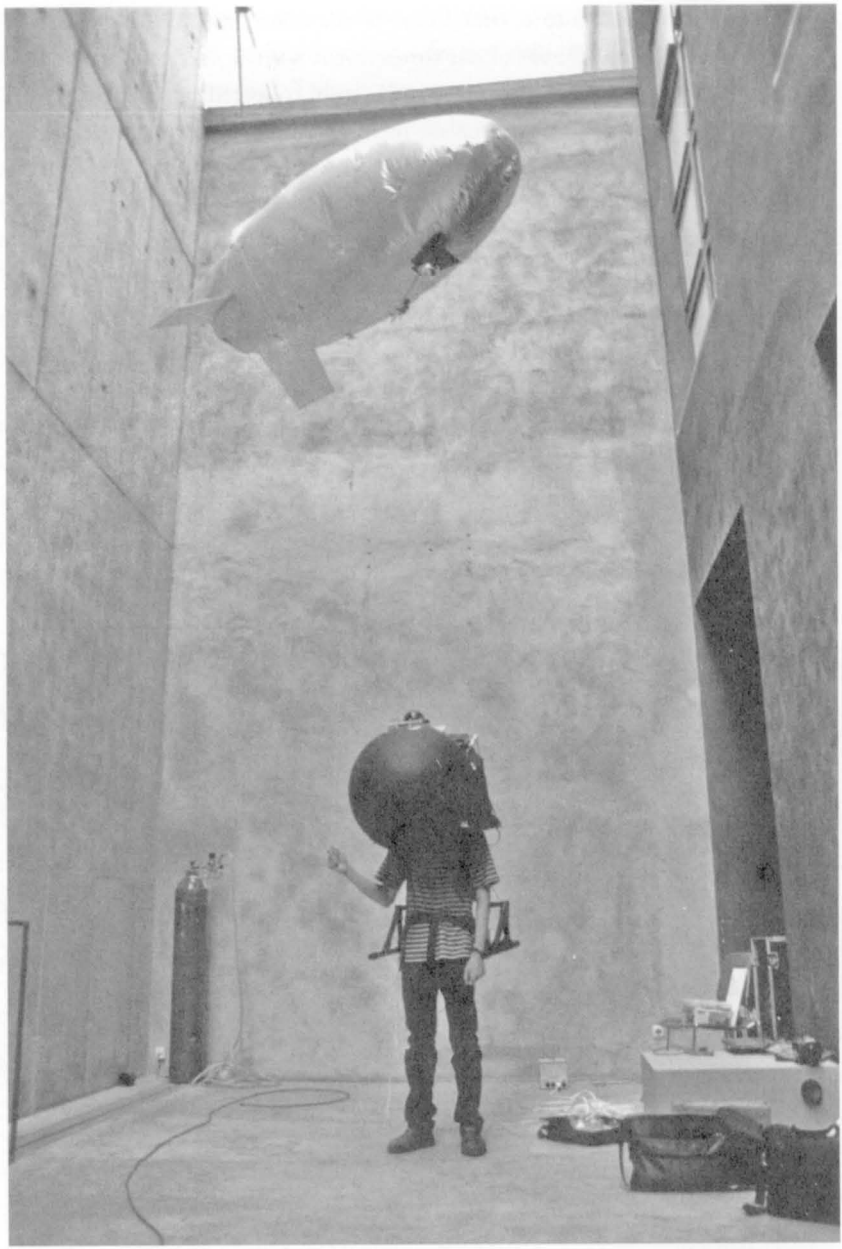

Figure 1.3 Hiroo Iwata, *Floating Eye*, 2000. By kind permission of the artist. Photo by Ars Electronica.

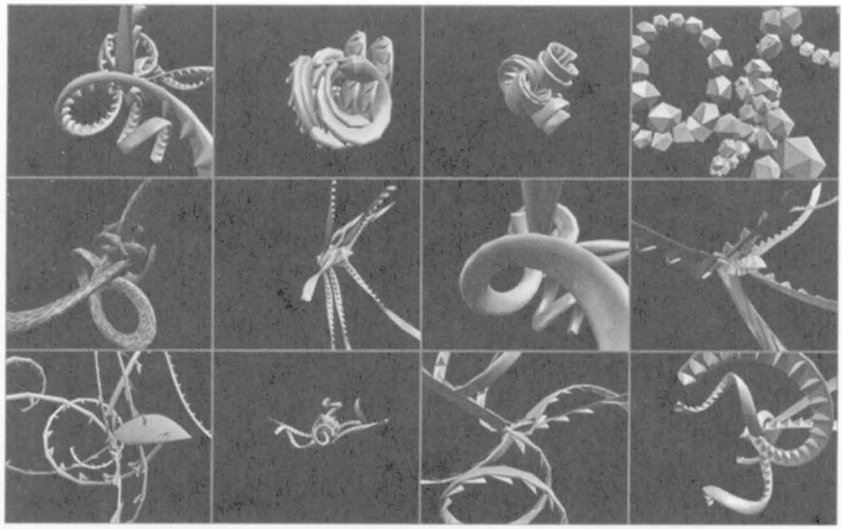

Figure 1.4 Karl Sims, *Genetic Images*, 1993. See plate 2. By kind permission of the scientist.

and in his technical journals (fig. 1.4). Constructed on a database, the interactive installation *Ultima Ratio* by Daniela Plewe offers a first glimpse of a future system for interactive theater (fig. 1.5). Intellectually challenging, her concept piece allows the spectator to solve an open conflict at a high level of abstraction using combination of different dramatic motifs. Plewe's goal is to generate a visual language for argument and debate.[4]

David Rokeby's *Very Nervous System* is a classic sound piece now twenty years old on publication of this book. Presented in galleries and public outdoor spaces and used in performances over the past two decades, this work creates a complex and resonant aural relationship between the interactor and the system (fig. 1.6).

In a finely meshed alliance between science and art, media art today explores the aesthetic potential of interactive, processual image worlds. Leading exponents of virtual image culture work in basic research and combine art and science in the service of today's most complex technology for generating images. These internationally prominent artists, who often work as scientists at research institutes, are engaged in the development of new interfaces, models for interaction, and innovative codes: they set the technical limits themselves according to their own aesthetic goals and criteria.

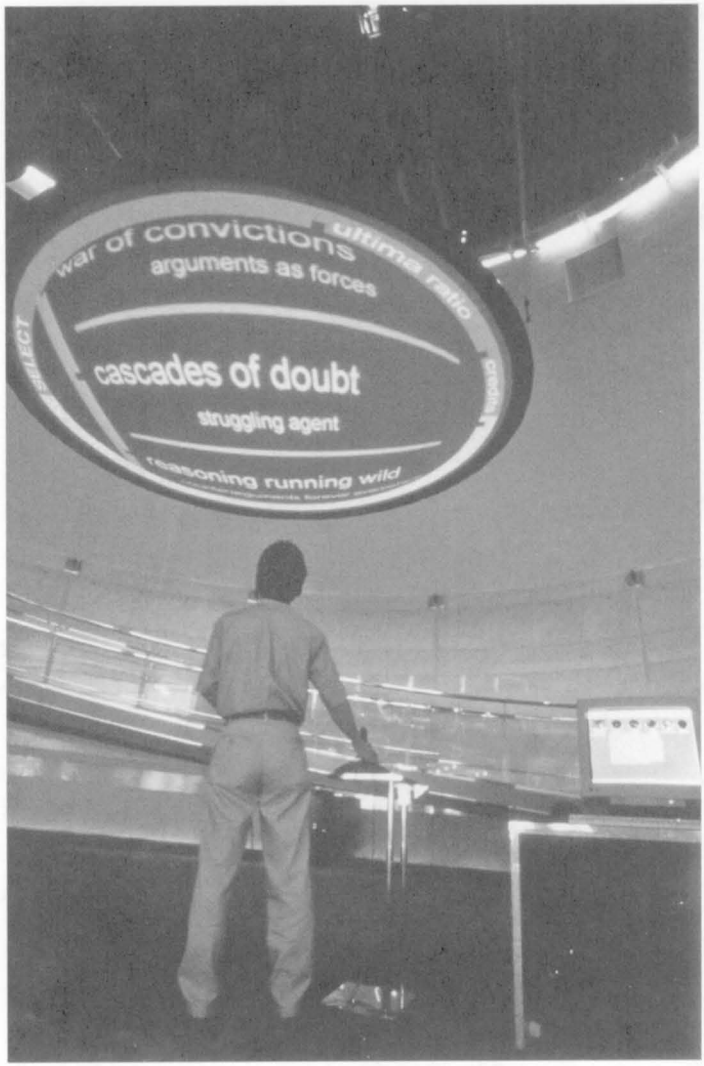

Figure 1.5 Daniela Plewe, *Ultima Ratio*, 1997. By kind permission of the artist.

Figure 1.6 David Rokeby, *Very Nervous System*, 1986. By kind permission of the artist.

The Next Five Seconds

These artworks both represent and reflect the revolutionary development that the image has undergone over the past few years. Never before has the world of images changed at such a breakneck pace as over the last few decades. Images were once exceptional and rare, reserved mainly for religious rituals; later, they were the province of art, then of museums and galleries. Today, in the age of cinema, television, and the Internet, we are caught up in a matrix of images. Images are now advancing into new domains. Television, for example, is changing into a zapping field of thousands of channels; gigantic projection screens are invading our cities; infographics permeate the print media; and cell phones transmit micromovies in real time. Currently, we are witnessing the transformation of the image into a computer-generated, virtual, and spatial entity that seemingly is capable of changing "autonomously" and representing a lifelike, visual-sensory sphere. Interactive media are changing our perception and concept of the image in the direction of a space for multisensory, interactive experience with a temporal dimension. Things that formerly

were impossible to depict can now be represented; temporal and spatial parameters can be changed at will so that virtual spheres can be used as models or simulations for making specific types of experience. Artists are making image spaces of interactive art that can be experienced polysensorially, spaces that promote processuality, narration, and performance, and thus also give new meaning to the concept of gaming. The dynamic process of change has fueled the interdisciplinary debate about the status of the image, a debate with protagonists such as Mitchell, Belting, Elkins, Stafford, and Manovich.[5]

But without exception, neither these artworks nor the last decades of digital art in general have received the appropriate attention by academic disciplines or have been added in adequate numbers to the collections of museums and galleries. We are thus in danger of erasing a significant portion of the cultural memory of our recent history. The evolution of media art has a long history and a new technological variety has now appeared.[6]

However, this art cannot be fully understood without an understanding of its history, which is why Rudolf Arnheim's recently published plea for integrating the new, interactive, and processual worlds of images into the experiences and insights that have come down to us from the art of the past begins the selected articles in this book. There are many stories yet to be told about media art, the discipline of art history, media artists, and their work. However, we are also waiting for a great deal more: studies that will aid media art to overcome its existence at the periphery of the discipline of art history. A first step, of course, will be to tell the story in numbers, places, names, and technologies, like many current international databases and archiving projects are doing.[7] Beyond that: by focusing on recent art against the backdrop of historic developments, it is possible to better analyze which aspects are new and which aspects inherited in media art. Therefore it is important that we become familiar with our media history, with its myths and utopias. Media art history and media archaeology are a valuable aid to understanding our present and our future goals in a period where the pace appears to get faster and faster—that is the epistemological thesis. It is not about a new canon, but about the many-voiced chorus of the involved approaches. For the interests of media art it is important that we continue to take media art history into the mainstream of art history and that we cultivate a proximity to film, cultural and media studies, and computer science, but also to philosophy and other sciences dealing with images.

A central problem of the current cultural situation stems from a serious lack of knowledge about the origins of audiovisual media. This stands in complete contradistinction to current demands for more media and image competence. Considering the current upheavals and innovations in the media sector, where the societal impact and consequences cannot yet be predicted, the problem is acute. Social media competence, which goes beyond mere technical skills, is difficult to acquire if the area of historic media experience is excluded. Media exert a general influence on forms of perceiving space, objects, and time, and they are tied inextricably to humankind's evolution of sense faculties. For how people see and what they see are not simple physiological questions; they are complex cultural processes that are influenced by many and various social and media technological innovations. These processes have developed specific characteristics within different cultures and it is possible to decipher these step by step in the legacy left by historical media and literature concerned with visualization, including the history of the fields of medicine and optics. Not least, in this way light can be shed on the genesis of new media, which are frequently encountered for the first time in works of art as utopian or visionary models.

Film, cinema, and even television we already regard today as "old" media, because the image industries develop and offer new generations of media at ever-shorter intervals, with the modern and postmodern periods already in the rearview mirror. Although there is scant analysis and engagement with these media because of their continuing dominant, self-evident position in connection with creating collective "reality" and illusionary spectacles, slowly but surely their dominance is waning. This will allow the pre- and posthistory of visual mass culture in the twentieth century to surface more clearly and promote awareness that it is necessary to engage with both the past and the present of media to understand their ability to produce illusions and their formation through distribution networks.

Mass communication using audiovisual media is generally regarded as a twentieth-century phenomenon. In fact, however, the contemporary forms of these media are the result of complex historical processes that had already formed finished sets of industrial technologies, distribution procedures, and forms of design by the mid-nineteenth century, which made it possible to supply a mass audience. And we can go back even further. Seeing machines and the image worlds of magic lanterns, panoramas, and dioramas are

regarded as having paved the way for photography, cinema, and the digital media of the present day. Yet without the revolution in image space, which the representational technique of perspective wrought in portrait and landscape painting, without the *camera obscura*, which became the guarantor of "objective observation" before photography was invented, the image media of the twentieth century would be unthinkable. At the same time, the prehistory of artificial visualization points the way forward to the digital world and its immediate future.[9] The contributions to the "Origins" section therefore deal explicitly with this complex of themes: rediscovering kinetic art and op art in a new context, Peter Weibel shows that terms like "virtual" were already current in the 1960s; Edward Shanken's questions pertain to methodology and canonicity and locate the historicization of cybernetic, telematic, and electronic art within a larger art historical context through a critical reflection on the mechanisms of canonization in art history. Erkki Huhtamo examines interactivity and tactility through a media-archeological perspective, and Dieter Daniels's essay analyzes the contribution of Duchamp's inventions to media art. Going further back into history, Oliver Grau discovers in the phantasmagoria a visual principle, so far not introduced into the theory of media art, which combines concepts from art and science in search of a total medium; and Gunalan Nadarajan in the writings of Al Jazari examines a history of Islamic automation Western art history has thus far been unaware of.

Based on this historical framework, the section entitled "Machine—Media—Exhibition" offers a critical reexamination of key terms in media art theory. Edmond Couchot examines hybridization and automatization for the future orientation of art and culture. The machine is looked at as a productive and transformative principle in Andreas Broeckmann's contribution considering the "aesthetics of the mechanic." While the transformation in media art is analyzed through the new contexts of textuality, technology, and cultural institutions by Ryszard Kluszczynski, Louise Poissant finds the transformation in the medium itself, as interest moved from the object's plasticity to that of the spectators' neural network. Investigating the shift from object to process and from lone artist to collaborative models of production and presentation, Christiane Paul shows that the accommodation of new media art within the institution and gallery runs counter to traditional ideas of the museum as shrine.

The dividing lines between art products and consumer products, between art images and science images have been disappearing more and more since

the 1960s. So also the distinction between maker and recipient has become blurred. Most recently, the digitization of our society has sped up this process enormously. In principle, more and more images are no longer bound to a specific place and can be further developed relatively easily. The cut-and-paste principle has become an essential characteristic of contemporary image and culture production. The spread of access to the computer and the Internet gives more people the ability to participate in this production. The part entitled "Pop and Science" examines, therefore, concrete forms that today determine the cultural context of new media and what consequences they could have for the understanding of art in the twenty-first century.

With her essay on Device Art, Machiko Kusahara takes us to a concept derived from the Japanese media art scene. On this basis she reexamines the art–science–technology relationship from both contemporary and historical aspects. Ron Burnett's contribution instead explores the ubiquitous use of the term "interactivity" as a marker between old and new media, asking questions about the context that led to the invention of photography and the cinema, with the goal of showing strong historical links among the various technologies in use today and the ways in which their discourses are interconnected. Lev Manovich traces the influence of science on abstraction and brings us to an understanding of the role played by scientific complexity theory in contemporary software abstraction. From the view of another neighboring discipline, the history of science, Timothy Lenoir examines the societal and ethical implications of contemporary technoscience with its multidisciplinary character and encourages collaborative research allowing technoscience to be made public and new media to be made critical.

An increase in the power of suggestion appears to be an important, if not the most important, motivating force driving the development of new media of illusion. Image science, or *Bildwissenschaft*, now allows us to attempt to write the history of the evolution of the visual media, from peep show to panorama, anamorphosis, myriorama, stereoscope, cyclorama, magic lantern, eidophusikon, diorama, phantasmagoria, silent movies, films with scents and colors, cinéorama, IMAX, television, telematics, and the virtual image spaces generated by computers. It is a history that also includes a host of typical aberrations, contradictions, and dead ends.

However, if one were to interpret the telling of this hitherto neglected story line of art and media history as a sign of the changes taking place in the discipline of art history, which parallels current developments in philosophy

and cultural studies and goes by the new label of "image science," this would be far too superficial. Rather, we must return to and develops an older and successful tradition in art history, which in Hamburg and elsewhere in the 1920s can only be classed as image science. It drew its inspiration from Aby Warburg's cultural history–oriented, inter- and transdisciplinary approach as well as from Panofsky's "new iconology." Although already in the nineteenth century, art history included artisanship, medieval studies, collections of photography and was, therefore, in effect image science (see Alois Riegl, *Spätrömische Kunstindustrie* [Vienna: Staatsdruckerei, 1901]), it was Aby Warburg, today regarded as the most important art historian of the early twentieth century, who helped to expand art history explicitly into image science. His research, which included all forms and media of images, the impressive library he built up, and his MNEMOSYNE image atlas all testify to the universal interpretive energy that can often reveal important discoveries in apparently marginal images. The Nazis extinguished this development, which only went forward again in the 1970s. Film, video, net art, and interactive art have, as yet tentatively, pushed art history in the direction of image science once again.

But today, image science sets out to investigate the aesthetic reception and response to images in all areas. Thus this new interdisciplinary subject is in good company with the recent research areas of the historical study of image techniques, the history of the science of artistic visualization, art history of scientific images,[8] and particularly the natural sciences–oriented occupation with images in science. This latter recently celebrated its inaugural congress at the Massachusetts Institute of Technology,[9] an event which also demonstrated that image science without art history—particularly without its tools for critical image analysis—is not capable of developing a deeper and historical understanding of images. It is in danger of propagating old myths and, lacking a "trained eye," of succumbing to the power of images. The rise of media art has added fuel to this debate, for questioning images has acquired not only new intensity but also new quality and media. The final part, "Image Science," starts with Felice Frankel's essay examining the role of intention in visual representations of scientific phenomena. She brings up the need to develop a visual language that can be used by scientists as well as artists.

Further heirs to this interdisciplinary tradition today are scholars who open up new perspectives pleading for an extended image science. Thus the founder of the new image science W. J. T. Mitchell provokes the reader with the headline "There Are No Visual Media"—asking "is 'visual media' simply short-

hand for 'visual predominance?'" and "what is at stake in straightening out the name 'visual' media?" From the history of film studies perspective, Sean Cubitt asks whether the field of projected light has more to offer than the emulation of the real, reproducing the separation of the object and subject and revealing a new term in the series subject—object—project. Image science is broadened beyond the visual in the contribution from Douglas Kahn on early computer arts, when music made on mainframes such as that by James Tenney at Bell Labs can be called the first digital art because it required computers for its realization. In the last essay included in this collection, Barbara Stafford brings us full circle, back to one of the major intellectual problems of our times, the accurate depiction of uncertainty as a nonimagistic notion of "mental representation" informed by recent findings in cognitive science.

This book represents the network of scholars who over the past years have been a part of the growing number of dedicated researchers searching for insights into the histories of media art in order to build a solid field of study for the future. Many of the authors had the opportunity to participate in the first international conference on the histories of media art, science, and technology at Banff, for which I served as chair. Planned long before the conference, the contributions of this book went through days of intense discussions at Banff and afterward. With a top-notch international advisory team and dedicated organization partners, this conference laid a foundation of scholarship to build on. The outcomes of the conference and future developments in the field can be found on the Web forum for the field, http://MediaArtHistory.org/. This book draws on great thoughts from preceding decades and is just the beginning of the emerging field of MediaArtHistories.

Notes

1. The pioneer project in the field is the Database of Virtual Art: http://virtualart.at/. See Oliver Grau, *For an Expanded Concept of Documentation: The Database of Virtual Art* (Paris: ICHIM, École du Louvre, avec le soutien de la Mission de la Recherche et de la Technologie du Ministère de la Culture et de la Communication, 2003), 2–15.

2. Gerhard Dirmoser, "25 Jahre Ars Electronica—Ein Überblick als Gedächtnistheater," in *Time Shift: The World in Twenty-Five Years, Ars Electronica 2004*, ed. Gerfried Stocker and Christine Schöpf (Ostfildern: Hatje Cantz, 2004), 110–115.

3. See Margaret Wertheim, "Lux Interior," *21C*, no. 4 (1996), 26–31; Eduardo Kac, "Além de Tela," *Veredas* 3, 32 (1998), 12–15; Charlotte Davies, "Osmose: Notes on Being in Immersive Virtual Space," *Digital Creativity* 9, no. 2 (1998), 65–74.

4. Bernhard Dotzler, "Hamlet/Maschine," *Trajekte: Newsletter des Zentrums für Literaturforschung Berlin* 2, no. 3 (2001), 13–16; Yukiko Shikata, "Art-Criticism-Curating—As Connective Process," *Information Design Series: Information Space and Changing Expression*, vol. 6, ed. Kyoto University of Art and Design, 145.

5. See David Freedberg, *The Power of the Images: Studies in the History and Theory of Response* (Chicago: Univ. of Chicago Press, 1989); Hans Belting, *Bild-Anthropologie: Entwürfe für eine Bildwissenschaft* (Munich: Wilhelm Fink Verlag, 2001); Jonathan Crary, *Techniques of the Observer: On Vision and Modernity in the Nineteenth Century* (Cambridge, Mass.: MIT Press, 1990); William J. T. Mitchell, *Picture Theory: Essays on Verbal and Visual Representation* (Chicago: Univ. Chicago Press, 1995); James Elkins, *The Domain of Images* (Ithaca: Cornell Univ. Press, 1999); Lev Manovich, *The Language of New Media* (Cambridge, Mass.: MIT Press, 2001).

6. Oliver Grau, *Virtual Art: From Illusion to Immersion* (Cambridge, Mass.: MIT Press, 2003).

7. Database of Virtual Art (founded in 1999), Langlois Foundation (2000), V2 (2000), the recent Boltzmann Institute Linz (2005), which was influenced by the concept of the Database of Virtual Art.

8. Bruno Latour, "Arbeit mit Bildern oder: Die Umverteilung der wissenschaftlichen Intelligenz," in B. Latour, *der Berliner Schlüssel: Erkundungen eines Liebhabers der Wissenschaften* (Berlin, 1996), 159–190; Christa Sommerer and Laurent Mignonneau, eds., *Art@Science* (New York: Springer, 1998); Martin Kemp, *Visualisations: The Nature Book of Art and Science* (Berkeley: Univ. of California Press, 2000).

9. The Image and Meaning Initiative (http://web.mit.edu/i-m/) held its first conference at MIT in 2001, followed by the Getty Center in 2005.

2

The Coming and Going of Images

Rudolf Arnheim

Let me begin with a few definitions. By "images" I mean two different but intimately related things. We have images when we use our sense of vision. We see physical objects, such as art objects, sculpture or paintings. But we speak of images also in a more universal sense. Our thoughts, inventions, and fantasies are sensory images not produced by the presence of physical objects. Furthermore images may be immobile like rocks or full of action like living bodies.

Both of them, however, are subject to "coming and going." Physical objects suffer from the fragility of matter. They are exposed to the destructive forces of nature and human neglect and brutal vandalism, which keep them from being what they were before. What also changes is our conception of things. Our image of the *Mona Lisa* is not what it was when it was painted.

In the more active media of communication there is a difference in the degree to which the audience communicates. In the theater it is mostly limited to applause. But take for example the liturgy of the churches with its prescribed responses. Through the ages and through different cultures there is an endless variety of response, to the degree of total involvement of all participants.

The technology of the modern media has produced new possibilities of interaction. Here is an example from the field of education: in a class on architecture the instructor presents on the computer screen images of a building.

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As he discusses various aspects and perspectives on the building or its size relative to its distance from observers, he varies the image accordingly. This enables him to illustrate his theoretical points concretely, not only by static examples like slides in the conventional lecture room, but as a dynamic counterpart, as actively alive as the instructor's performance; and the students react with their own requests. The object discussed need not be immobile like a building. It can be an action evolving in time.

To return to the fine arts, I will illustrate the theory with an obvious example taken from the work of this journal's figurehead, Leonardo da Vinci. His *Last Supper* may be called the most famous painting of the Western world. It exemplifies the various aspects of imagery here under discussion. What makes for the unusual attention and adoration this painting has received?

The Last Supper was designed around 1495, for its place and its "audience" in the refectory of the Dominican monks of Santa Maria delle Grazie in Milan. Ever since then, it has attracted attention. We owe to Goethe a masterly description of the painting, written in 1810. At that time the painting was already in the miserable state in which we know it today, thereby exemplifying the physical fragility of images. *The Last Supper* received its share of mistreatment via restoration, vandalism, and neglect. Yet the uniqueness of the work has survived. Its subject has been treated by many other artists, among them quite excellent ones, but none has equaled Leonardo's fame. To a large extent, this is due to the power of its composition, the elements of which survive even the worst reproductions.

The composition of *The Last Supper* is held together by its balancing symmetry and the horizontal base formed by the table and its parallel, the line of heads. This stability is dynamized by the way the perspective draws the viewer into the center and the varying gestures of the disciples, which swing toward or away from their master in their varying responses to his revelation. He, in his contrasting quietness, establishes the center of the room but is also kept in the world outside by the light of the landscape surrounding him.

The image of Jesus presents the viewer with the embodiment of humanness at its highest to serve both as a model of charity and as a leader raised to the level of the divine. But this model also embodies human suffering, the victimized martyr. We are therefore accorded an image of the epitome of human nature. This quality is needed by every good work of art, although to varying degrees of perfection. It applies as well to other fields of character and

behavior. As a single example, I mention the *Venus* of Melos, standing for femininity.

In the flow of coming and going, these significant images provide an indispensable counterweight. They offer a store of lasting meaning, without which we would be helplessly exposed to the flight of transitory happenings. This sharpens the key point of the present paper. The awareness and understanding of our experience depends on the interaction of stable, lasting images and the coming and going of happenings in time. The stationary images allow us to explore the world in its being, while the transitory ones let us follow what takes place in sequence.

This would seem to be relevant at the present time, as the millennium makes the calendar impose on us an arbitrary interruption in the continuity of time. In pondering the future we are tempted to limit our attention to the curiosity about the inventions and discoveries awaiting us. This, however, would be narrow-minded. What is needed is a wider view encompassing the coming rewards in the context of the treasures left us by past experiences, possessions, and insights.

I

Origins: Evolution versus Revolution

3

It Is Forbidden Not to Touch: Some Remarks on the (Forgotten Parts of the) History of Interactivity and Virtuality

Peter Weibel

Kinetic art and op art are being rediscovered. But the context in which these movements are regaining public awareness is new. First, they are being recognized as developments that ran parallel with the emergence of computer art, of computer graphics and animation. In the 1960s shows like "New Tendencies" (Zagreb and Milan) played a special role in this interplay among computer art, kineticism and op art. Second, this contextual shift makes it clear that works of op and kinetic art accomplished with manual and mechanical means have attributes of observer dependency, interactivity, and virtuality; indeed, terms like "virtual" were already current. Third, the presence of covert instructions to act—viewers of op and kinetic works are expected to press buttons, move components, and so on—reveals the rudiments of rule-based algorithmic art.

These procedural instructions forge a link to a further important direction of art in the 1960s: the happening and Fluxus movements, which substituted items of daily use for the work of art. These items of daily use were subsequently replaced by instructions for use which, addressed to the audience, now became instructions to act. Basic elements of algorithmic art therefore figured in happening and Fluxus, too.

Thus, the three major art movements of the 1960s—op and kinetic art, happening and Fluxus, computer graphics and animation—are being reconsidered from the algorithmic angle and placed in new relation to each other. With all three movements able to be considered as different forms of "algorithmic art," it becomes clear that the attributes of programmability, immersion, interactivity, and virtuality did not first appear in the media and

computer art produced from 1970 onward, but were already present in the op and kinetic art of the 1960s.

What Is an Algorithm?

Cameras, cars, planes, ships, household devices, hospitals, banks, factories, shopping malls, traffic planning and routing technology, architecture, literature, visual arts, music—no area of social or cultural life exists that is not permeated by algorithms. In science, the algorithmic revolution began in 1930 or thereabouts; in art, some thirty years later.

An algorithm is understood to be a decision procedure—a set of instructions to act—made up by a finite number of rules, a finite sequence of explicitly defined elementary instructions that exactly and completely describe the stepwise solution to a specific problem. The most familiar implementation of algorithms is in computer programs. A program is an algorithm written in a language enabling it to be executed in steps by a computer, and therefore every computer program (as a high-level machine language) is an algorithm, too. The task of executing the steps in generating procedures or decision-making processes that sometimes require hours or days of computing has been transferred to a machine: the computer. And as these computing machines became more advanced, so the programming became more precise. Computers are controlled by algorithms in the form of computer programs and electronic circuits. The first algorithm written specifically for a computer was recorded in 1842–43 by Ada Lovelace in her notes on Charles Babbage's *Analytical Engine* (1834). Since Babbage was unable to complete his proposed machine, however, Lovelace's algorithm (whose purpose was to compute Bernoulli numbers) was never executed on it.

The lack of mathematical precision of the early twentieth-century definition of an algorithm was a source of irritation to many mathematicians and logicians of the period. In 1906, Andrey A. Markov[1] created a general theory of stochastic, or random, processes on the basis of his so-called Markov chains, which were generalized by Andrey Kolmogorov in 1936.[2] These chains represent the mathematical model of a memory-free process that describes a physical system when the probability of state transition depends solely on the state of the system at a given time and not on the previous history of the process. The transition probability of the state at time $t + 1$ is dependent solely on the state at time t. In this way, the Markov chains allow sequences of mutually

dependent variables to be studied in accordance with laws of probability. They are sequences of random variables in which the future variable is dependent on the current variables, but independent of the state of its predecessors. In the late 1950s and early 1960s this theory of stochastic processes was successfully applied to the stochastic generation of poetry and music, that is to say: random music and random text. The concept of the algorithmic coincidence was accepted as the ultimate definition of chance, and led to the foundation of an algorithmic information theory by Gregory Chaitin[3] and Andrei Solomonov.

Around 1930 the intuitive concept of computability, or of the algorithm, underwent mathematical precision. The works of Kurt Gödel, Alonzo Church, Stephen Kleene, Emil L. Post, Jacques Herbrand, and Alan Turing[4] demonstrated that all formal versions of the concept of computability are equally valid and can be viewed as a precise version of the concept of the algorithm. Algorithms are older than computers, therefore, but have been most famously deployed in computer programming over the course of the past seventy years. Any problem able to be programmed can be solved algorithmically with any current programming language (high-level machine language).

The development of programming languages began with Axel Thue,[5] whose "Probleme über Veränderungen von Zeichenreihen nach gegebenen Regeln" in 1914 delivered the first precise version of an algorithmic decision process: with the aid of a finite alphabet (i.e., six letters) and a system of rules R (i.e., two rules of transformation) it was possible to determine in individual cases whether a specified sequence of signs could be generated from the given alphabet and system of rules. Semi-Thue systems of this kind were used to develop the theory of formal languages. In the 1950s Noam Chomsky referred to semi-Thue systems in order to describe grammatical structures of natural languages. On the basis of Chomsky's semi-Thue systems, John Backus and Peter Naur around 1960 introduced a formal notation enabling the syntax of a language to be described, and from this system of notation evolved (algorithmic language) ALGOL 60, the first successful programming language.

Algorithms in Art

Running in parallel development with these advances in computing machines, machine languages, and the associated algorithmic procedures and beginning around 1960, intuitive algorithms in the form of instructions for use and action also began to be used in forms of analog art ranging from painting to

sculpture. One might say that sequences of signs in the form of digits are instructions for machines to act. Known as programming languages, artificial languages, or digital codes, they are used in digital art. Sequences of signs in the form of letters can be instructions for human beings to act. These are termed natural languages, and are used in analog art. Accordingly, instructions to act exist for manual and mechanical tools like hands, buttons, keys, and so forth. And instructions to act likewise exist for digital and electronic tools. Accordingly, there are two forms of interactivity between work and viewer: manual and mechanical (for instance, in op and kinetic art) or digital and electronic (as in new media art).

For centuries algorithms have been used intuitively as control systems, instructions, rules of play, and as plans and scores in architecture and music. In music and the fine arts, algorithms have long been valuable instruments of creation. The artists' books of the Renaissance, such as Leon Battista Alberti's tract *De re aedificatoria* (1452), Piero della Francesca's *De prospectiva pingendi* (c. 1474), or Albrecht Dürer's illustrated book *Underweysung der Messung* (1525), already amounted to manuals for making paintings, sculptures, and buildings. Mathematical aids and even small mechanical contraptions are known to have been used by composers from Bach to Mozart, from Schönberg to Joseph Schillinger.[6] A central role is played in modern music by serial and static processes, by techniques and algorithms which are aleatoric and stochastic, permutative and combinatorial, recursive and fractal; and this function is exercised not just intuitively, but also in the sense of high-precision mathematics.[7]

There are two different uses of the algorithm in modern art: intuitive application, as in the Fluxus movement (a plausible example being Karl Gerstner's *Variables Bild* (*Rotbunte Reihen*) (Variable Image) of 1957/1965, which consists of variable wooden bars in a metal frame), and exact application, as in computer art. There have been attempts to reconcile both modes in various measures. The Fluxus artist George Brecht produced a work entitled *Universalmaschine*,[8] an explicit allusion to the computer as a *universal machine*,[9] and in 1969–1970 Karl Gerstner created a work entitled *AlgoRhythmus 1*.

Dick Higgins, another Fluxus artist, in 1970 published *Computer for the Arts* including a machine score for computer music by James Tenney (with text by Higgins). As early as 1962, a text by Umberto Eco appeared with the telling title *arte programmata*.[10] Written for the exhibition "Arte Programmata—arte

cinetica, opere moltiplicate, opera aperta" (Milan, 1962), Eco's text dealt with the interplay between accident and programming. This notion of programming was extended to architecture by the Italian architect Leonardo Mosso in 1969.[11]

In the analog art forms (op and kinetic art, Fluxus, happening) the intuitive use of the concept of the algorithm led to mechanical and manual practices of programming, procedural instructions, interactivity, and virtuality. In the "New Tendency" shows of the early 1960s in Zagreb, Milan, and elsewhere, viewer participation in the construction of a work of art played a considerable role. In works associated with Fluxus, happening, or performance, the object of painting or sculpture was entirely replaced by instructions to act. Along with stepwise instructions to bring about events, the instructions for use that implicitly accompany any item of daily use took the place of the actual item, in this way leading to the explicit integration of the audience.

Op and Kinetic Art

Kinetic art achieved major historical and popular influence in the 1960s, as evidenced by exhibitions like "Rörelse i Konsten" (Moderna Museet, Stockholm, May–September 1961), organized by K. G. Pontus Hultén and first shown under the title "Bewogen Beweging" in Amsterdam (Stedelijk Museum, March–April 1961), "Kinetic and Optic Art Today" (Albright Knox Art Gallery, Buffalo, 1965), and "Licht und Bewegung—kinetische Kunst" (Kunsthalle Düsseldorf, 1966). The titles of the shows point to the intertwining of the problem of representing movement with that of representing optical phenomena in which kineticism originated and developed. In both cases, mere representation was renounced in favor of real movement, real light. Optical illusions became recognizable as such. Real movement and real light became media of art. Perceptual phenomena and optical illusions were used not as instruments but as subjects, not as means of representation but as activated perceptual experiences in which the viewer was now a crucial factor.

As early as 1955, K. G. Pontus Hultén had curated the show "Le Mouvement" (featuring Agam, Bury, Calder, Duchamp, Jacobsen, Soto, Tinguely, Vasarely) at the Galerie Denise René in Paris, and contributed the text "Petit moments des arts cinétiques." With a title alluding to Moholy-Nagy's book *Vision in Motion* (Chicago, 1947), the exhibition "Vision in Motion—Motion

in Vision" at the Hessenhuis, Antwerp that same year showed work by artists including Roth, Macky, Piene, Tinguely, Spoerri, Bury, and Klein.

Although the chronology of kinetic art can be traced back to 1900, the de facto beginning was in 1920. The sources—avant-garde film (Walther Ruttmann, Viking Eggeling), Constructivism, Bauhaus, De Stijl, futurism—are as diverse as the stations (*arte cinetica*, 1914–16; Viennese kineticism, 1920–24, with protagonists including Franz Cizek). The primary source is Russian Constructivism, which produced geometrical objects free of any mimetic function (Tatlin, Rodchenko, El Lissitzky, Gabo, Pevsner). In Moscow in 1920, Naum Gabo demonstrated to his students that a single rod of wire, if set in motion with the aid of a clock spring, can become a volume or, more accurately, a virtual volume. This *Kinetic Construction No. 1* (fig. 3.1, fig. 3.2), which in 1922 was also exhibited in Berlin, emanated from "The Realistic Manifesto" Gabo wrote in 1920. Cosigned by his brother Antoine Pevsner, it was in fact a "Constructivist manifesto" (as early as 1915, Gabo named a sculpture *Constructed Head No. 1*), and is now considered to represent the beginning of Constructivism.

Illusory Movement—Illusory Volume

Kinetic Construction No. 1, whose very title expresses the historical connection between Constructivism and kinetic art (incidentally, in 1941 Zdenék Pešanék's book *Kineticism* appeared in Prague; it represents the missing link in the evolution of avant-garde film and kinetic sculpture) refers not only to motor-driven movement, the agent for all future kinetic sculptures of artists from George Rickey to Jean Tinguely, but also to a lesser-known motor driving the development to kineticism. That motor is apparent movement, virtuality: for Gabo's line—a rod of wire—produced an apparent volume. Virtuality connects kinetics with op art. Kinetic art evidently lies between Constructivism and op art, is connected with them both, and the connecting element is evidently perceptual phenomena. This realization allows us to advance beyond the purely mechanical categories of kinetics and chart the evolution from analog mechanical to digital electronic kinetics. Mobile parts are more than mere machine components; they are virtual components, too.

This finding also points to a further important source of kineticism, namely to the science of perception, of special optical phenomena encompassing everything from stereoscopy to stereokinesis. The new schools of gestalt and per-

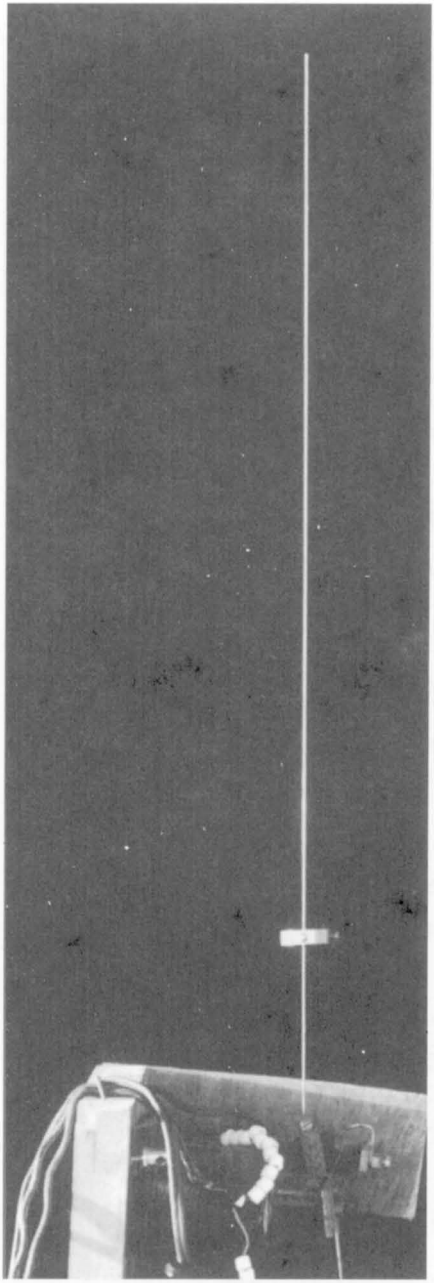


Figure 3.1 Naum Gabo, *Kinetic Construction No. 1*, 1920 (stationary). By kind permission of the Neue Galerie Graz.

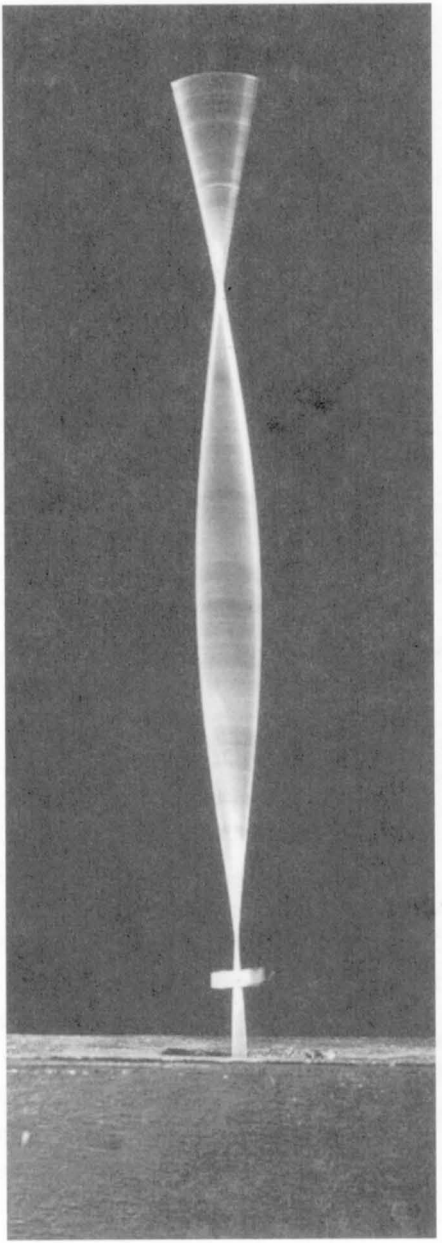


Figure 3.2 Naum Gabo, *Kinetic Construction No. 1*, 1920 (in movement). By kind permission of the Neue Galerie Graz.

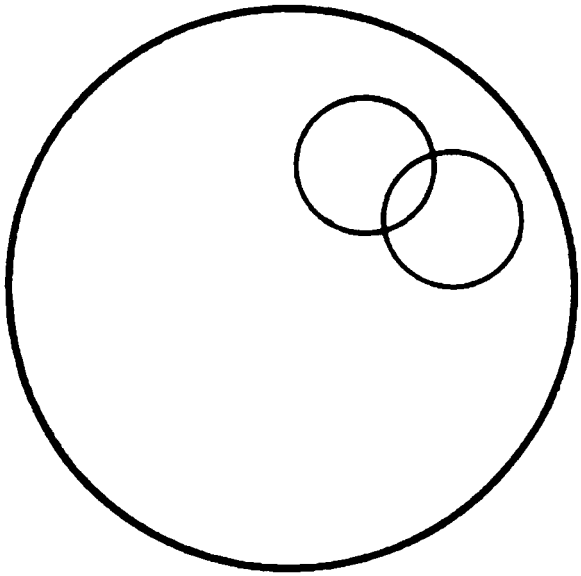


Figure 3.3 Vittorio Benussi, 1912. Apparent transparency with the stereokinetic phenomenon. If the circle pieces are glued or drawn onto a piece of card which is then slowly rotated, monochrome circles can then be seen—like the sheared edges of a roller—stretching backward. By kind permission of the Neue Galerie Graz.

ceptual psychology that arose around 1900 (Vienna, Prague, Graz, Berlin, Frankfurt) and are connected with names such as Ernst Mach, Christian von Ehrenfels, Alexius Meinong, Alois Höfler, Vittorio Benussi, Wolfgang Köhler, Max Wertheimer, Kurt Koffka, experimentally investigated the laws of visual perception, in particular gestalt and movement experiences, illusory movements, optical illusions, and so forth.

The Graz-based experimental psychologist Vittorio Benussi, an Italian national, in 1912 published "Stroboscopic Illusory Movements and Geometric-Optic Gestalt Illusions." The year 1921 saw the publication in Leipzig of Johannes Wittmann's "Über das Sehen von Scheinbewegungen und Scheinkörpern." Pentti Renvall's "Zur Theorie des stereokinetischen Phänomens" appeared in 1929.

These apparent movements and illusory bodies take us into the realm of the virtual. In 1912 Benussi had conducted a simple experiment that connected movement (kinetics) with depth perception (op art). Patterns of circles on

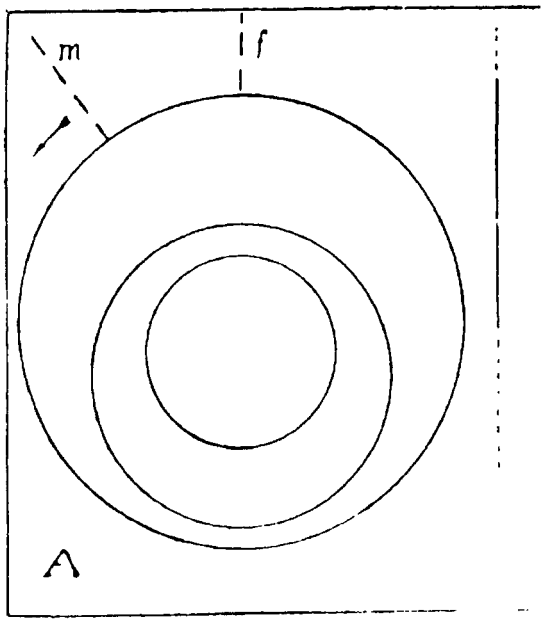


Figure 3.4 Cesare L. Musatti, 1924. Circles which produce stereokinetic effects when rotated. By kind permission of the Neue Galerie Graz.

rotating disks generated the optical illusion of moving cones, and as a result produced the illusion of a three-dimensional structure in movement (fig. 3.3). Movement in combination with depth perception (stereo manifestations) leads to a kinetic spatial effect (or the "stereokinetic effect," to borrow the term which Cesare L. Musatti, a pupil of Benussi in Padua, coined for stereokinetic spatial images and illusory bodies) (fig. 3.4). The optical disks of the film *Anémic cinema* (1925–26) and Marcel Duchamp's *Roto-Reliefs* (1923–35) are based on the same stereokinetic phenomenon (fig. 3.5).

Research into illusory bodies and illusory movements was carried forward in the 1950s and 1960s, partly with the assistance of apparatuses. Gaetano Kanizsa, a pupil of Musatti, followed up the investigations of Friedrich Schuhmann, who in 1900 had published the first "illusory contour," that is to say, the perception of a nonexistent, illusionary, virtual line. From 1955 onward, Kanizsa popularized as "subjective contours" those in reality nonexistent illusory contours, illusory boundaries, and illusory edges (*Scientific American* 234, April 1976, pp. 44–52) (fig. 3.6). Working in Innsbruck in the 1950s,

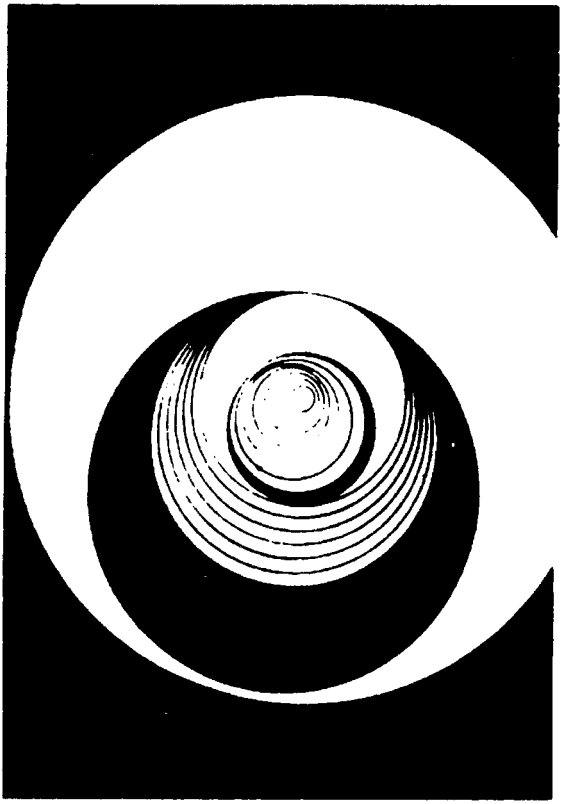


Figure 3.5 Marcel Duchamp, optical disk from the film *Anémic cinéma*, 1925–1926. By kind permission of the Neue Galerie Graz.

Theodor Erismann and his assistant Ivo Kohler deliberately generated optical malfunctions by means of inverting spectacles, thus adding to the foundations for understanding illusory worlds (fig. 3.7).

From Virtual Volumes to Virtual Environments

As can be seen, Naum Gabo's *Kinetic Construction No. 1* generated apparent—virtual, we would say today—movement. Art history shows us that the realm of virtual movement and virtual bodies stretches from the painting to the sculpture, from plane surface to three-dimensional space, and that already in the 1920s the term "virtual" had begun to be used instead of "illusory."

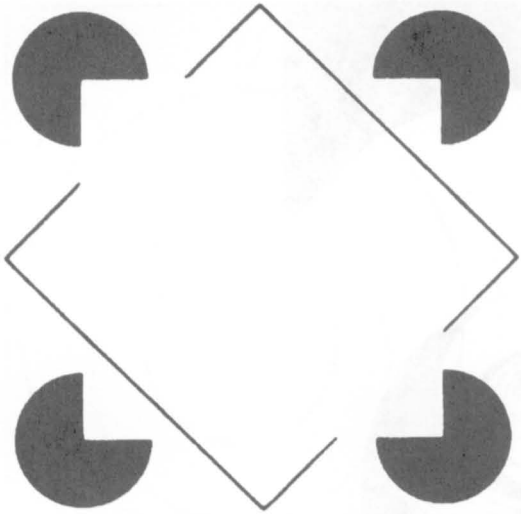


Figure 3.6 Resistance to superimposition is a measure of the intensity of perceiving subjective surfaces. Separating lines appear to be superimposing themselves over a subjective surface, but the subjective contours are destroyed by the line. Source: Gaetano Kanizsa. By kind permission of the Neue Galerie Graz.

Figure 3.7 The peaked cap with the mirror that turns everything on its head. Source: Ivo Kohler. By kind permission of the Neue Galerie Graz.

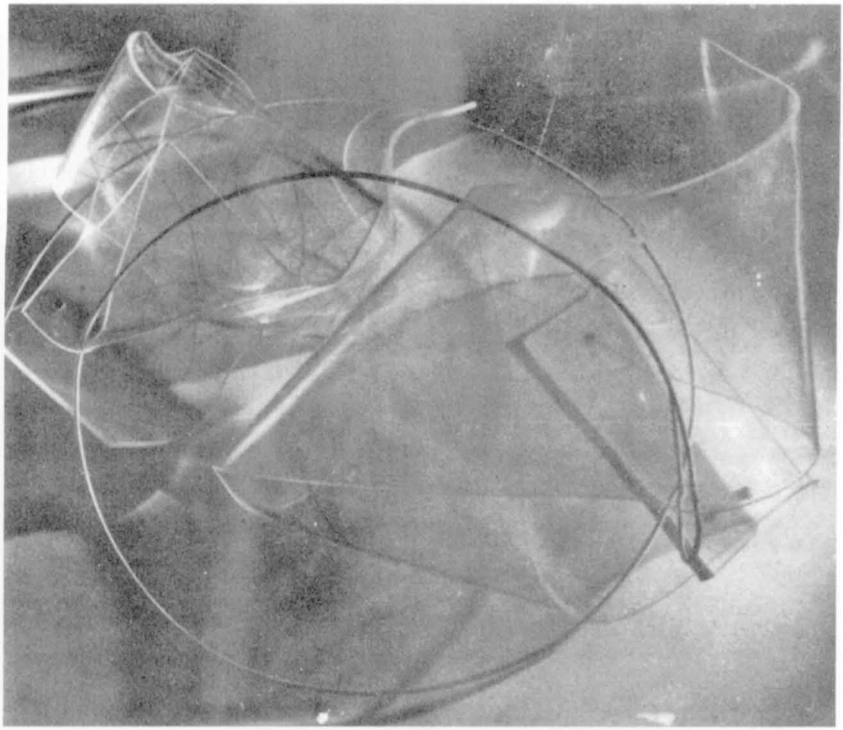


Figure 3.8 Moholy-Nagy, *Space Modulator*, 1940. By kind permission of the Neue Galerie Graz.

In his book *From Material to Architecture* (1929) Moholy-Nagy describes as the fifth stage in the development of sculpture the addition of the fourth dimension of time to the three dimensions of volume. Mass tends toward immaterialization as a result of movement. Through movement sculpture becomes the manifestation of virtual volumetric relationships. Moholy-Nagy therefore explicitly refers to the development of material and static volumes into ones that are kinetic and "virtual" (fig. 3.8).

Jesús Rafael Soto produced kinetic art not by fusing light and movement but by the classical device of producing with two-dimensional means the illusion of movement (fig. 3.9). In the process he quickly recognized the laws governing apparent movement, whereby precisely the relations among the elements, as opposed to the elements themselves, are crucial to the generation of illusory motion. He therefore spoke of "virtual relations" and extended these

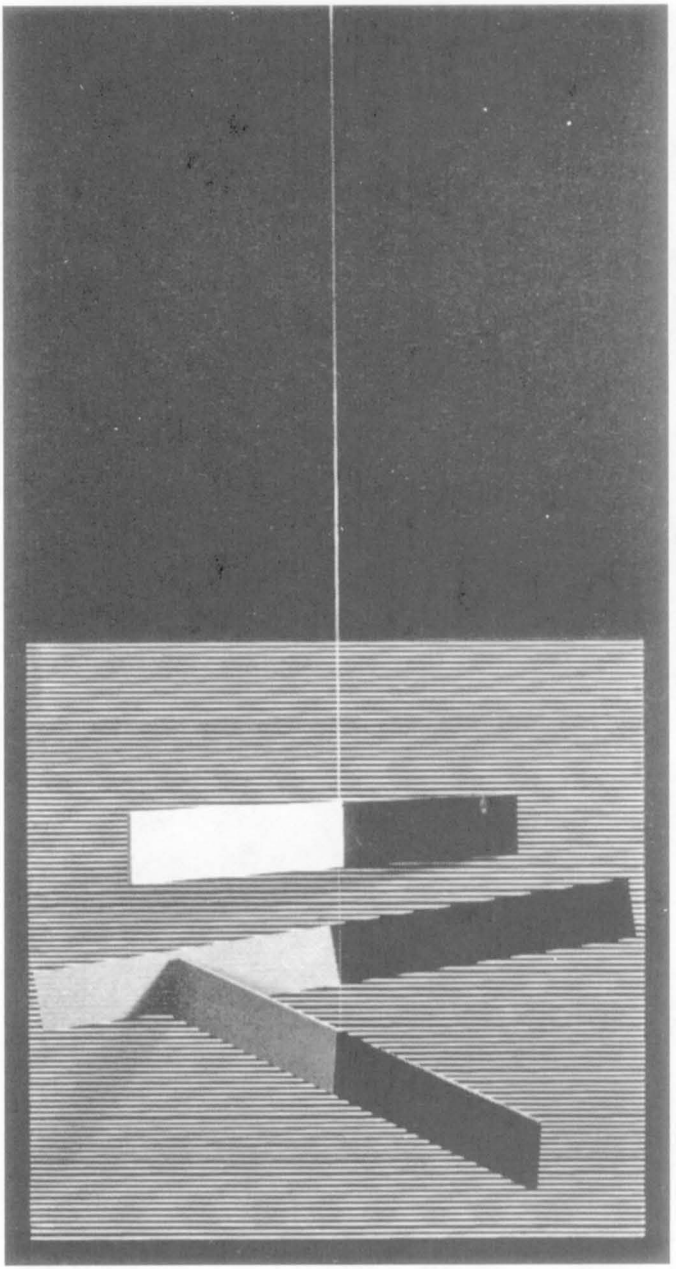


Figure 3.9 J. R. Soto, *Deux relations virtuelles*, 1967. By kind permission of the Neue Galerie Graz.

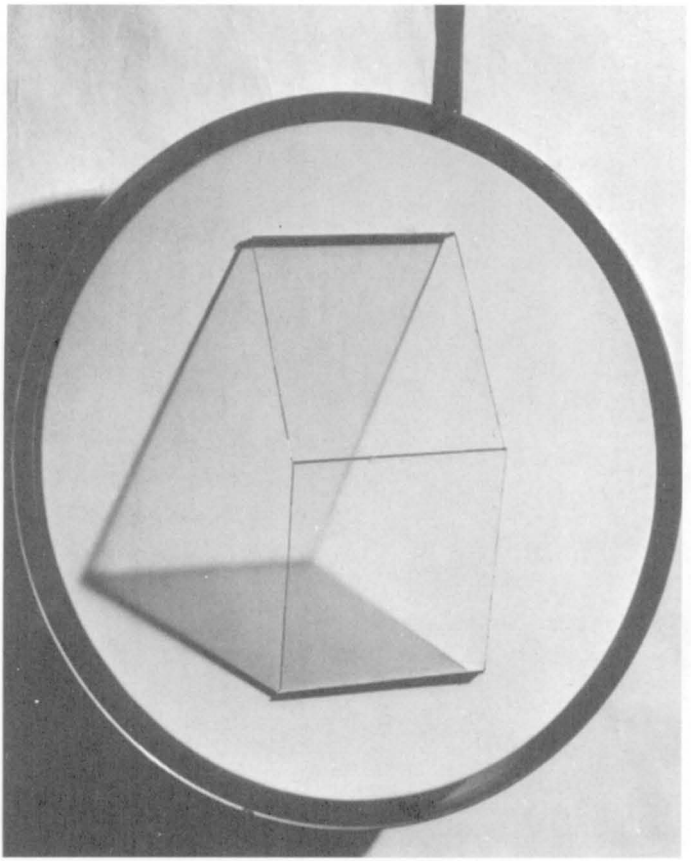


Figure 3.10 Gabriele de Vecchi, *Strutturazione virtuale A*, 1964. By kind permission of the VAF Foundation.

relations from the surface within a room into the "environment," at the same time drawing the viewer, too, into the work of art. In 1964 Gabriele de Vecchi spoke of "*Strutturazione virtuale*" (fig. 3.10), and in 1963 Giovanni Anceschi created a kinetic object with the title *Strutturazione, cilindrica virtuale* (fig. 3.11). In awareness of this tradition, Jean Tinguely in 1955 likewise made an electro-motorized sculpture entitled *Volume virtuel no. 1*, as well as an entire series of "virtual volumes" (1955–59), which were motor-driven sculptures with moving parts, wires, and wheels that, when moving at relatively high speed, produced the retinal impression of transparent three-dimensional bodies—virtual volumes, in other words.

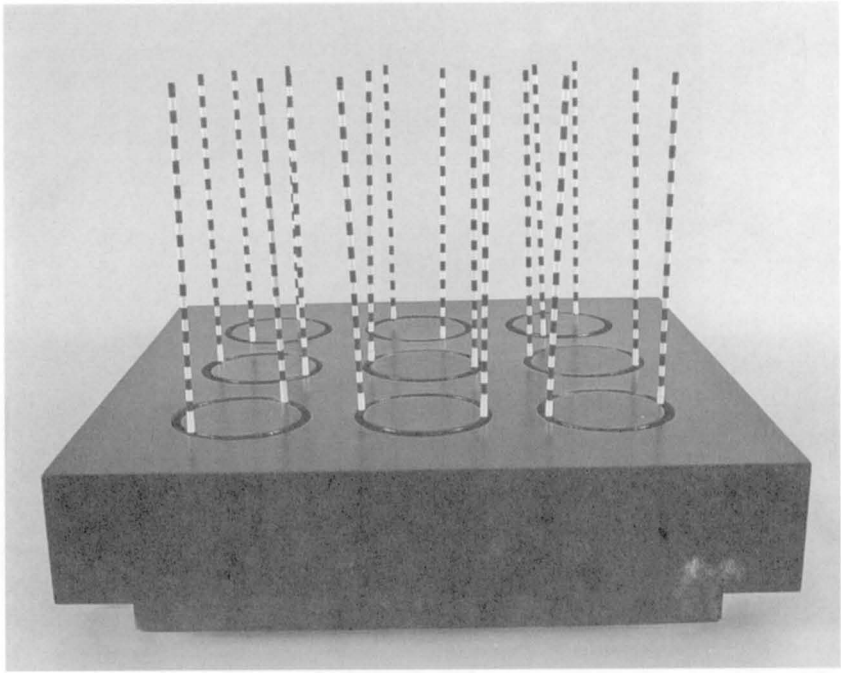


Figure 3.11 Giovanni Anceschi, *Strutturazione, cilindrica virtuale*, 1963, VAF Stiftung. By kind permission of the VAF Foundation.

Using analog means, Soto delivered a notion of a virtual environment that changes along with the viewer. Polysensual environments with optical and kinetic effects were likewise constructed by Getulio Alviani (*Cubo-Environment*, 1964–69), Gianni Colombo (*Spazio elastico*, 1967) (fig. 3.12), Mario Balocco (*Effetti di assimilazione cromatica con figure virtuali*, 1968–72) (fig. 3.13), Yaacov Agam (*Kinetisches Environment*, 1970), Domingo Alvarez (*Raumgrammatik Environment*, 1971), and Stanislav Filko (*Universum Environment*, 1966–67; *Kosmos Environment*, 1968). Under the title "Cinétisme, Spectacle, Environment," a show featuring de Vecchi, Colombo, Mavellet, Mari, Le Parc, and other artists was mounted in Grenoble in 1968.

Spectator participation soon extended from the adjustable painting (Yaacov Agam, *Transformables*, 1956, whose various pictorial elements could be slid around) to sculptures (by artists from Colombo to Tinguely), and from the sculpture into the space, the "environment" (Colombo, *Spazio elastico*, 1967). GRAV (Groupe de Recherche d'Art Visuel), founded in 1961 and made up

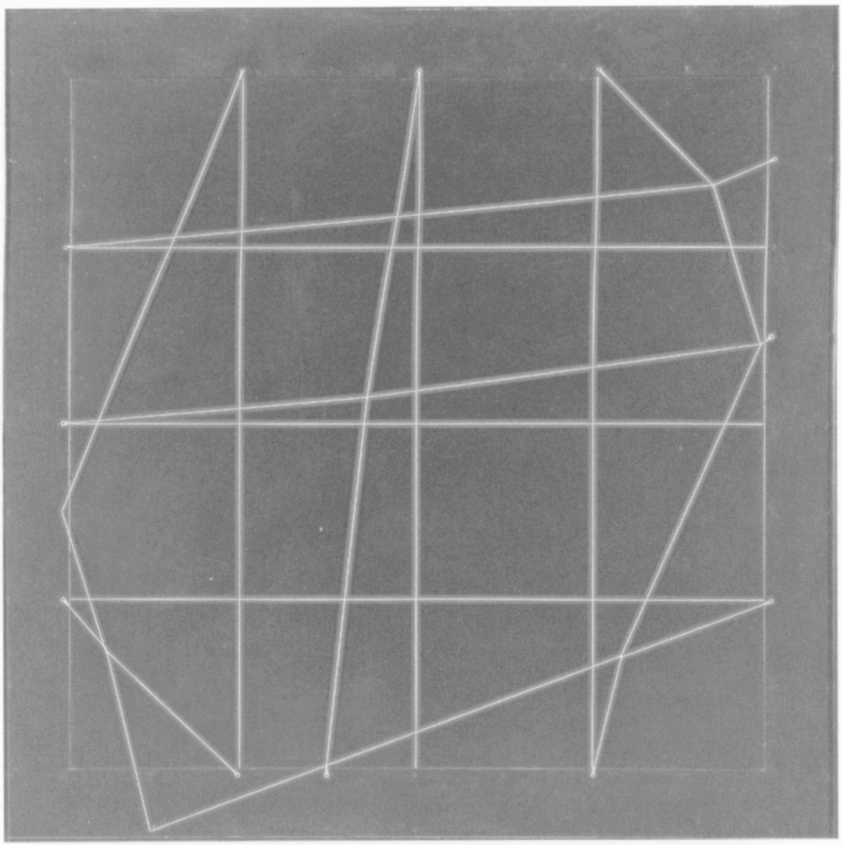


Figure 3.12 Gianni Colombo, *Spazio elastico,* 1967. By kind permission of the VAF Foundation.

by the artists Horacio-Garcia Rossi, Julio Le Parc, François Morellet, Francisco Sobrino, Joel Stein, and Jean-Pierre Yvara, in 1963 presented its first collective work: a labyrinth still on display at the Museum Cohue de Vannes. Twenty-two meters long, 3.65 meters wide, and made up of twenty single parts, the labyrinth is a homogenous space in which it is only too easy to lose one's bearings. Visitors can walk freely about the structure—in line with the museum's exhibition motto, which reads "Défence de ne pas participer, Défence de ne pas toucher."

As well as the movement implied by its name, therefore, kineticism produced elements which played an important role in the further development

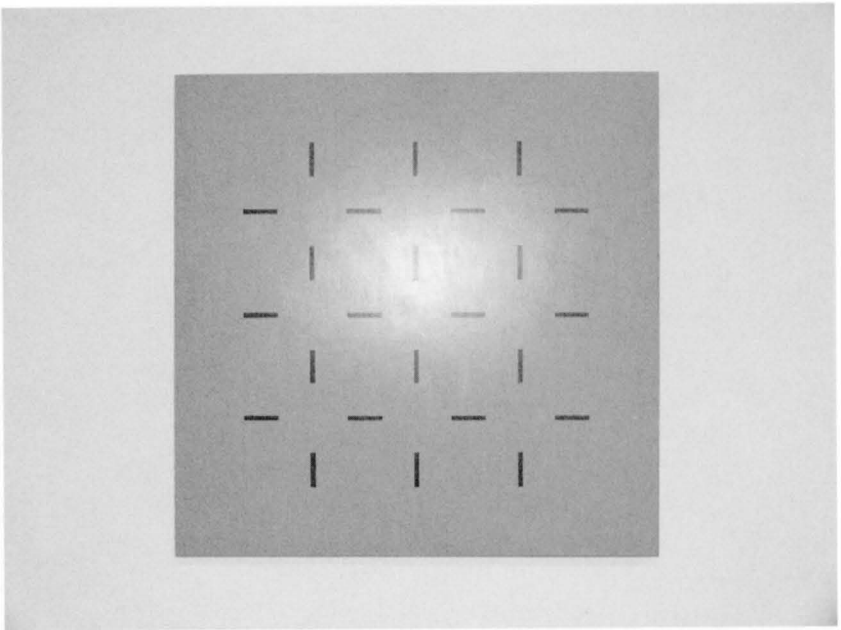


Figure 3.13 Mario Balocco, *Effetti di assimilazione cromatica con figure virtuali*, 1968–1972. By kind permission of the VAF Foundation.

of art: virtuality, the environment, the active spectator and/or user. Everything that would later characterize computer art and the interactive virtual environment was there already, albeit in purely analog or mechanical form.

Arte Programmata

The future of digital art can be found in approaches explored by kinetic practitioners. Bruno Munari in 1952 published *Macchinismo*, a manifesto aimed at reconciling art with the machine: "The machine must become a work of art! We will discover the art of the machines." This idea was carried forward in the 1962 exhibition "Arte Programmata: Arte cinetica, opera muliplicata, opera aperta," which was curated by Bruno Munari and Giorgio Soavi. Umberto Eco contributed a text from which the movement took its name. Arte progammata is a form of kinetic art in which on the one hand the movement is predictable because it more or less follows the rules of mathematical programs, but on the other hand, it at the same time permits random processes. That is

to say, the course of movement fluctuates between random and programmed, between precise predisposition and spontaneity, and therefore occurs within a system we would today term dynamically chaotic. Programmability—at least as a concept—had now taken its place alongside the notions of virtuality, the environment, the internal observer and/or interactivity (the user sets in motion the mobile work of art, the kinetic sculptures, co-constructs the "kinetic construction").

Working with colored light elements and movable machines in the period 1966–1968, Lev Nusberg and other members of the "Moscow kineticists" already produced so-called cyber-creatures. Viewers of this "cyber theater" were invited to participate in the programmed actions. Jeffrey Shaw, a leading pioneer of virtual environments and interactive art, similarly progressed from kinetic to cyber art. The virtual space, or environment, of his *Virtual Museum* (1991) likewise contains virtual sculptures caught up in virtual movements, apparent bodies in apparent movement in an apparent space—the transition from kinetic to cyber art is complete.

The optical changes induced by movement of the viewer in op art, the mobile elements of kinetic paintings and sculptures, the incorporation of viewers expected to manually interfere, to press buttons or keys: All this amounts to early—precomputer—forms of mechanical and manual interactivity. The works of art were exposed to random influences, or were rendered manually or mechanically controllable and programmable—algorithmic, in other words—by their viewers. Images were produced by programs before the computer came along, just as interactive and virtual relationships existed between works of kinetic and op art and their viewers. It is there—and not with the availability of the computer as technical interface—that the history of interactive and virtual art begins.

Notes

1. 1856–1922; Russian mathematician who helped to develop the theory of stochastic processes, especially those called Markov chains. Based on the study of the probability of mutually dependent events, his work has been developed and widely applied in the biological and social sciences. A. A. Markov, "Extension of the limit theorems of probability theory to a sum of variables connected in a chain," reprinted in Appendix B of R. Howard, *Dynamic Probabilistic Systems*, volume 1: *Markov Chains* (New York: John Wiley and Sons, 1971).

2. 1903–1987; A. Kolmogoroff, "Zur Theorie der Markoffschen Ketten," *Mathematische Annalen* 112: 155 (1936).

3. 1947–; Gregory Chaitin, *Algorithmic Information Theory* (Cambridge: Cambridge University Press, 1987).

4. 1912–1954; Alan Turing, "On Computable Numbers with an Application to the Entscheidungsproblem" (1936) in *Proceedings of the London Mathematical Society*, series 2, volume 42 (1936–37) pp. 230–265.

5. 1863–1922; Axel Thue, "Über unendliche Zeichenreihen," *Kra. Vidensk. Selsk. Skrifter.* 1 *Mat.Nat.Kl* 1906, Nr. 7, Kra 1906; "Über die gegenseitige Lage gleicher Teile gewisser Zeichenreihen," *Kra. Vidensk. Selsk. Skrifter.* 1 *Mat.Nat.Kl* 1912, Nr. 1, Kra 1912; "Probleme über Veränderungen von Zeichenreihen nach gegebenen Regeln," *Kra. Vidensk. Selsk. Skrifter.* 1 *Mat.Nat.Kl* 1914, Nr. 10, Kra 1914.

6. Joseph Schillinger, *The Schillinger System of Musical Composition*, volume I: books I–VII, volume II: books VIII–XII (New York: C. Fischer, 1946). First published as a correspondence course under the title *The Schillinger Course of Musical Composition* (ed. Lyle Dowling and Arnold Shaw, New York: C. Fischer 1941).

7. See Pierre Barbaud, *Musique Algorithmique (A Collection of Compositions Spanning Twelve Years of His Work).* Compositions include "Mu-Joken" (for six instruments, 1968), "Saturnia Tellus" (tape, 1980), "Apfelsextett" (for string sextet, 1977), and "Hortulus coelicus" (instrumental ensemble, 1975). Beginning in 1958, Barbaud championed a rigorously determined algorithmic composition process, made possible with the assistance of computers. His goal was to create human-made music with machines, reflecting only the human thought process, without emotion. Performances were by Ensemble GERM (Pierre Marietan, conductor), Élèves de l'École d'Archet Tibor Varga (Pierre Marietan, conductor), and Ensemble Instrumental de Musique Contemporaine de Paris (Konstantin Simonovitch, conductor). "Saturnia Tellus" was realized at l'INRIA; constructed by Pierre Marietan.

In 1979 Pierre Barbaud and his collaborator Frank Brown employed their computing program *Ludus Margaritis Vitreis* to produce music in the style of Bruckner. The task of the program is to work out musical sequences with harmonic part writing, using a simulated orchestra of ten instruments. One of the primary compositional tasks is carried out by a stochastic matrix responsible for linking together the chords. To define this matrix in specific cases, a work of the particular composer must first be analyzed—in this case Anton Bruckner's String Quartet in C Minor. The music so recomposed is then converted into audible form by a conversion program called

AUDITV, with every tone being assembled from units of 1/20,000-second duration, producing a remarkably precise adjustment to the required tonal effects. After being recorded on magnetic tape, the piece can then be performed. The *Ludus Margariti Vitreis* program was evaluated at the Research Institute for Information and Automation Science (IRIA) in Rocquencourt; the magnetic recording with the assistance of AUDITV took place in the Research Institute for Acoustic-Musical Coordination (IRCAM).

8. In 1965.

9. Responding to Hilbert's question about "decidability" in mathematics, until then unanswered, Turing came up with the idea now called a Turing machine. It was his exact formalization of what had informally been described by expressions such as "effective method."

Turing argued that his formalism was sufficiently general to encompass anything that a human being could do when carrying out a definite method. The Turing machine concept involves specifying a very restricted set of logical operations, but Turing showed how other more complex mathematical procedures could be built out of these atomic components. He had the further idea of the universal Turing machine, capable of simulating the operation of any Turing machine.

A universal Turing machine is a Turing machine with the property of being able to read the description of any other Turing machine, and to carry out what that other Turing machine would have done. It is not at all obvious that such a machine, a machine capable of performing any definite method, could exist. While one might intuitively think that tasks of ever-increasing complexity would need machines of ever-increasing complexity, this is not the case: It is sufficient to have a specific, limited, degree of complexity, and then greater amounts of storage capacity for more laborious tasks.

10. Originally published 1962 in the catalogue, ed. by Bruno Munari, accompanying the exhibition "Arte programmata" at the exhibition space of the Olivetti company. Reprinted in Volker W. Feierabend and Marco Meneguzzo, eds., *Luce, movimento & programmazione-, Kinetische Kunst aus Italien 1958/1968* (Cinisello Balsamo: Silvana 2001, 242–248).

11. Leonardo Mosso, *Architectura programmata* ed. Studio di Informazione Estetica and Vanni Scheiwiller (Turin: 1969).

4

Historicizing Art and Technology: Forging a Method and Firing a Canon

Edward A. Shanken

> Science and technology, the handmaidens of materialism, not only tell us most of what we know about the world, they constantly alter our relationship to ourselves and to our surroundings.... If this materialism is not to become a lethal incubus, we must understand it for what it really is. Retreat into outmoded forms of idealism is no solution. Rather, new spiritual insights into the normality of materialism are needed, insights that give it proper balance in the human psyche. A small beginning is to record its effects upon one art form. This book is directed toward that task.
>
> —JACK BURNHAM, *BEYOND MODERN SCULPTURE*

In the early 1990s my professional life fell under the influence of some writings about art and technology: Jack Burnham's *Beyond Modern Sculpture: The Effects of Science and Technology on the Sculpture of This Century* and Roy Ascott's essays, including "Is There Love in the Telematic Embrace?"[1] I was a first-year graduate student in art history at Duke University and had planned to study a more conventional topic. But the rush of the twenty-first century as the very near future simultaneously bore down on and uplifted me with great intensity. Recent developments in consumer technologies, including relatively powerful personal computers, user-friendly software, and interactive media, including CD-ROMs and perhaps more significantly, the World Wide Web, seemed to open up a new future of creative expression and exchange in which

everyone could be a multimedia content-provider and thus break free from the tyranny of the culture industry.

Inspired by, but skeptical of, such techno-utopian rhetoric, with Burnham and Ascott as my guides, with further illumination from the pioneering work of Frank Popper, Douglas Davis,[2] and Gene Youngblood and under the mentorship of Kristine Stiles, I began to think more and more about the effects that science and technology were having on contemporary art, and about how artists were using the ideas, methods, and tools of science and engineering to envision and create aesthetic models of the future. I also wondered what role art history might play in making sense of these developments in visual culture. Very quickly I realized that I had to study the entwined histories of art, science, and technology in order to have a clue about what was happening at the moment, much less what its future might bring.

The following discussion addresses the problem of writing a history of art that focuses on the nexus of art, science, and technology (AST). Although a fully elaborated history of AST must distinguish between science and technology with respect to their relationship to art, for simplicity's sake I shall refer to the intersection of art with either or both as AST. What follows constitutes a personal report from the trenches and a call to arms. Given the nascent state of the field, combined with its dynamic growth and extraordinary breadth, in some cases my arguments have forsaken subtlety in order to provoke. My foci are canonicity, methodology, and historiography, and my aim is to set out a prolegomena for future scholarship by critics, curators, art historians, and other cultural workers who produce, present, or otherwise try to make sense of AST.

Defining the Problem: Canonicity, Methodology, and Historiography

The development and use of science and technology by artists always has been, and always will be, an integral part of the art-making process. Nonetheless, the canon of Western art history has not placed sufficient emphasis on the centrality of science and technology as co-conspirators, ideational sources, and/or artistic media. Bound up in this problem is the fact that no clearly defined method exists for analyzing the role of science and technology in the history of art. In the absence of an established methodology (or constellation of methods) and a comprehensive history that would help clarify the interrelatedness of AST and compel revision, its exclusion or marginality will persist. As a re-

sult, many of the artists, artworks, aesthetic theories, institutions, and events that might be established as the keystones and monuments of such a revised history of art will remain relatively unknown to general audiences.

Indeed, there is no comprehensive scientific/technological history of art, as there are feminist and Marxist histories of art, for example. This leads one to wonder what a history of art written through a lens that emphasized AST would look like. What would be its monuments? How would they be related through historical narrative? What similarities and differences, continuities and discontinuities, might be mapped onto the use of technology for artistic purposes throughout the history of art? Why are there periods of fervent activity and others of apparent dormancy? In other words, how would the story go if standard survey texts such as Janson's *History of Art* were rewritten with an emphasis on the roles of science and technology on the history of art? In this regard, the sharp new two-volume set, *Art Since 1900*, written by Hal Foster, Rosalind Krauss, Yve-Alain Bois, and Benjamin Buchloh, ignores the history of art and technology to such an extent that Billy Klüver and E.A.T. are not even mentioned. Such exclusion from a text that is destined to gain canonical status has significant, deleterious ramifications for the history of AST.

With respect to the literature in the field, Linda Dalrymple Henderson's "Writing Modern Art and Science" is, to my knowledge, the only historiographical analysis of writing about AST, perhaps because relatively little art historical attention has focused on the subject.[3] More of such studies would be a valuable asset to current and future researchers as they evaluate and understand our intellectual heritage.

Leading art historians, including Jonathan Crary, James Elkins, Henderson, Martin Kemp, and Barbara Maria Stafford, have contributed greatly to understanding the history of AST during the Renaissance, Baroque, and modern periods. With respect to contemporary art, however, much of the pioneering historical, critical, and theoretical literature in English has been written by artists, including Ascott, Burnham, Critical Art Ensemble, Douglas Davis, Mary Flanagan, Alex Galloway, Eduardo Kac, Margo Lovejoy, Simon Penny, Peter Weibel, and Steve Wilson, to name just a few. Notable exceptions include the work of Jonathan Benthall, Marga Bijvoet, Charlie Gere, and Frank Popper, the media-archaeological scholarship of Oliver Grau and Erkki Huhtamo, and the criticism and editorial work of Tim Druckery.[4]

Curatorial practice has made important contributions historically, including the production of exhibitions and exhibition catalogs by Burnham, Pontus

Hultén, Frank Popper, and Jasia Reichardt, and, more recently, by Sarah Cook, Steve Dietz, Beryl Graham, John Ippolito, Christiane Paul, and Benjamin Weil,[5] who have also made contributions to exhibition theory with respect to curating electronic media. Festivals including SIGGRAPH, ISEA, and Ars Electronica, and major exhibitions at the ZKM also have provided important forums for discourses pertaining to AST, though the proceedings and catalogs generated by these events typically have focused more on practice, criticism, and theory than on history. Similarly, until the mid-1990s, the journal *Leonardo* primarily published writings by artists and scientists, in large part because critics and historians simply did not generate much material on the subject.

Much of the influential current literature is being produced in other disciplines, such as comparative literature, film history, performance studies, and cultural studies. Rather than argue for the innovative theoretical positions that characterize AST's history as embodied in works of art and articulated in artists' theoretical writings, much recent criticism, particularly that outside of art history, is heavily peppered with citations of the usual suspects: Benjamin, Barthes, Baudrillard, Latour, Derrida, Deleuze, and Virilio. Summoning such demigods to lend authority to an argument reifies the existing structures of power and authority in academic writing—a result that conflicts with the aims of poststructuralism and deconstruction. Suzanne Stone, the psychopathic television journalist portrayed by Nicole Kidman in the film *To Die For* (1995) famously stated, "you're nobody if you're not on TV." The same logic applies in academia: You're nobody unless you're footnoted. The historical monuments and documents of AST will continue to be excluded from the canon of art history and intellectual history unless their theoretical contributions to critical discourses are credited. If art historians do not succeed in doing so, no one will.

One must ask: What is the voice of art history and criticism with respect to AST? What unique and valuable contributions have they made, and what contributions can they make now and in the future to historicize the subject—both in art history and in a broader cultural framework? Although I have more questions than answers, I hope that these provocations will spur debate and dialogue so that artists and art historians, collectively, can define the problems of our specialized field more clearly and begin to address them, if not in a systematic and concerted way, then at least in a way that provides grounds for identifying and problematizing methods and goals.

My discussion begins with an analysis of Burnham's *Beyond Modern Sculpture*, which I shall consider critically with respect to methodology and historiography. Questions pertaining to methodology and canonicity shall be further developed through self-reflections on my own attempts to historicize cybernetic, telematic, and electronic art within a larger art historical context.

Beyond Modern Sculpture: Historiography, Methodology, and Teleology

Burnham began his career as an artist, first using incandescent light in 1954 and, following the model of Gyorgy Kepes, neon light in 1955. After earning a B.F.A. and M.F.A. in sculpture at Yale in 1959 and 1961, he became a professor of art at Northwestern. There, he continued his research on what he called *photokinetics*, or light-motion phenomena, and began writing his magnum opus, *Beyond Modern Sculpture: The Effects of Science and Technology on the Sculpture of This Century* (*BMS*), published in 1968. The subtitle, the author explained, was not intended to limit the subject of his inquiry so much as to identify the close parallels between the development of modern sculpture and the rationalism and materialism that characterize the scientific culture of which it is a part (*BMS*, vii–viii).

Even in the best of circumstances, it is difficult to gauge a book's influence. In the case of *BMS*, this difficulty is compounded by several factors, including: (1) its highly polarized reception; (2) the author's subsequent mysticism in the 1970s, which undermined his academic credibility; (3) the author's disappearance from public life since the early 1980s, which stunted his ability to spawn intellectual progeny; and (4) the cyclical nature of popular sentiment toward the idea of joining art with science and technology. Regarding this latter factor, after going through at least six printings, the book fell out of print in the early 1980s, but in the late 1990s experienced a significant resurgence of critical attention amidst a rebirth of interest in AST.[6] Despite the difficulties of ascertaining the influence of *BMS*, it is a landmark in the history of writing about art, science, and technology. As such, I believe it holds many clues into the past, present, and future of the field's historiography.

The book's preface, in particular, sheds much light on Burnham's methodology and warrants close reading for its insights into the historiography of AST. The author described a spiritual kinship with Gottfried Semper's *Der Stil in den technischen und tektonischen Künsten oder praktische Ästhetik* (1863).

Semper, Burnham stated, not only established a method for interpreting art as the combined result of "'purpose, material, and technique,'" but promoted the idea that art reflected the "economic, technical, and social relationships" undergirding society (viii). Burnham contrasted this methodological ethos with one developed thirty years later by Alois Riegl, who decried Semper's theory as *Kunstmaterialismus*—a reduction of interpretation exclusively to the material conditions of art production. In its place, Riegl advocated *Kunstwollen*, or artistic volition, which remained the dominant hermeneutic until the mid-twentieth century.[7] Drawing on Siegfried Giedion's (1962) archaeology of art historiography, Burnham explained that, despite its idealism, Riegl's *Kunstwollen* theory, updated by Wilhelm Worringer, resulted in two generations of art historians since the 1920s being "studiously taught to shun the crass manifestations of the technical milieu" (*BMS*, ix). Many artists and art historians working in the 2000s might argue that this prejudice persists. As mentioned above, the recent survey by Foster, Krauss, Bois, and Buchloh exemplifies an abhorrence of technology that contributes to the continued exclusion of AST from canonical histories of art.

Despite Burnham's explicit concern with methodology and historiography, perhaps the unusual approach taken in *BMS* stems from the author's lack of specialized training as an art historian, for he was neither indoctrinated into nor beholden to any particular methodological mold. Indeed, with a combination of irony and arrogance, he stated, "my lack of success with the tools of art scholarship is in part responsible for this present book. Had the tools served their purpose, I might not have sought out others less respected" (*BMS*, ix). At this formative juncture in establishing the histories of media art, science, and technology, perhaps artists, critics, and historians would do well to purge their methodological prejudices, scour retrograde methods like Semper's and Burnham's, and create synthetic, interdisciplinary approaches to analysis, interpretation, and exposition. I shall return to this proposal with respect to my own work, but first the methodology behind *BMS* shall be examined in greater depth, with particular attention to the question of teleology.

Burnham argued that science and technology have played an important role in art's increasing embodiment of the qualities of living beings. His examples traversed a vast swath of history, from the myth of Pygmalion's ancient living sculpture to the realization of automata in the eighteenth century, and from early twentieth-century vitalist sculpture to the emergence at mid-

century of art incorporating cybernetics, computers, and robots. His argument wove in and out of the teleological claim that the historical unfolding of art had been driven by the underlying goal of becoming ever more lifelike. Indeed, *BMS* was commonly criticized for being simultaneously too general and too deterministic. For example, in 1969, Donald Judd complained, "It's a pastiche of art survey information and misinformation. His idea of history, such as it is, is deterministic. Everyone has his hindsighted place and history rolls on."[8] Krauss, in *Passages in Modern Sculpture*, wrote, "Burnham argues that the most fundamental ambition of sculpture, since its beginnings, is the replication of life.... But is sculpture ... necessarily 'about' the imitation, simulation, and nonbiological re-creation of life? And if it is not about that, what are we to think of Burnham's thesis?"[9]

Despite the validity of these and other critiques of *BMS*, the prescience of Burnham's thesis has been striking. Developments in technoscience such as artificial life, bottom-up models of embodied intelligence in robotics, nanotechnology, and molecular biology have become important models and tools for AST research. Krauss acknowledged the material conditions of art production but did not grapple directly with science and technology, an omission, from Burnham's perspective, of the features that defined the prevailing epistemological conditions of the twentieth century. Although one cannot know with certainty the historic place of any given cultural moment within the context of large-scale cultural shifts, the conditions Burnham identified in 1968 have intensified over the past four decades. He likely would not have concurred with Krauss's paraphrasing of his thesis as "sculpture ... necessarily [being] 'about' the imitation, simulation, and nonbiological re-creation of life." For Burnham, the development toward an increasing embodiment of lifelike qualities was not exclusive to art, but was characteristic of rationalist, materialist culture as a whole, of which art was a part. At the same time, one reasonably might be skeptical, as Burnham himself later was, of a method that identified a certain set of artistic practices as avant-garde by virtue of mapping a model of scientific progress onto them.[10]

In "A Teleological Theory of Modern Sculpture"—the final section of the final chapter of the book—Burnham explicitly established his position regarding teleology with respect to art, science, and technology. He lay the groundwork for his argument by replacing the romantic refrain, "art for art's sake," with a more enigmatic explanation of art's raison d'être in scientific culture: "art is what we do when we expend great time, care, and patience on

an activity without knowing why" (*BMS*, 374). This apparently purposeful purposelessness set the stage for Burnham's subsequent reflections and prognostications on the crucial importance of art as a means of survival in an overly rationalized society. Indeed, like many intellectuals in the 1960s, he feared that the cultural obsession with, and faith in, science and technology would lead to the demise of human civilization. For Burnham, the apocalypse would not be caused by thermonuclear war but by the ascendancy of intelligent automata and cyborgs, a fear that Sun Microsystems cofounder Bill Joy trumpeted to great fanfare in *Wired* magazine in April 2000.[11] Joy's sudden awakening to this danger after years of contributing to it, art historian Kristine Stiles has noted, is "symptomatic of the problem" of a technologist "burying his head in the proverbial sand ... with utter disregard for the insights and research of his colleagues in the arts and humanities."[12] One can only imagine the impact that *BMS* might have had on Joy and other technologists had it been assigned reading along with electrical engineering and computer science texts in the 1970s.

Echoing McLuhan's description of art as a "distant early warning system," Burnham wrote, "Art ... may be a means for *preparing* man for physical and mental changes *which he will in time make upon himself*" (*BMS*, 373). Having previously reflected on the "role of sculpture in shaping our destination as a post-human species" (*BMS*, 371), he speculated that the "quasi-biological nature of future art ... implies a gradual phasing out, or programmed obsolescence of all natural organic life, substituting far more efficient types of life forms for our 'inferior' and imperfect ones" (*BMS*, 376). Alternately, he mused, an "increasing general systems consciousness" may convince us that our "desire to transcend ourselves" through technology is "merely a large-scale death wish," and that ultimately, "the outermost limits of reasoning" are not reachable by posthuman technology but "fall eternally within the boundaries of life." Would it not be ironic, he asked, if "organic life and 'intelligence' [are] ... the same thing" (*BMS*, 376). This rhetorical question anticipated discussions concerning embodiment, disembodiment, and the posthuman three decades hence.[13]

Burnham did not attribute a universal, transhistorical essence to art, science, or technology. In fact, following Semper, his teleological account was rooted in the historically variable contingencies of purpose, material, and technique. Culture was malleable for him, but once certain epistemic formations took shape, they could exert great and enduring influence until their in-

ternal logic was played out or otherwise replaced by alternative formations. For centuries, Burnham claimed, the ethos of rationalization dominated Western civilization, all aspects of which, including science and art, necessarily were sucked into its undertow. *BMS* provided an account of rationalization with respect to art. Burnham's teleological master narrative may be interpreted as reflecting the enduring characteristics of that ethos. It was internally consistent in the sense that it simultaneously made a case for and exemplified the persistence of rationalized culture, including the necessity that explanatory narratives coherently progress to a univocal, ultimate conclusion. In other words, the tendency to formulate grand, totalizing narratives paralleled the rationalism and materialism of the scientific culture that framed Burnham's argument and the teleological theories that pervaded science and technology —to say nothing of art history—at the time *BMS* was written.

Burnham was at once enthralled by and apprehensive of science and technology. His greatest fear, however, was that the rationalistic and materialistic milieu—of which science and technology were symptomatic and constitutive—would run rampant. Three decades later, the Sokal hoax and the ensuing "science wars" suggested that, while many humanists had adopted a much more relativistic and nonlinear approach to explain the march (not progress) of science, many scientists clung vehemently, if not antagonistically, to a more traditional and teleological notion that science progresses toward discovering absolute truth. Burnham forecast that if human civilization persisted along that rationalistic path, it ultimately would be supplanted by technology. If, however, culture was reordered according to the principles of general systems theory (a theory credited to biologist Ludwig von Bertallanfy and highly influential on Burnham's thinking and in the humanities and social sciences), he suggested that the species might come to realize that organic life held greater bounties of intelligence and insight than any form of technology.

Burnham's entire *oeuvre* as a critic, art historian, and curator—including his books *BMS*, *Art in the Marcusean Analysis*, and *The Structure of Art*, his catalog essays and regular contributions to *Arts* magazine and *Artforum*, many of which were compiled in the volume *The Great Western Salt Works*, and the theoretically and technically ambitious "Software" exhibition[14]—demand a more elaborated historiographical analysis than can be offered here. The most comprehensive account of the history of AST in the twentieth century, *BMS* not only provides the foundation for his other critical and theoretical work

but, for the purposes at hand, represents his most unabashed championing of AST. He would not remain an advocate for long.

The seeds of Burnham's disenchantment with AST began to emerge in "The Aesthetics of Intelligent Systems,"[15] and are evident in "Software," despite the exhibition's explicit use of computers. His most explicit and antagonistic pronouncement, however, appeared much later, in "Art and Technology: The Panacea That Failed,"[16] where he stated that art and technology are incommensurable on the most basic structural level. After writing *BMS* Burnham began forging a method that incorporated structuralism, alchemy, and kabbalah. This method, applied to his research on Duchamp and conceptual art, led him to conclude that the internal logic of Western art compelled it to reveal its own internal semiotic structure. Using Duchamp's *Large Glass* as a metaphor, he explained that art was stripping itself bare, "dissolving into comprehension."[17] Technology contributed nothing to that process and amounted to "whipped cream" on the cake, he later noted.[18] Having lost faith in the ability of technology to contribute in a meaningful way to the signifying system that, according to his theory, mediated the mythic structure of Western art, in "Software" he purposely joined the nearly absent forms of conceptual art with the mechanical forms of technological non-art to "exacerbate the conflict or sense of aesthetic tension" between them.[19]

For all his brilliance and erudition, Burnham's methods obscured his ability to understand the broader implications of technology as an integral part of art-making. Technology was, for him, merely a means to a predetermined end that had nothing to do with technology, per se. By shedding the surface layers he believed he could uncover a grand scheme, what he referred to as the metaprograms, self-metaprograms, and mythic structures that explained why art unfolded and evolved as it did and would continue to do so. In *BMS*, beneath the surface he posited and found life. In "Software" and *The Structure of Art*, he attempted to uncover the structural foundations of art as a social institution. In an odd way, this self-reflexive methodological approach may be compared with and contrasted to an advanced stage of post-Greenbergian formalism taken to a metalevel of analysis. Greenberg posited three ineluctable modalities of painting—the characteristics of flatness, frame, and facture—and valorized work that explicitly addressed these formal qualities. Burnham identified increasing vitality as the underlying principle that propelled the historical unfolding of art and valorized work that instantiated and revealed that systemic process.

While vitalism and structuralism may remain important philosophical models, their limits in explaining the underlying motivations of art's history hardly need to be rehearsed. Indeed, one of the important lessons of poststructuralism has been a suspicion, if not outright rejection, of the very idea of universalizing master narratives, a deconstruction of what Burnham himself might have described as the mythic structure of Western epistemology. His pioneering application of structuralism to art historical methodology remained one order of analysis removed from such an insight—that crucial level that distinguishes structuralism from poststructuralism. Despite this and other shortcomings, *The Structure of Art* remains a fascinating if abstruse text that begs critical reappraisal as part of a larger reconsideration of Burnham's important contributions to art history.

Art, Science, and Technology: Toward Forging a Method and Firing a Canon

From the invention of one-point perspective and the creation of oil paint to the development of interactive virtual reality environments and telematic art, technical innovation and the use of emerging scientific ideas and technologies as thematics and media have substantial continuity throughout the history of Western art. This is at once not saying very much while also making a significant claim. For one could state just as easily and correctly that various forms of sociology, economics, psychology, and philosophy, along with other analytic and creative tools have been employed in artistic practice and art historical interpretation for hundreds of years. What makes my claim significant is that the discipline of art history has embraced biography, formalism, feminism, Marxism, psychoanalysis, poststructuralism, postcolonialism, and other critical apparata as bona fide methodologies. This leads me to ask: How can this field develop a more comprehensive understanding of art and technology without appropriate methods designed to bring it into relief? What would such methods consist of? What insights might emerge into the relationship between art, science, and technology, especially during periods when they seem relatively unrelated?

The critical and historical work of the aforementioned art historians, critics, and artists offer valuable models that could be formalized into a set of methods. The history, philosophy, and sociology of science and technology, exemplified by the work of Thomas Kuhn, Andrew Feenberg, Paul Feyerabend, Douglas

Kellner, Bruno Latour, and Michael Heim, offer valuable tools for interpreting developments in AST. Literary criticism has a long tradition of critically analyzing media, ranging from pioneers like Marshall McLuhan to more contemporary authors including Jay David Bolter, N. Katherine Hayles, and Janet Murray. Emerging from various fields, cultural studies has developed synthetic methods that draw on a variety of critical approaches to analyze complex phenomena, particularly with respect to mass culture, including television, film, and mass media, as pioneered by Raymond Williams and more recently applied by media theorists Sherry Turkle and Lev Manovich to interpret screen-based multimedia. Given the increasing emphasis on inter- and transdisciplinary collaboration, social science methods from fields including anthropology and psychology, as in the work of Brigitte Steinheider, may offer important insights into the hybrid processes of such research.

Art history is, by its nature, an interdisciplinary undertaking. Ultimately, no single method is sufficient to exhaust the infinite possible interpretations of a work of art. AST, moreover, is a remarkably broad field with a long history. Hence, no single method could hope to provide a comprehensive tool for analyzing a subject of such breadth and duration. Nonetheless, the field of art history would benefit by studying the methods employed by other disciplines to analyze the relationship between science, technology, and culture in general and by elaborating a methodological framework(s) designed to address the particularities of the aspect of AST in question. Such a method(s) would offer valuable insights into the historical relationship of art, science, and technology and provide a basis for understanding how that nexus, in turn, relates to other cultural forces (e.g., politics, economics, and so forth) that have shaped the unfolding of art.

In the absence of a basic method that incorporates the history, theoretical content, and practical applications of science and technology, the canon of art history exhibits an impoverished understanding of the role of both technology in the history of art-making and the contributions of artists who have been important innovators in that regard. This is a slippery slope. On the one hand, the reconstruction of a master narrative is challenging theoretically, if not ethically. Indeed, many of the distinguishing characteristics of contemporary AST would seem to challenge the epistemological foundations that legitimate grand narratives. In this respect, the canonization of AST is arguably tantamount to ensuring its failure by its own criteria. At the same time, ca-

nonical revision that reflects the importance of technology throughout the history of art implies a critical reconsideration and recontextualization of artists, artworks, art-making practices, and historical narratives that previously have been excluded, marginalized, or not understood to their fullest potential. In a different context, Burnham himself once remarked, "all progressive things are accomplished with the aid of the System."[20]

In confronting this dilemma, I hope that the following considerations will at least help demarcate some of the critical issues that surround this problematic enterprise, with respect to the particularities of contemporary art involving emerging technologies and to the more general concern of including the study of science and technology as central to the history of art. I'll begin by sharing some of my thoughts on these questions with respect to art and art history after 1900, which I shall expand with more detailed examples drawn from my own work in the field.

Although theoretical challenges to master narratives and grand schemes constitute a valuable corrective to naturalized discursive strategies and methodological models, the problem of defining a data set remains. Discourse depends on and necessitates that participants in it agree that they have a more or less coherent subject to respond to or talk about. They may disagree vehemently about certain objects, methods, and goals, but there must be some common ground. Canons provide that common ground, a shared database of generally accepted objects, actors, and moments that are held together by virtue of their participation in the construction of an evolving discourse. In order to be part of the discussion, those objects, actors, and moments must be admitted to the canon by its gatekeepers. The primary gatekeepers are art critics, art historians, curators, dealers, and collectors and the institutions they represent: journals, the academy, museums, commercial galleries, auction houses, and collectors. Practically speaking, a canon can be only so large. While it must have sufficient examples to demonstrate its authority, its significance is predicated on a certain exclusivity. So, for each work newly admitted to it, another must be removed. The sorts of judgments that administer this gatekeeping function cannot be separated from ideological agendas, professional ambitions, and financial investments. Support for and acceptance of a work as a canonical monument requires strenuous and subtle negotiation in order to make a case that compels other gatekeepers to concur. For the more gates an object, actor, or moment succeeds in passing through, the more securely

entrenched in the canon it becomes. And, of course, the canon is neither monolithic nor set in stone.

Indeed, the canon of Western art history has been modified dramatically, particularly by reconstructions mounted in the name of Marxism, feminism, multiculturalism, and poststructuralism. In Janson's *History of Art*, second edition (1977), which I read in college in the 1980s, women artists were all but absent. The canon is, to be sure, patriarchal and authoritarian, but it is not fascistic. Rather, it has proven to be quite flexible and resilient. Its existence and status do not appear seriously threatened, in part because challenges to it have focused on remedying exclusions or altering its narrative of stylistic progression rather than dismantling the fundamental structures of power endemic to it. Such a project would demand fundamental epistemological shifts that lie beyond the domain of art history, though the field might be able to offer useful models of noncanonical schemes for creating a shared discursive database, perhaps incorporating interactive technologies to produce a nonlinear narrative structure. As appealing as such a transformation might be, one can imagine the extraordinary challenges they would pose in the classroom. More to the point, they do not provide a solution for remedying the lack of recognition and marginalization of AST. To accomplish that goal, the monuments of AST must be identified and admitted to the canon (or other discursive database).

One approach to canonical recognition is through surveys that include specific chapters on art and technology, as in Kristine Stiles and Peter Selz's *Theories and Documents of Contemporary Art*.[21] Alternatively, AST monuments might be woven into thematic or chronological narratives that integrate the role of science and technology more fully into the fabric of art history. Along these lines, the study of technology as a hermeneutic method must be incorporated as part of the art historian's standard methodological tool-kit. Artists and intellectuals working in this area must become involved in the process of negotiation and gatekeeping that will enable AST to gain canonical status or to enter into the discursive domain of whatever will replace it. Such involvement includes attaining positions of authority in professional organizations, funding and exhibition institutions, the academy, publishing, and so forth. In many respects, the AST clan, such that it is, has already begun to infiltrate these ranks, but it has a long way to go. I am not suggesting a takeover of the art world, merely a leveling of the playing field.

Telematic Embrace

In 1995 I presented my first paper on Ascott at the "Einstein Meets Magritte" conference in Brussels.[22] I continued to research the artist's work, and in 1997, I received a contract to publish a collection of his essays. In my lengthy introduction to *Telematic Embrace: Visionary Theories of Art, Technology, and Consciousness* (*TE*),[23] I attempted to contextualize Ascott's work as a practitioner, theorist, and teacher within the history of art, the history of technology, and intellectual history. My text was grounded fundamentally in the history of art in order to locate Ascott's oeuvre within a continuity of aesthetic strategies employed in experimental art in the twentieth century. For example, I framed Ascott's cybernetic work from the 1960s in the context of painterly tendencies ranging from Cézanne to Jackson Pollock, vitalist and constructivist tendencies in British art from Moore to Pasmore and Nicholson, the use of alleatory techniques and a process-oriented approach to art-making by Arp and Cage, the interactive aspects of kinetic art and happenings, and the conceptualism of Duchamp, Kosuth, and Art & Language. I considered Ascott's work with telematic art in the context of these constituents of cybernetic art, plus mail art, situationism, performance, artists' use of telecommunications, interactive video, and other experimental streams.

I attempted to dispel the commonly held belief that art merely emulates concepts that first emerge in scientific or technological contexts. I theorized that the historicization of ideas often fails to acknowledge artistic developments as an originary source because the languages of art are neither as literal nor widely spoken as the symbolic and textual languages of science and philosophy. My research suggested that ideas emerge simultaneously in various fields and that the cross-fertilization of those ideas presupposes that an underlying context already exists in order for seeds from one field to germinate in another. In the case of Ascott's work, I argued that cybernetics could be applied to the problems of art only because there already was a significant history of artistic experimentation with process, systems, and interactive forms. Cybernetics, then, provided a formalized, scientific method to describe approaches with which artists (and others) had already been experimenting. As an example, I showed how Ascott's *Change Painting* (1959) could be interpreted on the basis of cybernetic principles, yet its creation predated his

awareness of cybernetics. To be sure, the elaboration of the science of cybernetics also provided a theoretical foundation on which related aesthetic research could build, and I demonstrated how Ascott's art practice, theory, and pedagogy could be systematically applied to those models.

With respect to Ascott's theories of cybernetic art, I drew a parallel between the process by which ideas become historicized and the role of artists' writings in theorizing a field. In this regard, I claimed that his writings exemplified how innovative artists often established the theoretical foundations of their practice long before it was incorporated into critical, curatorial, and historical discourses. Over and above that claim, I emphasized that Ascott's writings, like those of artists associated with conceptual art, such as Kosuth and Art & Language, not only theorized his practice but were an integral part of it. Indeed, Ascott's integration of practice, theory, and pedagogy was a central theme of the introduction, as was his integration of artistic, philosophical, scientific, and non-Western systems of knowledge.

Given the importance of science and technology in Ascott's work, my analysis demanded explanations of cybernetics and telematics, in terms of both their basic principles and theoretical implications for the artist's work and for art and culture in general. Key sources for the evolution of cybernetic thought included the work of Norbert Wiener, Gregory Bateson, Heinz von Foerster, and James Lovelock. Simon Nora and Alain Minc's *Computerization of Society*, the 1978 report to French president Valéry Giscard d'Estaing in which the term "telematics" was coined, was a key source for theorizing the implications of computer networks. Moreover, diverse influences, including the metaphysical ideas of Charles Fourier, Henry Bergson, Teilhard de Chardin, and Peter Russell, the structuralist and poststructuralist notions of Barthes, Foucault, and Derrida, and Confucian, Taoist, Native American, and shamanistic traditions were explicated in relation to Ascott's theory and practice of cybernetic and telematic art.

McLuhan's famous adage, "the medium is the message," served as a foil for my analysis of the relationship between form and content in telematic art. I argued that "The processes by which technological media develop are inseparable from the content they embody, just as the developing content [conveyed by] ... technological media is inseparable from the formal structures that embody it." I concluded that "form, content, and process must be considered within the particular contexts of their creation and interpretation," and that telematic art "emerges as a dialogical process of interaction in which

exchanges of information create bonds through shared systems of meaning and value" (*TE*, 85–86).

Related considerations of the relationship between self and others in mediated, screen-based environments drew on Manovich's archaeology of screen culture, Heim's dialectical theories of technology, original reflections based on a literary notion of love in Lawrence Durrell's novel *Justine*, and my interpretation of Duchamp's *Large Glass* in contradistinction to Ascott's. Such questions led to a discussion of responsibility with respect to media, drawing on Baudrillard's "Requiem for the Media,"[24] and further commentary on the topic by artist-theorist Eduardo Kac, media historian–theorist Douglas Kellner, and film–media historian Gene Youngblood.[25]

My analysis and interpretation of Ascott's work of the early 1960s as protoconceptual kindled the insight that telematic art also shared affinities with conceptual art. This intuition, reinforced by an interview with artist Carl Loeffler and in response to an essay by Simon Penny, led to the conclusion that, like conceptual art, the meaning of telematic art, as theorized by Ascott, was embedded largely in its idea. In another context, I applied this strategy—identifying parallels across categories of practice that traditionally had been historicized as discrete and impermeable—to a more general analysis of the relationship between technology and conceptual art.[26]

I offer these examples to demonstrate the breadth and depth of sources and methods that I drew on in my research for *TE*. Although I certainly am more predisposed to and comfortable with some approaches than others, I did not come to the task with a predefined method but rather attempted to allow the subject of my inquiry to dictate an appropriate approach. In the case of Ascott's work, which itself draws on such diverse sources, a highly synthetic method seemed necessary. With respect to the creation of a methodology for writing the history of AST, I conceive of the emergence of methodology and historical narrative as a mutual and reciprocal process, in which each functions for the other as both the cart and the horse that pulls it.

Art and Electronic Media

In 2002 I started writing a book tentatively entitled *Art and Electronic Media*. It consists of a large-format, richly illustrated, hard-bound volume that includes a 20,000-word survey essay illustrated with 50 reference images; a works section of 180 color plates with captions of 100–150 words; a documents section consisting of 110,000 words of edited critical writings

pertaining to the topic; and, in addition, artist biographies and a bibliography. In other words, the volume will present itself as canonical. However, unlike other topics in the same book series, such as minimalism, arte povera, and conceptual art, there is no clearly defined canon of electronic art.

The opportunity and responsibility to create a canonical survey of this topic has been both euphoric and fearful. My overriding goal has been to enable the rich genealogy of art and technology in the twentieth century to be understood and *seen*, not just as a quirky and marginal activity, but as central to the history of art and visual culture since the early twentieth century. To this end, I included work of artists, engineers, and institutions from over thirty countries; attended to issues of race, gender, and sexuality; and structured the book thematically to emphasize continuities across periods, genres, and media.

While assembling this manuscript, I confronted a number of difficult questions about how to historicize the use of electronic media in and as art. The list below identifies some of these issues and the following discussion will address them more or less sequentially.

- How might various subgenres and modes of art inquiry within art and electronic media be classified and categorized?
- What role do particular media or technical innovations play in defining these histories, as opposed to aesthetic or art historical continuities?
- Given limited space and a finite number of illustrations, how does one balance the representation of work by artists with long careers with that of younger artists?
- How can the diversity of artists with respect to nationality, race, gender, sexuality, and other characteristics best be represented? How can a topic of such diversity be addressed in a coherent narrative of 20,000 words?

The other books in the series shared an organizational structure whereby the survey, works, and documents sections were divided into consistent subsections. *Arte Povera* was divided into subsections, structured primarily by artist or locale; *Minimalism* was structured according to chronological subsections; *Conceptual Art* was structured thematically. Organizing the book by artist was not applicable to *Art and Electronic Media.* I rejected using a chronological structure because I wanted to stress how similar media and/or concepts have been used at different times for varied artistic goals. I opposed a medium-

based organizational scheme for two main reasons: (1) it would foreground technological apparatus as the driving force behind the work (a message I did not want to convey); and (2) it would fail to show how related conceptual and thematic issues have been addressed by artists using varied media. The ability to show these sorts of continuities was a top priority, so I elected to organize the book thematically, despite the difficulty of defining themes that are internally coherent and meaningful.

As I began to consider themes with which to organize the book, I also was compelled to define a database, which, as mentioned above, constitutes an essential core of any canon. In the absence of an overarching thesis and predetermined methodology, I intuited that by simultaneously formulating thematic sections and compiling a list of works, each activity would inform the other. Further, I anticipated that the process of defining and populating those sections would enable me to identify critical issues. Ultimately, I hoped that the thematic issues raised by the individual works and the sections they constituted would drive the narrative.

I made a list of some five hundred works, discovering in the process a richness in the field that previously I had not appreciated so fully. This database revealed absences in the thematic scheme, and vice versa. The sections I initially sketched out morphed several times, coming to be defined as follows:

Coded Form and Electronic Production

Following a long artistic tradition of employing technology to generate form or produce multiple images, the emergence of computer graphics and electronic photocopying in the 1950s and 1960s, and high-resolution digital photography, printing, and rapid prototyping (RP, which enables the production of three-dimensional copies) in the 1980s and 1990s expanded the possibilities for artistic production and reproduction. Artists include Ken Knowleton, Sonia Sheridan, and Michael Rees.

Motion, Light, Time

Defying the traditional conception of art as a static object, beginning in the early twentieth century artists began to introduce actual motion into their work, making explicit the continuity of consciousness in the perception of art through time and space. The use of artificial light, such as neon or laser, as an artistic medium also explicitly draws attention to the extension of art in time and space, thereby shifting the artwork from being an illuminated object

to being an actual light source. Artists include Gyula Kosice, Nicholas Schöffer, and Raphael Lozano Hemmer.

Networks, Surveillance, Culture Jamming

Even prior to the advent of computer networking and satellite communications, artists produced work in which the exchange, transfer, and collaborative creation of information often involve remote participants. Public access cable, satellite transmissions, and especially the union of computers and telecommunications (often referred to as *telematics*) vastly expanded these capabilities. Artists include Roy Ascott, Julia Scher, and rtmark.

Simulations and Simulacra

Simulations are copies that share many attributes with the concrete originals they represent. By contrast, the term "simulacra" can refer to a form of similarity particular to media culture, wherein distinctions between original and copy become increasingly murky. The originals may no longer exist, may never have existed, or their significance has been dwarfed in comparison to the simulacra, which attain a level or primacy and authenticity that traditionally had been the exclusive province of the original. Artists include Myron Krueger, Char Davies, and Jeffrey Shaw.

Interactive Contexts and Electronic Environments

Art has always been implicitly interactive in the sense that it demands some manner of perceptual and cognitive interaction on the part of the viewer. Artists working with electronic media increasingly came to think of themselves as providing open-ended contexts that offered audiences infinite possibilities for the production of unpredictable meanings through creative exchanges. Artists include Le Corbusier, Keith Piper, and Toshio Iwai.

Bodies, Surrogates, Emergent Systems

Artists have joined their bodies (and/or those of their audiences) with electronic media or created robots and other forms of surrogates in order to examine the cyborgian nature of human existence and to ponder what a posthuman existence might consist of. Their work bridges the apparent divide between carbon-based organisms and silicon forms of intelligence and life, between the real and the artificial, suggesting that these distinctions are becoming in-

creasingly blurred if not simply a social convention. Artists include Stelarc, Christa Sommerer and Laurent Mignonneau, and David Rokeby.

Communities, Collaborations, Exhibitions, Institutions

Although the history of art traditionally has celebrated a cult of individual artist-geniuses, the field increasingly has recognized the importance of exhibitions, institutions, and communities in shaping the production, reception, and historicization of art. Owing to its technical requirements and financial overhead, art involving electronic media often demands close collaboration between artists, scientists, and engineers, and between individuals, communities, and institutions. This section includes the ZKM, the Software exhibition, and Rhizome.org.

Thematic categories do not admit of hard and fast distinctions. Indeed, there are many works in the book that could have fit comfortably in two or more sections. For example, Sommerer and Mignonneau's *A-Volve* (1993–94) was appropriate for the sections "Simulations and Simulacra" or "Interactive Contexts and Electronic Environments," but the emphasis of this work on the creation of and corporeal interaction with artificial life forms was the factor that determined its place in the section entitled "Bodies, Surrogates, Emergent Systems." On the other hand, Jane Prophet's *TechnoSphere* (1994–95) also emphasizes the interactive creation of artificial life forms, but to my knowledge was the first to do so using a Web-based interface. As a result, this work was placed in "Networks, Surveillance, Culture Jamming." In both these cases the placement of the work in a particular section helped to represent the diversity of practices within it and the extensive crossover between sections. In this way, I hoped that the sections would at once hold together in their expansiveness while demonstrating their permeability, that they would be internally coherent yet interpenetrating. In some cases, decisions were based on intuition, while in others they were determined very purposely in order to achieve a more balanced representation in each section. Overall, my goal was for each section to make sense as a unit, while mutually reinforcing the other sections in order to form a coherent and comprehensive whole.

When I began the project, 180 color plates and 50 reference images seemed to be a lavish abundance. I quickly realized how even twice that number would not provide a sufficient platform for representing the international

scope and richness of electronic art. This situation demanded making tough choices to select works that represented the diversity of the field by decade, gender, nationality, and so on, in a way that seemed fair. For example, how many works sufficiently represent the work of a pioneer, like Paik, with a career spanning five decades, compared to an artist working with electronics for less than ten years? As suggested above in the discussion of canonical revision, for each additional illustration allotted to a pioneer, one less artist could be included in the volume. I made a decision to make the book as inclusive as possible by providing only one color plate for any given individual artist, except in the case of collaborative work. I placed no limit on black-and-white reference images, which I used to represent the breadth of an artist's career and to include additional artists not represented in the works section. In the end, over two hundred artists from over thirty countries were represented. Women artists in the field—few and far between in the 1960s—came to represent a significantly larger proportion of the book, constituting approximately one-third of the artists since 1990. Issues of race, nation, gender, and sexuality were not addressed explicitly as distinct topics; rather, this diversity was woven into the fabric of the volume.

The problem of constructing a narrative that brings together the extraordinary diversity of artistic strategies and media over many decades was a major struggle. As a scholar, I was trained to identify a problem, establish a thesis with respect to that problem, and compile a series of arguments that draw on extant literature, primary sources, and theoretical propositions in support of the thesis. The general topic of art and electronic media admits of no apparent thesis. Burnham's thesis of increasing vitality neither holds true nor offers useful insight into the subject. I began by writing separate short essays for each of the sections. My initial goal was to address the diversity of work within each section, while at the same time suggesting the cumulative effects of artistic development within a broadly defined area of inquiry. As a result, the narrative within each section often follows a chronology, but in a nonteleological way that emphasizes parallels and affinities. For example, in the section "Motion, Light, Time," I drew on Robert Mallary's theorization of "transductive art"[27] to identify a broad range of electronic art, including Jean Dupuy's *Heart Beat Dust* (1968), Gary Hill's *Soundings* (1979), Shawn Brixey's *Photon Voice* (1986), Carsten Nicolai's *Milk* (2000), and Sachiko Kodama and Minako Takeno's *Protrude/Flow* (2001). Spanning more than three decades, all of these works transform matter and energy from one form or state to another.

Concluding Reflections: Art History, Interdisciplinary Collaboration, and the Interpretation of Hybrid Forms

Although eighteenth- and nineteenth-century aesthetic theories asserted the autonomy of art, the development by artists of one-point perspective, anatomy, photography, and virtual reality attest to the deeply intermingled histories of art, science, and technology.[28] Moreover, throughout history, artists have created and utilized technology to envision the future, not just of art, but of culture and society in general. Unfortunately, the history of art has neglected to incorporate this visionary conjunction of AST into its canon in any systematic way. Just as the insights afforded by diverse methodologies, ranging from feminist theory to Marxism to poststructuralism, have resulted in substantial revisions of the art historical canon, so the history of art must be revised in a way that explicitly addresses interactions between art, science, and engineering. This revision will be required not only because it corrects an obvious omission but because contemporary artists are increasingly employing science and technology as artistic media and students are increasingly being trained to use them as standard materials and techniques and to collaborate with scientists and engineers in the pursuit of interdisciplinary research.

Leading contemporary artists are now directing interdisciplinary graduate programs at major research institutions where they are training a new generation of hybrid practitioners.[29] As the number of such hybrid practitioners increases, their impact on the centrality of technology and science to the practice of art and design (and vice versa) also will force a reconsideration of the canons of art history and the histories of science and technology. Such work seeks to create new forms and structures of meaning that expand the languages of art, design, engineering, and science, and that open up new vistas of creativity and invention.

In order to understand the evolving relationship between contemporary art, science, and technology, one must grapple with the complex processes and products that sustain and result from collaborative research. The evaluative methods of art history do not offer adequate measures of success or failure. Interpretive scholarship in this arena will require an interdisciplinary approach that joins together multiple methods of analysis. New methods for ascertaining the value of the new hybrid outcomes of interdisciplinary collaboration must be developed just as new methods for teaching, cultivating, and recognizing the value of hybrid scholars must emerge. Perhaps even new forms of

critical and/or historical exegesis and means of publication and distribution must be developed to articulate and convey the meaning and significance of evolving forms of interdisciplinary creation.

On a philosophical level, if the fruits of hybrid research practices are not strictly science, or engineering, or art, then one must wonder about the epistemological and ontological status of these hybrid forms: what exactly are they? What new knowledge do they produce or enable? What is their function in the world? On a practical level, the future sustainability of hybrid research depends on answering these questions, because the academic careers of scholars whose work fuses disciplines will be cut short if their contributions are not recognized and rewarded within the university. The absence of appropriate methods for evaluating and granting tenure to interdisciplinary professors will create a disincentive for future scholars to pursue interdisciplinary work, disrupt the ability of existing interdisciplinary faculty to mentor future hybrid researchers, and prevent the ascension of interdisciplinary faculty to positions of power and authority in academe, where they can influence infrastructural change and facilitate the creation of new forms of invention, knowledge, and meaning at the intersections of art, science, and technology.

Notes

The first version of this essay was presented at "Historicising Digital Art" sessions at the annual meeting of the Association of Art Historians, University of London, Berkbeck College, London, UK, April 11–12, 2003, chaired by Charlie Gere. Subsequent drafts were presented at Future Technology: Media Arts and Culture Colloquium, coordinated by Ken Rinaldo at the Wexner Art Center, The Ohio State University, Columbus, Ohio, April 28, 2003, and at the MediaArtHistory organizational meeting at Villa Vigoni, Menaggio, Italy, May 28, 2004. This essay is dedicated to Roy Ascott, Jack Burnham, Douglas Davis, Frank Popper, and Gene Youngblood.

1. Jack Burnham, *Beyond Modern Sculpture: The Effects of Science and Technology on the Sculpture of This Century* (New York: Braziller, 1968); Roy Ascott, "Is There Love in the Telematic Embrace?," *Art Journal* 49:3 (fall, 1990), 241–247.

2. Especially Doug Davis, *Art and the Future: A History/Prophecy of the Collaboration between Science, Technology, and Art* (New York: Praeger, 1973), Frank Popper, *Origins and Development of Kinetic Art* (Greenwich, Conn.: New York Graphic Society, 1968) and

Art: Action and Participation (London: Studio Vista, 1975), and Gene Youngblood, *Expanded Cinema* (New York: Dutton, 1970).

3. See Linda Dalrymple Henderson, "Writing Modern Art and Science—I. An Overview; II. Cubism, Futurism, and Ether Physics in the Early Twentieth Century," *Science in Context* 17 (2004): 423–466.

4. Survey texts, including Christiane Paul's *Digital Art* (London and New York: Thames and Hudson, 2003) and Rachel Greene's *Internet Art* (London and New York: Thames and Hudson, 2004), together with edited anthologies, such as Ken Jordan and Randall Packer's *Multimedia: From Wagner to Virtual Reality* (New York: Norton, 2001), Noah Wardrip-Fruin and Nick Montfort's *New Media Reader* (Cambridge, Mass.: MIT Press, 2003), and Judy Malloy's *Women, Art, and Technology* (Cambridge, Mass.: MIT Press, 2003), as well as Rudolf Frieling and Dieter Daniels's *Media Art Net 1: Survey of Media Art* (Vienna and New York: Springer, 2004) and *Media Art Net 2: Key Topics* (Vienna and New York: Springer, 2005), originally published online at http://mediaartnet.org/, also have helped to historicize the field, though it must be noted that of these authors and editors, only Daniels is trained as an art historian.

5. Other important AST curators and archivists include Isabelle Arvers, Annick Bureaud, Andreas Broeckmann, Nina Czegledy, George Fifield, Rudolf Frieling, Darko Fritz, Jean Gagnon, Jens Hauser, Sabine Himmelsbach, Manray Hsu, Tomoe Moriyama, and Michelle Thursz.

6. Marga Bijvoet, *Art as Inquiry: Toward New Collaborations between Art, Science, and Technology* (New York: Peter Lang, 1997); Mitchell Whitelaw, "1968/1998: Rethinking a Systems Aesthetic," *ANAT News* 33 (May 1998), http://www.anat.org.au/pages/archived/1999/deepimmersion/diss/mwhitelaw.html/; Edward A. Shanken, "The House That Jack Built: Jack Burnham's Concept of Software as a Metaphor for Art," *Leonardo Electronic Almanac* 6:10 (November 1998), http://mitpress2.mit.edu/e-journals/LEA/AUTHORS/jack.html/; and Simon Penny, "Systems Aesthetics and Cyborg Art: The Legacy of Jack Burnham," *Sculpture* 18:1 (January/February 1999), http://www.sculpture.org/documents/scmag99/jan99/burnham/sm-burnh.shtml/.

7. Burnham notes that subsequent critics compared this idealistic theory with the mystical and metaphysical concepts of "phlogiston" and "élan vital," which he described as "spurious doctrines that employed impressive terms to cover phenomena that had no satisfactory physical explanation" (*BMS*, viii–ix).

8. Donald Judd, "Complaints, Part 1," *Studio International* 177, no. 910 (1969), 184. Cited in Janet McKenzie, "Donald Judd," *Studio International* (2004), http://www.studio-international.co.uk/sculpture/donald_judd.htm/. Cited 30 June 2005.

9. Rosalind Krauss, *Passages in Modern Sculpture* (Cambridge, Mass.: MIT Press, 1977), 209–211.

10. Willoughby Sharp, "Willoughby Sharp Interviews Jack Burnham," *Arts* 45, no. 2 (Nov. 1970), 21.

11. Bill Joy, "Why the Future Doesn't Need Us," *Wired* 8, no. 4 (April 2000).

12. Kristine Stiles, "Rants," *Wired* 8, no. 7 (July 2000).

13. See, e.g., N. Katherine Hayles, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics* (Chicago: University of Chicago Press, 1999).

14. See *Art in the Marcusean Analysis* (State College, Penn.: Penn State Papers in Art Education, 1969); *The Structure of Art* (New York: George Braziller, 1971); *The Great Western Salt Works: Essays on the Meaning of Post-Formalist Art* (New York: George Braziller, 1974); *Software, Information Technology: Its New Meaning for Art*, ed. Judith Burnham (exhibition catalogue) (New York: The Jewish Museum, 1970).

15. Jack Burnham, "The Aesthetics of Intelligent Systems," in *On the Future of Art*, ed. Edward Fry (New York: The Viking Press, 1970), 95–122.

16. Jack Burnham, "Art and Technology: The Panacea That Failed," in *The Myths of Information: Technology and Postindustrial Culture*, ed. Kathleen Woodard (Madison: Coda Press, 1980); reprinted in *Video Culture*, ed. John Hanhardt (New York: Visual Studies Workshop Press, 1986), 232–248.

17. Willoughby Sharp, "Willoughby Sharp Interviews Jack Burnham."

18. Jack Burnham, personal correspondence with the author, 16 March 2001.

19. Jack Burnham, personal correspondence with the author, 23 April 1998.

20. Quoted in Grace Glueck, "Art Notes: The Cast Is a Flock of Hat Blocks," *New York Times*, 21 December 1969.

21. Kristine Stiles and Peter Selz, *Theories and Documents of Contemporary Art: A Sourcebook for Artists* (Berkeley: University of California Press, 1996).

22. Edward A. Shanken, "Technology and Intuition: A Love Story? Roy Ascott's Telematic Embrace," in *Science and Art: the Red Book of Einstein Meets Magritte* (Dordrecht: Kluwer Academic Publishers, 1999), 141–156.

23. Edward A. Shanken, "From Cybernetics to Telematics: The Art, Pedagogy, and Theory of Roy Ascott," in Roy Ascott, *Telematic Embrace: Visionary Theories of Art, Technology, and Consciousness*, ed. Edward A. Shanken (Berkeley: University of California Press, 2003), 1–94.

24. Jean Baudrillard, "Requiem for the Media," in *For a Critique of the Political Economy of the Sign* (New York: Telos Press, 1983, c. 1972).

25. Eduardo Kac, "Aspects of the Aesthetics of Telecommunications," *Proceedings, ACM SIGGRAPH '92* (New York: Association for Computing Machinery, 1992), 47–57; Douglas Kellner, *Jean Baudrillard: From Marxism to Postmodernism and Beyond* (Cambridge: Polity Press, 1989); and "Resurrecting McLuhan? Jean Baudrillard and the Academy of Postmodernism," in *Communication for and against Democracy*, ed. Marc Raboy and Peter A. Bruck (Montreal/New York: Black Rose Books, 1989), 131–146; Gene Youngblood, "Virtual Space: The Electronic Environments of Mobile Image," *International Synergy* 1, no. 1 (1986), 9–20.

26. See my "Art in the Information Age: Cybernetics, Software, Telematics, and the Conceptual Contributions of Art and Technology to Art History and Aesthetic Theory," doctoral dissertation, Duke University, 2001; and "Art in the Information Age: Technology and Conceptual Art," in *SIGGRAPH 2001 Electronic Art and Animation Catalog* (New York: ACM SIGGRAPH, 2001), 8–15.

27. Robert Mallary, "Computer Sculpture: Six Levels of Cybernetics," *Artforum* (May 1969), 29–35.

28. The ideas presented below are derived from my essay, "Artists in Industry and the Academy: Collaborative Research, Interdisciplinary Scholarship, and the Interpretation of Hybrid Forms," *Leonardo* 38:5 (October, 2005): 415–418.

29. Many graduates of the Planetary Collegium Ph.D. program founded and directed by Roy Ascott in 1996 currently head interdisciplinary programs. These include

Eduardo Kac at the School of the Art Institute of Chicago; Jill Scott at the Hochschule für Gestaltung und Kunst, Zürich; Bill Seaman at the Rhode Island School of Design; Christa Sommerer and Laurent Mignonneau at the Kunstuniversität Linz; and Victoria Vesna at UCLA. Pioneering AST Ph.D. programs in the U.S. include the Digital Arts and Experimental Media (DX Arts) at the University of Washington, co-directed by Richard Karpen and Shawn Brixey; the Media, Art, and Technology program at UC Santa Barbara, directed by George Legrady; and the Digital Media program, directed by Janet Murray at Georgia Tech's School of Literature, Communication, and Culture. Other notable U.S. graduate programs include the Arts Computation Engineering program, directed by Simon Penny at UC Irvine; the Arts, Media, and Engineering program, directed by Thanassis Rikakis at Arizona State University; and the Art and Technology program, directed by Ken Rinaldo at The Ohio State University.

5

Twin-Touch-Test-Redux: Media Archaeological Approach to Art, Interactivity, and Tactility

Erkki Huhtamo

> A visual sense is born in the fingertips.
> —F. T. MARINETTI

The idea of interactive art is intimately linked with touching. As it is usually understood, an interactive artwork is something that needs to be actuated by a "user."[1] If the user "does nothing," it remains unrealized *potential*—rules, structures, codes, themes, and assumed behavioral models designed by the artist and embedded in a software-hardware configuration. An interactive work challenges one to undergo a transformation from an onlooker to an "interactor," an active agent. A peculiar kind of dialogue develops. In addition to mental interaction that is a precondition to the reception of art in general, physical bodily action—one that involves more than just movement of the eyes—takes place. One touches the work, often repeatedly—either physically, by stepping on a pressure-pad, fingering a "touch-screen," clicking on a mouse or pressing a custom-made interface, or remotely, mediated by a video-camera, sound, light, or heat sensors, and so on. As innocuous as these acts may seem, they have potentially far-reaching consequences for the notion of art as we have come to know it. Not only does the emphasis on touch run counter to the customary idea of the "untouchability" of the art object; it challenges us to compare art with a whole range of other human activities—from work to play—where physical contact is expected.

It is not just the "proxemic" relationship between humans and human-made contraptions—from power looms to mechanical toys and videogame

consoles—that matters. If the traditional proxemics, as developed by Edward T. Hall and others, focused on relatively short range relationships within physical spaces, it is increasingly clear that we have entered the era of "teleproxemics."[2] Technological systems from mobile phone networks to the Internet connect humans with each other across great distances, redefining the idea of place in the process. As Marshall McLuhan already stated in the early 1960s, the formative development of the "global village" (whether it has happened as McLuhan predicted or not) emphasized the role of tactility as part of a more general reconfiguration of the senses.[3] Artists and "metadesigners"—Kit Galloway and Sherrie Rabinowitz, Roy Ascott, Paul Sermon, Hiroshi Ishii, Rafael Lozano-Hemmer, and many others—have explored the ramifications of what it means to "teletouch" at a distance. Although the models they have created have rarely been implemented on a permanent basis, the transmission, simulation, and/or substitution of the sense of touch have become vital concerns on many fields from personal telecommunications (including "cybersex") to networked multiperson training simulators, games, telemedicine and remote-controlled warfare. That such developments run parallel with artists' and designers' explorations of similar issues is enough to warrant an inquiry.

This article develops a media-archaeological approach to "touching art" as a contribution to a wider cultural mapping of interactive media.[4] The emphasis is on technologically mediated situations, where the interaction happens via an interface, a hardware-software complex designed for this purpose. The issue of proxemic social interactions between human participants, like those taking place in happenings, body art, and experimental dance pieces, all major elements of the "dematerialized" art scene since the 1960s, is of secondary importance here.[5] The psychophysical constitution of the human–machine interaction is not a major concern in this essay either. Social psychologists like Sherry Turkle have already done a substantial amount of work to uncover its complex "mechanisms."[6] The emphasis here is cultural and historical, dealing with questions such as the following, without pretending to provide conclusive answers: What are the cultural, ideological, and institutional ramifications of touching artworks—whether these artworks are labeled as "touchable" or not? What are the discursive formations informing such practices? How has touching art been related with the acts of touching taking place in other contexts—at work, leisure, and in ritual? Finally, why does asking questions like these matter?

Before beginning to tackle such complicated issues, we must state certain premises. First of all, this essay will focus on cases that involve corporeal engagement with an artwork—the use of one's hands, arms, feet, or even the entire body. So far most discussions of tactility in art have concentrated on what Laura U. Marks has characterized as "tactile, or haptic visuality."[7] This refers to a peculiar visual relationship between an observer and an image (whether static or in motion). As Marks explains, the issue concerns both the modes of visual perception and the "haptic" qualities assigned to the images themselves. The discussion about haptic vision (also known as "visual touch") originated around 1900 in the works of German art historians like Adolf Hildebrand and Alois Riegl. As Jacques Aumont has pointed out, Hildebrand identified two tendencies in figurative art, "the optical pole of distant vision" and "the haptic (tactile) pole of close vision."[8] The first tendency emphasized representation, often situating characters and events "deep" within perspective spaces, while the latter emphasized the "near" presence of the objects themselves, highlighting their textures and surfaces, in other words, the "skin" of things.

For Hildebrand, these tendencies were linked with two ways of seeing: "the nearby image" (*Nahbild*), which corresponded to the everyday vision of a form in lived space, and "the distant image" (*Fernbild*), which corresponded "to the vision of this form in terms of the specific rules of art." The former could be interpreted as more informal and intimate, while the latter was more formal and distant, bound by the conventions of representation. However, as has been pointed out, in actual practices of looking the "optical" and the "haptic" can never be entirely separated. Rather, the observer negotiates between these modes. These ideas have been developed further by Deleuze and Guattari, and others, elaborating on the ideological implications of this division.[9]

The idea of "haptic visuality" implies the transposition of qualities of touch to the realm of vision and visuality. It confronts the issue of the physicality of touch indirectly, through a corporeal operation involving the eyes and the brain. The hands are not part of it, except as an imaginary "projection." Although useful, the notion of "haptic visuality" cannot be applied as such to the analysis of phenomena like interactive art, where the body—sometimes coupled with a "body image," like the "levitating hands" in virtual reality applications—is directly involved. The haptic gaze is supported—and

perhaps at times contradicted?—by other corporeal operations. Quite clearly, any segregation of the senses from each other is out of the question. As McLuhan stated, "tactility is the interplay of the senses, rather than the isolated contact of skin and object."[10] This applies well to interactive art, which often engages not only sight and touch, but sound as well.

Like David Howes, I emphasize the cultural nature of sensory perception. "The cultural meaning of the senses ... is not simply derived from any presumed inherent psychophysical characteristics, but elaborated through their use," Howes writes.[11] In short, sensory perception is culturally coded. Codes are not learned and used in mechanical ways. In sensory activities a process of negotiation takes place, where internalized "schemes" are tried out and activated in various ways in response to sensory "input," sometimes subverting the most obvious meanings.[12] Anthropologists and cultural scholars like Constance Classen and Howes have provided ample evidence about variations in the sensory expressions and responses within different cultures. The most obvious example is salutation; there is a great variety of salutations, not only in those involving touch, but also those that do not. Far from being haphazard or anarchic, these conventions correspond with social sanctions and divisions, and deeply felt needs within the society. Touching is never just an improptu act, a personal expression of "universal" feelings and intuitions. The meanings of touch depend on the cultural context within which they are activated and negotiated. In a technological culture, forms of touch have been instrumentalized into coded relationships between humans and machines. Arguably they have been genderized as well, a fact reflected in strategies of interface design.

Artists have designed ingenious ways of mediating between humans and machines, and between humans and humans via the *mediation* of machines. But are their solutions always "original," without precedent? Or could artists rather be seen as transmitters and transformers of sensory traditions rooted in preceding cultural forms? As art historians have shown, artists are not always fully aware of their influences and the implications of their choices. In some cases, however, they can be highly aware of their goals, drawing on cultural models and modifying them to suit their needs. Both alternatives are encountered in the artists' involvement with touch. From the media-archaeological perspective artists can be considered cultural agents working within cultural traditions (even when they deliberately claim to clash with them) and reenacting existing forms and schemes in their works, either consciously or uncon-

sciously. An artwork can give us clues about how cultural traditions work and recycle their elements in an effort to renew themselves. Of particular interest are the cultural elements and clichés that appear, disappear, and reappear in cultural traditions and provide "molds" for cultural expressions and experiences. Inspired by the work of Aby Warburg and Ernst Robert Curtius, I have called such elements "*topoi*" (*topos* in the singular).[13] What kind of *topoi*, if any, can be discovered operating in interactive artworks? What purposes do they serve?

Art and the (Anti-)Tactile Tradition

How convenient it would be to state that tactile art began with interactive media art! However, this is not the case. Although it has usually been seen as a phenomenon of secondary importance, the idea of "touchable art" was already evoked in the context of the historical avant-gardes of the early twentieth century; the discourses on touching artworks go much further back in time. To understand the role of tactility in contemporary media arts, one must first trace these earlier manifestations. One also has to explore their reverse: the absent and prohibited touch. We could speak about "tactiloclasms"—cases where physical touching is not only absent, but expressly prohibited and suppressed. Instead of being a minor issue involving one of the "lower" senses at the fringe of dominant cultural practices, the question "to touch or not to touch" turns out to have wide implications. Far from being marginal, it is linked with important cultural issues—contestations and tensions, rules and transgressions—happening in social spaces. These issues are still—and perhaps more than ever—felt in today's museums and galleries due to the ongoing "crisis" of the traditional art object, the emphasis on interactivity and tactility and the emergence of what Nicolas Bourriaud has called "Relational Aesthetics."[14] Many exhibitions now present both works that encourage touching and those that strictly prohibit "fingering."[15] Exhibition visitors often find this situation confusing, yet it is not totally unique or unprecedented.

The emergence of the discourse on haptic visuality in the end of the nineteenth century echoed both the dominant aesthetics and the academic practices of displaying artworks. "Touching with one's eyes only" was a manifestation of an ideological "mechanism," where the formation of the aesthetic experience was associated with "stepping back"—maintaining physical

distance from the artwork. Touching a sculpture or a painting was not only deemed vulgar, but forbidden. Behind this situation there were multiple determinants that did not always merge seamlessly with each other. The Romantic cult of the genius had emphasized the "otherworldly" quality of the artwork; as a product of "divine" inspiration, it had a special "aura" that made it almost sacrilegious—and therefore also tempting, at least for those longing for a "touch of genius"—to touch it with one's hands. Art museums and galleries were conceived as "temples of beauty and the sublime." Religious connotations associated with behavioral modes were thinly veiled (but not fully suppressed) by secular ones—indeed, touching a statue of a saint to gain power or "contact" has been part of many religious traditions involving images. However, alongside the veneration of their otherworldly qualities, artworks were also admired for their superior craftsmanship, which emphasized their material quality. They were increasingly seen as commercial products—collectibles, investments, and status objects for the bourgeoisie. Thus the prohibition of touching was linked with the "untouchability" of private property, as the "cult value" was gradually replaced by exchange value.

Another development was the democratization of the museum, spurred by the ideology of visual education of the masses.[16] While access to museums had earlier been retricted to privileged visitors who were assumed to know the proper codes of behavior, the situation changed in the "age of the masses." Artworks were increasingly enclosed in transparent display cases or behind protective sheets of glass and kept under the inspecting eyes of museum guards. Even the *potential* for touch, now seen as a threat of transgression, was eliminated. As Classen has shown, the nineteenth-century museum, where nontactility reigned supreme, was not a given, but a cultural and ideological construct.[17] In the early museums, stemming from private collections and cabinets of curiosities, touching the artifacts was often not only allowed, but encouraged. Many visitors took this as self-evident and were offended if the right to touch the objects was denied. Not just three-dimensional objects, but even paintings were touched, as a complement to the act of looking. The tactiloclasm that came to dominate the museum institution, and in many cases is still valid today, was a combination of factors—ideas about public domain and private property, notions of access and education, social hierarchies translated into relationships to objects, surveillance, and protection (the museum could be seen as an ideological machinery whose purpose was to ease mounting social tensions).

It is not entirely inappropriate to compare the museum to another great nineteenth-century institution, the department store. While the museum did its best to eliminate all forms of tactile access to the artifacts on display, the department store looked for a working relationship between tempting haptic visuality (represented above all by the window display) and tactile access to the goods for sale. In the nineteenth century most merchandise was still kept safely behind counters, only reached by the mediation of shop assistants. The right to touch the merchandise had to be carefully controlled, because the department store could inadvertedly encourage kleptomania, a "dangerous" mixing of social classes and sexes, as well as chaotic and even manic behavior during sales events. This did not prevent Emile Zola from characterizing the department store as "a cathedral of modern commerce," while the architect and polytechnician Julien Guadet called it a "museum of merchandise."[18]

The museum, the church, and the department store all regulated behavior, although the suppression of the tactile dimension took different forms. Such more or less strictly enforced institutional "tactiloclasms" provide the backdrop against which the emergence of the "society of interactivity" should be assessed. Popular culture, including penny arcades and other forms of "Automatic Entertainments," as well as avant-garde art, provide early hints of a sprouting phenomenon that burst into the cultural mainstream during the twentieth century.

The Futurist Art of Tactilism

Although F. T. Marinetti's "Manifesto of Tactilism" (1921) has been considered one of the minor manifestos of futurism, it is the most programmatic and explicit early plea for an art of touch.[19] It emerged logically from the futurists' attack on academic institutions and bourgeois culture. The art museum with its static displays was the embodiment of "passéism" and an obvious target for the futurist veneration of speed, machines, masses, and art turned into a social force. While proclaiming the destruction of decadent and obsolete cultural forms, the futurists wanted to renew the totality of contemporary culture by resorting to multisensory and synesthetic strategies.

In his manifesto Marinetti outlines the principles of Tactilism as a new art form, including the education of the tactile sensibility, the creation of "scales" of different tactile values, and the construction of models for tactile artforms. Marinetti's list includes various types of "tactile tables," consisting of different

materials to be touched, as well as tactile divans, beds, clothes, rooms, roads, and even theaters. It is a pity that Marinetti does not explain all of his ideas in detail. The rooms, however, anticipate some aspects of installation art with their walls covered by large tactile boards made of different materials. The floor provides tactile values by means of running water, stones, brushes, velvet, weak electricity, and so on. All this is said to offer "maximum spiritual and sensual pleasure to the naked feet of male and female dancers." In the tactile theaters the audience members would place their hands on long tactile "belts" that move at variable rhythms.[20] The belts could also be applied to small rotating wheels, accompanied by music and lighting effects.

For Marinetti, his "still embryonic tactile art" must be kept distinct not only from painting and sculpture, but also from "morbid erotomania." Its purpose is to achieve tactile harmonies and to contribute to the "perfection of spiritual communication between human beings, through the epidermis." Marinetti does not consider his tactile art as separated from the other senses. Rather, he feels that the distinction between the senses is arbitrary; Tactilism can contribute to the discovery and cataloging of "many other senses." Still, Marinetti remarks that "a variety of colors" should be avoided in the tactile tables so that they do not lend themselves to "plastic impressions." Because painters and sculptors tend to subordinate tactile values to visual ones, Marinetti suggests that Tactilism may be "especially reserved to young poets, pianists, stenographers. . . ." This statement is interesting. It seems to prioritize the writer's, the pianist's, and the stenographer's hands because these are means for evoking nonvisual realms of imagination and suggestion beyond the visible. Their touch is both sensual and intrumental. If this interpretation is correct, it could be associated with Marcel Duchamp's famous critique of "retinal" art. For Duchamp, instead of clinging to the surface effects as the impressionists did, art had to become "cerebral," penetrate beyond the retina, beyond the purely visual. Of course, Marinetti only hints at the intellectual possibilities of tactile art. Still, his reasoning embodies an interesting paradox: Tactilism, the ultimate art of the surface, is really about what is beyond it. It is in the mind of the toucher. It is not a coincidence that he also compares Tactilism with X-ray vision and points out its practical value for surgeons and the handicapped. With Tactilism, "a visual sense is born in the fingertips," one that "sees" deeper than the skin.

Knowing the futurists' affectionate relationship with technology, it is striking to note that the "Manifesto for Tactilism" says nothing about machines as

a new touchable realm (with the possible exception of the mechanisms for the moving belts in the tactile theaters). One wishes Marinetti had mentioned the hands of the typist (captured in motion in a "photodynamism" by fellow futurist Anton Giulio Bragaglia already in 1912) or those of the driver clutching a steering wheel, almost a fetish for the futurists. Such "interface awareness" obviously had not yet developed, although the works of some futurists, like Gino Severini, did contain mechanical parts to be manipulated by the viewer.[21] It had also been implied in Giacomo Balla and Fortunato Depero's manifesto "The Futurist Reconstruction of the Universe" (1914), which described varieties of fantastic machines and "futuristic toys." Depero's *Plastic Complex: Motorumorist Pianoforte* (1915), a mechanical noise-making machine, was controlled by a human performer via a keyboardlike interface. Marinetti's reference to weak electric shocks given to the dancers in his tactile room is, however, a lead worth following. It refers to what may have been the most popular technologically augmented tactile experience. Well-known to the public through popular-scientific lectures at fairground attractions, doctors' offices, and even homes, electric shocks were a nineteenth-century novelty that was considered both exciting and healing. "Electricity is Life" was a well-known slogan in the broadsides for shows and on devices administering electric shocks. The quack machines meant for domestic electrotherapy had their counterpart in the coin-operated "strength testers" at penny arcades; the task was to grasp two metal handles for as long as possible while a steadily increasing electric current flowed through one's body.

Already in their first manifesto (1909) the futurists had promised to "sing of great crowds excited by work, by pleasure, and by riot."[22] It was in the mass society that various technology-related tactile experiences emerged during the nineteenth century, ranging from work in mechanized factories and offices to the new kinds of pleasures offered by the varieties of coin-operated devices at amusement parks, penny arcades, and on city streets. While the department store windows kept their desirable offerings behind panes of glass, the strength testers, mutoscopes, and other "Automatic Entertainments" invited the user to a direct physical contact. As one can still experience at places like the Musée Mecanique in San Francisco, the "user interfaces" of such devices often had hand- or foot-shaped molds. Some even had surrogate metal hands, challenging the visitor to an arm-wrestling match with Uncle Sam or some other mythic figure. Operating these devices often required more physical strength than dexterity, which seems to have directed their

"gender-designation" toward the male, while a more passive onlooker's role was reserved for women. However, other devices, including shooting games and even mutoscope-like peepshows, appealed to females as well; the gender divide was never as sharp as has been assumed. These devices also inspired lively discursive manifestations, often evoking tactile relationships. This issue has been dealt with in the author's earlier writings.[23]

There is no lack of evidence about the influence of popular culture on the avant-garde movements of the early twentieth century.[24] Sergei Eisenstein's revelation, according to which his radical intellectual montage, including the principle of "shock attraction" used in his classic *Battleship Potemkin* (1925), was influenced by the experience of riding on a roller coaster, is a striking example, but not the only one.[25] It might be claimed that Picasso's and Braque's practice of using found material, including tram tickets, newspaper cuttings, cloth, and other pieces of residue from the urban mass culture in their collages was *potentially* tactile, in line with Marinetti's tactile tables, even though they hardly encouraged actual touching. The tactile dimension was enhanced by the soirées, cabarets, city wanderings, and other events organized by the Dadaists, surrealists, and other radical movements to break down the barriers between artists and non-artists. The sensational boxing match between the Spanish Dadaist Arthur Cravan and the reigning world champion John Johnson (1916), which led to Cravan's predictable knockout in the first round, shifted the focus from the art object to the corporeal tactility of spectator sports, although the audience's participation was limited to haptic visual sensations from the other side of the ring. However, the infamous and deliberately provoked scuffles that sometimes took place between the performers and the spectators at Dadaist and surrealist events demonstrated that cracks were beginning to appear in the invisible shield separating art from its audience.

Duchamp, Kiesler, and the Invitation to Touch

Marcel Duchamp's readymades should also be discussed this context. As is well known, Duchamp chose visually unremarkable mundane objects that were put to tactile uses in everyday life without much thought—a bicycle wheel and a stool, a bottle rack, a snow shovel, and the protective cover of an Underwood typewriter, familiar from thousands of offices. In their mass-

produced ordinariness such objects easily turn "invisible" in their normal contexts. Duchamp's idea of displaying them in the gallery in the place usually reserved for "untouchable" art objects is an ambiguous gesture that created a powerful irony. Far from denying the tactile nature of these objects, it could be claimed that their new site (with its preexisting connotation of "distance") increased the temptation to touch them as a subversion of their newly acquired "status." Duchamp provided some of his readymades with enigmatic texts that may have urged the visitors to come closer to study them, thus further increasing the tension between "to touch or not to touch." It should perhaps be noted that as cultural artifacts, texts—whether on the pages of a book or as public inscriptions or notices—seem less controlled by tactile restrictions than images. Books are tactile objects par excellence, meant to be perused with one's fingers. Public inscriptions, often carved in stone, may not have been meant to be touched (prohibitions controlling their untouchability exist), but they often have nevertheless endured the touches of generations of believers or tourists.

The first of Duchamp's readymades (their "distant forerunner," according to Octavio Paz), *Bicycle Wheel* (1913), was different from the others in that it incorporated an active possibility of (interactive) movement.[26] There is some evidence suggesting that Duchamp himself enjoyed putting it in motion by hand. Whether this was ever done by exhibition visitors is uncertain, but the form of work could certainly persuade the user to interaction. Unlike its typical situation when it is attached to a bicycle, the wheel protrudes toward the viewer, while the stool serves as a pedestal.[27] This might warrant calling it —without belittling its other possible readings and identities—a "proto-interactive" work. It went further in this direction than Man Ray's *Objet à detruire* (Object to Be Destroyed), a modified metronome with a cutout eye attached to its pendulum. Although Man Ray also uses mechanical motion, the (destructive) suggestion is largely transmitted by the title, obviously challenging the viewer to break the hypnotic spell of the to and fro movement of the eye.[28] Constantin Brancusi's *Sculpture for the Blind* (c. 1920), an egg-shaped, polished marble object, suggests touching both by its formal qualities and its title, reminding one of the strong potential tactility of Brancusi's work.[29] Meret Oppenheim's *Le déjeuner en fourrure* (Breakfast in Fur/Fur Teacup, 1936) is an example of a surrealist object with a suggestive but ambiguous tactile quality. It is not meant to be touched physically—it exists

more in the realm of haptic visuality, albeit on its tactile edge, almost "within the reach of the hand." Of course, while the fur may be inviting to the hand, it may also feel repulsive if associated with the act of drinking.

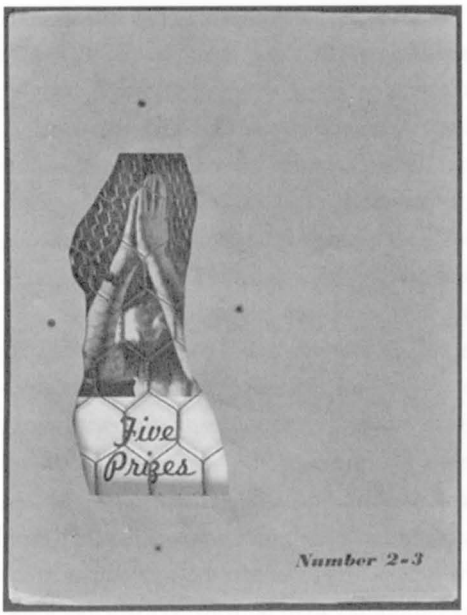
Traditional exhibition design served as a "machinery" for maintaining the untouchability of art within museums. Therefore it is logical that tactile ideas were probed on this field by avant-garde innovators like Duchamp, Man Ray, and Frederick Kiesler. Duchamp's and Man Ray's play with lighting at the opening of the 1938 Exposition Internationale du Surréalisme is a *cause célèbre*. The main hall was nearly dark, and the visitors were given flashlights to see the works. Even the flashlights were quite dim, forcing the visitors to get very close to the artworks, leading to an unusual interaction with the environment.[30] Kiesler incorporated touch on multiple levels into his famous design for Peggy Guggenheim's Art of This Century gallery in New York (1942).[31] He created swiveling "baseball bat" wall mounts that detached the artworks from the walls and made them "rush" toward the spectator, as well as "biomorphic displays," systems of strings stretched between the floor and ceiling, holding small sculptures in between, potentially elevated or lowered by the visitor. Perhaps Kiesler's most radical—and controversial—gesture was the construction of peep boxes for viewing artworks in the Surrealist Gallery. Thus André Breton's *Portrait of the Actor A. B.* could be seen by pulling a lever that opened a diaphragm, allowing the work to be seen inside the box. Reproductions of the contents of Duchamp's *Boite en valise* could be inspected by peeping into a hole and turning a large "ship's wheel" (obviously a homage to Duchamp's *Rotoreliefs*). Critics immediately associated these designs with popular cultural motives, calling them "a kind of artistic Coney Island," or "a penny-arcade show without the pennies." According to Lewis Kachur, they also recalled Julien Levy's original plan for a surrealist nickelodeon arcade for the 1939 New York's World's Fair.[32] Although they hardly created a tradition, Kiesler's designs are an important link between popular "proto-interactive" devices and the interactive media of the future.

However, the most explicit experiment in tactility by Kiesler is the little-known *Twin–Touch–Test*, a work created in collaboration with Duchamp for the surrealist *VVV: Almanac* in 1943.[33] It is disguised as a prize competition, complete with a cutout coupon to be returned with the entry. Returning cut-outs by mail was, of course, a common form of "programmed feedback" in the popular press. The reader is asked to join the palms of one's hands from both

sides of a chicken wire fence, and caress it until ready to describe the experience "in no more than one hundred words." If there is no access to a wire screen, the back cover on the journal, containing a piece of actual chicken wire inserted in a cutout slot in the shape of a female torso, could be used. Detailed instructions for conducting the experiment both alone and with another person are given. Although it has been described simply as an "autoerotic exercise," the fact that a two-person mode is also available suggests a training for sensual interpersonal communication, which Marinetti mentioned as one of the goals behind his tactile experiments.

As can be expected, the work contains numerous other connotations. As far as I know it has not been pointed out, for example, that the photograph on the Twin–Touch–Test page, showing a young female (Peggy Guggenheim's daughter Pegeen) engaged in the act of caressing the wire fence with her hands, eyes closed, undergoes a transformation when seen through the chicken wire slot of the back cover. Only a part of the photograph is visible as if through a peephole.[34] The most prominent features are the raised hands behind the wire fence, while the girl's shoulder may be mistaken for her head pushed back (her real head is framed outside). The connotation might be religious exctasy, but sadomasochistic fantasies, reminiscent of those seen through the peepholes in Jean Cocteau's film *Le sang d'un pôete* (1930), may be evoked as well. Ironically, the words "Five Prizes" can also be seen, increasing the ambiguity of the view.

The gender of the implied user has been left deliberately ambiguous. Although the photograph shows a girl doing the exercise in the autoerotic mode, the female figure of the cutout would seem to suggest the male as the implied "toucher" (as well as the "peeper" when the back cover is closed). The profuse and fetishistic use of naked female bodies in surrealist exhibitions and actions—from "prepared" mannequins to actual nude models—would seem to reinforce this.[35] Duchamp himself used a female breast, made of soft foam-rubber, in his famous cover design for the deluxe version of the exhibition catalog *Le Surréalisme en 1947*, accompanied with the exhortation: *Prière de toucher* (please touch). The erotic tactile play of the cover was made even more explicit in the photograph of a nude model posing in the exhibition hall next to Kiesler's *Totem of the Religions*, wearing nothing but a bandage over her eyes and Duchamp's foam-rubber breast covering her sex.[36] Although this action may be interpreted as merely a typical surrealist prank, it also engages the



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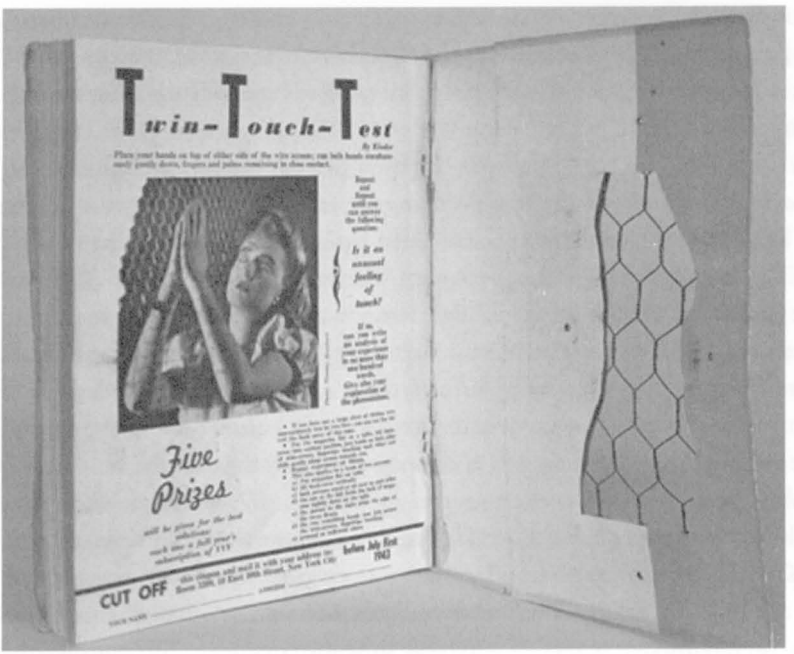

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Figures 5.1a, 5.1b Frederick Kiesler and Marcel Duchamp, *Twin-Touch-Test*, 1943. See plate 3.

discourse on tactility by placing a living human body among the artworks and even providing her with a kind of eroticized "push button." The "blinding" of the model further emphasizes the tactile register. Enrico Donati, the American painter who helped Duchamp in the production of the foam breasts, remarked that "I had never thought I would get tired of handling so many breasts," to which Duchamp is said to have replied: "Maybe that's the whole idea."[37] Perhaps—perhaps not; *Prière de toucher* was an oblique commentary on the amount of naked breasts in surrealist art at the time.

Feminist Play with the Tactile Passive Body

Art that emphasized the tactile relationships between bodies, often mingling those of the performers and the participants, became a major element of the happenings, performances, "body art," and other art events of the 1960s and the '70s. As already stated, this topic falls outside the frame of this essay, so the discussion will be limited to a few projects that linked bodies with technological interfaces. Of primary importance is Valie Export's *Tapp und Tastkino* (Touch and Taste Cinema, 1968). Helped by her partner Peter Weibel, who—ironically—worked as her barker, Valie Export appeared in the city street wearing a box with curtains that covered her naked breasts. The passers-by were exhorted to reach out their hands and fondle them. In this "expanded (or perhaps reduced?) cinema" piece, the naked female bodies offered by (mostly male) producers and exhibitors to the anonymous collective consumption of cinema audiences have been replaced by a personalized and proxemic experience involving not representation, but "the real thing." Unlike the pornographic images on a screen, this experience is controlled by the female subject herself. While fondling her breasts, the toucher is also forced to encounter her gaze. This is the opposite of the voyeuristic situation reigning in the cinema, where the characters never really look back (although they may pretend to do so). The haptic visuality of pornographic cinema was replaced with corporeal bodily contact.[38]

Valie Export made this link even more explicit in her *Action Pants: Genital Panic* (1969), a performance in which she entered a cinema showing a pornographic film in pants with the crotch cut away and a sub-machine gun on her sholder, offering herself to be sexually used by the audience, as a replacement to the projected sex on the screen. Marina Abramovic, another pioneering feminist artist, used a similar strategy in her action *Rhythm 0* (1974). For the

duration of six hours, she submitted herself passively to the physical manipulation by the (mostly male) audience, even providing an array of torture and pleasure instruments for the purpose.[39] Abramovic aimed to expose the taboos, desires, and inhibitions related with physical tactility in the "society of the spectacle," where the relationship to bodies has purportedly been distanced and commodified.[40] Both Export's and Abramovic's actions had been anticipated by Yoko Ono's *Cut Piece* (1965) that introduced the figure of the seemingly passive female subject left at the (tactile) mercy of the spectators.[41] Another early tactile feminist work was Orlan's *Baiser de l'artiste* (The Kiss of the Artist, 1976–77). Orlan posed as a coin-operated dispenser machine, behind a "shield" showing a naked female body. After depositing a coin that fell into a basket between Orlan's legs, the user was allowed to kiss her.

Tactile motives also began to appear in works that directly linked the spectator with media technology. Although it may encourage haptic visuality, the television set in its daily use is a nontactile object (in spite of Marshall McLuhan's arguments for its tactility).[42] The television set was redefined as an object for touching and manual manipulation in the early installations and actions by Nam June Paik and Wolf Vostell. By modifying the electronic television image with a magnet, or by turning knobs or shouting into microphones, Paik's "Participation TV" works turned the TV set from a terminal for passive consumption of remotely transmitted content into a means of self-expression. Paik's goal of "doing television with one's fingers" was not only a transposition of his earlier preoccupations as a pianist from the aural to the visual, but arguably echoed the *topos* expressed in Marinetti's saying: "a visual sense is born in the fingertips."[43] Portapak, Sony's early portable videocamera and recorder, provided Paik and an entire generation of video artists a means of exploring the body as it became interfaced with technology. The Portapak came to be used in live performance and tape works focused on the artist's body, as well as in closed-circuit installations, where the visitor's body image was captured and transmitted back as if in a technological mirror. Video scanned the skin and magnified body parts, creating an intimate, haptic discourses. It also helped to set up stage situations where actual and represented bodies were juxtaposed or superimposed. Video was linked with the possibilities of the computer in the early works by interactive art pioneers like Myron Krueger and Erkki Kurenniemi, leading to new ways of exploring the relationships between bodies, technology, and body images.[44]

An Internet search for "tactile art" produces mostly results that refer to a specific phenomenon, namely aesthetic experiences for the blind. There are exhibitions and museums of tactile art, usually offering replicas of well-known sculptures or embossed, relieflike versions of famous paintings (including, in one case, Duchamp's *Nude Descending a Staircase*). In these cases the sense of touch is meant as an ersatz to the missing visual channel. While it can be argued that a faithful replica of Rodin's *The Thinker* could indeed give some kind of an idea of the artwork (sculpture itself can be seen as potentially tactile, although this possibility is negated by institutional restrictions), the tactile translations of paintings and other two-dimensional images are more problematic. A relieflike copy of *Nude Descending a Staircase* may transmit some idea of its representational content to experienced hands, but other levels are lost. Some rare original artworks have been meant for both the visually impaired and people with normal sight. The Japanese artist Takayuki Mitsushima, whose works were recently shown at the Touch, Art! exhibition at the Kawagoe Art Museum in Japan, was weak-sighted at birth and lost his sight completely by the age of ten.[45] His collages use delicate paper cuttings to create relieflike surfaces that appeal both to blind visitors and those with normal sight. Remarkably, the artist uses colors, resorting to the visual memories from his childhood. Mitsushima also took part in *Tactile Renga* (1998–), a collaborative networked painting project he created with media artists Toshihiro Anzai and Rieko Nakamura. As part of the project, a new kind of printer and plotter technology for the creation of embossed images was developed.[46]

The realm of tactility in art is not, however, limited to the experiences for the visually impaired. Interactive art, in particular, is tactile art almost by definition. As already stated in the beginning of this essay, interactive art requires the user's action to function. The work then responds in some way, and a "conversation" between the user and the work develops. This is, of course, the most rudimentary definition of interactive media. Adding the issue of tactility raises numerous questions that cannot be fully answered here. First, the nature of the touch itself: Is it possible to create taxonomies of different kinds of touches? What are the connotations of caressing versus hitting, pressing versus pulling? How does proxemic touching differ from teleproxemic touching? How does actual physical touching differ from "virtual touching"

(without direct contact with the interface)? Second, the function of the touch: Does touching the work trigger "local responses" (from the physical artwork and/or the surrounding space) or "remote responses" (i.e., touching the work affects realities that are spatially distant, while the responses are mediated by the work)? Do the responses come from a system (a software-hardware complex) or from other human beings via the mediation of the system? Third, the relationship between touch and the other senses: Is the goal of the work the "purification" and segmentation of the sensorium by separating touch from the other sensory channels, or, rather, their synthetic integration? Can the work serve the interchangeability of the senses, or the simulation of other senses? Fourth, the role of tactility itself: Is all art that involves touching "tactile art"? Must there be a physical response ("force-feedback") to the user's touch for the application to qualify as tactile? Does tactile sensation have to be a goal in itself, or can touching play a more metaphorical or instrumental role, and still warrant the piece's classification as tactile art?

Here it is possible to give only tentative answers by examining some artworks where the issue of touching plays an important role. Quite clearly, a very rich range of "touch modes" has been proposed by new media artists, from gently fingering living plants (functioning as an interface to growing a digital garden) in Christa Sommerer and Laurent Mignonneau's *Interactive Plant Growing* (1993) to aggressively throwing balls at a wall-relief made of modified computer keyboards in Perry Hoberman's *Cathartic User Interface* (1995). While some artists prefer to use standard interface devices (mouse, keyboard, joystick), others see designing their own as an essential aspect of the work. Ken Feingold's *The Surprising Spiral* (1991) has two interface objects: a touch screen designed as the cover of a simulated book and a pile of books with a model of a mouth on top of it (putting one's finger across the "lips" makes the mouth speak). A tactile interface does not always involve the use of hands. The user communicates with Tony Dove's interactive narrative installation *Artificial Changelings* (1998) by stepping on interactive floor pads. Marnix de Nijs' *Run Motherfucker Run*, recently awarded at Prix Ars Electronica (2005), invites the viewer to run on a large industrial treadmill. In the virtual reality installation *Osmose* (1995) Char Davies used a combination of a breathing interface and body motion tracking as a way of controlling the user's movements within a virtual world.

To what extent should the user "feel" the responses from the work? In most cases artists seem content with providing visual-aural feedback, only implying

tactile responses. There are, however, works where tactile feedback has become an integral part of the concept itself. Bernie Lubell's surprising wooden (resolutely nondigital) interactive installations often contain pneumatic tubes and soft diaphragms (inspired by the work of Étienne-Jules Marey) that provide the interactor genuine tactile sensations. In *Cheek to Cheek* (1999) the interactor sits on a specially built wobbly stool; the gyrations of one's bottom are transmitted through pneumatic tubes to one's cheeks, leading to an uncanny "autoerotic" experience. Christa Sommerer and Laurent Mignonneau's recent works have also explicitly begun to explore the tactile dimension. *NanoScape* (2002) uses powerful magnetic forces to "tactilize" (visualize would not be the right word) the invisible nanolevel phenomena. The interface is a ringlike device worn by the user; by moving one's hand over a special table one feels the forces in motion without actually touching the table surface. In *Mobile Feelings* (2001–) Sommerer and Mignonneau explore wireless tactile communication between human participants. Using Bluetooth-technology and advanced microsensors for mobile communication, they have created wireless objects that allow users feel each other's heartbeats, and will soon provide other sensory experiences as well. While the first versions were hidden inside actual pumpkins (an organic interface evoking the plants in *Interactive Plant Growing*), the later egg-shaped objects strangely remind one of Brancusi's *Sculpture for the Blind* (and the human heart, of course). The idea behind *Mobile Feelings* can also be read as a *topos* going back to the seventeenth-century proposals for intimate distant communication by means of magnetism.

Mobile Feelings raises the issue of tactile communication over a distance. This in itself is not a new idea. Kit Galloway's and Sherrie Rabinowitz's telematic art workshops (1980s), Paul Sermon's *Telematic Dreaming* (1992) and Stahl Stenslie and Kirk Woolford's *CyberSM* (1993) were all in their own ways concerned with exploring the intimate touch between people separated by distance. The teletouch could be achieved either by a mental transposition of visual impressions (two "body images" touching each other) or by using a custom-made "teledildonic" interface, technologically transmitting the partner's body movements.[47] Numerous art and design projects have explored the real-time transmission of the sense of touch to another location by means of force-feedback interfaces. A well-known example is *inTouch* (1997–98), created by the Tangible Media group at the MIT Media Lab,[48] which used synchronized wooden "massage rollers" as its telematic interface. Japanese media laboratories in particular, such as the one led by professor Hiroo Iwata

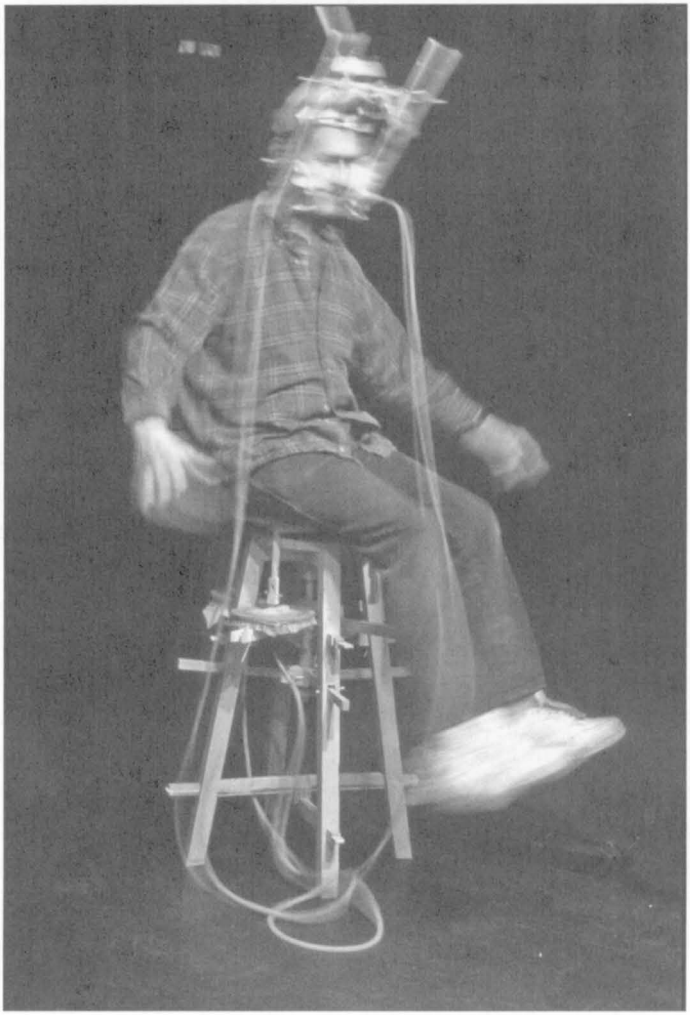
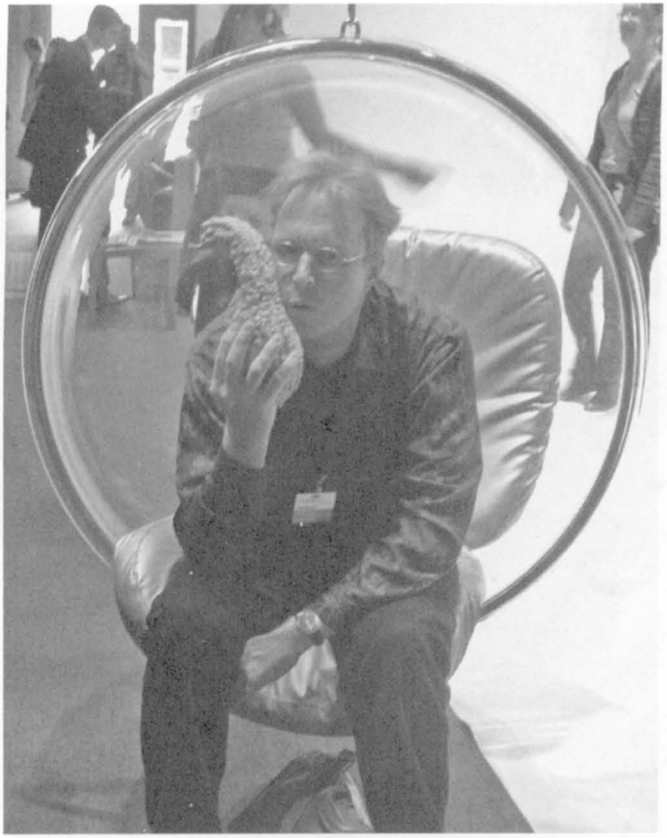


Figure 5.2 Bernie Lubell, *Cheek to Cheek*, 1999. By kind permission of the artist.



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Figures 5.3a, 5.3b Professor Machiko Kusahara and the writer experimenting with Christa Sommerer and Laurent Mignonneau's *Mobile Feelings I* (2001) at Ars Electronica 2001. See plate 4. Photos by Christa Sommerer.

at the Tsukuba University, have created many prototypes for new kinds of force-feedback applications, often shown at Siggraph. Recently the possibilities of teletactility have also been explored by artists and designers interested in smart clothes and wearable media, which is a logical path to follow, clothes being the most intimate and persistent "interface" everyone uses.

There are also works where touching plays a more metaphoric and/or instrumental role. Marinetti's idea of "a visual sense born in the fingertips" was realized by Agnes Hegedues in her installation *Handsight* (1992), where

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Figure 5.3 (continued)

"the hand that sees" is a Polhemus sensor disguised as an eyeball. It is held in hand by the user to explore a virtual world supposedly inside a glass jar—a poetic but also rather literal translation of McLuhan's idea of technology as an extension of the human body. In Rafael Lozano-Hemmer's teletactile work *Displaced Emperors* (1997), the user's "hand image" was projected on the facade of the Linz Castle, peeling away layers of history. The idea of a data-glove (reduced to a wearable ring) was given a new role and interpretation, rich in cultural connotations. Although no actual touch was involved, the sense of mediated touch was strong. Feingold's *The Surprising Spiral*, already

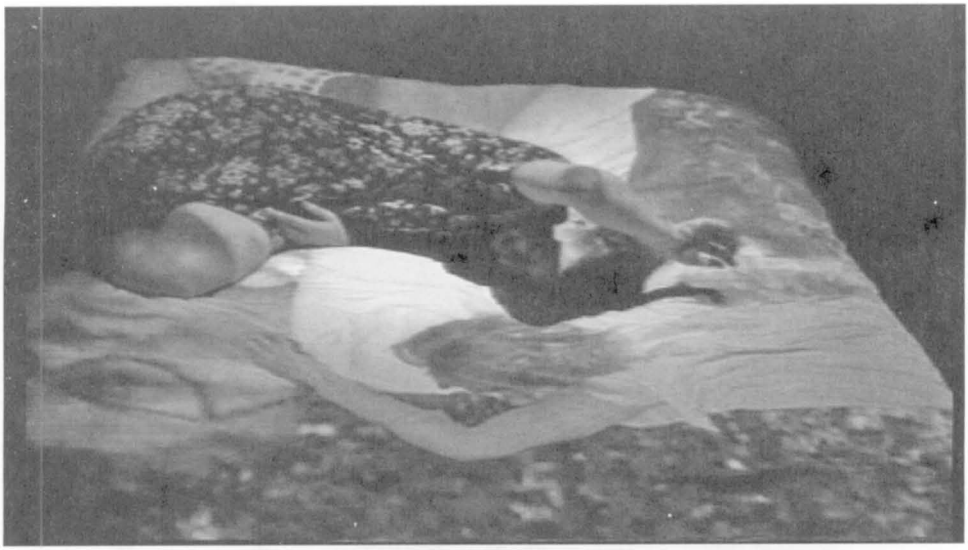

Figure 5.4 Paul Sermon, *Telematic Dreaming*, 1992. By kind permission of the artist.

mentioned above, not only explores tactility, but also tactility's media-archaeological implications and earlier discursive manifestations. The name on the back of the book interface reads "Pierre de Toucher," an explicit reference to Duchamp's *Prière de toucher*. The work builds a dense network of references around tactile media, from fairground attractions (also present in Feingold's later works using speaking and animated puppet heads, descendants of popular "talking heads" and ventriloquist dummies) to surrealism, Duchamp, and Alain Robbe-Grillet's *L'immortelle* (1963), a film where sensual touching plays a central thematic role.[49]

These examples by no means exhaust the range of uses of tactility in contemporary media art. While exploring state-of-the-art technologies and new ways of linking humans and machines, many artists draw from a rich pool of shared cultural storehouse of sensory experiences, discourses, and imaginaries. Sometimes this happens unknowingly, but often quite consciously, as Feingold's example shows. The critical and theoretical exploration of this pool has only recently begun in earnest. The recently introduced book series Sensory Formations, published by Berg, is one demonstration of this interest. As it happens, the volume about tactile culture, *The Book of Touch* (2005), edited by Constance Classen, has devoted very few of its 450 pages to the topic of

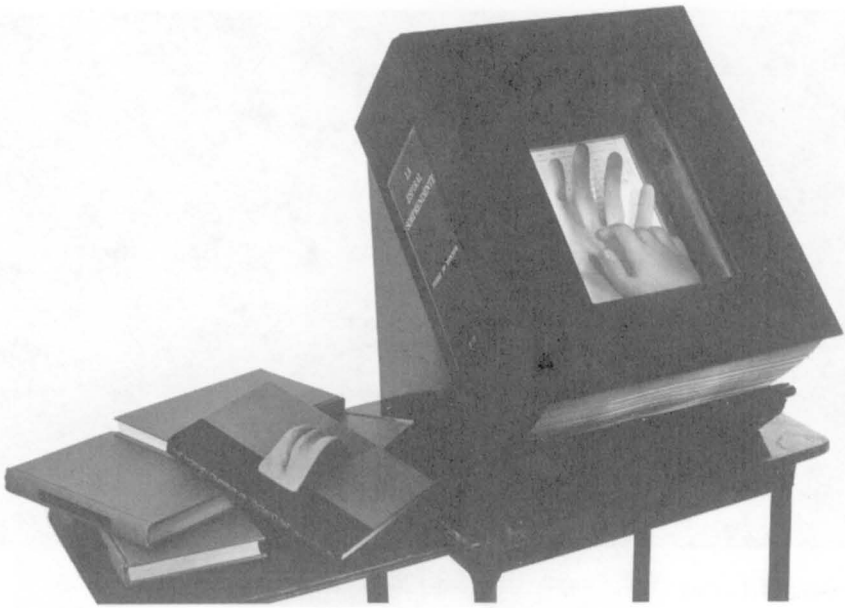

Figure 5.5 Ken Feingold: *The Surprising Spiral* (installation detail), 1991. Interactive installation: computer, laserdisc, audio, projection, silicone, wood, books. Collection: ZKM Center for Art and Media, Karlsruhe. By kind permission of the artist.

interacting with machines and media.[50] The words "interactive" and "interactivity" don't even appear in the index. After hundreds and thousands of years, during which the "(in)human touch" was the most important form of tactility in its countless manifestations, the practice of touching technological artifacts for self-expression, communication, entertainment, or erotic sensation is still a recent phenomenon. Videogames, purportedly one of the dominant forms of tactile media already now and even more clearly in the near future, only have a history of some thirty-five years. How these developments will affect the realm of tactility as we know it remains to be seen. How will the "new" merge or converge with the "old"? Interactive artworks can provide some—strictly imaginary—sneak previews.

Notes

1. The juries for the "Interactive Art" category at the prestigious Prix Ars Electronica competition have in recent years made efforts to annihilate this definition—they have

given awards to many works that recuire no active input from the spectator at all. For a closer analysis, see my essay "Trouble at the Interface, or the Identity Crisis of Interactive Art," available online at http://www.mediaarthistory.org/ (in the section "programmatic key texts").

2. This concept was used by the experimental designers Anthony Dunne and Fiona Raby in their presentation "Fields and Thresholds" at the Doors of Perception 2 conference in Amsterdam, 1995. See http://www.mediamatic.nl/Doors/Doors2/DunRab/DunRab-Doors2-E.html/. On proxemics, see Edward T. Hall, *The Hidden Dimension* (Garden City, N.Y.: Doubleday, 1966).

3. On McLuhan's ideas about tactility, see Takeshi Kadobayashi, "Tactility, This Superfluous Thing—Reading McLuhan through the Trope of Sense," *University of Tokyo Center for Philosophy Bulletin*, 4 (2005), 26–35.

4. For earlier stages of this project, see my articles "'It Is Interactive, But Is It *Art*?,'" in *Computer Graphics Visual Proceedings: Annual Conference Series, 1993*, ed. Thomas E. Linehan (New York: ACM SIGGRAPH, 1993), 133–135; "Seeking Deeper Contact: Interactive Art as Metacommentary," *Convergence* 1, no. 2 (autumn 1995), 81–104; "Time Machines in the Gallery: An Archeological Approach in Media Art," in *Immersed in Technology: Art and Virtual Environments*, ed. Mary Anne Moser with Douglas McLeod (Cambridge, Mass.: MIT Press, 1996), 232–268; "From Cybernation to Interaction: A Contribution to an Archaeology of Interactivity," in *The Digital Dialectic: New Essays on New Media*, ed. Peter Lunenfeld (Cambridge, Mass.: MIT Press, 1999), 96–110, 250–256; "Slots of Fun, Slots of Trouble: Toward an Archaeology of Electronic Gaming," in *Handbook of Computer Games Studies*, ed. Joost Raessens and Jeffrey Goldstein (Cambridge, Mass.: MIT Press, 2005).

5. For overviews of these developments, see Udo Kultermann, *Art and Life*, trans. John William Gabriel (New York and Washington, D.C.: Praeger, 1971); *Out of Actions: Between Performance and the Object, 1949–1979*, ed. Russell Ferguson (New York: Thames and Hudson, 1998).

6. See Sherry Turkle, *Second Self: Computers and the Human Spirit*, 20th anniversary edition (Cambridge, Mass: MIT Press, 2005 [1984]).

7. Laura U. Marks, *Touch: Sensuous Theory and Multisensory Media* (Minneapolis and London: University of Minnesota Press, 2002).

8. Jacques Aumont, *The Image*, trans. Claire Pajackowska (London: BFI Publishing, 1997 [1990]), 77–78.

9. Deleuze and Guattari, *A Thousand Plateaus: Capitalism and Schizophrenia*, trans. Brian Massumi (Minneapolis: University of Minnesota Press, 1987).

10. Marshall McLuhan, *Understanding Media: The Extensions of Man* (London: Sphere Books, 1967 [1964]), 335.

11. David Howes, *Sensual Relations: Engaging the Senses in Culture and Social Theory* (Ann Arbor: University of Michigan Press, 2003), xx.

12. About the use of "schema," see E. H. Gombrich, *Art and Illusion* (London: Phaidon Press, 1977 [1960]).

13. For *topoi* in media culture, see my "From Kaleidoscomaniac to Cybernerd: Towards an Archeology of the Media," in *Electronic Culture*, ed. Timothy Druckrey (New York: Aperture 1996), 296–303, 425–427. For an interesting collection of essays on Warburg's contribution to cultural history, see *Art History as Cultural History: Warburg's Projects*, ed. Richard Woodfield (Amsterdam: G+B Arts International, 2001).

14. Nicolas Bourriaud, *Relational Aesthetics* (France: Les presses du réel, 2002 [1998]).

15. I experienced this on a recent visit to the exhibition Ecstasy: In and About Altered States (MOCA, Los Angeles, 2005). To give just one example, here is a story of my encounter with Olafur Eliasson's *Your Strange Certainty Still Kept* (1996). The following note had been posted at the entrance to the installation: "Viewers with light sensitivities please be advised: the artwork uses strobe lights." Entering the darkened space, I noticed a transparent "curtain" created by water dripping from the ceiling. It was illuminated by strobe lights, which made the waterdrops "dance" in different formations. The installation was placed close to the entrance, and there was no barrier that would have prevented the visitors from standing right next to it; it was even possible walk around the water curtain to the other side. Because of this it felt natural to stretch out one's hand and feel the running water. In fact, this caused interesting changes to the patterns of light as well as to the surface of the water as it fell to the pool below, and may well have been intended by the artist (at least, there was no notice forbidding it at the entrance). However, when I started playing with the dripping water, a guard immediately intervened and told me that it was forbidden to touch the

water. To my question why it was so, he explained that he had "received instructions." Exiting from the other side, I began to suspect that the unannounced tactiloclasm had nothing to do with Eliasson and everything to do with the fact that the museum administration was concerned about the floor getting wet from sprinkles. Indeed, I noticed the familiar yellow "Cuidado piso mojado/Caution wet floor" signboards, at both entrances to the installation (although one of them was folded and leaning against the wall).

16. See Tony Bennett, *The Birth of the Museum: History, Theory, Politics* (London and New York: Routledge, 1995).

17. Constance Classen, "Touch in the Museum," in *The Book of Touch*, ed. Constance Classen (Oxford and New York: Berg, 2005), 275–286.

18. Stephen Bailey, *Commerce and Culture: From Pre-Industrial Art to Post-Industrial Value* (Tunbridge Wells: Penshurst Press, 1989), 46. For a history of the early department store, see Michael B. Miller, *The Bon Marché: Bourgeois Culture and the Department Store, 1869–1920* (Princeton: Princeton University Press, 1981).

19. F. T. Marinetti: "Tactilism" (1924), in Marinetti, *Selected Writings* (New York: Farrar, Straus, and Giroux, 1972), 109–112.

20. Interestingly, similar ideas were proposed by Luis Bunuel and Salvador Dalí as a tactile addition to their film *Un chien andalou* (1929). The spectators were supposed to receive tactile sensations to enhance the deliberately shocking scenes they witnessed on the screen. Such ideas have since become commonplace in the theme park industry.

21. See Classen, *The Color of Angels: Cosmology, Gender, and the Aesthetic Imagination* (London and New York: Routledge, 1998), 128. Classen refers to Severini's *Dancer with Movable Parts*.

22. "The Founding and Manifesto of Futurism" (*Le Figaro*, February 20, 1909), in Marinetti, *Selected Writings*, 42.

23. See my "Slots of Fun, Slots of Trouble: Toward an Archaeology of Electronic Gaming."

24. See Kirk Varnedoe and Adam Gopnik, *High & Low: Modern Art and Popular Culture* (New York: The Museum of Modern Art, 1990).

25. Tom Gunning, "The Cinema of Attractions: Early Film, Its Spectator, and the Avant-Garde," in *Early Cinema: Space Frame Narrative*, ed. Thomas Elsaesser and Adam Barker (London: British Film Institute, 1990), 56–62.

26. Octavio Paz, *Marcel Duchamp: Appearance Stripped Bare* (New York: Seaver Books, 1981), 185.

27. Varnedoe and Gopnik point to the wheel jacks used in bicycle repair shops as a possible iconographic source for Duchamp's piece. Whether the connection is actual or not, the wheel jack is a highly tactile application. Varnedoe and Gopnik have also published a photograph from 1915 showing a bicycle display (from a shop or a fair?) with a commercial installation resembling Duchamp's. Varnedoe and Gopnik, *High & Low*, 275.

28. The complex evolution and personal background of this work has been investigated by Janine Mileaf, "Between You and Me: Man Ray's *Object to Be Destroyed*," *Art Journal* 63, no. 1 (spring 2004), 4–23. Although the work may date back to 1923, versions with different titles were shown over the years, and Man Ray later produced several replicas. It got the title *Objet à detruire* only in the early 1930s, when Man Ray provided it with a cutout of Lee Miller's, his lover's, eye. Privately the work came to signify the hypnotic spell Miller had on him, and the new title can be read as a sign of despair or an effort to break Miller's spell, after she had left him. Other readings are also possible. Whether Man Ray himself smashed any of the versions is unclear; he definitely planned doing so as a performative act. One version was smashed by a group of protesting students in 1957, taking the suggestion of the title seriously (Mileaf, "Between You and Me," 5).

29. The work can be seen in the Brancusi gallery of the Philadelphia Museum of Art. For the yet unwritten history of tactility in art, it is worth remembering the close relationship between Brancusi and Duchamp.

30. Lewis Kachur, *Displaying the Marvelous: Marcel Duchamp, Salvador Dalí, and Surrealist Exhibition Installations* (Cambridge, Mass.: MIT Press, 2001), 73–74.

31. See *Peggy Guggenheim and Frederick Kiesler: The Story of Art of This Century*, ed. Susan Davidson and Philip Rylands (New York: Guggenheim Museum Publications, 2004).

32. Kachur, *Displaying the Marvelous*, 201.

33. *VVV*, no. 2–3, 1943. In the journal the experiment is credited to Kiesler. See the reproduction in *Frederick Kiesler: Artiste-architecte* (Paris: Centre Georges Pompidou, 1996), 137.

34. Obviously this use of the peephole is another anticipation of Duchamp's last major work, *Etant données*, which he worked on for two decades in secret. This work is far too complex to be dealt with here. Another peephole work was Duchamp's *Rayon vert*, which Kiesler installed according to Duchamp's instructions in the Le Surrealisme en 1947 exhibition. It was peeped at through a hole in the wall, seen through a sheet of green gelatin sandwiched between two panes of glass.

35. See Kachur, *Displaying the Marvelous*.

36. Pictured in *Frederick Kiesler: Artiste-architecte*, 124.

37. Francis M. Naumann, *Marcel Duchamp: The Art of Making Art in the Age of Mechanical Reproduction* (Ghent and Amsterdam: Ludion [distr. Abrams, New York], 1999), 165.

38. Laura U. Marks does not agree about the haptic visual quality of pornographic cinema. For her, hapticity has more to do with revealing and hinting. See Marks, *Touch*, 15. In this sense *Tapp und Tastkino* could be haptically erotic, if Valie Export did not shatter the eroticism by the presence of her direct stare.

39. See *Out of Actions*, 100–101. In her work with Ulay, Abramovic also created situations that encouraged audience tactility. In *Imponderabilia* (1977) Ulay and Abramovic stood naked in the narrow entrance to the museum, facing each other. Visitors could only enter sideways, touching their bodies; they were also forced to decide whether to look at Abramovic or Ulay, thus making a gender-oriented choice (see *Out of Actions*, 101).

40. In 2005 Abramovic performed a version of Export's *Action Pants: Genital Panic* as part of her *Seven Easy Pieces*, at the Guggenheim Museum, New York.

41. Ono sat motionless on a stage inviting the audience to cut off any of her clothes with scissors. The link between Ono and Export has been made by Regina Cornwell, "Interactive Art: Touching the 'Body in the Mind,'" *Discourse* 14, no. 2 (spring 1992), 206–207. Another work by Ono, *Painting to Hammer a Nail* (1965), originally introduced in slightly different form as a series of instructions in her book *Grapefruit* (1964), also featured audience tactility: the visitors were invited to hammer nails into

a wooden panel hanging from the wall. This seems like a concrete interpretation of Duchamp's famous saying: "The spectator makes the picture" (Paz, *Marcel Duchamp*, 86). Other tactile works from fluxus include Ay-O's *Tactile Box* (1964) and *Finger Box* (1964), meant to be released as fluxus editions. The cubical boxes have holes for the finger to penetrate. The boxes contained foam rubber.

42. For a discussion of McLuhan's idea of television as a tactile medium in relation to the work of David Cronenberg, see Mark Fisher, *Flatline Constructs: Gothic Materialism and Cybernetic Theory-Fiction*, chapter 2.8, "Tactile Power." Available online at http://www.cinestatic.com/trans-mat/Fisher/FC2s8.htm/.

43. "Fingering the TV screen" had already been practiced in the early 1950s in the popular children's television program *Winky Dink and You* (CBS, 1953–57, plus a short rerun in the 1960s), where the child was encouraged to draw on the TV screen following the finger of the host, Jack Barry. A transparent "Magic Window" would be attached to the screen, and the child would draw on it with Magic Pens. The window and the pens could be bought as a set, as the host often reminded viewers throughout the program.

44. A rich source of Krueger's ideas is his book *Artificial Reality II* (Reading, Mass: Addison-Wesley, 1990). About the recently rediscovered Kurenniemi, see Mika Taanila's remarkable DVD about his career, *The Dawn of DIMI* (Helsinki: Kiasma/Kinotar, 2003).

45. Touch, Art!, Kawagoe Art Museum, January 7 to March 26, 2006. I visited the exhibition on the opening day. It featured works by six contemporary Japanese artists. While some of the works were genuinely tactile (meant to be touched), touching certain works was forbidden. The exhibition thus shared the problematic relationship to touching that is often encountered in contemporary art exhibitions.

46. For more information about this ambitious project, see http://www.renga.com/tactile/.

47. Although as an artwork, *CyberSM* anticipated the explosive interest in "sex machines," high-tech masturbatory devices that have arguably become one of the most titillating forms of tactile cyberculture, albeit usually without the possibility of teletactile communication. Examples can be easily found on the Internet.

48. Credited to Scott Brave, Andrew Dahley, and Hiroshi Ishii.

49. For an analysis of *The Surprising Spiral*, see Cornwell, "Interactive Art: Touching the 'Body in the Mind,'" 213–214.

50. *The Book of Touch*, part IX, "Touch and Technology," 399–447. This section is very mixed, and only Susan Kozel's Essay "Spacemaking: Experiences of a Virtual Body" (439–446) analyzes new media art, the experience of using Paul Sermon's *Telematic Dreaming*.

6

Duchamp: Interface: Turing: A Hypothetical Encounter between the Bachelor Machine and the Universal Machine

Dieter Daniels

Translated by Jeanne Haunschild and Dieter Daniels

Can Marcel Duchamp's ideas and the discourse he opened on an art that goes beyond the "retinal" be extended to include the so-called new media and further on media art? In a collection of essays, I have worked out multiple affinities between the work of Marcel Duchamp and the effects of the media on art and society.[1] This may, not least of all, show the personal passions of the author, for these two fields have been the focus of my academic work up to now. For this reason it should be obvious that in the present text, I felt the need to look for something beyond my individual obsessions by searching for a possible, deep-rooted common ground between the two fields—and for a new perspective on the basic questions of the relevance of the arts and the technical media in today's world.

Does art merely react to what media technology has developed, whether accepting it as a working medium or countering it with art-inherent strategies? Or does art offer still other models and insights that oppose the actual pressure of technical progress and have other assets that perhaps even surpass it, thus contributing to an understanding or even to a formulation of our media-sated world? These questions are posed in the field of media art even more urgently. Does an art that deploys technical means simply supply an illustration or, at best, a subversively ironic misappropriation of a technological potential, whose power over, and repercussions on, our life today are barely comprehensible and, even more so, unassailable in an art context? Such an

impotence of art in the age of the media has been propagated, for instance, by Friedrich Kittler: "Certainly, art has historically been a highly efficient method of signaling the presence of omnipotence. But as, already in Hegel's time, it ceased to be the highest form of mind, so it is today that art under computer conditions is replaced by a sorcery that no longer swears to omnipotence but to reality.... And artists, unless they themselves have become engineers or programmers, have been cut off from this power over reality."[2]

The actual distribution of power between art and the media may be indisputable. But does this not amount to a confusion between cause and effect, to making the power of the factual the yardstick for the imagination? And do not media technology and art equally find their roots in models, sketches, and blueprints—in the imagination of things that do not yet exist—before they become concrete as apparatuses and art works? In my considerations I would like to proceed from two cases in point, that of Alan Turing, the mathematician and most important co-inventor of the computer, and Marcel Duchamp, perhaps the most influential artist of the twentieth century. You may well ask why it is that two individuals and their respective biographies should be at all useful in the investigation of such a comprehensive theme, particularly since neither during his lifetime had any contact with the other, or possibly even knew of the other's existence. But the following is not meant to prove anything, but only sound out the range of a hypothetical encounter between two concepts. The method is experimental, in the sense of trying to follow a hypothesis as far as possible, without hesitating to touch upon the absurd.

In the first part of my essay, by a partly ironic expansion of art historical terminology, I would like to attempt to apply concepts from new technologies to Duchamp's work. In the second part, parallels will be drawn between Duchamp and Alan Turing; the third will present works by Duchamp in analogy to current media techniques; the fourth will conclude by investigating the common structural grounds between today's media practice and the designs drafted by Duchamp and Turing.

The element that links these four parts is the convergence of man and machine. The point of man–computer communication is generally called an interface.[3] It sets up a relationship between the two information structures and to a certain extent it defines the parameters of interaction between two immaterial settings through the material world. Available for input are switch, keyboard, mouse, joystick, dataglove; for output, screens, loud-

speakers, projectors, or virtual reality glasses. Corresponding on the side of the human body are fingers, eyes, and ears; examples of other body parts will be cited later.

Because of the way we today commonly speak of interactivity as a technical achievement, we all too easily forget that similar principles existed long before digital technology was ever introduced, though this was an interactivity between man and man and not between man and machine. A good example is a chessboard: a board with 64 squares and 32 pieces functions as a direct man–man interface. The game rules, as well as the chess pieces and the coded display of the "user interface" or chessboard, determine the course of the interaction. The "interface" or chessboard is meant to serve as an exchange between the thoughts of two people, thoughts that are, however, not altogether mutually readable, but whose possible intentions can be deduced from the moves each player makes. In other words, despite a clearly coded system, there is a degree of interpretation needed that can be compared to the interpretation of an artwork, at least insofar as we follow Duchamp's approach.

Art History

There is an entire series of Duchamp's drawings and two oil paintings on the subject of chess, in which he works out this process of "interpretation." In *La Partie d'échecs* from August 1910 he painted, in a style still firmly in line with Cézanne, his two older brothers Jacques Villon and Raymond Duchamp-Villon in the garden at Puteaux playing chess. But in 1911 the twenty-three-year-old Marcel made his entry into the Paris avant-garde, thanks to his brothers' mediation and, using the same motif in *Étude pour les joueurs d'échecs* (1911), manifested his personal encounter with the formal vocabulary of cubism. Counter to the basic realistic elements, the picture plane is strikingly divided into two halves, as if the two conceptual systems of the chess-playing brothers were separated by a slash. Shortly afterward, *Étude pour portrait des joueurs d'échecs* (1911, fig. 6.1) took a decisive step toward a reduction to a few formal elements. The dissolution of perspectival space corresponds to the doubling of the two faces, in which the chess piece itself becomes the physical location where the two profiles meet. And, in fact, the chess game is set directly between the two countenances, becoming a literal "inter-face." What is striking is the emphasis given the hands of the players, one of them in action, the other making a thoughtful gesture. On the whole it

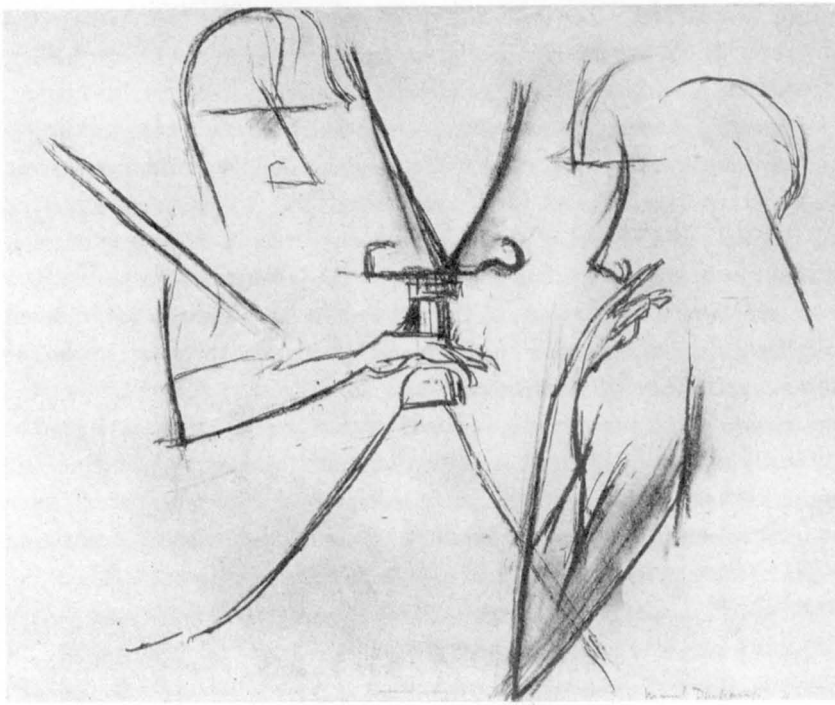

Figure 6.1 Marcel Duchamp, *Étude pour portrait des Joueurs d'Échecs*, 1911. Philadelphia Museum of Art, Collection Arensberg.

is made clear that, through eye and hand, the two heads, that is, the thinking that takes place within them, are linked across the chessboard. These sketches eventually led to the oil painting *Portrait de joueurs d'échecs* (1911), a piece that perhaps shows Duchamp's obligation to cubism the most clearly and yet takes his work a step further. He, in fact, carries over the cubist perceptual space into the chess game's conceptual space. Again our attention is called to the active hand holding the chess piece in the lower left that has been strangely and very pointedly set into the picture.

For Duchamp chess was always a metaphor for art, and these two passions were always meant as complementary, just as much as they were also in competition. Their rivalry went so far as to inspire the myth that he had given up art in favor of chess. As a French master Duchamp played successfully at international tournaments and wrote a book on recherché endgame variations.[4] "Through my close contact with artists and chess players I came to

the conclusion that while all artists are not chess players, all chess players are artists."[5]

Under the leitmotif of the interface, an analogy between painting and chess could be spun further. The easel painting and the chessboard are both a user interface, and the thought constructs that are represented by manual proceedings (applying the paint, moving the pieces) invite interpretation. But of course the comparison is a lame one. The transmission in art only goes in one direction, from painter to the viewer—and that, in part, over a distance of centuries. In chess and in the electronic media, the exchange is interactive and takes place in real time, as we say in current terms. It is via media art that such interactions first begin to cross-pollinate.

Duchamp expands the theme of chess with the mysterious painting *Le roi et la reine entourés des nus vites* (1912). The king and the queen are still a part of the chessboard, but the "fast nudes" that surround them come from another world. They move between the static figures, perhaps like the two naked hands of both the chess players, which carry out the symbolic movements of the pieces and never come in physical contact with each other. At the same time the king and queen, via the "fast nudes," are also in a potentially erotic relationship. This painting spans a bridge from the chess studies to the erotic machinery of the *Large Glass*. That becomes clear in the compositionally related first sketch on the subject of the *Large Glass, La mariée mise à nu par les célibataires*, also from 1912. Instead of an *intellectual unveiling* of the player's intentions manifested in the chessboard, a *physical exposure* of a woman's body takes place between the two bachelors.

The arc that Duchamp spanned from chess to sex in the successive transformation of this series of pictures is the leitmotif for the following considerations. It is the passage between two extreme forms of interhuman relations: here, the complete reduction to the intellect and a strictly formalized exchange of information via a system of codes and rules; there, complete physicality with all its sensual components. Chess and sex serve Duchamp as the cornerstones for investigating the function of the pictorial artwork that, quite in the sense of classical aesthetics, links physical expression with intellectual content. For Duchamp the artwork is, so to speak, a sensual interface between the intellect of the artist and of the viewer; the message must pass through the physical stage. The original work would thus be the physical trace of an individual's mental act. The most radical culmination of this concept is Duchamp's *Paysage fautiv* (1946), a drawing that consists of nothing more than an

ejaculation of sperm, whereby he anticipated Warhol's piss paintings in a more subtle form.

The tie-in between chess and sexuality, also found with other artists (Max Ernst, Dalí), was later summed up by Duchamp in a famous photo showing him playing chess with a young naked woman in 1963 at his first large retrospective in the Pasadena Museum. On the other hand, the game between Marcel Duchamp, his wife Teeny, and John Cage entitled *Reunion* in Toronto 1968 shows that a chessboard can also serve as a technical interface (fig. 6.2). Every move made on the chessboard's electrical contacts triggered a change in the electronic sound structure. This pioneering, interactive media artwork is not

Figure 6.2 Marcel Duchamp, his wife Teeny, and John Cage at "Reunion," Toronto, 1968. Photo by Shigeko Kubota. The chess board is wired as an interface to generate a composition by Cage.

unconditional evidence of Duchamp's intentions, since he only appeared here as an accomplice in Cage's musical concept, but the work was undoubtedly inspired by Duchamp and composed for him.[6]

Media Theory

From the notes in Duchamp's *Green Box* we learn that the complex apparatus of the *Large Glass* served only to transmit the sexual desire of the bachelors in the lower half to the bride in the upper half. The nine bachelor forms called *Moules mâlic* are comparable to chess pieces and the clearest relic left from the game of chess to be found in the Glass. The bachelors' lust remains unfulfilled, since it is only technically transmitted to the bride, without ever resulting in a physical encounter. Thus Duchamp insists in his very first drafts that there is no real contact between the bachelors and the bride, only an "electric link" and a "short circuit on demand."[7] The lower half of the glass is the driving force of the whole erotic mechanism that Duchamp coined a "bachelor machine."

The term "bachelor machine," since its first appearance in the cryptic notes of the *Green Box*, has had an amazing career that made it known far beyond the framework of the *Large Glass*. It served in 1954 as the title of a book by Michel Carrouges that, according to André Breton, rattled surrealism, was taken up in 1972 by Gilles Deleuze and Félix Guattari in *L'anti-Oedipe*, and made into the theme of a large exhibition curated by Harald Szeemann in 1975.[8] Carrouges reaches far back into the nineteenth century and, in the series of bachelor machines that he presents, the *Large Glass* is one of the last examples and, above all, the only pictorial one among otherwise purely literary descriptions of such machines.

Yet to say this is to ignore the fact that glass and box, that is, picture and text, were given the same title by Duchamp: *La mariée mise à nu par ses célibataires, même*; they are two halves of *one* work. The *Large Glass* shows the blueprint of a machine, a construction rendered as a "precision painting, and beauty of indifference" that only becomes comprehensible and begins to ferment in our minds via its workings described in the *Green Box*.[9] The *Large Glass* and the *Green Box* stand in the same relation to each other as a chessboard to its game rules, or as a computer to its program.[10] No part makes sense without the other; only in concert do they become a functioning unity (fig. 6.3). Carrying this analogy further would make the *Large Glass* the

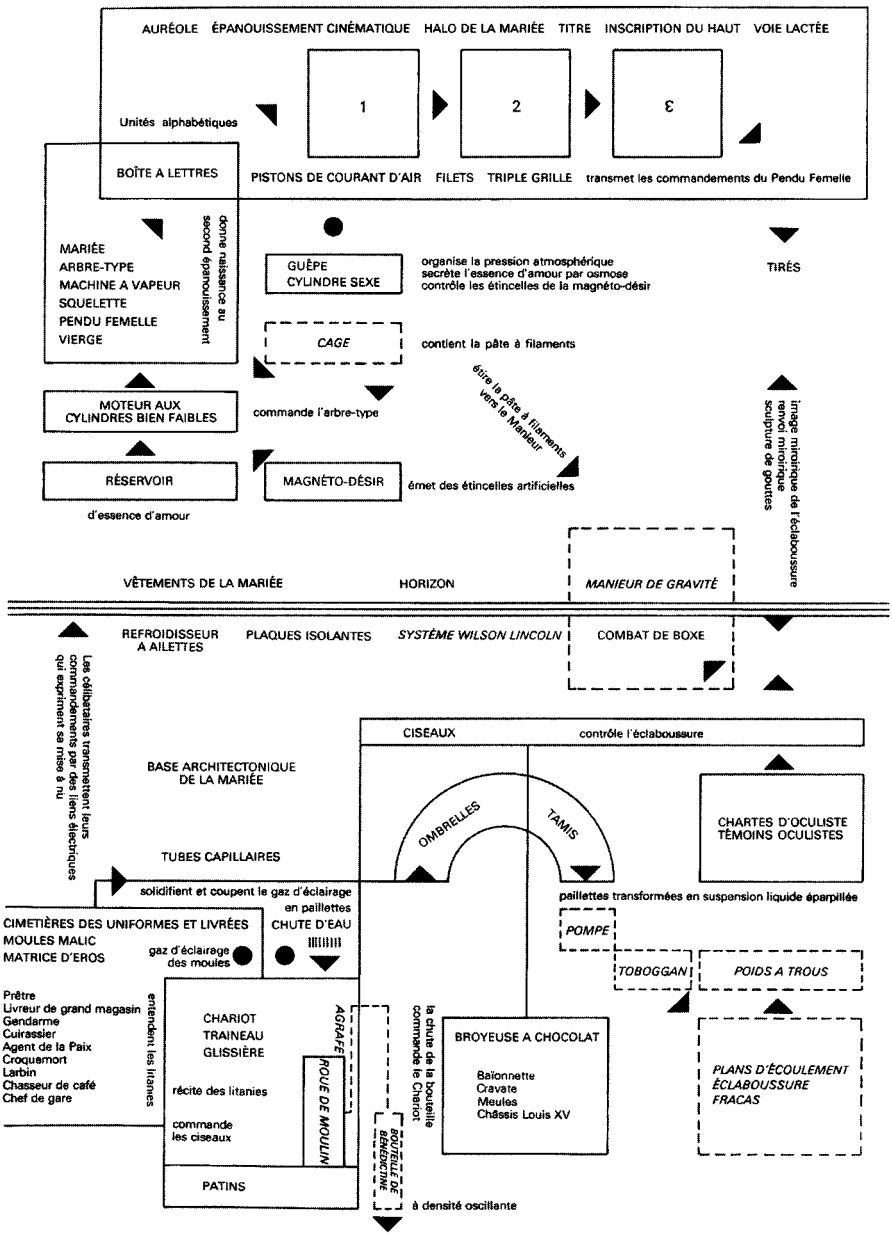

Figure 6.3 Diagram of the *Large Glass* according to the notes from the *Green Box*, by Richard Hamilton, published in *L'Oeuvre de Marcel Duchamp*, Centre Pompidou, Paris 1977, p. 108.

hardware and the *Green Box* the software of the bachelor machine. Yet instead of a computer we should perhaps speak more correctly of a blueprint for a computer. Just as in the *Large Glass*, in a computer design and description, construction schema and program language are developed in parallel and mutually determine each other.

In the books of Poe, Villiers, Verne, Jarry, Roussel, and Kafka we find imaginary machines, which Carrouges also considers to be bachelor machines. Some can talk and some can write, yet they cannot take that one more decisive step: their language remains descriptive, it is not operational. For a computer, however, the program language is part of its function; it no longer describes, it acts. When I type in "delete," I do in fact delete data. This switch from description to command can never be reached through literature alone. In the fields of art and literature, language cannot be made operational; this is first possible only when they join forces with the technology of an apparatus.[11]

This ontological turning point in language's function is possible only through the division between machine and program, between hardware and software. The *Large Glass* and the *Green Box* portray such a relation of machine and program and go a crucial step further than all other literary bachelor machines.[12] Even if its function remains an imaginary one, that is, remains art, it points to the possibility of a machine consisting of hardware and software, together forming what Alan Turing defines as a "universal machine" that provides the theoretical basis for all computers: "The importance of the universal machine is clear. We do not need to have an infinity of different machines doing different jobs. A single one will suffice. The engineering problem of producing various machines for various jobs is replaced by the office work of 'programming' the universal machine to do these jobs."[13] Yet there is one important difference between Duchamp and Turing: the *Large Glass* portrays the complex inner-psychic course of unfulfilled sexual desire via technical metaphors; the universal machine, as the beginning of artificial intelligence, does the opposite in that it portrays an otherwise human activity, thinking, as now predominantly performable by a machine.

Since all machines, including the universal machine of the computer, have up to now been built by humans, the *Large Glass* could specify the reasons *why* we at all bother to design and manufacture such machines. Such is a first thesis on the relation between the bachelor and the universal machines, which may still sound somewhat off the wall. In order to underpin it there are various strategies available. We could draw on the authorities of postmodernism,

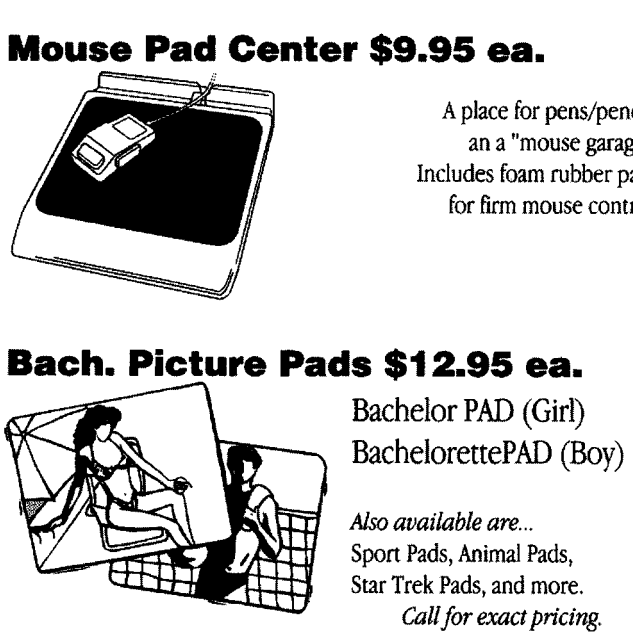

Figure 6.4 Bachelor Mouse Pad, ca. 1994, advertisement.

such as Jean Baudrillard, who writes: "Artificial intelligence is a bachelor machine," without, however, even mentioning either Duchamp or Turing.[14] A glance at the "collective unconscious" would be just as good, where the tie between the bachelor and the universal machine seems already firmly anchored. It is manifest in many trivial everyday metaphors for the man–machine interface, such as the "bachelor mousepads," which transform everyday work onscreen to a symbolic, erotic potential for fondle-bytes (fig. 6.4).[15]

The world of geeks, nerds, and hackers provides the most drastic examples for psychic effect of computer technology and thus for the status of the universal machine as a bachelor machine. The almost entirely male community of hackers thrives in what they call "bachelor mode" because nights at the computer allow no room for contact with the opposite sex.[16] One of them says: "I think of the world as divided between flesh things and machine things.... I stay away from the flesh things.... I often don't feel like a flesh thing myself. I hang around machines, but I hate myself a lot of the time. In a way it's like masturbating."[17] There is not much to add to such statements.

The attempt to get to the bottom of the tie-in between the bachelor and the universal machine takes us to the latter's originator, Alan Turing, the

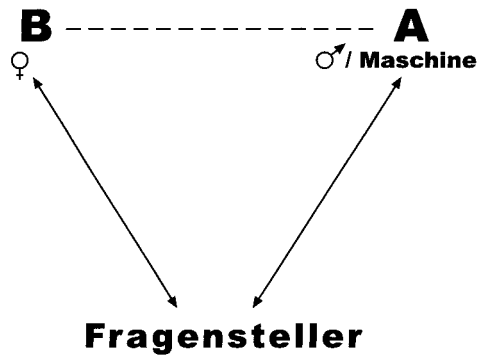

Figure 6.5 Diagram of the Turing test.

English mathematician, who already in 1935–1936 described the essential features of a computer *cum* universal machine in his paper "On Computable Numbers." He did a trial run with a "paper machine," that is, he simulated it per written calculation, even before the first programmable device was built. The acid test came with World War II, whose outcome is intertwined with the fact that Turing's meanwhile functional machine broke the code of the German Enigma cipher. A universal machine can, according to Turing, imitate all other machines, and the case of the mechanical Enigma cipher machine provided the practical evidence to prove this. But what does this mean in reference to other, specifically human functions?

In a 1950 paper that was as philosophical as it was mathematical, Turing posed the question: "Can a Machine Think?"[18] To answer this he suggested what is today known as the Turing test. This paper is cited in almost all academic literature (and even in practical tests) in what is only a very abridged version: a test person must discover via a written dialogue whether he or she is "talking" with a machine or a person. However, Turing's original concept is much more complex. He called his test an "imitation game" that consisted of a threefold arrangement. A man and a woman in separate rooms must answer an interrogator via a teleprinter. The interrogator is given the task of finding out which one is the man and which the woman. Then in the second phase, the machine replaces *the man* and the error quota in the interrogator's replies are compared to the previous results (fig. 6.5).[19]

The purpose of the test, according to Turing, lies in "drawing a fairly sharp line between the physical and the intellectual capacities of a man."[20]

The interrogator is supposed to try to determine the gender of his opposite number without seeing or touching his two coplayers, solely by means of verbal communication. The proof that the machine can think does not lie in the resolution of practical questions but in an imitation of a gender-specific communication without physical contact. Turing was convinced that a machine could assume all human qualities not only in purely intellectual fields but, as he said in a radio interview in 1951, for example, those "influenced by sex appeal."[21] The crucial criterion of successfully replacing a man by a machine in Turing's test is, therefore, the ability to confuse the interrogator by means of the sexual identity of his or her counterpart. Though sexuality is not an explicit theme, Turing's entire text reads like a perfect psychograph of Turing himself, who was not only highly intelligent but also a homosexual and who, at a time when being the latter was still a criminal offense in England, made no effort to conceal it.

Electronic networks today actually correspond to a globally expanded reconstruction of the Turing test. The Internet takes up the function of Turing's communication via teleprinter and makes the decoupling of corporeality and verbal dialogue through a technical medium an everyday mass phenomenon. And should it in the least surprise us that gender swapping is a popular game in Internet chats: "60% of those who pose on the cyberboard as libidinous women are in reality men," a popular magazine reported already in 1994, at the very beginning of the Internet boom.[22]

It is indeed absolutely amazing that as early as 1950, long before online sex was ever heard of, the goal of the man in Turing's imitation game was to deceive the test person as to his sexual identity, while the woman is meant to help him or her identify the genders of the two partners correctly. Quoting Turing: "I am the woman, don't listen to him!"[23] This allocation of roles seems at first to reflect the conventional schema of the helpful female and the combative male. Likewise, the second phase of the test, when the man is replaced by the machine, seems to correspond to the usual pattern of masculine self-identification with technology. But the test goes deeper, for its real goal is to decouple all physical and biological sexual characteristics from the psychic-intellectual forms of speech that, if the test is to succeed, must likewise be determinable as specifically masculine or feminine.

Thus Turing's test implicitly contains a thesis that forty years later Judith Butler supported in a feminist context: gender identity is not a physical category but a discursive construct that first comes to light in performative acts

through language.[24] Strangely enough, Butler does not go into the phenomenon of gender-swapping over the electronic nets and the virtual communities of MUDs (multi-user domains) and MOOs (MUD-object-oriented), although it arose simultaneously with her theses and could serve as their ideal evidence. Inversely, Sherry Turkle thoroughly studies these virtual gender constructions on the Internet from a sociological viewpoint and refers specifically to the Turing test, but completely ignores the sexual dimension of Turing's original paper.[25] Only by going back to the origins of the universal and bachelor machines can we find the common basis for these postmodern gender- and cybertheories. And against the background of these theories, the two machines imagined by Duchamp and Turing become, at the same time, recognizable as specifically masculine scenarios that revolve around an insurmountable distance from the female and, as a result, install a media-technical communication as a replacement for a physical encounter.

It is more to the point I am making here when Donna Haraway, the pioneer of cyberfeminism, in 1985 describes cyborgs as creatures in a postgender world.[26] The relationship of Butler's theses to Turing's test is made clear by Juliane Rebentisch: "By the imitation in play here, the imitative structure of the so-called feminine and the so-called masculine is shown up as such, as is also its contingent."[27] I would like to go even further by presuming that Turing left it to the reader's logic to conclude what he expressly never allowed himself to write. If a machine can "imitate" thinking so successfully that no difference from a human can be detected in the dialogue, then we must characterize this feature as thinking, since no criterion can be cited that would define the difference from an imitation of thinking—which means that when a machine successfully "imitates" a gender identity, this must then be accorded. With this, any prerequisite of a natural, unalterably binary gender division among humans is obsolete. For Turing and Butler the consequences are similar: the idea of sex as predetermined by nature is replaced by gender identity as individual performative construction, reacting to a set of society's conventions.

However, Turing was to experience personally the conventional inflexibility and mercilessness of society versus any difference between the physical sex and the mental gender. In 1952, that is, soon after he published his paper on the Turing test, he was forcibly given hormone injections to "cure" his homosexuality.[28] Marcel Duchamp tried a more playful way: he bridged the insurmountable separation of the sexes shown in the *Large Glass* with an "imitation

game" slipping into the role of his alter ego Rrose Sélavy. She appears as the authoress of some of his works' plays on words, and, in the famous transvestite photos by Man Ray, Duchamp is reincarnated in her image.

The overall constellation of the Turing test and the *Large Glass* are comparable, since in both there is a technically transmitted discourse between the sexes that is kept in play by the fact that no actual physical encounter can occur. Turing's paper contains such cryptic formulations as: "Finally, we wish to exclude from the machines men born in the usual manner." Or: "One might for instance insist that the team of engineers [who build the machine] should be all of one sex."[29] All this is supposed to exclude a "biological," that is, heterosexual, solution to the generation of intelligence, but at the same time it confirms the status of *the universal machine* as a *bachelor machine* in that sexuality can no longer lead to procreation. Again statements by hackers are today the most explicit ones on this track: "Men can't have babies, and so they go to have them on the machine. Women don't need a computer, they have them the other way."[30]

Michel Carrouges defined the bachelor machine as "a fantastic imaginary picture that transforms love into a lethal mechanism." And it is surprising how close he comes to Turing's universal machine when he calls it an "improbable machine," but simultaneously declares: "This machine's main structure is based on mathematical logic."[31] A psychoanalytical correspondence to the Turing test is provided by Deleuze and Guattari's definition. They borrow "the term of 'celibate machine' to designate a machine that produces a new link between wish machines and organ-less bodies for the purpose of a new humanity or of a glorious organism."[32] In 1972 they described psychophysical processes with media-technical metaphors, even before the debate on cyborgs ever took place.

It is possible that all who have followed this train of thought up to now will no longer be surprised that most computer inventors have been interested in chess and have tried to solve chess problems with their machines: Babbage, Turing, Zuse, Shannon, and Wiener.[33] Turing, even before his test, saw the game of chess as the best opportunity "to have a machine show its intelligence."[34] For this he developed a preliminary version of the test in which one test subject plays against two invisible opponents in separate rooms, one of which is a "paper machine," that is, a program prescribing firm rules written by hand that calculate the chess positions. "A man provided with paper, pencil and rubber, and subject to strict discipline, is in effect a universal ma-

chine," as Turing expresses it. The test subject "may find it quite difficult to tell" which of his invisible opponents is a "rather poor chess player" and which is the "paper machine," Turing continues, for: "Playing against such a machine gives a definite feeling that one is pitting one's wits against something alive."[35] This experience is based on experiments Turing carried out himself.

Duchamp's *Green Box*, the origin of the term bachelor machine, has remained in the stage of a "paper machine" that, although it demands no such "strict discipline" from the user, captivates him via its countless links through the notes, within which he moves in no firm sequence as through a hypertext. Machines, science, and sexuality overlap here in the same way they do in the subtexts of Turing's investigations.

In Duchamp's sequence of pictures from the years 1911 to 1912, which led to the *Large Glass*, and in the two different versions of Turing's test, first chess and then sex serve as a model of interpersonal connection or man–machine interchangeability. Turing was to be proved right in his prognosis in the case of chess. The interface of the chessboard can serve in a game between humans exactly the same as in communication with a machine, while the rules of chess, in principle, form a calculable multiplicity of game combinations. This is why chess was the first domain of interpersonal activity in which the computer became a serious rival to man. On May 10, 1997, the IBM computer Deep Blue beat the world champion Garry Kasparov with a score of 3.5 to 2.5. It won $700,000 and IBM stock soared.[36]

Today's practical trials of the borderline between media, men and machines do indeed touch on the same cornerstones that already played a key role in the creation of the *Large Glass* and the development of the Turing test: chess and sex.[37] Could it be that the actual significance of Duchamp's and Turing's machine models will thus evolve within the current testing of the limits of media-technical experience and at the same time herald their potential synthesis?

Technological Imagination

"How is it possible that a common basic structure is part of all bachelor machines?" Michel Carrouges asks in retrospect of his case studies from the nineteenth and twentieth centuries. Like Jean Suquet or Thomas Zaunschirm he has no answer.[38] All of them have noted a broad correspondence between

themes from Duchamp's *Large Glass* and other works of literature and art. In the continuation of this puzzle I will juxtapose post–*Large Glass* works by Duchamp with popular depictions of media technology. I don't want to conceal the fact that it was the coincidence of these pictures that inspired this essay.

I'll begin again with the game of chess. Duchamp's *Pocket Chess Game* from 1944 is for him first of all a practical device with no claim to art. Fifty years later, comparable travel sets are available as pocket chess computers or as software for the laptop. The wooden chessboard is replaced by a peripatetic game for bachelor globetrotters. In both cases, a game between two people is turned into a solitary engagement with an imaginary opponent. And while Duchamp played long-distance chess preferably by mail, Internet chess has become today's great success story.

For his biographer Robert Lebel, Duchamp added a rubber glove and thus expanded his travel chess set to an assemblage, making it into an artwork (fig. 6.6). But why the glove? We'd do well to remember the hand that is placed so

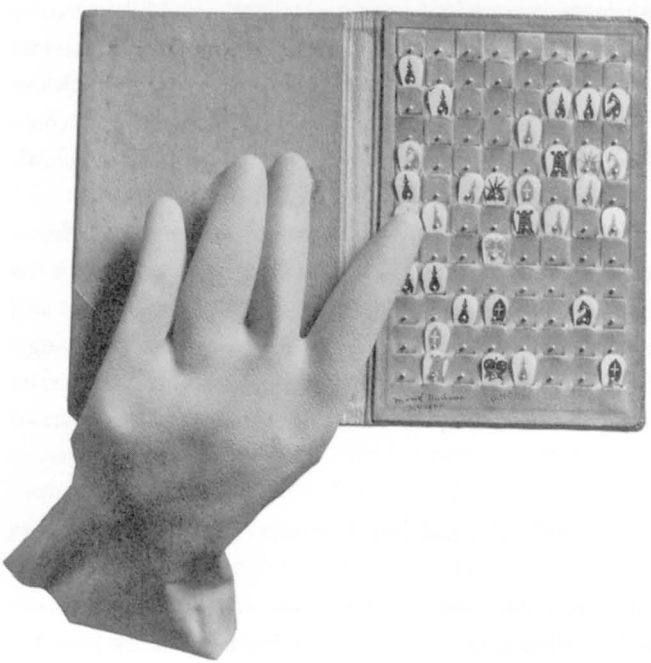

Figure 6.6 Marcel Duchamp, *Pocket Chess with Rubber Glove*, 1944. Collection Lebel, Paris.

strikingly in Duchamp's chess drawing and painting, both from 1911 (see fig. 6.1). The hand as a physical element intrudes into the mental space of chess. In the same way the dataglove intrudes into the dataspace, which it thus makes physically tangible instead of only manipulable via keys and signs. In today's digital technology, the size of the human finger is a physical limitation in humanity's continual attempt to miniaturize the interface of the keyboard. This limit to the manual access of immaterial information is what Duchamp seems to investigate in his assemblage with a rubber glove and a pocket chess game—in his own way.

By means of interfaces with physical references like the dataglove, movement within dataspace approaches natural movement. In this way cyberspace becomes a place of physical experience and is given a potentially erotic dimension, exactly as Turing had foreseen in the still thoroughly nonsensual computer era of punched cards and endless columns of numbers (fig. 6.7). This opposition between tactility and reading (that is, that a text only works in the imagination whereas the haptic finds a direct path to consciousness) may be one aspect of the book cover that Duchamp designed for Le Surréalisme en 1947 under the motto "Please touch" (fig. 6.8).

Figure 6.7 *Cybersex*, cover of the magazine *Spiegel*, 1993. Copyright: Der Spiegel.

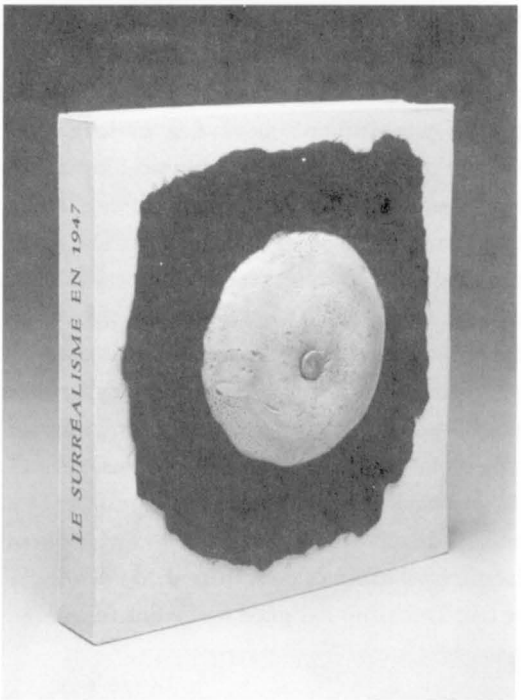

Figure 6.8 Marcel Duchamp, *Prière de toucher*, cover for *Le Surréalisme en 1947*, Museum Ludwig, Cologne.

In comparison to Turing's purely verbal test structure, the bachelors in Duchamp's *Large Glass* have the media-technical luxury of an electric visual link to their bride; according to the notes in the *Green Box*, what is transmitted are the "cinematic effects of the electric stripping bare."[39] This imaginary apparatus of the *Large Glass* could well correspond in some of its essential elements to the media-technical devices that since the 1990s have been designed around the theme of cybersex. The dataglove has been expanded to include the whole body and tactile impulses are added to the optical signals. Like the artificial women of nineteenth-century science fiction novels, cybersex has remained a mostly imaginary practice; it never took off in real life the way it was expected at the time of the virtual reality euphoria. Like some pieces of media art, cybersex is a hypothetical incarnation of inherent motives of the universal machine. This is made even clearer by the fact that some of the most discussed examples of cybersex devices are developed in an art context.[40] They

pretend to be real machines, simulating a physical encounter by means of media-technical apparatuses, but most of their erotic attraction is born in sexual fantasy instead of physical experience.

With Duchamp, too, fifty years after the *Large Glass*, the previously imaginary bride goes concrete in *Étant donnés*. Instead of a technosexual metaphor only comprehensible via the *Green Box*'s operating instructions, we, through two eyeholes in a door, gaze at a perfect illusion whose effect, without any textual explanation, is direct. A comparison to virtual reality discloses the fact that the illusion of the object of desire can always only be seen by one viewer who is obliged to turn away from the real world and look through two peepholes at a perfect simulation, whether the ocular device is two holes in a door or virtual reality glasses. But where are the bachelors who were linked media-technically to their virtual bride in the *Large Glass*? In *Étant donnés* as in cybersex we as viewers take up their position.[41] While in the *Large Glass* a text-based metaphor is still in operation, we are now in the position of those to whom a virtual bride appears in absolute perfection while remaining absolutely out of reach.

The immense interest today in the possibility of teledildonics is evidenced by the success of the website "FuckU-fuckme," which claimed worldwide interest with several thousand hits daily.[42] The product offered here is, however, a fake, launched in 1999 by the Moscow Internet artist Alexei Shulgin.[43] The direct casts of the primary sex organs necessary for such interfaces are also found in Duchamp's works that lead up to *Étant donnés*, such as the *Female Figleaf* from 1950. Duchamp's entire love of detail is also dedicated to the perfect depiction of skin in the preliminary models and the end version of *Étant donnés*. The first model for *Étant donnés* from 1948–49 has an inscription on the reverse side that expressly states that the female dummy may not be touched even in the case of repairs or a new frame for the work, since otherwise the sensitive shading of the skin would be destroyed.[44] We see that even when dealing with concrete material, the contradiction is maintained between perfect illusion and untouchability.

Here we must once again quote Turing: "No engineer or chemist claims to be able to produce a material which is indistinguishable from human skin. It is possible that at some time this might be done, but even supposing this invention available we should feel there was little point in trying to make a 'thinking machine' more human by dressing it up in such artificial flesh."[45] Behind these reflections stands the question as to whether something like a

tactile illusion can even exist. The relation between verbal imagination and tactility is also what Duchamp deals with in the rubber breasts as book cover under the motto "Please touch." He had already confided to Julien Levy in 1927 ever-wider-reaching speculations: "He said jokingly he was thinking of contriving a mechanical woman whose vagina would be made up of interconnected springs and ball bearings and be contractile, possibly self-lubricating and activated by a remote control, perhaps located in the head." Duchamp illustrated his explanation of a striking anticipation of present-day cybersex designs by bending two wires: "When these wire lines are formed in such a way that the exact effect is triggered and you then extract them from their function as message transmission, they become abstractions."[46] The technical function of the "Network of Stoppages," which connects the bachelors to the bride, could hardly be more exactly described, since they too are an abstraction of a randomly formed cord that serves as the means of transporting masculine desire. At the same time, five years after ending work on the *Large Glass*, Duchamp announced the incarnation of the imaginary bride that was to end forty years later in *Étant donnés*.

But the bride in *Étant donnés* will remain for the viewer just as untouchable as for the bachelors in the *Large Glass*, for whom according to Duchamp they long only "negatively" while suffering the torture of Tantalus.[47] The unattainability of what seems close enough to touch is in *Étant donnés* not made any less urgent by "artificial flesh" in Turing's sense. The question of whether a technical surrogate for a physical encounter is possible is denied by both Duchamp and Turing. This has not prevented present-day media technology from developing a material called "cyberflesh" that, in its tactile feel, comes very close to the mucous membrane that lines the inner body.

En Route to the Universal Bachelor Machine

Long before the existence of blueprints for cybersex, Turing's test as well as Duchamp's *Large Glass* point out the consequences of synthesizing telematics and artificial intelligence. This leads to the actual goal, not yet redeemed, but seemingly subliminally present: the machine as perfect sexual partner. This goal would be reached in merging Turing's and Duchamp's models to become the *universal bachelor machine*.[48] This would be, however, no longer a construct stemming from an artistic or mathematical imagination, but would follow

from the practice of dealing with media techniques, which have already been prefigured in the cited examples.

What would this practice look like? Do I perhaps always lose against my new Internet chess opponent because he is a computer with even more power than Deep Blue? And when I want to have intercourse with my distant partner per data suit, how will I know that I am actually linked to him or her and he or she is not just running my known favorite software while finding amusement elsewhere? Such fictions are a vital part of current media developments, which are working toward the goal of a universal bachelor machine. This means that media technology turns Turing's and Duchamp's models into reality—*without ever having heard of them*!

What does this mean in regard to the "power over reality" that Friedrich Kittler claimed for technology and not for art (quoted at the beginning of this essay)?[49] As to the factual situation, the difference between art and technology seems to be clear. Duchamp's bachelor machine can be found stored in a safe place, the Philadelphia Museum of Art. On the other hand, we sit opposite umpteen copies of Turing's universal machine daily. Put even more simply: Duchamp's machine remains a model, that is, art, while Turing's machine is in operation; a theory has become a technology. In this respect, the "power over reality" could hardly be more different: comprehensively in Turing's case, negligibly in Duchamp's case. But is this the last word on the impotence of art versus technology?

Duchamp's and Turing's machine models each stem from a deeply individual imagination. In both cases the technical model can be understood as a substitute for the solution to a difficult or even hopeless sexual and emotional situation. Expressed in the words of Friedrich Nietzsche: "The degree and the type of a person's sexuality reach into the highest pinnacle of his mind."[50] This is at least claimed by their biographers who pinpoint the decisive impulse for the step to a new conceptual approach as stemming from an incisive personal and sexual loss.[51] In both cases the interchangeability between man and machine provides a substitute for a physical and emotional deficit.

The universal machine and the bachelor machine both made their first appearances in the form of "paper machines." Up to this point there was no question of a difference in power between them. Both are "atremble with reflections on the future," as André Breton, and with him Walter Benjamin, formulates as the only value of an artwork.[52] But here ends the factual

analogy. Despite the meticulous technical details, no functioning machine could be built using the directions given in the *Large Glass* and the *Green Box*. Their technical features and imagined functions do not result in an operative system, but their associative ambivalence and multiplicity correspond to a psychic feedback that lies between a "wish machine" and a genuine technical machine. It is from this that the psychic motifs and connections come about that lead to the construction of real apparatuses. Duchamp's *Large Glass* shows how closely the wish to build machines is linked to becoming a machine oneself.

Turing's machine, on the other hand, was built. It has become an indispensable part of everyday life. Most machines are built to take over the tasks of humans. But the universal machine has no special purpose; its functions are as varied as human thought, with which it now competes. In so doing it surmounts the individual as well as the imaginary. By becoming technical practice, the universal machine as a veritable apparatus in all fields of life lays the foundation for the generalization of the psychical aspiration, that is, the wish for a man–machine replacement. Paradoxically, its individual motif of origin, which resulted from Turing's most profound personal loss, *remains "inscribed" in the universal machine* beyond his person. What else shows the use of the computer in the noted examples from gender-swapping to cybersex?

But how can something be "inscribed" in a universal machine, since it is characterized by the fact that it can imitate all other machines, even including humans, and consequently does not dispose of any unchanging capacities of its own? This claim to universality would then be its only specification. But again, what does universality mean here? Turing as mathematician stepped over a boundary line that was previously taboo: the mental purity of *mathematical function* is transmitted via the computer to the world of things, that is, it becomes a *real, technical function*.[53] Thus, from the hypothetical universality of his theoretically rendered machine, an actual universal use develops for the apparatus based on it. In today's factually universal deployment of computers, as proven by the examples of machine-chess and machine-sex, (which have no connection to Turing), the same motifs become manifest that had occupied him when he developed his theory of the universal machine. Parallel to the technical universality of the function of the apparatus actually built, the psychic universality of the motives behind its invention becomes evident. And it is exactly for this reason that the universal machine can be aligned with the series of bachelor machines that, mysteriously, all have a common basic struc-

ture, although they crop up in extremely diverse forms and, above all, among different authors. The psychic universality of the bachelor machines corresponds to the functional universality of Turing's machine.

The machine's claim to universality is, at the same time, the touchstone for its "power over reality." For the definition of this power depends on how far the substitution and the accessibility of all areas of reality go that are reached by the machine. Only when all areas of life can become operational does the universal machine also represent "omnipotence."[54] And it is exactly here that the *decisive difference between Turing and Duchamp* becomes apparent. Turing seems to consider an absolute man–machine exchangeability possible and almost inevitable. For him there is no "special human feature" that "can never be imitated by a machine."[55] Duchamp's *Large Glass*, in contrast, remains in an onanistic cycle of frustration with a "short circuit on demand."[56] Like all bachelor machines it stands for the unattainability of a perfect substitute—and thus for the *suffering from the phenomenon* it describes.

This suffering from the phenomenon, which the *Large Glass* as well as *Étant donnés* describes, seldom becomes very explicit with Duchamp. But as is sometimes the case with such complex trains of thought, the initial idea can clearly outline the core of what then becomes the basis of a larger-scale construction. Thus Duchamp's *Box of 1914*, the predecessor to the *Green Box*, already contains such a central note whose meaning first becomes visible and understandable through the later, more complicated structure. He writes very cryptically of "L'électricité en large" as the "only possible use of electricity 'in the arts.'" This widespread electrification "in the arts" (the quotation marks doubtless signal irony) follows immediately after: "Given the fact . . . ; if I assume I would suffer very much" and a very unambiguous, even onomatopoetic allusion to onanism. I do not want to go into this first hint of the later title *Étant donnés*, but into what for Duchamp is a very unusual, even unique confession of suffering from the phenomenon described. It is the sole occasion in all Duchamp's notes on the *Large Glass* where the word "I" is used. And on one of the copies of the box he has added by hand on this note: "Given . . . ; if I assume that I would suffer very much (express it like a mathematical theorem)."[57] This is exactly what *Alan Turing was successful in doing, expressing his suffering in a mathematical theorem.* Because of its "widespread electrification," this machine has established itself in today's society. More and more this universal technology is taking over the role that was once reserved for the arts, creating a suprapersonal expression of suffering, love, and desire.

Despite this, the omnipotence of the machine runs into clear limitations, which in turn can be marked by exactly those two test fields that Turing and Duchamp had invoked: chess and sex. In the case of chess the equality of the machine was proved no later than Deep Blue's victory over Kasparov. In the area of general, interhuman communication, however, there is no serious competition of the machine in sight. In 1950 Turing had predicted that his test would be passed by a machine by the end of the century.[58] In 1991 the Loebner Prize announced that it will award $100,000 to the first program that passes Turing's criterion for a five-minute dialogue.[59] Up to now the results of the annual tests are far removed from the short examples of dialogues cited by Turing in 1950, in which, among other things, poetry is spoken of.[60] The theme of sex has several times played a central role in the programs that turned out to be the best, but has proved a far cry from an erotic irritation.[61] By means of an unequivocal interface and the game's set rules, chess has become operational. On the other hand, "sex appeal" (which Turing believed machines also susceptible to), as a game of rules and a game of overstepping those rules, has eluded all operational capacities.

The flexible rules of interhuman communication, according to Turing, can be learned by the machine only through longer exchanges with people. As a prerequisite he names the capacity of the machine to feel pleasure and frustration. Only in this way can the machine be educated, since reward and punishment is the only way to learn and the only means by which the machine can become comprehensively intelligent in a human sense.[62] A capacity for pleasure would thus be one of the prerequisites for thinking in its fully developed form. This is exactly what in today's research for simulating emotions in artificial intelligence seems to be so difficult to program.[63] That is why machines up to now have neither convinced us of their "sex appeal" nor produced art.[64]

Phone sex and the countless new forms of sexual encounter and identity-change on the Internet—forms of an sexuality, stimulated by media without any physical encounter—are only acted out between humans up to now and are much further developed than any man–machine exchange. The human imagination and the will to realize it in this field is still far beyond the capacity of the machine. Exactly this human wish to play the part of a machine, even perhaps to become one, in order to dispose of the incapacity for physical fulfillment in a sexual encounter, in order to encompass it in a form that is separable from one's own agony of impotence—that is the theme that Duchamp so meticulously depicts in the *Large Glass*. But today the bachelor ma-

chine has left the field of art and literature far behind and instead become a motif of the omnipresent practice of media technology. The universal machine of the computer serves as a means to realize these wishes, but its capacity does not suffice to fulfill them completely, nor to replace the human counterpart.

This as-absurd-as-it-is-significant contest between the operational capacity of the universal machine and the imaginative capacity of the bachelor machine comes down to the question of who can better imitate whom: whether the machine a man or whether the man a machine.[65] The universal machine is one in a series of bachelor machines, but it at the same time *claims to be their ultimate end*, since its principle has become a technical, factual reality, independent of any individual and beyond any imagination. It is sometimes called the "Turing machine" and in this way one could say that Turing "lost his name to a machine."[66] But countless nameless people follow his highly individually motivated wish of replacing a human by a machine, because his machine has put this seemingly within our reach. Only from a synthesis of the psychic universality of the bachelor machine in tandem with the mathematic and technical universality of Turing's machine does a steady expansion in the technological "power over reality" result.

From a technical viewpoint, this contest will continue into the future, its result open to all comers. But up to now, the above examples show that the bachelor machine, having started out as an artistic vision, has turned into a way of embracing and developing technologies. As such, it is still miles ahead of the universal machine, which started out from technology so as to maybe one day equal man.

Notes

1. See Daniels 2003. The present essay is based on a chapter from this book and was reworked in many parts for this first English publication.

2. Kittler 1993, 47, 51.

3. Use of the word "man" throughout this essay is intentional, as it indicates the gender issues involved.

4. See Strouhal 1994, *Duchamps Spiel*, an informative study which, at least as concerns chess, also deals with Turing.

5. Duchamp in a talk at the chess congress in Cazenovia (Strouhal 1994, 11).

6. See the photo and audio documentation in the book by Shigeko Kubota, *Marcel Duchamp and John Cage* (n.p, n.d.).

7. Duchamp 1975, 59. On the countless references to the technology of the telegraph and radio concerning the link between bachelors and bride see the very detailed studies made by Linda Dalrymple Henderson, above all, the section "Wireless Telegraphy, Telepathy, and Radio Control in the Large Glass" (Henderson 1998, 103–115).

8. See Carrouges 1954; Deleuze and Guattari 1974; Clair and Szeemann 1975.

9. Duchamp 1975, 46.

10. This division into physical schema and formal rules in chess corresponds to two ways of experiencing the world, according to Duchamp: "I think that every chess player experiences a mixture of two aesthetic pleasures: first the abstraction of the delineation that is similar to the idea of poetry when writing, second, the sensuous pleasure in physically executing the delineation on the chess board." (Speech at the chess congress in Cazenovia 1952, in Strouhal 1994, 19.) Similar things could be said of the aesthetic experience of working with a computer.

11. Cf. Friedrich Kittler, "Es gibt keine Software," in Kittler 1993a, 229ff.

12. Jean Suquet writes on the *Large Glass* along these lines: "The machine runs only on words." Jean Suquet, "Possible," in de Duve 1991, 86.

13. Turing 1992, 7.

14. Baudrillard 1989, 128.

15. This corresponds to an action by the Hamburg female artists group "—innen," who in 1996 handed out men's mouse pads at the CeBit computer fair printed with the slogan: "Has your computer ever feigned an orgasm?"

16. Levy 1994, 83.

17. Statement by hacker Burt in Turkle 1984, 198.

18. Alan M. Turing, "Computing Machinery and Intelligence," in *Mind* 59 (1950). Reprinted in Turing 1992, 133–160.

19. It is surprising that the sexual components of the test have gone unnoticed by authors who otherwise very exactly register the gender-specificity of the media. See, e.g., Kittler 1986, 30; Wiener 1990, 93; and even in explicitly feminist studies on gender and computers, e.g., Kirby 1997, 136, 177. On the other hand, the Turing biographer Andrew Hodges, for example, finds the test a "bad analogy" that shows the "definitely camp humour in Turing's paper, reflecting his gay identity," which moreover encourages a "wild misinterpretation of what he had in mind." See Andrew Hodges, "The Alan Turing Internet Scrapbook," with links to other texts on the theme, at http://www.turing.org.uk/turing/scrapbook/index.html/. A more profound analysis of the gender-specific implications of the test is given by Rebentisch 1997.

20. Turing 1992, 134.

21. Hodges 1983, 540.

22. *Stern*, May 5, 1994, p. 56.

23. Turing 1992, 134.

24. Butler 1990.

25. Sherry Turkle, *Life on the Screen* (1995). Note the flirt of a student with the program Julia that he took for a girl (chapter 3, "Julia").

26. Haraway 2000, 292.

27. Rebentisch 1997, 29.

28. Cf. Hodges in Herken 1994, 12.

29. Turing 1992, 135–136. A certain irony can be seen in play here in Turing's formulations.

30. Statement by hacker Anthony in Turkle 1984, 235.

31. Carrouges in Clair and Szeemann 1975, 21.

32. Deleuze and Guattari 1974, 25.

33. Pias 2002, 198. According to Claus Pias, chess can be seen as a mental image (*Denkbild*) of the computer. It is almost a matter of course that hackers also develop chess programs, whose aim is to have the machine beat the human player. See Levy 1994, 89ff.

34. Turing's ACE report from 1945, according to Hodges 1983, 333.

35. Turing 1992, 127, 113, 109. It may today seem absurd or ironic to have a person "play" a machine in order to deceive another person into thinking he or she is playing against a person instead of against a machine. But this reflects only the phase of the pre-apparatus thought experiment.

36. Garry Kasparov later insisted that Deep Blue must have secretly received human assistance. However, in the meantime, even standard chess programs are able to beat grand masters; thus in May 1999, a "Fritz," version 5.32, available on CD-ROM beat Judith Polgar (Elo 2677) by 5.5 to 2.5. And in October 2002, the two-week match between the upgraded version "Deep Fritz" and chess world champion Wladimir Kramnik ended in a draw.

37. "The milieu of chess players is far more sympathetic than that of artists. These people are completely cloudy, completely blind, wearing blinkers. Madmen of a certain quality, the way the artist is supposed to be, but isn't, in general." (Duchamp, quoted in Cabanne 1987, 19.) This statement by Duchamp could today easily be applied to the phenotype of the computer hacker, whereby the celibate tendency in both milieus is clear.

38. Carrouges in Clair and Szeemann 1975, 44. See also Jean Suquet on Duchamp's *Large Glass* and Herman Melville's tale "The Paradise of Bachelors and the Tartarus of Maids" from 1852, in which nine bachelors meet nine lonely, freezing virgins who are operating a large machine that produces a kind of spermatic liquid out of old clothes. This enigma of a coincidence, which goes as far as "a correspondence of names and numbers," Suquet calls the actual reason for his book (Suquet 1974, 229ff). Thomas Zaunschirm (1982) comes to similar far-reaching conclusions in *Robert Musil und Marcel Duchamp*.

39. Duchamp 1975, 62.

40. At the Art Academy for Media, Kirk Woolford and Stahl Stenslie developed a cybersex suit that drew a lot of attention in the media, but whose function was more symbolic (see, e.g., "Prinz Reporterin testete Cyber-Sex, Orgasmus und Computer, Wie war's?," in *Prinz*, May 1994). Compare also the statements of artists in *Lab 1, Jahrbuch der Kunsthochschule für Medien*, Cologne (1994), 40ff, 74ff.

41. See Daniels 1992, 288–289.

42. Cf. Howard Rheingold, "Teledildonics," chapter 4 in Rheingold 1991.

43. See http://www.fu-fme.com/. According to Alexei Shulgin there were many orders for the nonexistent product, and on his website, in the meantime, the traffic was so high that it would have been possible to run ad banners bringing in several thousand dollars a month.

44. For the inscription, see Schwarz 1997, 794, cat. no. 531.

45. Turing 1992, 134.

46. Levy 1977, 20. From 1925 Duchamp several times collaborated with Frederick Kiesler, whose designs for audiovisual depiction techniques in part approach concepts of today's virtual reality. See Daniels 1996.

47. Duchamp, *Notes*, 1980, note 103. According to Greek mythology, Tantalus is punished by the gods and made to suffer hunger and thirst while water and the most luscious fruits are held before his eyes but withdrawn at his every attempt to reach them.

48. Jean Baudrillard developed theses on the sexual dimension of media technology that come very close to the ones represented here: "The relationship to a discussion partner via telecommunication is the same as that to input knowledge in data processing: tactile and groping.... That is why electronic data processing and communication, in a kind of incestuous convolution, always fall back on each other" (Baudrillard 1989, 121, 122).

49. See Kittler 1993b, 47, 51.

50. Friedrich Nietzsche, *Jenseits von Gut und Böse*, part 4, epigram 37.

51. Andrew Hodges draws a direct connection between the death of Chris Morcom, the young Turing's first love, and the notion of the universal machine, claiming that

the idea was born out of Alan Turing's personal loss. The transformation of love into a death mechanism as a principle of the bachelor machine fits in when he goes on to write: "Christopher Morcom had died a second death, and *Computable Numbers* marked his passing" (Hodges 1983, 110, 108, 45ff). Arturo Schwarz sees Duchamp's unfulfilled, incestuous love for his sister Susanne as an explanation for almost everything in his work (Schwarz 1969). Such interpretations are always one-dimensional and, as concerns Arturo Schwarz, clearly exaggerated. Yet nothing speaks against their having a true core.

52. Benjamin 1989, 500.

53. Andrew Hodges writes about Turing's first, still mechanical machine experiments from 1939: "The machine seemed to be a contradiction," because "a pure mathematician worked in a symbolic world and not with things.... For Alan Turing personally, the machine was a symptom of something that could not be answered by mathematics alone." The machine was a way "of making some connection between the abstract and the physical. It was not science, not 'applied mathematics,' but a sort of applied logic, something that had no name" (Hodges 1983, 157). Duchamp's work aims exactly in the same direction of something not yet named—beyond painting, literature, or technology.

54. See Kittler 1993b, 47, 51.

55. Turing in Hodges 1983, 539–540.

56. Duchamp 1975, 59.

57. The wording in the note: "L'électricité en large—Seule utilisation possible de l'électricité 'dans les arts' Étant donné . . . ; si je suppose que je sois souffrant beaucoup (énoncer comme un théorème mathematique)" (Duchamp 1975, 36–37; Suquet's addition to this in Suquet 1974, 191).

58. Turing 1992, 142.

59. Compare the transcripts of the tests at http://www.loebner.net/Prizef/loebner-prize.html/.

60. Turing 1992, 146.

61. See, e.g., the Turing test transcript on the winner of the Loebner Prize 1995 by Joseph Weintraub. The tests were, however, carried out only in the reduced version of man vs. machine, not in the man–woman–machine constellation of the imitation game suggested by Turing.

62. Turing 1992, 118ff, 121ff, 154ff.

63. For Baudrillard the machine's inability to feel pleasure is exactly the last defense in man's assurance of not being a machine: "What will always distinguish the functioning of even the most intelligent machines from man is the ecstasy, the pleasure, of functioning.... All kinds of artificial props can contribute to securing man pleasure, but he cannot invent anything to feel pleasure in his place" (Baudrillard 1989, 130). But, according to Turing, such a position leads to a vicious solipsistic circle (Turing 1992, 146). In analogy to Ludwig Wittgentstein's study on conveying pain, he put it this way: Only I can know if I feel pleasure (cf. Ludwig Wittgenstein, *Philosophical Investigations*, no. 244ff). Turing went to Wittgenstein's seminars in Cambridge, and on a conceptual relation between them there would be at least as much to say as on that between Duchamp and Turing (Hodges 1983, 152ff).

64. Turing investigates the question of whether art production is a criterion for thinking within the framework of arguments on consciousness. See Turing 1987, 164ff.

65. At the Turing test competition for the Loebner Prize in 2000, the testers had, at least once, mistaken all human opponents for a computer, but no computer was mistaken for a human.

66. Bernard Dotzler and Friedrich Kittler, in Turing 1987, 5.

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7

Remember the Phantasmagoria! Illusion Politics of the Eighteenth Century and Its Multimedial Afterlife

Oliver Grau

In 1919, a Viennese student of philosophy Natalia A. consulted the psychoanalyst and early Freud-disciple Victor Tausk, complaining that her thoughts were being controlled and manipulated for years by a strange electrical device by doctors in Berlin. An *Influencing Machine*, according to the patient's obsessive idea, operated clandestinely, which forced upon her dreams, repellent smells, and emotions, telepathically and telekinetically.

Influencing Machine, created in 2002 by the Scottish-American artist Zoe Beloff, is a representation of Natalia's ominous medium (fig. 7.1). Stereoscopic floor diagrams viewed through red and green glasses and interactive video draw the visitor into a 3-D environment consisting of performative collages and DVD film (fig. 7.2). Using a pointer, we can interactively influence video sequences from medical teaching aids, home movies, and commercials, which appear as interactive loops on a letter-sized glass display.[1]

This is how we enter Natalia's inner world of images. With her *Influencing Machine*, the artist succeeds in presenting us with hallucinatory visions of "the" new medium.

Beloff visualizes the cinematographic as an intimate-interactive dialogue. Sounds of short-wave transmissions, popular songs of the 1930s, as well as recordings of atmospheric and geomagnetic interference expand a strangely oppressive scenario, with which the artist invokes a phantasmagoric presence or immersion into the mental topography of a schizophrenic. That older image media may acquire fresh importance in fields of artistic experimentation is a generally accepted insight in media art history. Beloff compiles her work of

Figure 7.1 Zoe Beloff, *Influencing Machine*, 2002. By kind permission of the artist.

electronic passages from material that, after extraction from lost contexts, emerges as a media-archaeological arrangement inscribed with new meaning. This renders *Influencing Machine* a sensitive reflection on media per se as well as a meditation on an ultimate medium. Beloff, too, demonstrates that machines are not mere tools and emphasizes just how deeply rooted technological media are in the subconscious, in media history, in the space of utopian projections and how they transport magical beliefs. The artist's gaze backward in time transports us to a thinking-space in the sense of Ernst Cassirer—and makes us aware of the evolutionary development of the media through aesthetic means.[2]

Although it has become a fancy word in modern art debates in other contexts[3] on the ideas underpinning the *Influencing Machine*,[4] we appear to encounter the "uncanny" described by Freud in conjunction with the "survival of primitive ideas," the resurfacing of infantile conceptions of life that the

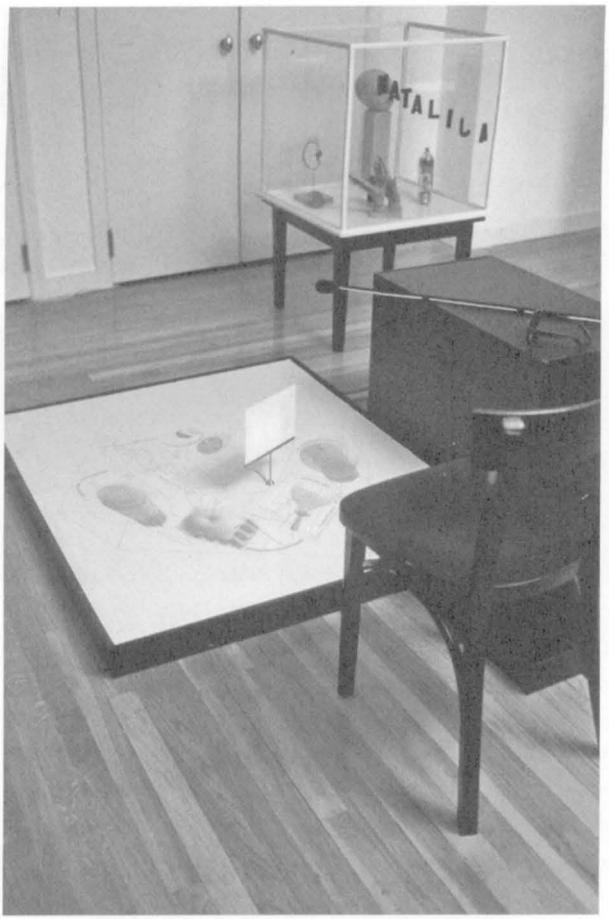

Figure 7.2 Zoe Beloff, *Influencing Machine*, 2002. See plate 5. By kind permission of the artist.

rational adult imagines have been overcome. These include belief in the existence of supernatural destructive forces, the return of the dead or contact with them, all of which belong to the doctrine of animism. According to Freud, the uncanny results from the contradiction between what we think we know and what we fear we perceive at a particular moment.[5]

There are also reflections of the phantasmagoria: Brazilian artist Rosângela Rennó's 2004 media-archeology work *Experiencing Cinema* comprises the intermittent projection of photographs onto a volatile screen, made from nontoxic

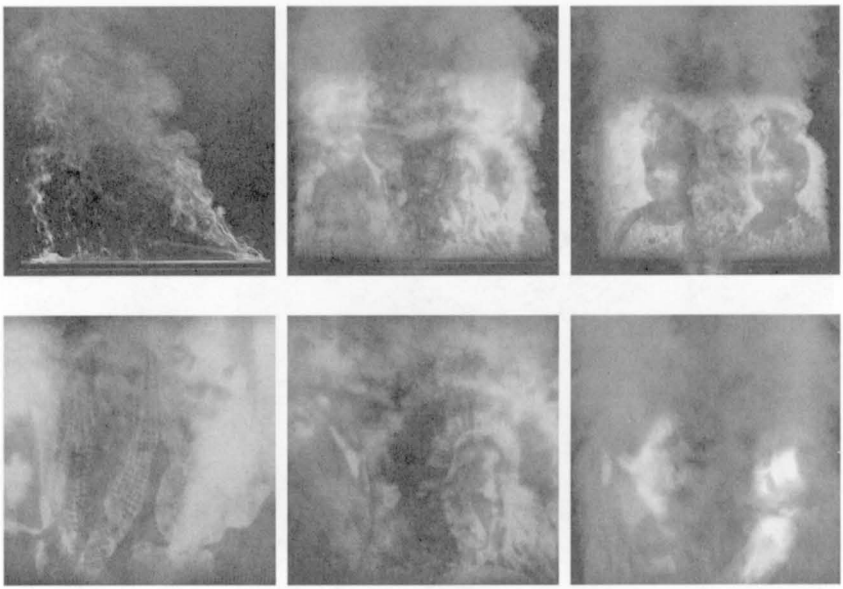

Figure 7.3 Rosangela Rennó, *Experiencing Cinema*, installation, 2005. See plate 6. By kind permission of the artist.

smoke from vegetable oil (fig. 7.3).[6] Or consider Toni Oursler's *Influence Machine*, a "psycho-landscape" for Soho Square, New York,[7] which reflects on historic shows that invoked the "spirit" of the site, such as the phantasmagoria. In this context, we could also take a look at Gary Hill, Douglas Gordon, or Laurie Anderson.

Media exerts a general influence on forms of perceiving space, objects, and time, and they are tied inextricably to the evolution of humankind's sense faculties. Currently, we are witnessing the transformation of the image into a computer-generated, virtual, and spatial entity that seemingly is capable of changing "autonomously" and representing a lifelike, visual-sensory realm. For how people see and what they see are not simple physiological questions; they are complex cultural processes. Not least, in this way light can be shed on the genesis of new media, which are frequently encountered for the first time in works of art as utopian or visionary models. Therefore a central problem of current cultural policy stems from a serious lack of knowledge about the origins of audiovisual media. And this is in complete contradiction with the current demands for more media and image competence.

Marginal and fragile, Beloff's cinematographic code seems like a highly expressive visualization of a media-historical phantasm, as brought forth by *laterna magica*, panorama, radio, early television, and the discussion of cyberspace and virtuality. In this way, the artist expands an individual psychosis into a societal and image-political horizon.

Whereas Beloff utilizes set pieces from media history, the almost forgotten play *Lichtenberg*, written by Walter Benjamin in the 1930s, designs a set of new utopian media.[8] At a productive distance from the conditions that prevail on Earth, the inhabitants of the Moon study our blue planet with the help of utopian media, and so even the famous experimental physicist Lichtenberg becomes the focus of media users' interest. Thus, the Moon knows everything about the Earth, but the Earth knows nothing about the Moon. Those media are: the Spectrophone, which detects and keeps under surveillance everything that happens on Earth—it is both ear and eye of God; the Parlamonium, which transforms human speech (which is irritating to the ears of Moonlings) into the delightful music of the spheres; and the Oneiroscope, which materializes the psychoanalytically motivated desire to visualize dreams.

Although all three devices trigger associations with Beloff's *Influencing Machine*, it is the Oneiroscope that brings us closest to Beloff's work. Benjamin's visions are of media that can hear all, see all, and even read the mind's dreams; but they remain passive, whereas the *Influencing Machine*, in Natalia's magical beliefs, affects the psyche and the sexual organs.

Utopians versus Apocalyptians

Media revolutions have often led to bipolar discourses between utopians and apocalyptians, platonic, or even apocalyptic commentaries. These positions often exhibit an antitechnology thrust and have developed partly from critical theory and poststructuralism. At the other end of the spectrum are the utopian-futurist prophecies. Both poles are either positive or negative teleological models, which follow largely the pattern of discourse surrounding earlier media revolutions. On the utopian side, variations of ideas like *Now we will be able to touch with our bodies into the far distance*, and *now the illusion will become total*, have collided with fears like *our perception will suffer*, *our culture will be destroyed*, and even *we will lose our bodies*. Eisenstein,[9] Minsky,[10] Youngblood,[11] and Moravec[12] belong probably to the "utopian" group, while Eberhard,[13] Postman,[14] Baudrillard,[15] and even Flusser[16] come more from the

"apocalyptic" side. This discourse, provoked by media revolutions, returns again and again: recall the discussion around virtual reality ten years ago, the cinema debate in the early twentieth century, the panorama in the eighteenth century, and so forth. But analogies or fundamental innovations in contemporary phenomena can be discerned only through historical comparison, and that is what this approach is based on.

We know that Marshall McLuhan's influential materialistic discourse interpreted media as externalizations of bodily organs and sensory perception. In my view, however, new and older image media not only conform to the Extensions of Man, they also expand the sphere of our projections and appear to bring us (so the utopian idea goes) not only into contact with far-off objects telematically, but also virtually, and this is my point here, with the psyche, with death, and with artificial life—with the most extreme moments of our existence. At the same time and in the opposite direction, these phenomena appear to be reaching out to us and to an increasing number of our senses. Pseudo-certainty of these illusions is created by the cultural technique of immersion.

The Magic Lantern and Phantasmagoria

The recurrent hope that is ascribed to the media of "bringing back what is absent" finds its most impressive expression in the attempt to communicate with the dead. We know that Athanasius Kircher and Gaspar Schott pressed the *laterna magica* into the service of the Jesuits' *propagatio fidei* in order to put the fear of God into their audiences by illuminating the devil (fig. 7.4).[17] Unfortunately, today there are very few opportunities for experiencing the visual media of the nineteenth century. This is in total contrast to the situation regarding the painting and sculpture, theater, and music of this period. Without actual experience of performances, access to the origins of modern audiovisual media is blocked for interested observers. Imagine what it would mean for our appreciation of modern art if the paintings by Matisse or Monet were available only as postcards or book illustrations!

The rise to fame of this optical wonder began with the projection of the image of a corpse by its first mediator, the traveler Rasmussen Walgenstein (1609–1670), at the court of King Frederik III in Copenhagen.[18] As of the mid-seventeenth century, the *laterna magica*, or magic lantern, provided the means to tell stories in projected images;[19] however, from the outset when

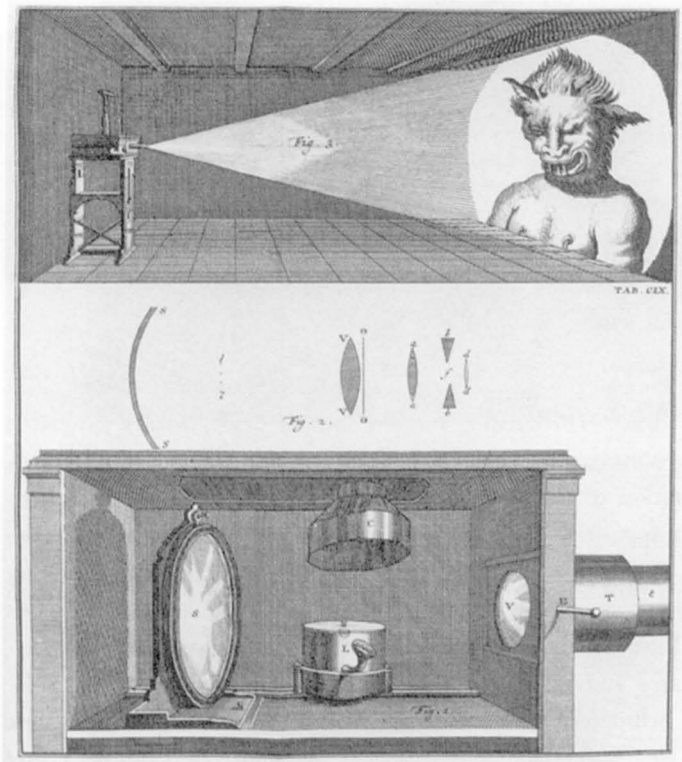

Figure 7.4 *Projection of the Devil,* in Guliemo Jacobo sGravesande, *Physices Elementa Mathematica,* ill. 109 (Genf: 1748), p. 878.

the device was in less scrupulous hands, it was employed to deceive, terrify, and manipulate naive spectators. The courtiers in attendance in Copenhagen were frightened out of their wits to such a degree that the king, who could not abide timidity, commanded the performance to be repeated three times, that is, until the spectators had become accustomed to the new visuality, which annulled the effect.[20] Although eye-witnesses did not record any actual details concerning the content of these first magic lantern shows, they are unanimous in their verdict that Walgenstein was a "showman," who was out to produce shock effects and deceptions, and to play on his audience's superstitions using a new optical instrument. It was apparent that for him, the main attraction of the magic lantern was its ability to make supernatural apparitions and ghosts appear as if by magic. These objections raised against the magicians operating

the lanterns express a general deep-seated suspicion, which continues to be leveled today at the suggestive power of images, particularly by writers.[21]

During the following decades, use of the *laterna magica* spread and its tiny light made a great impression in the dark nights of those days, which we have difficulties imagining today. Contemporary accounts testify to the magical and spiritualistic nature of the magic lantern performances: After some minutes, the likeness of a person, who was familiar to the assembled company, in the form of the generally accepted notion of a spirit seemed to rise slowly from out of the floor, quite recognizable and clear to see. From February 1790, such shows were institutionalized in a special theater in Vienna's Josefstadt. This establishment was entirely draped in black and decorated with skulls and a white "magic circle." The evening's entertainment began with a simulated storm complete with thunderclaps, wind, hail, and rain. The dramatic climax was the conjuration of spirits. At each performance, three so-called spirits appeared. Each apparition took some steps toward the audience, and then disappeared in the manner in which it had appeared. Ghosts and terrifying apparitions made a spectacular comeback in the 1790s. In the mid-1780s showmen like Paul Philidor had begun to put on shows in Germany for curious and fascinated audiences, which were modeled on the performances by Johann Georg Schröpfer, a freemason and magic lantern illusionist, whose occult powers were legendary.[22] The pièce de resistance of Schröpfer's later shows was the projection of ghostly apparitions onto smoke using a concealed magic lantern.[23] The images produced by this technique were flickering and ephemeral, and the effect was apparently very frightening. Schröpfer used a whole suite of tricks including projection with mirrors, hollow voices spoken through concealed tubes, assistants dressed as ghosts, and thunder sound effects. To this arsenal of illusions Paul Philidor added the recently invented Argand lamp, which produced a much stronger light and thus enabled larger audiences to see the images—this was the birth of the phantasmagoria (fig. 7.5).

Another pioneer of this early illusion industry was the master of illusion Johann Carl Enslen, who was well known all over Europe for his "Hunts in the Sky," his flying sculptures, and many other meticulously organized illusions. His phantasmagoria shows in Berlin expanded the repertoire of subjects that Philidor had presented in his ghostly presentations.[24]

It was in Berlin too that the phantasmagoria cast its spell over the most famous protagonist of the genre, the Belgian painter, physicist, brilliant orga-

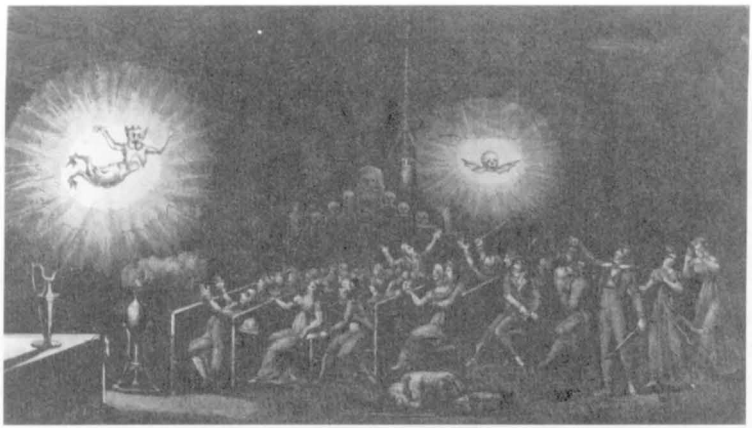

Figure 7.5 *Phantasmagoria,* in Etienne Gaspard Robertson, *Mémoires récréatives scientifiques et anecdotiques,* frontispiece (Paris: 1831).

nizer, balloonist, and priest Etienne Gaspard Robertson (fig. 7.6). In 1798, he exported the immersive medium to postrevolutionary Paris, and, starting in 1802, he presented it all over Europe, from Lisbon to Moscow.[25] The nineteenth century saw the success of the medium all over the West.[26]

Laterna magica projections continued to evolve further from the eighteenth-century traditions and became more differentiated. Projection apparatuses like the fantascope achieved mobility and moved silently on polished brass wheels behind a semitransparent screen (both screen and apparatus were invisible to the audience) so that the projections appeared to move closer and further away. Moreover, a dissolver in front of the lens made it possible to shift dramatically from one scene to another so that a sophisticated impression of movement and different moods was created. The phantasmagoria opened up the virtual depth of the image space as a sphere of dynamic changes for the first time. This was all made possible by the use of a screen.[27]

As with "illusionism" or "immersion," however, phantasmagoria is by no means a simple term. Toward the mid-nineteenth century, phantasmagoria had also become a key political concept. Even Marx used the term in 1867 in *Das Kapital* where he refers to the origination of surplus value as "phantasmagorical."[28]

Robertson had spectacular success in Paris with his shows, especially after he moved them to the atmospheric venue of an abandoned Capuchin monastery,

Figure 7.6 Etienne Gaspard Robertson. From Francoise Levie, ed., *Lanterne magique et fantasmagorie*, Musée national des techniques (Paris: CNAM, 1990), p. 6.

which the audience could enter only via a cemetery. He refined Philidor's technical innovations and improved on Enslen's atmospheric repertoire, offering his audiences Voltairesque visions, the temptation of St. Anthony, and the three witches from *Macbeth*.[29]

In the evening twilight the spectators made their way through the courtyard, proceeded down a long dim corridor hung with dark paintings to the Salon de Physique, a *Wunderkammer*—a cabinet of wonder—with optical and aural attractions such as peep shows, distorting mirrors, and tableaux of miniature landscapes. Robertson produced electrical sparks, which he called *fluidum novum*, that "for a time could make dead bodies move." Thus, "the other side," the new medium of electricity with its utopian connotations was linked with sensory illusions so that the audience was in the right scientific

and magical frame of mind as they entered the projection room. Here, Robertson announced, the "dead and absent ones" would appear.[30]

The viewers were surrounded by utter blackness, there was no foreground, no background, no surface, no distance, only overwhelming, impenetrable darkness—"sublime darkness," as Burke has put it. This innovation distinguished the phantasmagoria from all other image machines of the period. The awareness of being in a room was progressively negated by the absolute darkness, haunting music, and particularly the image projections. Together these elements served to constrain, control, and focus perception.

Once seated, the audience heard the voice of a commentator, who spoke of "religious silence"; this was then immediately broken by sounds of rain, thunder, and a glass harmonica. This instrument, which all famous composers of the time, from Mozart to Beethoven, wrote pieces for, was invented by Benjamin Franklin, a representative of the new scientific age and master of electricity. It provided an eerie soundtrack for this visual spectacle and heightened the audience's immersion in the staged images even more. Then, out of the darkness, glowing apparitions approached the audience.

Today, the illusions of these image caverns may appear amusing; but contemporaries' media competence was at an entirely different level. Robertson describes guests striking out at the misty images, and the journal *Ami des Lois* advised pregnant women to stay away from the phantasmagoria to avoid having a miscarriage.[31] It could be argued that this was, in fact, merely good publicity. This is certainly true in part, yet a medium that differed radically from its advertising would certainly not have achieved such lasting success. In 1800, the well-known Parisian writer Grimod de la Rynière wrote: "Herewith it is established that the illusion is complete. The total darkness of the room, the selection of pictures, the astounding magic of their truly monstrous growth, the magic that accompanies them—everything is arranged to impress the imagination and conquer all your senses."[32]

Certainly Robertson could not allow himself to be put on the same level as charlatans like Cagliostro, nor be associated with representatives of Catholic image magic, such as della Porta, Kircher, Schott, and Zahn.[33] He referred to himself as a producer of "scientific effects," although, naturally, he did not give away his tricks. Robertson's iconography also included the recently executed contemporaries, such as Marat, Danton, and Robespierre. In a variation of the doctrine of transubstantiation, he made them come alive again with

his magic medium in the swirling sulphurous smoke. Louis XVI, however, he hesitated to resurrect in postrevolutionary Paris. And when a paid extra in the audience stood up and shouted "My wife! It's my departed wife!" then panic would break out. Typically, the shows ended with skeletons, and with Robertson warning, "Look well at the fate that awaits you all one day: Remember the phantasmagoria!"

In the figure of Robertson and the phantasmagoria the ambivalence of the era is concentrated as in a burning glass. The yoke of the Church's authority had just been shrugged off and the phantasmagoria established itself in its former architectural territory. However, the brightness of the Age of Enlightenment was already beginning to darken with eerie testimonies of superstition, pseudoscientific experiments, and the horror of the mass executions during the Terror, which appeared in front of the audience during the phantasmagoria séances. The fresh suggestive potential of a hitherto unknown medium transformed the perception of magical tricks into what appeared to be scientific.[34]

The medium of the phantasmagoria is part of the history of immersion, a recently recognized phenomenon that can be traced through almost the entire history of art in the West, as documented in my latest book.[35] Immersion is produced when works of art and image apparatus converge, or when the message and the medium form an almost inseparable unit, so that the medium becomes invisible.

In the phantasmagoria, phenomena come together that we are again experiencing in today's art and visual representation. It is a model for the "manipulation of the senses," the functioning of illusionism, the convergence of realism and fantasy, the very material basis of an art that appears immaterial, as well as the associated issues pertaining to epistemology and the work of art itself. In contrast to the panorama (fig. 7.7), which made wide vistas of landscapes available, the phantasmagoria connected with the old magic of shamanism to overcome the separation from one's ancestors through the medium.

The image worlds of the terrifying magic lantern thus tapped into notions that already existed in the populace and amplified them through powerfully suggestive new media. Although Beloff does not present her images as a supernatural presence we perceive a simulacrum of implausible beliefs. Therefore, the phantasmagoric fascination remains. But phantasmagorical spaces play an important role in connection with utopian media also in other fields of media art, like telepresence and genetic art.

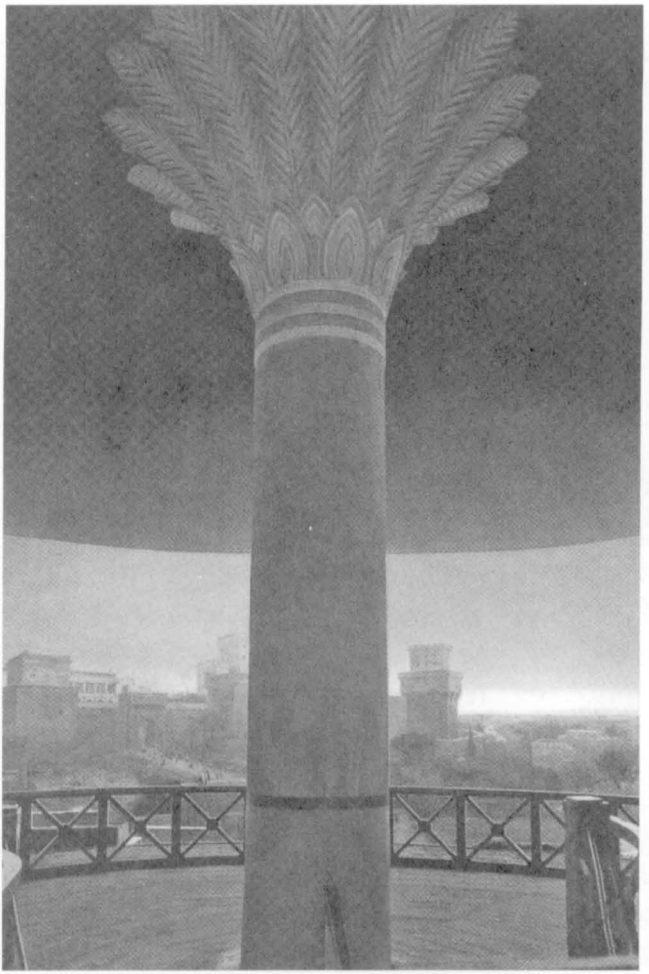

Figure 7.7 Interior of the Panorama rotunda Altötting. Panorama by Gebhard Fugl, 1903. Photo by Erika Drave, Munich, SPA Foundation Panorama Altötting. By kind permission.

Figure 7.8 Paul Sermon and Andrea Zapp, *A Body of Water*, telematic installation, 1999. By kind permission of the artists.

Telepresence

A new, data-mediated epistemology has opened up with the new parameter telepresence and its global exchange of images—a paradox.[36] Digital images appear on HMDs, CAVEs, walls, or in the case of Paul Sermon's *Telematic Dreaming* on a simple bed sheet, or in *A Body of Water* on a wall of water. The installation *A Body of Water* (1999) visualizes in a ghostly way the social power of Paul Sermon's and Andrea Zapp's art (fig. 7.8). In a chroma-key room, visitors to the Wilhelm-Lehmbruck-Museum established contact with visitors in a disused mine, the Waschkaue Herten at a second location of the installation. Projected onto gauzy pyramids of water spray from showers in the mine, images of the museum visitors themselves gain phantasmagorical intimacy. In this ruin of the industrial age, Paul Sermon and Andrea Zapp created an experience that was both uncanny *and* vivid. Quantum physics teaches us that reality is a product of observation; here, however, near and far come together in real time to create a paradox: *I am there where I am not and experience sensory proof against my better judgment.*

Formulating an imaginary space evoking the generations of miners who washed the ubiquitous coal dust from their sweating bodies, Sermon expands

telematics to include social critique that is disturbing in its phantasmagorical intimacy. While *Influencing Machine* makes contact with the psyche, the use of telepresence throughout media history again and again attempts to make contact with transcendence, as shown in previous literature. Paul Sermon's installations must also be understood in this context.

Digital Evolution: A-Life

Recently, within the evolution of art genres, digital art media have begun to change the traditional tableaux of art in the direction of a processual model of art.[37] The new parameters, such as interaction, telematics, and genetic image processes, have not only encouraged and intensified the crossing of boundaries, as the theory of media archaeology has often argued. The trend is toward a fusion of the observers' perception with an image medium that is moving increasingly toward the inclusion of all human senses; this is becoming prevalent in media art. Whereas the phantasmagoria connects with death via immersion and spiritualism, *A-Volve*, the icon of genetic art by Christa Sommerer and Laurent Mignonneau, visualizes luminous artificial life in a semidarkened space.[38]

Artworks are being created that integrate as simulations the genres of architecture, sculpture, painting, and scenography, or even historical image media such as theater, cinema, and photography. All these elements are absorbed into a space that exists only by virtue of its effects.

Digital images open up an interactive image space that is fed information from sensors and data banks. This enables it to change its visuality in a processual and "intelligent" way. These are images whose physicality approaches the function of a display or screen; images that serve as surfaces for projecting networked information, which can telematically bring distant actions up close and, conversely, allow us to perform actions in distant places. Digital images thus blur the distinctions between hitherto separate genres. Through the use of genetic algorithms, an image space can appear to be biologically populated and undergo evolutionary processes and changes, thereby amalgamating artificial nature and art.

The idea of letting objects float almost magically in front of an audience as in phantasmagoria and the magic lantern is currently encountered—apart from, obviously, in IMAX cinemas—particularly in computer art. Artist-scientists such as Thomas Ray, Christa Sommerer, and Karl Sims simulate

processes of life: evolution and selection have become methods used by media art. With the aid of genetic algorithms, the scenic image worlds of the computer not only have gained new tools for design but also can be endowed with the semblance of being alive. Software agents, which appear to be three-dimensional, transmit their phenomenology to the next "generation" of agents according to patterns of evolutionary reproduction, which is then combined in new variations according to the principles of crossover and mutation. The sole constraint is the selection framework determined by the artist.

A phantasmagoric installation that combines playful combinations with the visualization of complex forms of artificial life, *SonoMorphis* was created in 1999 by Berndt Lintermann. In its dark space, ever-new biomorphic bodies are created on the basis of genetic algorithms (fig. 7.9). Lintermann makes the artificial creatures rotate continually and enhances the spatial effect with stereo sound, which is also generated by random processes. Lintermann's intention was to create a highly flexible interactive structure for his installation, which he would like understood as an instrument consisting of visual and acoustic components. The number of possible forms is 10^{80}—according to Lintermann, analogous to the number of all the atoms in the universe. Be that as it

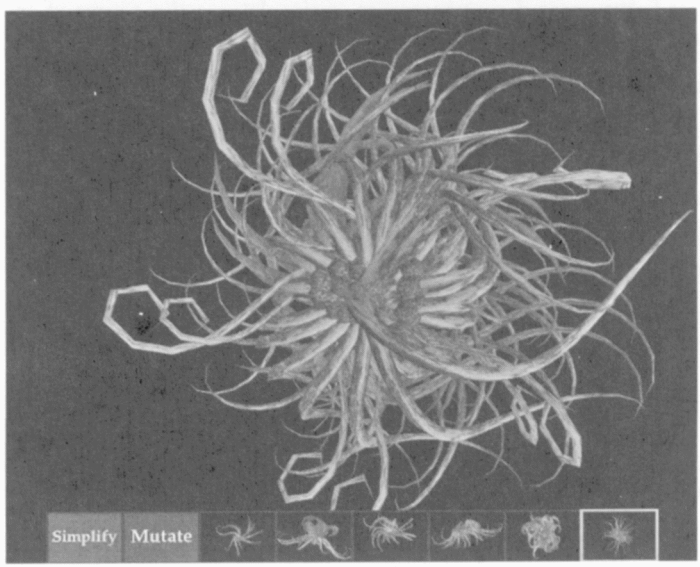

Figure 7.9 Berndt Lintermann, *SonoMorphis*, CAVE installation, 1999. See plate 7. By kind permission of the artist.

may, the number of possible variants in *SonoMorphis* is incredibly high and impossible to explore even in part. And, in the darkness of a CAVE, the lifelike forms appear as a modern phantasmagoria.

The discussion about genetics and artificial life, or a-life,[39] that at first was mainly confined to the disciplines of bioinformatics and computer science, was supplemented by models, visions, and images from art that became catalysts in this controversial debate. From a theoretical point of view, evolution represents a groundbreaking process for images: the controlled use of random principles enables the creation of unpredictable, irreproducible, unique, and transitory images. One of the problems with representatives of the hard-core a-life approach, like Langton and Ray, is that they regard computer ecospheres as "alive" in the conventional meaning of the word.[40] A-lifers claim that the projected creatures are not only *similar* to life, they are life itself, which is, from a theoretical point of view, naive. The pictorialisms of a-life may be labeled images, but they are computations, like all digital images. As far as the functions and program of life processes are concerned, the image is an abstraction based on the biomorphic structure of concretization. The scientific legitimacy of an image is especially the result of an algorithmic analogy to lifelike principles of evolution. Nonetheless, the process succeeds in visualizing facets of scientific theories about life, and the results are images, no more, but also no less.

To use the vocabulary of art, a-life research seeks among other things to break down the divisions between genres and to dissolve the distinction between art and life—in the future, as Ray and Sommerer suggest, in ubiquitous computer networks.[41]

Thus phantasmagorically animated artificial life and artificial consciousness remain human projection onto human-made technology in transition, a symbolic space, which above all says something about the reflection of the image of the human within the development of technology—this is reflected by Lintermann too.

This brief excursion into the history of media, which seeks the old in the new, brings us to the question, "What is really new about new media?" and should enable a more penetrating view of current hype regarding media development.

The phantasmagoria stands for a principle, which so far has not been introduced into the discourse about media art: a principle that combines concepts from art and science to generate illusionism and polysensual immersion using

all contemporary means available. In fact, the phantasmagoria represents a turning point in image history, between the suggestive images of Roman Catholicism (Kircher) and self-declared rationalism. In my view, the issue is as follows: Just as it has been possible to demonstrate and establish the history of immersion in conjunction with the panorama, the phantasmagoria can be understood as a media principle that suggests that contact can be made with the psyche, the dead, or artificial life forms. It is therefore necessary to expand McLuhan's theory. Addressing emotions and paranormal human experiences with magical means stems from the insecurity produced by the technological utopia. Benjamin's persiflage moves already in this direction. Considered in this light, a number of contemporary artists can be found working today in the tradition of the phantasmagoria, a hybrid between art, science, and magic.

Coda: Implications for Image Science

If we take a broad look at the history of image media to date, we see that a main force behind the development of new media for creating illusions is the aim to gain greater power of suggestion. This mechanism appears to be the motive behind perennial efforts to renew and maintain power over the observer through developing new potential for suggestion and erecting ever-new regimes of perception. The magic lantern, panoramas, dioramas, phantasmagoria, cinema, computer displays, and technical image media all appear in this perspective as aggregates of continually changing machines, forms of organization, and materials that remain, in spite of all standardizations, seldom stable; we are constantly fascinated by the possibility of heightening the illusion.

Finally, digital images give new meaning to the category of "image" in the history of the media. Differences between inside and outside, near and far, physical and virtual, biological and automatic, image and body are disappearing. We can recognize a sheer endless stream, which on closer scrutiny reveals supposedly established entities, like cinema, to be assemblages of components that are arranged in ever-changing new constellations in the kaleidoscope of evolutionary development of the art media.

Immersion, as we recognize today, is undoubtedly a key element for understanding the development of the media, although the concept remains somewhat opaque and contradictory. Obviously, the relation between critical distance and immersion is not a simple matter of "either–or"; the many and

diverse connections are interwoven, dialectic, in part contradictory, and most certainly dependent upon the individual dispositions of the observers and their historically acquired media competence. Immersion can be a mentally active process; in the majority of cases, however, both in earlier and more recent art history, immersion is mental absorption initiated for the purpose of triggering a process, a change, a transition. Its characteristics are a diminished critical distance to what is represented and an emotional involvement in the same.[42]

An increase in the power of suggestion appears to be an important, if not the most important, motive force driving the development of new media of illusion. Image science, or *Bildwissenschaft*, now allows us to attempt to write the history of the evolution of the visual media, from peep show to panorama, myriorama, stereoscope, cyclorama, magic lantern, eidophusikon, diorama, phantasmagoria, silent films, color films, films with scents, IMAX, cinéorama, anamorphosis, television, telematics, and the virtual image spaces generated by computers. It is a history that also includes a host of typical aberrations, contradictions, and dead ends. But image science without art history—particularly without its tools for comparison and critical image analysis—is not capable of developing deeper historical insights. It is in danger of propagating old myths and, lacking a "trained eye," of succumbing to the power of the images. The rise of media art has added fuel to this debate, for questioning images has acquired not only new intensity but also a new quality.

Image science does not imply that the experimental, reflection, and utopian spaces provided by art are to be abandoned. On the contrary: within these expanded frontiers the underlying, fundamental inspiration that art has provided for technology and media, which is associated with names such as Leonardo, Wallgenstein, Pozzo, Barker, Robertson, Daguerre, Morse, Valery, Eisenstein, and many exponents of the art of our digital present, is revealed with even greater clarity. Image studies is an open field that engages equally with what lies between the images, as in the case of Beloff, and with the new perspectives resulting from interplay with neuroscience, psychology, philosophy, research on emotion, and other scientific disciplines.

Notes

1. See Pascal Beausse, "Zoe Beloff, Christoph Draeger: images rémantes—After-Images," *Artpress* 235 (1998): 43–47; Chris Gehman, "A Mechanical Medium. A Conversation with Zoe Beloff and Gen Ken Montgomery," *Cinéma scope* 6 (2001):

32–35; Timothy Druckrey, "Zoe Beloff," in *Nam June Paik Award 2002*, International Media Art Award NRW (Ostfildern-Ruit: Hatje Cantz, 2002), 20–21; and Steven Shaviro, "Future Past: Zoe Beloff's Beyond," *Arthyte: Magazine of Digital Arts* 3 (1998): 17–18.

2. More so than perhaps any other thinker, Ernst Cassirer reflected on the power of distance for intellectual productivity and creating awareness. In *Individuum und Kosmos*, he proposes that distance constitutes the subject and is alone responsible for producing the "aesthetic image space" as well as the "space of logical and mathematical thought." See E. Cassirer, *Individuum und Kosmos* (Darmstadt: Wissenschaftliche Buchgesellschaft, 1963 [1927]), 179. Two years later, Aby Warburg stressed the intellectual, awareness-enhancing power of distance and even included this "original act of human civilization" in the introduction to his *Mnemosyne-Atlas* (*Der Bilderatlas Mnemosyne: Gesammelte Schriften Abteilung 2, Band 2* [Berlin: Akademie Verlag, 2000], 3–6).

3. Anthony Vidler, *Unheimlich: Über das Unbehagen in der modernen Architektur* (Hamburg: Edition Nautilus, 1992).

4. Victor Tausk, "On the Origin of the 'Influencing Machine' in Schizophrenia," *Psychoanalytic Quarterly* 2 (1933): 521–522.

5. Sigmund Freud, "Das Unheimliche," in *Gesammelte Werke*, vol. 12, ed. Anna Freud (Frankfurt am Main: Fischer, 1947), 227–268.

6. The first program comprises thirty-two images extracted from family albums gathered in different countries, presenting couples, groups, or families in formal situations, "bourgeois portraits" of domestic scenes. Other programmes are available: "love movies," "crime scenes," and "pictures of war."

7. *The Influence Machine* was developed with the assistance of the Public Art Fund in New York. It was presented in Madison Square Park from 19–31 October 2000. The "ghosts" of key figures in media history such as television pioneer John Logie Baird and the Fox Sisters, who claimed to have made telegraphic contact with the spirit world in the mid-nineteenth century, roamed the square at night. Just yards from where Logie Baird made his first public experiments in the 1920s (a room above Bar Italia on Frith Street), *The Influence Machine* was a fractured multimedia landscape of spectres, sounds and light. The ghosts escaped the machine ...

8. Walter Benjamin, "Lichtenberg," 1932, in his *Gesammelte Schriften*, IV/2, ed. Rolf Tiedemann (Frankfurt am Main: Suhrkamp, 1991), 696–720.

9. See Sergei Eisenstein, *Das dynamische Quadrat: Schriften zum Film* (Leipzig: Reclam, 1988). (Originally: *Stereokino*, 1947.)

10. See Marvin Minsky, *Society of Mind* (New York: Simon and Schuster, 1988).

11. See Gene Youngblood, *Expanded Cinema* (New York: E. P. Dutton, 1970).

12. See Hans Moravec, *Robot: Mere Machine to Transcendent Mind* (Oxford: Oxford University Press, 2000).

13. See J. A. Eberhard, *Handbuch der Ästhetik*, part 1 (Halle: Hemmerde und Swetschke, 1805).

14. See Neil Postman, *Amusing Ourselves to Death: Public Discourse in the Age of Show Business* (New York: Penguin Books, 1986).

15. Jean Baudrillard, *Symbolic Exchange and Death* (London: Sage Publications, 1993).

16. Vilém Flusser, *Ins Universum der technischen Bilder* (Goettingen: European Photography, 1985).

17. See Ulrike Hick, *Geschichte der optischen Medien* (Munich: Fink, 1999), 115ff. and 129–130; W. A. Wagenaar, "The Origins of the Lantern," *New Magic Lantern Journal* 1, no. 3 (1980): 10–12; Francoise Levie, ed., *Lanterne magique et fantasmagorie*, Musée national des techniques (Paris: CNAM, 1990); Laurent Mannoni, *The Great Art of Light and Shadow: Archaeology of the Cinema* (Exeter: University of Exeter Press, 2000 [1995]).

18. Its name—*laterna magica*—(coined by Charles Francois Millet Dechales, who saw one of Walgenstein's shows in 1665 in Lyon) reflects faithfully the lantern's miraculous ability to blow up small pictures of spectacular subjects to life-size proportions. Charles Francois Millet Dechales, *Cursus seu mundus mathematicus* (Lyon: 1674), vol. 2, 665.

19. The three most important players in the early history of the magic lantern were the scientist Christiaan Huygens (1629–1695), who probably invented it and was also its earliest critic, the traveler Thomas Rasmussen Walgenstein (1627–1681), who gave shows all over Europe and probably had a decisive influence on how the device was received by intellectuals and scientists, and Johann Franz Griendel (1631–1687),

who began to produce magic lanterns for sale in 1671 in Nürnberg and founded a tradition of manufacture that would last for over two hundred years. Griendel was a former Capuchin friar who converted to protestantism and moved to Nürnberg in 1670. He had extensive knowledge of military architecture, optics, and mathematics. Among the optical instruments that he offered for sale in 1671, and on a list of 25 instruments that he sent to Gottfried Wilhelm Leibniz in Hannover, there was also a magic lantern. Its design, a horizontal cylinder mounted on a funnel-shaped metal base, differed considerably from Dutch and other Western European models with their vertical cylinders or rectangular wooden boxes.

20. Oligerus Jacobeus, *Museum regierum, seu catalogus rerum* (Copenhagen: 1710), vol. II, 2.

21. See Martin Jay, *Downcast Eyes: The Denigration of Vision in Twentieth-Century French Thought* (Berkeley: University of California Press, 1993).

22. Baltasar Bekker, *Chr. August Crusius' Bedenken über die Schöpferischen Geisterbeschwörungen mit antiapocalyptischen Augen betrachtet* (Berlin: 1775).

23. This technique was described for the first time 1769–1770 by Gilles-Edmé Guyot in "Nouvelles récreations physiques et mathematiques."

24. He showed Petrarch at Laura's graveside, told the story of Abelard and Eloise, and presented portraits of Frederick the Great and General Ziethen; see Stephan Oettermann, "Johann Karl Enslen's Flying Sculptures," *Daidalos* 37, 15 (1990): 44–53.

25. J. E. Varey, "Robertson's Phantasmagoria in Madrid 1821," *Theatre Notebook* 9–11 (1954–55 and 1956–57).

26. Shows were also put on in North America, some of them using the phantasmagoria lanterns of the Dumontiez brothers. Instead of the spirits of Voltaire and Frederick the Great, audiences there made acquaintance with George Washington, Benjamin Franklin, and Thomas Jefferson. Theaters in London, New York, Berlin, Philadelphia, Mexico City, Paris, Madrid, Hamburg, and a host of other cities staged phantasmagoria shows and established the magic lantern in the early nineteenth century as a useful device in staging public performances for large audiences. The rapid technical progress in the first half of the nineteenth century was followed by a change in the culture of the magic lantern in the second half. In the early 1820s, the British company Carpenter and Westley produced a sturdy metal model, which used an Argand-type lamp.

This made it possible to use the magic lantern in the classroom, in lectures and seminars. It may not be purely coincidental that magic, spiritualism, and horror were so closely associated with the new medium, for up to the mid-nineteenth century spiritualism developed into a veritable mass movement in the United States. In 1859, it was estimated that there were some eleven million spiritualists. Alan Gauld, *The Founders of Psychical Research* (New York: Schocken, 1968), 29. On the relationship of spiritualism and electricity, see Wolfgang Hagen, "Die entwendete Elektrizität: Zur medialen Genealogie des 'modernen Spiritismus,'" http://www.whaagen.de/publications/. Among the spiritualists were many prominent personalities of the era, including, for example, Harriet Beecher Stowe and President Abraham Lincoln. Russel M. Goldfarb and Clara R. Goldfarb, *Spiritualism and Nineteenth-Century Letters* (Rutherford, N.J.: Fairleigh Dickinson University Press, 1978), 43–44.

27. According to the Oxford English Dictionary the word "screen" appeared for the first time around 1810, in connection with the phantasmagoria.

28. Adorno and Benjamin work with his term. The phenomenon of world fairs was analyzed by Benjamin as "phantasmagorical." See Margaret Cohen, "Walter Benjamin's Phantasmagoria," *New German Critique* 43 (1989): 87–108.

29. In addition, he manufactured and sold the so-called fantoscope lantern. The ingenious design of this apparatus allowed both the projection of transparent slides and opaque, 3-D puppets.

30. E. G. Robertson, *Mémoires récrétifs, scientifiques et anecdotiques d'un physician-aeronaute* (Langres: Clima Editeur, 1985). See also "La Phantasmagorie," *La Fleur Villageoise* 22 (28 February and 23 May 1793).

31. *L'ami des lois*, 955 (28 March 1798), 1.

32. Grimod de la Reyniére, in the *Courrier des Spectacles*, 1092, 7 March 1800, 3.

33. Barbara Maria Stafford and Frances Terpak, *Devices of Wonder: From the World in a Box to Images on a Screen* (Los Angeles: Getty Research Institute, 2001).

34. The dissolving technique invented for the magic lantern rendered the expansion or compression of time a special aesthetic visual experience, which was enhanced by the magic and illusionistic effect of the medium. The next logical step—we are getting closer to films—was to combine the large-format panorama with moving effects.

This stage refers to other predecessors of cinematography and is focused on the aesthetic category of the illusion of movement. Although the experience of time elapsing between different images in the mechanical theaters of classical antiquity and the Renaissance became the primary source of fascination with these media, and the magic lantern had anticipated this central innovation of the diorama, it was the moving panoramas as exhibited at the World Exhibitions of the nineteenth century that represented the breakthrough of movement as the core element of the illusion *dispositif*. Simulated journeys on steamships and trains, with images of slowly changing landscapes rolling past, were particularly popular as moving panoramas. Such visual experiences were also introduced into the theater, where long, painted backdrops mounted on rollers, so-called changing panoramas, were pulled past the onlooking audience. See Marie-Louise Plessen, ed., *Sehsucht: Das Panorama als Massenunterhaltung im 19. Jahrhundert*, exhibition catalog, Bundeskunsthalle Bonn (Basel: Stroemfeld/Roter Stern, 1993), 230ff. In the first half of the nineteenth century, the desire to see changing images, whether merely details or as a whole, stationary or moving, led to a great number of popular *mise-en-scènes* of images in which the representation of temporal processes was a constitutive characteristic. Toward the end of the century, panoramas were developed where the audience sat on a rotating platform, and one revolution—to see the entire painting—took twenty minutes.

35. Oliver Grau, *Virtual Art: From Illusion to Immersion* (Cambridge, Mass.: MIT Press, 2003).

36. Generally: Ken Goldberg, ed., *The Robot in the Garden: Telerobotics and Telepistemology on the Internet* (Cambridge, Mass.: MIT Press, 2000), esp. my essay: "The History of Telepresence: Automata, Illusion, and the Rejection of the Body," 226–246.

37. Recently: Martin Rieser and Andrea Zapp, eds., *New Screen Media: Cinema/Art/Narrative* (London: British Film Institute, 2002); Gerfried Stocker and Christiane Schöpf, eds., *ARS ELECTRONICA: CODE = The Language of Our Time* (Ostfildern: Hatje Cantz, 2003).

38. Laurent Mignonneau and Christa Sommerer, "Creating Artificial Life for Interactive Art and Entertainment," in *Artificial Life VII, Workshop Proceedings* (Portland: University of Portland 2000), 149–153.

39. See Christopher G. Langton, ed., *Artificial Life* (Cambridge, Mass.: MIT Press, 1995); M. A. Bedau, "Philosophical Content and Method of Artificial Life," in *The Digital Phoenix: How Computers Are Changing Philosophy*, ed. T. W. Bynam and J. H. Moor (Oxford: Blackwell, 1998), 135–152.

40. See Thomas Ray, "An Approach on the Synthesis of Life," in *The Philosophy of Artificial Life*, ed. Margaret Boden (Oxford: Oxford University Press, 1996), 111–145.

41. Laurent Mignonneau and Christa Sommerer, "Modeling Emergence of Complexity: The Application of Complex System and Origin of Life Theory to Interactive Art on the Internet," in *Artificial Life VII: Proceedings of the Seventh International Conference*, ed. M. A. Bedau (Cambridge, Mass.: MIT Press, 2000).

42. This aspect was the focus of two conferences on emotions organized by the Academy of the Berlin-Brandenburg Academy of Sciences in Menaggio, which included interdisciplinary approaches to the effects of emotional stimuli on observers of images generated by various media. A very recent publication in this area from an interdisciplinary perspective is Oliver Grau and Andreas Keil, *Mediale Emotionen* (Frankfurt am Main: Fischer, 2005).

8

Islamic Automation: A Reading of al-Jazari's *The Book of Knowledge of Ingenious Mechanical Devices* (1206)

Gunalan Nadarajan

Introduction

The *Kitab fi ma rifat al-hiyal al-handasiyya* (*The Book of Knowledge of Ingenious Mechanical Devices*) by Ibn al-Razzaz al-Jazari was completed between 1202 and 1204 and published in 1206. It was arguably the most comprehensive and methodical compilation of the most current knowledge about automated devices and mechanics. The work systematically charted out the technological development of a variety of devices and mechanisms that both exemplified and extended existing knowledge on automata and automation. Donald Hill, who translated and has done the most to promulgate the importance of this text, claimed, "[I]t is impossible to overemphasize the importance of al-Jazari's work in the history of engineering. Until modern times there is no other document from any cultural area that provides a comparable wealth of instructions for the design, manufacture and assembly of machines.... Al-Jazari did not only assimilate the techniques of his non-Arab and Arab predecessors, he was also creative. He added several mechanical and hydraulic devices. The impact of these inventions can be seen in the later designing of steam engines and internal combustion engines, paving the way for automatic control and other modern machinery. The impact of al-Jazari's inventions is still felt in modern contemporary mechanical engineering" (Hill 1998, 231–232).

This essay presents al-Jazari's *The Book of Knowledge of Ingenious Mechanical Devices* (1206) as a significant contribution to the history of robotics and automation insofar as it as enables a critical reevaluation of classical notions and

the conventional history of automation and therefore of robotics. Al-Jazari is in some ways the most articulate of what is a long tradition of "Islamic automation" in Arabic science and technology wherein automation is *a manner of submission* rather than the means of control that it has come to represent in our times. Thus, al-Jazari's work is presented as exemplary of Islamic automation, where the notions of control that have informed the conventional history of automation and robotics are substituted by subordination and submission to the rhythms of the machines. It is proposed here that "Islamic automation" also provides some interesting examples of what I call "untoward automation," which involves the deliberate and elaborate programming for untoward behavior in automated devices. In addition to articulating the cultural specificities of technological development, this essay positions al-Jazari's work as a catalyst for critical readings of and new directions in robotic arts.

Islamic Science and Technology

Before embarking on a presentation of al-Jazari's work, it is useful to contextualize the Islamic science and technology that informed and substantiated his work. It is noteworthy that the Abbasid caliphate that ruled over most of the Arab world from 758 to 1258 C.E. emphasized and encouraged the systematic development of science and technology. With its new capital in Baghdad, the Abbasid caliphate, especially during the rule of al-Mamun (819–833) invested huge amounts of resources in cultural activities and scientific scholarship. Al-Mamun was a firm believer in the value of drawing, as can be seen in the intellectual traditions of Greek, Sanskrit, and Chinese knowledge that thus infused Islamic science and technology. It is noteworthy that a substantial portion of Greek texts was translated into Arabic under the Abbasid caliphate, especially from the mid-eighth century until the mid-eleventh century. The principal driving force behind these translation initiatives was the establishment of the library, Khizanat al-Hikma (The Treasury of Knowledge), and a research institute, Bayt-al-Hikma (House of Wisdom), in the early ninth century. This quest toward developing a comprehensive knowledge resource was so ambitiously pursued that by the middle of the tenth century, the caliphate had gathered close to 400,000 volumes, and by 1050, all significant works of the Hellenistic period were available in Arabic (see Hill 1993, 10–14).

It is noteworthy, though, that our current notions of science and technology are significantly different from those that mediated the quest for knowledge in Islamic societies. The word, *'ilm*, that is most commonly used to denote "knowledge" in Arabic, Hill reminds us, included a wide range of fields as astronomy, mechanics, theology, philosophy, logic, and metaphysics. This practice of not differentiating between seemingly separate fields is best understood in the context of the Islamic view of the interconnectedness of all things that exist and wherein the quest for knowledge is a contemplation on and discovery of this essential unity of things. It is this essential unity and coherence of all things in the world, referred to in Islamic philosophy as *tawhid*, which makes it almost impossible to articulate and maintain the distinctions between the sciences and other areas of inquiry and experience.

According to Avicenna, a significant philosopher-scientist and an important Islamic proponent of this view:

> [T]here is a natural hierarchy of knowledge from the physics of matter to the metaphysics of cosmological speculation, yet all knowledge terminates in the Divine. All phenomena are creations of Allah, His theophanies, and nature is a vast unity to be studied by believers as the *visible sign* of the Godhead. Nature is like an oasis in the bleak solitude of the desert; the tiny blades of grass as well as the most magnificent flowers bespeak of the gardener's loving hand. All nature is such a garden, the cosmic garden of God. Its study is *a sacred act*. (Cited in Bakar 1999, 114; emphases mine)

In Islam, Avicenna's notion of "visible sign" is embodied in the term, *a' yat* (sign), where the scientific study of the natural world and its manifestations issues not from an impassioned curiosity but from a passionate quest to discover these signs and thus arrive at a better understanding and appreciation of God's magnificence. The Qur'an has several instances where this invocation to Muslims to decipher the *a' yat* is made. For example, in Surah 10: "He it is who has made the sun a [source of] radiant light and the moon a light [reflected], and has determined for it phases so that you might know how to compute years and to measure [time] ... in the alternative of night and day, and in all that God has created in the heavens and on earth, there are messages indeed for people who are conscious of Him" (cited in Bakar 1999, 70).

Bakar argues that in thus deciphering the peculiar ways in which each thing manifests itself and exists in this world, one arrives at an understanding

of its specific *islam* (manner of submission), that is, of how that thing submits to the will of God (Bakar 1999, 71). This notion of *islam* as a manner of submission is a useful reference point to begin a discussion of the Islamic notion of technology. While it is logical to assume that the Islamic notion of technology is related to and continuous with its notion of *'ilm*, there are practically no scholarly studies that are dedicated to the exploration of the Islamic conceptualization of technology. Although there are several works that exhaustively *describe* the various technologies developed by Islamic societies and scholars, these works rarely deliberate on their specific philosophical and cultural underpinnings. This paucity might be indicative of the refusal within Islamic thought to present technology as a *material application* of scientific knowledge, a practice that is common in many conventional histories of technology. It is suggested here that in the Islamic worldview, technology is yet another *a' yat* but of a different sort. It is suggested that technological objects are signs that have been *made to manifest as such by human design*. And it is important here to clarify that this design itself is a sign of the submission of the person who "makes" the technological object as much as it is a sign of the object's functional operations reflecting its own manner of submission. In Islamic aesthetics and technology alike, the notion of the human creator is philosophically subordinated to that of God the creator. The task of human creativity in Islamic thought is thus conceived as that of *referring to* and *making manifest God's creative work* rather than "showing off" one's own ability to create. In this sense, then, technological objects are also *a' yat* that manifest the *islam* or "manners of submission" of those forces and processes that are implicated in them.[1]

"Fine Technology" as Genealogical Nexus

In this reading of al-Jazari's work I draw on Michel Foucault's genealogical method. It is well beyond the scope of this essay, however, to engage in a full explication of the specific details and values of the genealogical method in reading histories of technology. Thus, what will be presented here is a very brief introduction to the principal elements of the genealogical method as formulated by Foucault via his reading of Friedrich Nietzsche.

According to Nietzsche, who first formulated the critical possibilities of genealogy as historical method: "whatever exists, having somehow come into being, is again and again reinterpreted to new ends, taken over, transformed,

and redirected by some power superior to it; all events in the organic world are a subduing, a becoming master, and all subduing and becoming master involves a fresh interpretation, an adaptation through which any previous 'meaning' and 'purpose' are necessarily obscured or even obliterated" (Nietzsche 1967, 77). Thus, the meaning of a thing in history is not fixed and unchanging as is sometimes conveniently assumed in conventional historical methods.

The conventional historiographical practice usually seeks out the *Ursprung* (origin), wherein there is, Foucault claims, "an attempt to capture the exact essence of things, their purest possibilities and their carefully protected identities because this search assumes the existence of immobile forms that precede the external world of accident and succession" (Foucault 1980, 142). The genealogical method in contrast is governed by the *Herkunfts-Hypothesen* (descent-hypothesis) that turns away from such metaphysical preconceptions and "listens to history"; leading the historian to the discovery that there is no eternal essence behind things; that things "have no essence or that their essence was fabricated in a piecemeal fashion from alien forms" (Foucault 1980, 142). With his ears cocked up to detect the faintest of sounds made within the historical space, the genealogist finds "not the inviolable identity of their origin," but rather "the dissension of other things." "Genealogy," he thus claims, "is gray, meticulous, and patiently documentary. It operates on a field of entangled and confused parchments, on documents that have been scratched over and recopied many times" (Foucault 1980, 139). Foucault also argues that genealogy is able and attempts to record events in their singularity without reference to some teleological design or purpose. He recognizes the usefulness of the genealogical method in subverting the totalizing histories that grew from the Hegelian teleological versions of history where notions of "purpose" or "utility" tended to predetermine the specific ways in which a thing's history was "always already" interpreted.

The primary value of the genealogical method in interpreting histories of technologies, it is proposed here, is in its suspension of utility or instrumental rationale of a technological object in its readings.[2] The genealogical method forgoes the notion of "original" utility in predetermining interpretation and instead seeks out the specific discourses and practices that constitute a particular technological object or experience. In this essay, it is proposed that there is a *genealogical nexus* between what have been variously described and discussed as machines, automation, and robotics. In formulating the link between them

as genealogical, the conventional practice of identifying either one of them as preceding or proceeding from the other (i.e., the habit of origin-seeking) is problematized. It is suggested here that one develops a better appreciation of their complex historical interactions and contemporary constitution by working from this *temporary suspension of their differences* within this nexus. It is also proposed here that the notion of "fine technology" provides a useful reference point to instantiate and analyze this nexus between machines, automation, and robotics. "Fine technology," science and technology historian Donald Hill states, "is the kind of engineering that is concerned with delicate mechanisms and sophisticated controls" and that "before modern times, comprised of clocks, trick vessels, automata, fountains and a few miscellaneous devices." Hill notes that the "apparent triviality of these constructions should not . . . be allowed to obscure the fact that a number of the ideas, components and techniques embodied in them were to be of great significance in the development of machines technology" (Hill 1993, 122).

Some of the earliest examples of fine technology are recorded in the works of an Egyptian engineer, Ktesibius from Alexandria circa 300 B.C.E. Vitruvius, the architect and theorist, claims that Ktesibius invented the organ and monumental water clock. According to Devaux, "Diodorus Siculus and Callixenes give this description of animated statues of gods and goddesses that featured at the festivities organized in 280 B.C. by Ptolemy Philadelphus in honor of Alexander and Bacchus: a four-wheeled chariot eight cubits broad, drawn by sixty men, and on which was a seated a statuette of Nysa measuring eight cubits, dressed in a yellow, gold-brocade tunic and a Spartan cloak. By means of a mechanism she would stand up unaided, pour out milk from a golden bottle, and sit down again" (P. Devaux, cited in Ifrah 2001, 169). The works of Philo from Byzantium (230 B.C.E.) whose text *Pneumatics* exists in a number of Arabic versions has also described a variety of automata and trick vessels that exemplify early fine technology. Another early text, which again only exists in Arabic versions, is *On the Construction of Water Clocks* by Archimedes. This work, though suspected to have been only partially written by him with later additions by Islamic scholars, was instrumental in introducing some of the principles of water-mediated control and power generation that was systematically developed by Islamic engineers. Hero from Alexandria (first century C.E.) is probably one of the most well-known and most widely read of the authors of fine technology. His primary texts are *Pneumatica* and *Automata*, where he expounds on the fundamentals of pneumatics and plans

for a variety of machines and automata that embody and are driven by such pneumatic forces.

While there are several important and interesting exponents of fine technology exemplifying Islamic automation, for the purposes of this essay, we will restrict our discussion to the work of the Banu Musa. *Kitab al-Hiyal* (The Book of Ingenious Devices) by Banu Musa bin Shakir (9th c.) is one of the foundational texts for the development and systematic exploration of automated devices in the Islamic world. It is clear from the various references in their text that they knew of Hero's work, which had already been translated by Qusta Ibn Luqa during their time (c. 864) and possibly with their support. In fact, of the slightly more than one hundred devices that they describe in their book, Hill identifies twenty-five devices with similar features to and in some cases almost completely resembling Hero's and Philo's automata. However, it is crucial here that despite these similarities in the physical and operational features between these automata, the culturally specific ways in which these machines were conceived and used by the Banu Musa are significantly different enough for one to be cautious not to perceive their work as simply derivative. It is also noteworthy that the Banu Musa were inventors in their own right and that there are several machines described in this book that are uniquely theirs and perhaps even invented by them. For example, their fountains are unique in their designs and mechanical features. Hill claims that the Banu Musa "display an astonishing skill in the manipulation of small variations in aerostatic and hydrostatic pressures." This attention to and ability to harness minute variations required the use of several innovative mechanisms including the crankshaft (which Hill suggests is the first recorded use of this historically significant technology); a variety of and differently arranged siphons; float valves that helped mediate and trigger the changes in water levels; throttling valves that helped maintain regular flow with minimal water pressure; and most importantly, the development of a sort of "on–off" control mechanism that responded to distinct and varying limits.

The Book of Knowledge of Ingenious Mechanical Devices

Al-Jazari was in the service of Nasir al-Din, the Artuqid King of Diyar Bakr, and he spent twenty-five years with the family, having served the father and brother of Nasir Al-Din. Al-Jazari notes in his introduction to the book that he "never began to construct a device of mine without his anticipating it [i.e.

its purpose] by the subtlety of his [the king's] perceptions" (al-Jazari 1206/1976, 15; words in brackets mine). While this patronage provided him with the financial means to continue his own research into the development of such devices, he felt obligated not just to make these machines for the benefit of the functional and aesthetic pleasures of the king but also to record it in for future generations and more importantly to contextualize his own work in relation to that of his predecessors whose works he was well aware of. He explicitly and/or indirectly refers to the works of Hero, Philo, Archimedes, Banu Musa, al-Muradi, and Ridwan—drawing upon the technical achievements and mechanical peculiarities of their works even while quickly noting how he has tried to further refine and depart from their mechanisms.

The book is presented in six categories (*naw'*)—ten chapters on water clocks, including one of his most dramatic and ambitious, Elephant Clock; ten chapters on what are called "vessels and figures that are suitable for drinking sessions" presenting a variety of trick automata vessels dispensing wine and water; ten chapters on water dispensers and phlebotomy (blood-letting) devices; ten chapters on fountains and musical automata, some of the devices explicitly seeking to improve on the rhythms and patterns expressed by the fountains of the Banu Musa; five chapters on water-raising machines—one version of which still survives in Damascus, in the As-Salhieh district on the slopes of Mount Qassiyoun; and five chapters on a miscellaneous list of machines, including geometrical designs for a latticed door, an instrument for measuring spheres, and a couple of locks. These devices are presented as *hiyal* (ingenious devices) that are driven by two forms of motive power, water and air pressure. The motive power of these pressures are inherently unstable and capricious and thus had to be managed in complex and meticulous ways so as to create the desired effects.

Jazari's descriptions are methodical and ordered in a form that he rarely veers from. He typically begins with a general description of the machine and follows this with a number of sections that provide details on the specific ways in which the machines work, along with accompanying drawings that illustrate the structural aspects of the machine. It is useful to note that these illustrations are relatively static with little or no dynamic elements incorporated into them to suggest their potential movement—the dynamics of the machines are only described through his exhaustive and point-to-point descriptions of how the mechanism works. In the following section, the descriptions of several automata are presented as in the original texts so as to

enable a clear understanding of style, detail, and specific mechanical outcomes of these machines.

Arbiter (Hakama) for a Drinking Session (Chapter 3 of Category II)

This is an elaborate three part automated *hakama* consisting of three distinct automata—a slave girl on a dais, a castle with four slave girls and a dancer and finally an upper castle with a horse and rider. The highly ritualized session begins with a servant bringing the automata in three different sections and assembling them in the middle of a drinking party seated in a circle around it. It is then left in the middle of the assembly until a period of *about* twenty minutes has elapsed. Then it emits an audible musical sound and the horse and rider rotate slowly past the members of the assembly as if to stop opposite one of them. The dancer makes a half turn to his left and [then] a quarter turn to his right. His head moves, as do his hands, each holding a baton. At times, both his legs are on the ball. At times [only] one. The flautist plays with a sound audible to the assembly and the slave girls play their instruments with a continuous regular rhythm, with varied sounds and drumbeats. [This continues] for a while and then the rider comes to a halt, with his lance pointing to one of the party. The slave girls are silent and the dancer is still. Then the slave girl tilts the bottle until its mouth is near the rim of the goblet, and pours from the bottle clarified, blended wine till the goblet is nearly full, whereupon the bottle returns to its previous position. The steward takes it [i.e., the goblet] and hands it to the person toward whom the lance is pointing. [After the goblet is drained] the steward puts it back in front of the slave girl. This is repeated about twenty times, at intervals of about twenty minutes. Then the leaves of the door in the upper castle open and a man emerges from the door, his right hand indicating "no more wine" and the left hand indicating "two more goblets." (al-Jazari 1206/1974, 100)

Boat of Automata (Chapter 4 of Category II)

The boat is placed on the surface of a large pool of water, and is seldom stationary but moves in the surface of the water. All the time it moves the sailors move, because they are on axles, and the oars move it [i.e. the boat] through the water until about half an hour has elapsed. Then, for a little while, the flute player blows the flute and the [other] slave girls play their instruments that are heard by the assembly. Then they fall silent. The boat moves slowly on the surface of the water until about half-an-hour has passed [again]. Then the flute player blows the flute audibly and the slave girls play the instruments, as happened the first time. They do not desist until they have performed about fifteen times. (al-Jazari 1206/1974, 107)

Perpetual Flute (Chapter 10 of Category IV)

Water flows from the supply channel and falls into funnel N and flows through end H of the pipe because it is tilted toward tank K and float E. It runs through hole P into tank A, driving the air from it, which streams into pipe J. The flute plays until the water rises to the level in the siphon S—the hole P is narrower than end H [of the pipe]. The water rises in the tank of float E, the float rises and lifts the extension H with its rod, pipe L tilts and discharges from end T into tank Z and float W. Water runs through hole Q into tank B, driving the air from it, which streams through pipe D into the flute's jar, which plays like a flute until tank B is filled. The water rises to the bend in siphon F, and in the tank of float W, which rises, lifting the extension of end T with its rod. The water in tank A has evacuated through siphon S. Then the water runs away from end T, which comes away from tank B. And so on as long as the water flows. (al-Jazari 1206/1974, 176)

Islamic Programming

Hill claims that one main distinguishing feature of the Arabs was a constant striving after control in order to construct machines that "would work automatically for long periods *without human intervention*" (emphasis mine). He states, "many types of control, most of which are thought of as quite modern, were employed to achieve these results: feed-back control and closed-loop systems, various types of automatic switching to close and open valves or change of direction of flow, and precursors of fail-safe devices" (Hill 1998, vol. 4, 30). In relation to al-Jazari's machines, Hill is similarly puzzled that in some cases "the techniques devised for given purposes were often more sophisticated than were strictly necessary. It is simpler, for example, to maintain a static head by fixing an overflow pipe, rather than using a valve-operated feedback control" (Hill 1998, vol. 2, 233).

Ifrah claims that al-Jazari in his works "gives a description of true *sequential automata*, driven notably by a camshaft, which transforms the circular motion of a sort of crankshaft into an alternating motion of a distributor: such automata thus mark a break with the Greco-Roman concept of the simple device endowed with automatic movements" (Ifrah 2001, 171). This, he argues, is a significant milestone in the *sequential programming* of machines, in that he views it as having achieved a greater level of control over the movements. While this retrospective reading of al-Jazari's works as yet another tendency in the greater teleology of the striving toward machines that achieve greater

levels of control fits well into a cybernetic conceptualization of the history of automata, it fails to acknowledge the religious and cultural specificities that informed Islamic automation as that exemplified by al-Jazari. It is suggested here that the reasons for these elaborate mechanisms devised by Islamic engineers were informed by the religious worldviews within which the works were conceptualized and made.

As discussed earlier, since the notion of Islam requires the human creator to always subordinate his creative interventions to those of God as creator, these devices need to be understood not as means to show how effectively and efficiently one could control the natural forces of air and water but as conduits of allowing these forces *to play out* their capricious movements that were pleasurable because they conceived as *expressions of God's will*. It is not surprising therefore to note in several of the early texts on automata, specifically that of the Banu Musa, the expression "if God wills" accompanying the technical descriptions of several devices. The fact that this has become such a conventional expression in the everyday lives of Muslims might make one doubt that these references are anything but conventionalized ways of speaking and writing in these societies, and thus might make it seem not worthy of serious attention. However, this notion of including divine will in mechanical treatises is peculiar to Islamic scholars of the medieval period and thus needs to be understood within the context of how religion mediates scientific and technological aspirations.

One of the most conspicuous uses of this expression in mechanical treatises is that of the Banu Musa. In describing one of their trick vessels (Model 20) which dispenses a variety of colored liquids through a complex series of siphons, they state: "It is [also] possible for us to install floats and valves in this jar as we did in the pitcher that accepts [nothing], if God wills" (Banu Musa 1979, 80). While many of their trick vessels rely on the subtle "sleights of hand" of an accomplice servant who manages the flow or lack thereof through a hole that controls the aerostatic pressures in these vessels, some of them are based on the motive power of hydrostatic and aerostatic pressures, which are not easily subject to such artful manipulations. It is significant that they begin using the expression "If God wills" in Model 20 in reference to a trick vessel of the latter kind.

It is impossible within the scope of the present essay to systematically study other comparable texts of this period and make an assessment of the significance these Islamic engineers placed on divine will in mechanical devices and

processes. However, based on the organic context within Islamic science and technology developed as an extension of religious inquiry in the medieval period coupled with such explicit articulations, as noted above, of the relationship between divine will and mechanical processes, it is useful to remain attentive to these interconnections. It is pertinent here that the creative programming of these devices issues not from an engineering intent to achieve greater levels of control but as a means to show the sophisticated ways in which divine will operates in or on the world. Thus the elaboration and sophistication of these machinic processes seem to be aimed at ensuring the most conspicuous and viscerally pleasing expression of the wonders of divine will.[3]

Untoward Automation

Some aspects of Islamic automation support a useful model for rethinking programming for robotics and automation in terms of untoward automation—one *where predictable movement is substituted by unpredictable or untoward behavior.* It should be emphasized here that programming for untoward behavior is not the same as programming for emergent behavior, as the former is unpredictable by structurally enabling difference without setting the parameters of such differential effects. According to Ifrah, one of the principal breakthroughs in programming that led to the development of the computer was "to devise a machine whose functioning would be controlled by a modifiable control unit governed by a sequence of instructions recorded on a malleable input medium that was independent of the material structure of the internal mechanisms" (Ifrah 2001, 178). Interestingly and conversely, one of the features that enables Islamic automation to sustain its untoward behavior is the fact that there is no such separation. The material structure of these automata, the motive power that drives them and the material elements that support the sequential programming are intricately interconnected. In the concluding part of this essay, some unique features of this "untoward automation" are presented through a discussion of three kinds of automata developed by al-Jazari.

For the fountains (*fawwara*) that al-Jazari developed and describes in his book, he claims to have drawn some of his ideas from his predecessors, the Banu Musa. Al-Jazari had very specific ideas of how to improve on the designs of the Banu Musa. He claims that of the fountains that change shape (*tabaddala*), "I did not follow the system of the Banu Musa, may God have mercy

upon them, who in earlier times distinguished themselves in the matters covered by these subjects. They made the alternation with vanes turned by wind or by water do so that the fountains were changed at every rotation, but this is too short an interval for the change to appear (to full effect)" (al-Jazari 1974, 157). Al-Jazari was obviously more concerned with creating an aesthetic experience one could dwell on rather than presenting such fountains as mere distractions. This concern toward prolonging, intensifying, and diversifying the experiences of those who encounter these devices is also found in an another discussion (category IV, chapter 7) where he notes this of a particular musical automaton designed by a predecessor which he had personally examined: "even if the [water] wheel caused a number of rods to fall in succession it would not be slow enough to display the changes adequately." However, his designs, despite their attention to longer intervals between spurts, coordinated alternations, and diverse shapes, only seemed to be more programmed. The composite result of these programs do not seem to be focused on creating more predictable fountains that had a regularized rhythm but to bring a greater level of variety and depth to the experience without compromising on the untowardness of the fountains' repertoire.

In the various phlebotomy (blood-letting) devices he constructed, al-Jazari incorporates elements into its automated operations that show sensitivity to the psychological state of the patient who is being bled (*al-mafsud*). He states clearly at the outset of the section where he discusses these devices that "it is based upon [the work of] a predecessor, that was simply a sphere for collecting the blood. I have excelled him with various designs" (al-Jazari 1974, 136). He describes how one of these devices incorporating two automated scribes is programmed to switch constantly between providing accurate information to the patient on the exact amount of blood that is filling the basin and also distracting the patient from these indicators. He writes, "I decided to use two scribes because the scribe in the circle rotates and then his pen becomes invisible to the patient, and the scribe's back turns toward the patient's face, while the board [that reveals the measurements] is not concealed from him at all" (al-Jazari 1974, 146; words in brackets mine). Al-Jazari also incorporates within this particular bloodletting device an elaborate mechanism for constantly distracting the patients even while reassuring them that the procedure is progressing smoothly. He has incorporated within the castle, which forms the principal motif for this device, a series of twelve automated doors that open each time a specific quantity (in this case, 10 *dirhams*, equivalent to 30 grams)

has been gathered in the basin, to reveal an automaton (a young male slave) that carries a board indicating "ten" so as to reinforce the measurement indicated initially by the automated scribe. One can easily imagine how the constant distraction provided by the rotating scribes and the successive openings of the doors that result therefrom would have helped a patient get through this painful procedure.

With regard to the Boat of Automata described above, Hill interestingly comments, "no method is described for imparting movement to the sailors, which indeed could only have been done while water was being discharged, not throughout the entire session" and also that "the interval between successive discharges would lengthen as the static head in the reservoir fell" (Hill 1974, 256). These comments indicate first, an inability on the part of Hill to fully appreciate the aesthetic appeal of the untoward automation that many of al-Jazari's automata seem to exemplify, where one's amusement derives not in the continuous and regular rhythms of automated performance but in the unpredictable and therefore surprising flurry of movements. For example, Hill has elsewhere noted that an important feature of Islamic machines is "the frequent occurrence of delayed-action mechanisms, which delayed the opening or closing, until a set period had elapsed" (Hill 1976, 233). However, Hill does not seem to consider the possibility that these delays were not always seeking to effect control over the timing of the automated movements, especially since the delays did not mediate the motive power so as to effect a controlled movement. Very often what resulted from these delays was a movement that had an order that was within certain predefined but not completely controlled parameters. So these delay mechanisms might have been more focused on an elegant management and "languishing within" the subtle caprices that resulted from them rather than on their control.

Conclusion

This essay is a modest contribution to the displacement of al-Jazari from the linear and conventional histories of automata that view him as an early proponent of "not yet so effective" methods of controlling machinic movements through programming. It has been argued here that the task of what has been referred to here as Islamic automation reflected in al-Jazari's works was not to achieve effective control over an automata but to present through these

automated processes a vicarious expression of divine will and the peculiar *manners of submission* inherent to those forces that provide the motive power for these devices. It has also been suggested that al-Jazari's work provides a useful platform to rethink automation in terms of untoward automation—a notion that might prove especially significant in developing new ways of working with robotic arts that are not informed by and therefore celebrate the departure from the instrumental logic of conventional robotic programming.

Notes

1. It is important here to clarify that although I elaborate a notion of how Islamic technology was conceived within a particular historical context, it is impossible within this essay to extrapolate and extend the study into how such religiously framed notions of technology operate in contemporary Islamic societies.

2. A more thorough analysis of the historiographical value of the genealogical method for the history of technology, though necessary, is well beyond the scope of this essay.

3. It has been suggested that conceptualizing these machines as being structured to express submission rather than achieve control does not represent a radical difference in interpretation insofar as submission is nothing more than the dialectical flipside of control. While it is true that one could conceptualize "control–submission" as a dialectical relationship expressed within machinic processes, this does not problematize the fact that control-oriented discourses of cybernetics and the industrial revolution that have informed conventional histories of automation are radically different from those that informed medieval Islamic engineering of automata.

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II

Machine—Media—Exhibition

9

The Automatization of Figurative Techniques: Toward the Autonomous Image

Edmond Couchot

Figurative techniques depend on a whole array of procedures, which frequently aim at limiting the amount of time, materials, and movements involved in the creative process. This entails making certain operations automatic in order to alleviate part of the physical or intellectual work of the image-maker. The tendency toward *automatization* appears very early in the history of images. The handprints on the walls of Magdalenian caves already bear witness to this tendency, regardless of their symbolic significance. Again, one finds the same quest for automatization in the invention of complex machines for weaving and tapestry-making.

Optic, Geometric, Chemical, and Electronic Procedures

The search for automatization is neither constant nor systematic throughout the ages, but depends rather on historical conditions. Sometimes, figurative techniques did not evolve much for very long periods of time, as was the case during part of the Middle Ages. It also happened that they changed quite fast, as in the Renaissance period. Indeed, in the early fifteenth century the automatic processing of images gained speed. Painters elaborated a figurative technique that enabled them to construct a three-dimensional scene more easily: linear perspective. The procedures were optic and made use of little "viewing machines" (perspectographs). They were also geometric: there were "legitimate constructions" of "basic squares," and also the "vanishing point," "distance point," and so on. Remarkably, the perspectivist model of construction

prevailed in painting, with a few stylistic variations, until cubism proposed another model in the early twentieth century.

At the same time, during the nineteenth century, the automatization of figurative techniques underwent considerable change. Photography, whose principle of optical projection was isomorphic to that of perspective, made it possible not only to obtain an image resembling reality through chemical and optical means, but also to fix this image, and, with the invention of the negative, to copy it indefinitely. Perspective was only a first step in the automatization of images and was still largely based on the hand and the eye of the painter, but the full expansion of automatization started with the appearance of photography. From then on, image-making was set on a frantic race to automatization, which was greatly enhanced by scientific and industrial progress.

Cinematography made it possible to record images, no longer by rapidly slicing the flow of time, but by capturing time sequences of a certain duration that one could copy indefinitely like photos. Automatization made a great leap forward with television. Not only could television produce images that gave the illusion of movement like cinema, but it could also broadcast them automatically at considerable distances via Hertzian and cable transmission at the very second they were shot. Traditional images are always obtained by leaving a trace (a material trace in the case of painting, an optical-chemical trace in the case of photography and cinema, and an optical-electronic trace in the case of television).

Yet it is remarkable that even though automatization increases and its functions become ever more complex, photographic, cinema, and TV images follow a generally identical conception and perception of time and space in which the subject and the object are defined in relation to each other, in diametrical opposition on each side of the projection plane. The subject always occupies an epistemic position as he or she remains the master of viewpoint. These techniques produce the vast majority of images, and their diffusion has created a series of perceptive habits (a perceptive habitus) that is all-pervasive and universally shared by image-makers and image-viewers alike, regardless of their cultural differences.

Digital Procedures

With digital images, a radically different automatization mode appears. Let's not forget that digital images have two fundamental characteristics that

distinguish them from the images mentioned earlier: they are the result of an automatic calculation made by a computer. There is no longer any relation or direct contact with reality. Thus the image-making processes are no longer physical (material or energy-related), but "virtual."[1] Also, digital images are interactive, that is to say they can establish a form of dialogue with those who create or watch them—to the extent that interactive digital images exist only if their viewer (and their creator first) interacts with them.

The position of object, image, and subject is no longer linear. Through the interfaces, the subject hybridizes himself with the object and the image. A new feature of subjectivity is appearing. According to Roy Ascott, for example, subjectivity is no longer localized in a sole point in the space but distributed through the networks; according to Siegfried Zelinski, subjectivity is the possibility of action at the frontier of the networks; according to Pierre Levy, subjectivity has become fractal; Derrick de Kerckhove speaks of "borrowed subjectivity," the possibility of "alienarization." Therefore a new perceptive habitus is emerging.

Calculation and interactivity endow images with technical faculties that no images have ever possessed before. The computer automatically creates the shapes, the colors, the movements of the image—or more accurately of the *virtual semiotic objects* that the image simulates and from which it is inseparable: the digital image that shows on a screen is not only a luminous surface that the eyes see, it is also the product of a calculation, a program and a machine. Again, computers control the modes of circulation and reception of images, that is to say their socialization (from multimedia to the Internet). Computers deal more and more with operations that were previously performed only by humans, and each step in technical progress pushes the automatization of figurative processes a little further.

The development of modeling techniques shows this clearly. The first graphic tools made a number of operations previously limited to traditional automatic tools, while simultaneously offering new possibilities. These first graphic devices only processed two-dimensional images, but were soon joined by other tools that were designed to process more and more realistic three-dimensional images and set them in motion. Nevertheless, the two- or three-dimensional visual objects that composed images remained rudimentary and totally dependent on the programmer. But, thanks to research carried on simultaneously, in particular in artificial life and intelligence, these very disciplined objects were progressively endowed with the faculty to perceive

certain specific characteristics of other virtual objects (e.g., shapes, colors, positions, speeds, trajectories), and to engage in more and more complex relations with them or with the viewer.

Thus, images—that is to say, the virtual semiotic objects composing them—became capable of *behaving* like more or less sensitive, "intelligent," and lively artificial beings—more or less *autonomous* beings. Let's understand "autonomous" to mean *capable of creating its own laws*.

Autonomy and Artificial Intelligence

This idea of autonomy is not a novelty; it was already around as early as the mid-1950s—at the very time computers were invented—when von Neumann propounded a theory of self-reproducing automata. Some time later, John H. Conway, a mathematician, invented his famous "Game of Life" which was able to create simulations of virtual live beings that could grow, multiply and die. Christopher Langton then imagined "self-reproducing automata" (fig. 9.1); shortly after came "cellular automata networks," "morphogenetic algorithms" (i.e. Mandelbrot's fractals, Richard Dawkins's biomorphs), and "L-systems." And finally, "genetic algorithms" and the evolutionary strategies inspired by Darwin's theory, based on notions of variation and selection, arrived.

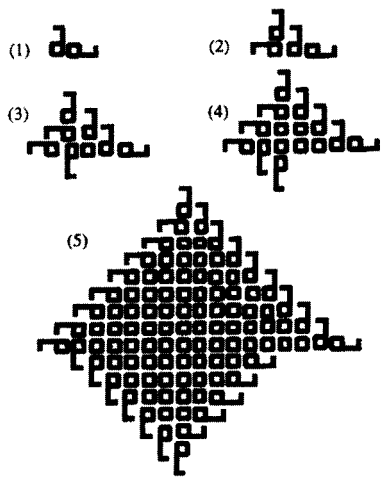

Figure 9.1 Christopher Langton, *Langton's Loops*, self-reproducing cellular automata, 1984.

On the other hand, a new direction in computer research, connectionism was developed along principles different from those used previously by researchers in artificial intelligence, as the latter reduced the mind's operations to a mere series of calculations. We owe to connectionism, among other things, the invention of "neural networks": computer-calculated virtual networks simulating living cells that behave—because of the way they are interconnected—in a way none of them would behave if they were taken in isolation. This is referred to as "emergent" behavior. Neural networks are able to develop "cognitive strategies" and to find nonprogrammed solutions when they are placed in certain situations. They are capable of memorizing information, no longer in the form of data, recorded in the computer's central memory, but in the form of connections linking a relatively large number of elements together.

Artificial life and intelligence then join and reinforce the system's autonomy. At the basis of neural nets and of genetic algorithms, the same principle prevails: that of highly complex interactivity between constituent elements of artificial life and intelligence (genes and neurons) that, thanks to their configuration, interact in order to produce emergent phenomena. Interactivity then enters a more elaborate stage. My colleagues and I suggested the term "second interactivity" to refer to this stage. The evolution of interactivity techniques follows, in this sense, that of cybernetics. Whereas the "first cybernetics" dealt with notions of information, control, and communication (in animals and machines), the second cybernetics deals with notions of self-organization, emergent structures, networks, adaptation, and evolution.

In a similar way, whereas the "first interactivity" focused on the interactions between human beings and computers following the action–reaction or reflex model, the second interactivity examines action insofar as it is led by corporality, perceptions, sensorimotor processes, embodiment, and autonomy (or "autopoiesis," to refer to a concept we owe to Francisco J. Varela[2]). Autonomy itself doesn't form a homogeneous block but can be subdivided in two subgroups, according to certain specialists. The term "*low* autonomy" (or also "low self-organization") concerns systems whose "performances are realized thanks to changes in the connections that were not explicitly programmed,"[3] and "*high* self-organization," systems that accomplish tasks that "*emerge from the way the machine itself evolves*" (ibid.). To the physical and mechanical models of the first interactivity are now added models issued from cognitive science or

First cybernetics	First interactivity
control and communication in animal and the machine retroaction, homeostasis information	relation between man and machine by reflex model or action-reaction
2nd cybernetics	**2nd interactivity**
cognition auto-organisation emergente structures networks adaptation evolution	action/perception sensori-motor processes embodiment autopoiesis

Figure 9.2

biology. Thus computers and the images they produce gradually acquire the characteristics of intelligent and live beings (fig. 9.2).

Autonomy in Interactive Artistic Installations

While programmers are busily involved in research in the fields of artificial life and intelligence, explorers in the field of art have in turn tried to make these techniques their own, in order to create novel images endowed with new aesthetic characteristics. There are few examples, but they are very significant. I will only refer to the work of my colleagues Michel Bret and Marie-Hélène Tramus, from the center of university research I belong to, in collaboration with the neurophysiology department of the Collège de France. The device they set up invites the spectator to interact in real time either with a virtual tightrope walker or with a virtual dancer. The synthetic creature's body is programmed to obey biomechanical laws (its movements stay within the limits of feasibility) and is endowed with reflexes that help it maintain its balance on the ground. These features are imposed on it from the outside by the programmer (fig. 9.3).

But the creature also has a brain made up of a network of virtual neurons. This network enables it to learn certain gestures specific to dance or tightrope

Figure 9.3 Michel Bret, Marie-Hélène Tramus, and Alain Berthoz, *The Virtual Tightrope Walker,* 2004. Copyright Michel Bret. By kind permission of the artists.

walking, by trial and error, during a preliminary training session with a real tightrope walker or a real dancer. During a second phase, a tightrope walker faces the virtual tightrope walker projected on a large screen; she then interacts with the virtual creature through the aid of a sensor placed on her own belt. The moving sensor's speed variations are then analyzed in real time by the computer: the virtual tightrope walker reacts[4] by improvising balancing gestures. These steps haven't been prerecorded in a central memory: they are not those the creature has learned nor do they repeat those of the real tightrope walker.

Rather, they are the result of a compromise between the balancing strategies that the creature has learned and the unexpected movements of the real

Figure 9.4 Michel Bret, Marie-Hélène Tramus, and Alain Berthoz, *The Virtual Tightrope Walker*, 2004. The virtual tightrope walker interacting with a real tightrope walker. See plate 8. Copyright Michel Bret. By kind permission of the artists.

performer. The neural networks configure themselves as the real tightrope walker stimulates them by her gestures, and endow the virtual creature with a certain degree of autonomy—true, of low autonomy in this case, but still, a sufficient degree of autonomy to produce the invention of new gestures. The process is the same when the device brings a real and a virtual dancer face to face. It is also possible to confront the synthetic creature with a spectator who is neither a tightrope walker nor a dancer; the exchange of movements then becomes different (fig. 9.4).

A Reembodied Dialogue

From an artistic point of view, the use of models issued from cognitive science in order to create autonomous visual artifacts capable of reacting to the gestures of real beings has enabled some artists to reinstate the decisive importance of the body, in all its mysterious complexity, at the core of aesthetic

relations. These experimental artists, who draw inspiration from connectionist theories, no longer consider thought as a product of the brain alone (Descartes used to think the pineal gland was the very place to which the soul was attached), but as a product of an indivisible body–brain. Perception and action are closely related and both take part in the elaboration of thought.

This position is opposed to a certain conceptualist vision of art in which the functions of body are considered secondary compared to intentions and pure Ideas. An unprecedented artistic situation springs from the choreographic interaction between real and virtual beings. Indeed, this situation is not too far removed from those provoked by certain interactive "immersion" devices, certain "online" and "offline" multimedia works, or certain hypertexts that can spark the audience's surprise and wonder, their imagination, their desire to explore and play. But autonomy brings an unusual element to interactive relations.

By inviting the spectator to use his or her own body in order to exert an influence on a virtual being endowed with intelligent and perceptive qualities (albeit very primitive, compared to the human body–brain), the dialogue between works and viewers is reembodied: it literally reincarnates. Art then becomes an art of the body questioning itself through itself, an art of the body's thought. It becomes an art that still produces and calls for forms (for there is no formless art), but the forms it produces are of a new kind: no longer the forms of the objects we perceive, but those of our perceptions themselves, grasped as forms, moving, transient, yet aesthetically coherent, on the chaotic background of the world around us.

Conclusion

The application fields of autonomous systems are not limited to images or to physical interactivity. "Intelligent agents" that issue directly from research in artificial life and make up a large part of these systems have filtered into every software. They operate with utmost discretion and their activity is extremely varied: they collect and analyze information (often illegally), control the operations of distributed networks, assist in electronic commercial transactions and accountancy, and perform electronic surveillance (or espionage). Even though these are only the first steps of autonomous computerized systems, they are spreading faster and faster and are increasingly efficient. Their development opens a new phase in human involvement with digital technology.

The capacity of human-made artifacts to simulate intelligence, life, and evolutionary processes will certainly change most human activity dramatically during this century. One can desire this upheaval, and one can certainly find it terrifying. In its attempt to tear these systems away from their mere technological efficiency, should art—or should it not—keep its control over beings it wants to endow with autonomy, in the name of creative freedom? This paradox isn't new, for every artist has always had the desire to see their creations break free from them and enjoy a life of their own in the eyes of others. But it is now set in terms that demand a radically different approach to the question of art.

Notes

1. These calculations rely on modeling algorithms to create realistic or nonrealistic images that are qualified as synthetic. But computers can also treat nondigital images (i.e. paintings, photos) once a scanner has digitized them.

2. On this subject, see Francisco J. Varela, *Autonomie et connaissance: Essai sur le vivant* (Paris: Seuil, 1989).

3. Henri Atlan, *Encyclodaedia Universalis 2004* (DVD), "auto-organization" entry.

4. An exoskeleton placed on a real dancer is used for this purpose. The movement is then analyzed either later or in real time. In the first case the procedures are manual (indicating the positions that were selected) or automatic (extracting remarkable positions). In the second case, the information provided is directly used in a learning process that modifies the matrix of the networks in real time.

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10

Image, Process, Performance, Machine: Aspects of an Aesthetics of the Machinic

Andreas Broeckmann

For many centuries, machines have influenced the way we construct, read, and understand the world. The pantograph is a simple mechanism for magnifying images, while the *camera obscura* allows us to project a proto-photographic image of our surroundings in real time, waiting to be captured in paint or on photosensitive surfaces. Trains traveling from city to city have given us the view from the window, a continuously transforming landscape observed by an unstoppable, fleeting gaze that can only pan, never zoom.

Such mediated approaches to the world have been further dramatized by digital machines, which force their signals to pass through the barely material interface of electrical currents and algorithmical calculations. Digital apparatuses abstract the visible as well as the conceptual, all sensory and mental information, to a high level of ephemerality where only the reconstruction in recognizable, concrete abstractions like text, image, and sound bring them into our perceptual range. Like in a text-to-speech translation program, we are continuously made aware of the construction, sensing the break beyond analog physicality.

There is a growing number of such digitally fed interfaces surrounding us, constructing and driving our shared reality, from office software structuring our working days, through wireless transmission systems enabling complex telecommunications and leisurely derivations, to the hyperpresence of televised images and televised "truths." For want of a better word, we can call this condition *digital culture*, a social environment, field of action and interaction, in which meanings, pleasures, and desires are increasingly dependent on

their construction or transmission and thus on their translation by digital devices. The necessary technical abstraction that the contents have to go through is becoming a cultural condition, which has effects far beyond the actual mechanism of extrapolated signal switching.

The German philosopher and cultural historian Martin Burckhardt suggests, in his study *Der Geist der Maschine*, that "the spirit of the machine" traverses human culture in a deep furrow, tying the invention of alphabets to the discovery of the unconscious and the development of calculating machines. Burckhardt argues for a broad understanding of what constitutes machines, approaching them not so much as technical apparatuses, but as cultural dispositions that articulate and disarticulate human agency, constructing relationships and cutting ties with multiple natures and multiple cultures.

What does it mean to think through the machine in artistic practice? This question lies at the heart of an investigation into an "aesthetics of the machinic," which the following text tries to evoke. Aesthetic experiences are shot through, perforated and articulated by the machinations of machines, apparatuses that are the exoskeletons of our perceptions and expressions. The apparent functional abstractions of digital machines, and their application and development by artists, make it easier to address the machinic also in relation to predigital art.

There is a notion of the digital that posits a deep break of *digital aesthetics* away from the aesthetics based on analog techniques. I will not pursue this discussion here; but I hope that the following will help to suggest that such an understanding of a digital aesthetics hinges on the technical aspects of artistic production. In contrast, an approach that highlights the experiential qualities of art, and the aspects of reception, is more likely to identify an aesthetic continuum between analog and digital aesthetics. This approach implies that, in this respect, media art should not be discussed in separation from contemporary art practice in general.

The recent reevaluation of conceptual art as a precursor to digital media art is an indication that the concepts of media art have evolved in a broader cultural environment in which game theory, cybernetics, space travel, television, genetics, and other areas of human endeavor were having an impact on cultural practices. However, there is much more media art "*avant la lettre*" in other historical periods that can be reread through the paradigms of an aesthetic theory that does not take digital technology as its main cue, but rather takes the machine as a productive and transformative principle.

Some key categories of such a reflection on art theory from the perspective of digital culture will be discussed below. The notion of the "image" is receiving a wide-ranging reevaluation in light of the conditions of its production, distribution, and display in digital culture. Then follow three sections which deal with different concepts of an artistic production that is not oriented toward finished, singular works, but at nonlinear and open, time-based structures (execution, performance, process). These aesthetic categories play a crucial role in computer-based art and can, at the same time, be applied fruitfully to nondigital art. In the last section, the notion of the "machine" is discussed as a conceptual tool for analyzing a particular type of aesthetic work, which hinges not on conveying an authorial artistic intention, but on the experience of machine-based, apparently autonomous processes, which, as is suggested, can be associated with the notion of the sublime. The overall goal of this discussion is a demonstration of the conceptual bridges between different fields of art theory, and a suggestion to mine recent scholarship on computer-based art for a reassessment of other art historical periods.

Image

Media art reminds us that the disciplinary terrain covered by art history extends far beyond the purely visual. While images continue to play a dominant role in our understanding of art, recent time-based, interactive, and generative artworks encourage us to revisit historical art practices and the aesthetic categories that guide their evaluation. While painting, sculpture, architecture, and other art forms produce mostly stable objects that can be viewed and reviewed over extended periods of time, more immediately time-based works have for a long time posed the problem of documentation and retrospective evaluation. Original music and theater performances, dance and ritual, festivities of all kinds, can only be "revived" for historical evaluation to a very limited degree. This is a condition of cultural production and has a strong impact on the way in which cultural traditions evolve.

One of the oldest and still most prevalent forms of artistic abstraction is the image. Its historical study, in a modern understanding of critical evaluation of form and content, has developed over the last four centuries, from the descriptions of the late Renaissance, through the emergence of academic art history at the beginning of the twentieth century, to the recent considerations of a *Bildwissenschaft* (German for "image science," best understood in the tradition

of visual studies). It is worth reconsidering the path that art history has taken from iconography—the study of the coded meanings of images—and iconology—the study of the semantic and generally speaking "social" conditions of producing and reading images. In these two approaches, the image is taken as a given; it is read in depth and contextualized. On the basis of modern hermeneutics, the approach of iconics (*Ikonik* in German) has sought to look more closely at the perceptual production of the image and to study its meaning as a result of the process of reception. Thus, temporal structures within images have come into view not as mere narrative dispositions, but as "programs" that need to be executed and thus actualized by the viewer.

More recently, and on the basis of older philosophical, semiotic, and technical debates, *Bildwissenschaft* or visual studies is asking more generally what "images" are—a question that arises, not accidentally, at a time when digital technologies erode the traditional understanding of the image as a limited surface covered by a visual construction. Digital images are unstable processes, which, even as "static" displays, are the results of continuous and ongoing computations. Printed computer graphics are the analog, arrested results of such processes and are thus not digital images in a narrower sense of the word.

An artist whose work exemplifies this digital dimension of the field of images, is Toronto-based David Rokeby. His long-term project *The Giver of Names* is an interactive installation in which a table surface is observed by a camera system (fig. 10.1). As soon as an object is placed on the table and recorded by the camera, a computer system connected to the camera analyzes the observed visual structure and matches it with a label from an existing database of shapes and words. The results of the analysis trigger a short, quasipoetical text that is composed of words from the database, displayed on a computer screen, and read out by a text-to-speech system. Is this a simulation of how we make sense of the things we see in the world? Or is it a potentially autonomous perceptual machine system that might work as a training device for machines, trying to develop a human sense of poetic language, based on visual input? Would we say that what the machine observes in *The Giver of Names* is an "image"?

Rokeby's work helps us to understand that the notion of the "image" is not a sufficient category for understanding the current, digitally spurred expansion of the perceptual field. The aesthetics of electronic or digital artwork hinges, to a large extent, on nonvisual aspects, such as narrativity, processuality, performativity, generativity, interactivity, or machinic qualities. In order to em-

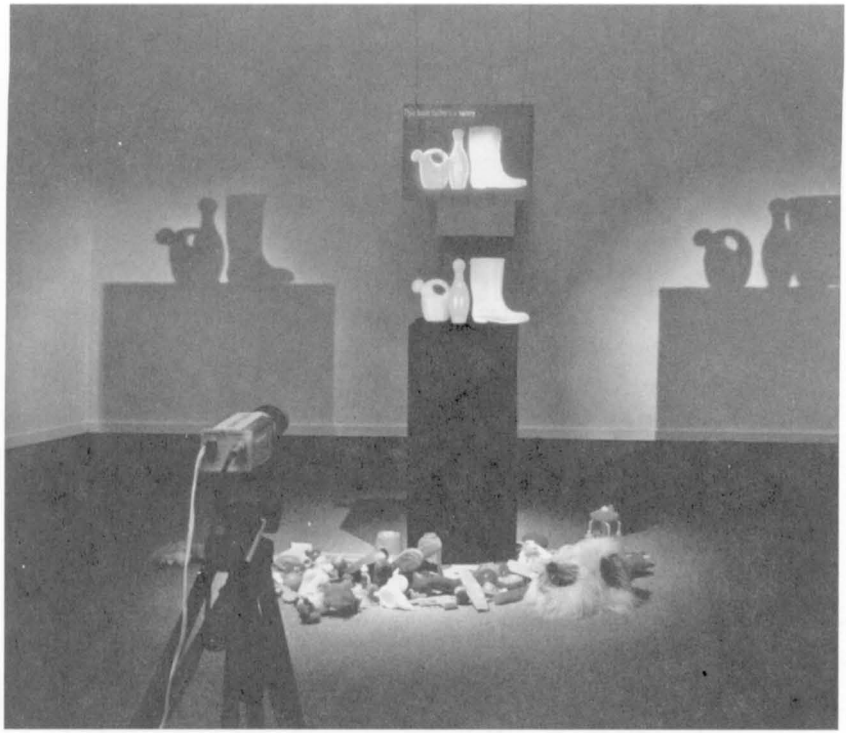

Figure 10.1 David Rokeby, *The Giver of Names*, 1991–. See plate 9. By kind permission of the artist.

brace these practices, we need to develop an aesthetic theory that is able to approach recent works of contemporary art that deploy digital technologies and that expand the categories of art-theoretical reflection. This theoretical work can then also influence the interpretation of predigital art, which may come into view as more dynamic and process-oriented than hitherto thought.

Execution

Computer software has, over the last few years, been recognized as a cultural artifact in its own right. Software was, for a long time, taken to be a neutral instrument. More recently, a growing critical and differentiated understanding of its constructedness, and of the way in which ideological presuppositions can be coded into software, has been paired with research by social historians of

science and technology. The evolution of the free and open source software movement, as well as the extensive use of—by no means fault-proof—digital systems in all walks of social and political life, has helped to build a critical understanding of "software as culture."

Wedded to this development is the emergence of "software art" as a term that describes artistic practices and projects that deal explicitly with the aesthetic and social dimensions of computer software. In this context, the British cultural theorist Matthew Fuller has proposed the useful distinction between "critical software," which reflects on the specificities and limitations of existing software programs, "social software," which deals with and expands the communal and social dimensions of software and software production, and "speculative software," which explores the very essence and the boundaries of what can be conceived as software.

In the 1960s and '70s the term software was still used for the "content" stored on or displayed by technical devices—thus the 1971 "Software" exhibition in New York and the early-'70s electronic art magazine *Radical Software*. Since the proliferation of computers in the 1990s, however, "software" has come to refer to the programs that run specific tasks on computer systems. "Executables" are coded sets of rules that can be worked through by a machine in iterative processes, executing tasks which interlock with other processes, turning the computer into a complex machine that is part black box, part tool, part display.

The continuous processing of code requires a precisely described, encoded "software" program that is executed by the "hardware" technical processing units. This structure lies at the heart of digital systems, and it has been reflected by artists not only since the advent of the personal computer, but since the emergence of cybernetics and game theory in the 1950s. A recent example are the programs developed by the Dutch *socialfiction.org* group, whose *.walk* project offers descriptions for "coded walks" through a city, instructing the human participants what to do, when to turn right, when left, and how to transform the rules controlling their behavior. This application of the principle of computer code to human behavior in the city offers a reflection both on the principles of technical software operations, and—in a postsituationist manner—on the way in which we act and interact in urban environments.

Similarly open, scripted scenarios were devised by happening and fluxus artists of the 1960s. An interesting example is Robert Rauschenberg's *Black Market*, an installation with an assemblage of different objects, including a

suitcase filled with things that the audience is invited to replace with other objects that they bring into the gallery. A small notebook documents the exchanges made. The gradual transformation of the installation is coded into the system and needs to be executed for the artwork as process to exist. Just as there is no market if nobody is trading, and no "computer" if no process is running, there is also no artwork if the program of the piece is not continually executed.

This is not a solely ontological or constructivist argument in the sense that the world, or an object, exists only if it is actualized by human perception. Here, the aesthetics of the work is dependent on a realization of the program. It is not the objects in the fixed assemblage that make up the core of Rauschenberg's work, but the conceptualization of the process of exchange. It should be a matter of discussion whether this principle must also be applied to paintings like Rembrandt's *Night Watch* or *Abraham's Sacrifice*, whose temporal structures have been analyzed by art historian Max Imdahl, or Jan Vermeer's *View of Delft*, with its shifting viewpoint that implies a virtual movement in space and that needs to be recreated as a virtual movement by the viewer during the reception. Such images have a spatiotemporal structure that requires a processual approach, "*Betrachtung*" as an act of realization, of execution, which is itself the very momentum of the aesthetic experience.

Performance

"Performance" is the domain of "live art." As a blanket term for music, dance, theater, and experimental variations thereof, it can be understood as the nonparticipatory live presentation of body movements, images, and sounds. In many cases, the notion of performance implies the presence of human actors or players on a stage, or a stagelike area. The same term is used to indicate the quality of a technical apparatus in operation: we can speak of the "performance" of a specific computer system, or of a car. This dual meaning is interesting in that it points to some general aspects of performance, for example, that it is an authorial execution system, an execution system that has a main actor. Performance can be understood as the presentation, the making present (and perceivable) of the results of an execution.

Performativity was an important issue in the art of the 1950s and '60s when the static paradigms of modernist art were being broken up by situationism, Fluxus, and intermedia, but also by the gestural and partly

mechanized painting performances of artists like George Matthieu and Jackson Pollock. Performativity has again come into view of the arts through the emergence of computers, not so much as a naturalistic counterreaction, but because of the impulse that digital systems have given to new ways of scripting live performances in dance and music. Automated or semi-automated machine-based notations have created a new relationship between composer or choreographer and performer, interjecting machinic operators into the creative process. In this respect, the experimentations of David Tudor in music were probably even more influential than the interactive transformation of William Forsythe's principles of dance choreography.

An interesting point of discussion is a comparison between, on the one hand, the scripted and documented walks by land artists like Robert Long, at times strongly authorial endurance pieces which were not meant to be repeated and copied, and on the other hand, the instructions for happenings by artists like Allan Kaprow or Dick Higgins, whose performances—or rather executions—were meant to be realized by any number of people in order to become what they were intended to be, namely, happenings.

In comparison, interactive or reactive installations, which were so prevalent in the media arts of the 1990s, are participatory execution systems. Unlike in a performance, where the execution is conducted by a main actor, in interactive systems the interacting person is typically not executing a more or less open program, but is included in the technical system as a secondary factor, or as a trigger, who can then observe passively the programmed results of his or her action. While the performance of interactive systems is frequently realized by the physical involvement, or contiguity, of the participant, their teleology may be channeled even further by a narrative structuring of the program.

In live performances based on digital media, a crucial factor is generally the relationship between onstage performers and offstage controllers of sound and video input and of the response parameters of the technical environmental. The degree of freedom offered to the performers is frequently competing, or in dialogue, with a programmed machine that imposes, or responds to, specific actions. Many artists exploring this field are consciously playing with this relationship, and attempting to use the dialogue in exciting work that embodies the tension of the struggle between human and machine in an open, unstable system. The "performance" of such a system is not immediately dependent on the involvement of an external actor, or on responses from

an audience, though it may be dependent on externally set parameters and conditions.

Process

While the term "process" in its most general sense implies any set of consecutive procedures sequenced in time, the notion of process-based art refers to the time-based evolution and transformation of describable yet not fully programmed sequences of events that build on one another in a nonteleological manner. Such processes are realized in social, semantic, and technical settings and are closely associated with the notions of communication, as a manner of semiotic interchange, and connectivity, as a form of temporary structure bonding noninterdependent actors.

Processuality in art is closely tied to the existence of communication tools. Of course, any communicative development in the preparation of an artwork —for instance the collaborative realization of a theater production or a movie —can be described as a process. However, it only makes sense to speak of process-orientation in cases where the evolving process itself is a main factor of the aesthetic experience of the work. Thus, in the formulation of an aesthetics of the machinic, it is necessary to emphasize the interlocking of machinic processuality with the social dimensions of engagement in process-based art.

The artists group Knowbotic Research (KRcF) has explored such machinic processes throughout the second half of the 1990s, especially in the project series entitled *IO_dencies*, and in the project *Anonymous Muttering* (fig. 10.2), which connected on-site visitors, music DJs, Internet users, and a computer system into a complex, interactive, open, and nondirectional assemblage. The output, and thus the aesthetic experience, varied from one interface setting to the other, and was mutually influenced by actions performed at any one of the connected positions, whether online, on-site, or automated. Whereas *Anonymous Muttering* created a delirious experience of being perceptually (and thus conceptually) overwhelmed, *IO_dencies* took a more analytical approach, trying to create interfaces and online communication tools that allowed participants to interact and continuously transform a shared knowledge environment. Processuality here meant an explicit communication not only mediated by machine systems, but a communication with these systems and the productive and transformational forces they brought to the assemblage. These works are

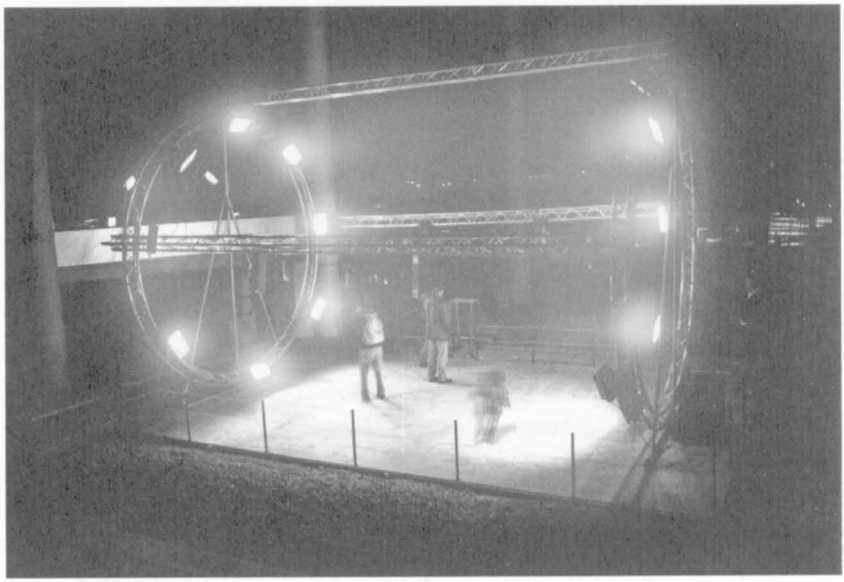

Figure 10.2 Knowbotic Research (KRcF), *Anonymous Muttering*, 1996. Photo: Jan Sprij, Rotterdam. By kind permission of the artists.

thus exemplary of an artistic engagement with technologies in which the machinic dimensions of a system including technology and human actors are deliberately explored, rather than taken for granted or ignored.

This kind of process-oriented art is, I would argue, without historical precedent. We find an interest in the aesthetics of processes, for instance, in the *corps exquise* experiments of the surrealists, or in the mail art networks of the Cold War era. However, the digital communications technologies of the last decade have created a historical situation in which communication and connectivity have taken on a new social and artistic significance, which is now explored not only through such technical media, but also in purely analog, local, and translocal artistic practices and projects. Unlike the artistic strategies of performativity, the dynamics of process-oriented art is coupled with the logic of its operational environment, be it the postal service, the Internet, or a particular segment of society. Whereas performance seeks to eliminate the impression of such a contextual dependency, the aesthetics of process-based art crucially implies this context—it cannot be other than relational.

As was indicated earlier, the notion of the "machine" applied here refers not to machines as technological apparatuses, but as any kind of productive assemblages of forces, be they technical, biological, social, semiotic, or other. The notion of the "machine" is an operative term that makes it possible to describe open formations which do not require systemic structures, but that hold the potential for manifold realizations. The "machinic," then, is a quality of such formations; it describes an open, productive process arising from specific yet nonteleological relations between the constituent parts of the machine. The aesthetics of the machinic suggested here encompasses a form of aesthetical experiences that are effected by such machinic structures in which neither artistic intention, nor formal or controllable generative structures, but an amalgamation of material conditions, human interaction, processual restrictions, and technical instabilities play the decisive role.

It is therefore appropriate to introduce the notion of the sublime as a crucial quality of an aesthetics of the machinic. The aesthetical experience of the sublime, as characterized by Romantic writers of the late eighteenth and early nineteenth centuries, is characterized by a confrontation with unbounded and overwhelming nature, a transgressive experience that is based not on an appreciation for the grandiose beauty of nature, but on a disturbed sense of amazement about its limitless and uncontrollable force. Of course, the notion of the natural sublime is historically associated with, on the one hand, the experience of alpine and maritime wilderness and natural catastrophies like earthquakes, and on the other hand, with the progressive subjugation of nature under human will in the course of industrialization. The sublime is thus a paradoxical sign of both intimidation and frustration about the loss of "natural nature." Importantly, Kant insists that the basis of the sublime experience lies in the viewer's feelings, not in the object itself—making the notion of the sublime a decidedly aesthetical category.

The sublime is thus a sensation realized in the event of being confronted with some external force; it is an experience emerging from the imaginary drama of an unbridgeable gap between our experience and the forces that move it. The paradigmatic Romantic artwork is German painter Caspar David Friedrich's *Monk by the Sea* (*Der Mönch am Meer*), of which Friedrich's contemporary Heinrich von Kleist wrote that, looking at the painting was as though,

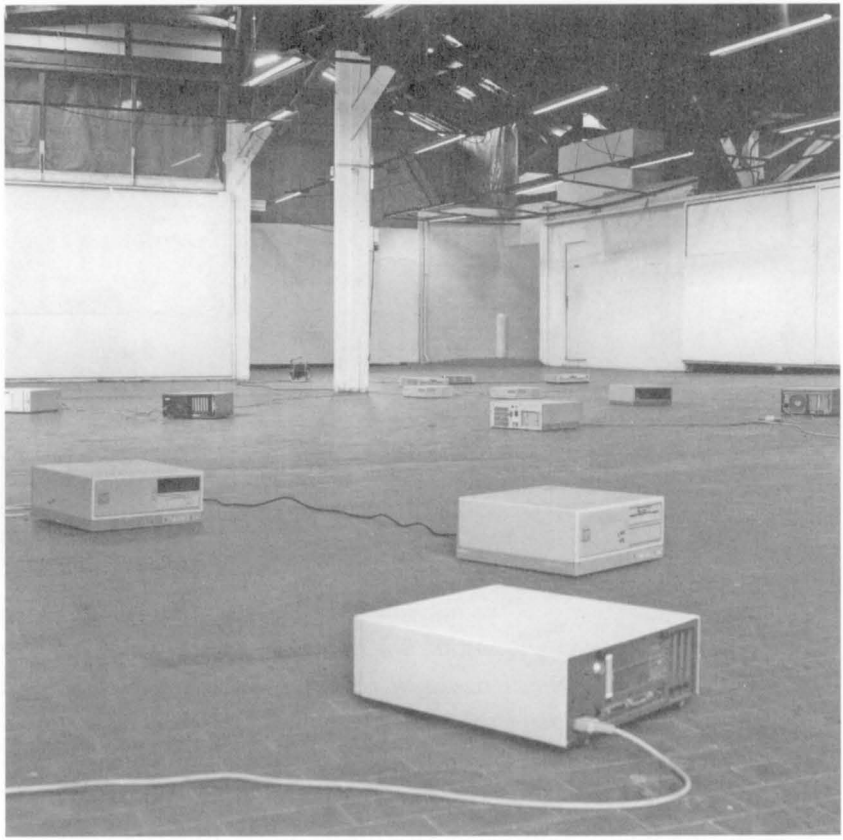

Figure 10.3 Maurizio Bolognini, *Sealed Computers*, 1992–. By kind permission of the artist.

"in the face of an overwhelming spectacle of nature, one tried to close one's eyes, yet the eye-lids had been cut away . . ." (Kleist, review in *Berliner Blätter*, 1810).

Closely connected to the Romantic unease about nature is the modern unease about machines. While modernist humanism has done everything to reinstate human perception of a contained world as the core motor of aesthetic experience, the emergence of technological art has brought the sublime back into the experience of contemporary art. Can we discuss modernist painters like Piet Mondriaan and Barnett Newman as artists of the machinic? They clearly play at the boundary between rational pictorial structures and a surplus that seeks to transgress rationalist certainty.

A most radical gesture in this respect is the project by Maurizio Bolognini, *Sealed Computers* (fig. 10.3), for which the artist places over a dozen computers in a gallery space, networks them and has them jointly compute simple, generative graphic structures which, however, deliberately do not get displayed: the monitor buses of all the computers are sealed with wax, and the installation offers no indication of the communication between the computers, or its results. What we can perceive are the interconnected computers, humming, apparently processing code. They are neither keeping a collective secret from us—we would need to subjectify the computers for this—nor are they even "conceiving" of the results of their computations as visual structures. We know that they are as alone as we are.

The aesthetics of the machinic is an experience in the face of art that hinges on machine-based processes that are beyond human control. The only chance we have is to destroy the illusion and switch off the machine. For the time being, and as nature teaches us, this is not really an option.

Conclusion

The aesthetic categories analyzed—image, execution, performance, process, machine—form no conclusive list, but rather provide a sample of terms which can open up a renewed dialogue about a contemporary aesthetic theory that uses the experiences of digital culture to rethink art. While the argument laid out here would require a much more extensive and detailed art historical investigation, its main aim is to counter claims that "digital art" or "media art" might require an entirely separate aesthetic theory. A more idiosyncratic aspect of the discussion above is the attempt to argue for an "aesthetics of the machinic" which might help to describe an aesthetic experience that we can have not only in the face of an autonomously operating technical system, but also in the face of an artwork that enforces a logic of experience which surpasses our subjective control.

11

From Film to Interactive Art: Transformations in Media Arts

Ryszard W. Kluszczynski

The following essay is an introduction to a history of twentieth-century media arts, which outlines their transformations from film to interactive multimedia arts. My aim is not merely to analyze the process of substitution or complementation of the "old" media arts by newer ones, but also to focus on the persistence of the former, their reappearances in new technological contexts. I would like to make clear that the history of media arts involves an obvious interplay between textuality, technology, and cultural institutions.

Cinema Faced with the Challenge of Electronic Technologies

The forms of filmmaking, the contexts in which contemporary film art functions, have undergone deep transformations. For cinema, the consequences of technological progress in the field of electronics and the increasingly frequent employment of new technologies in various areas of culture have been far-reaching and profound.

The tools used by filmmakers are changing. In some cases (e.g., that of Zbig Rybczynski or Peter Greenaway) changes have led to an advancement and consolidation of artistic attitudes and strategies which, although clearly present, were previously realized only at the expense of enormous effort (Rybczynski) or were muted and sidetracked by the traditional properties of the film medium (Greenaway). As regards many other film artists, one can observe certain sweeping transformations of their poetics and the issues they have addressed. It is also easy to notice numerous innovations in the areas of image

presentation, editing, and narrative structure. Not only does state-of-the-art technology equip cinema with tools allowing for a better (easier, faster) realization of traditional film tasks, but it also initiates (or deepens) changes in film strategies, creating new conventions, transforming genres, contravening traditional relations between reality and its audiovisual representations. That, in turn, leads to a formation of new recipient attitudes, transcending both the identification-projection model and the distancing conventions of Brechtian cinema. Modern electronic technologies are profoundly affecting the ontological structures of traditional cinema and film.

What is more, cinema is beginning to function in new communication channels. If televising films was responsible for transforming the extant models of recipient response to a cinematic work and for introducing the first changes in film poetics, then the invention of the VCR contributed immensely to developing these changes, especially in the field of response mechanisms. Nonetheless, the genuine revolution is occurring at present, with the dissemination of interactive DVDs; its effects will have been felt even more strongly with the appearance of films, which will make full use of the navigational, interactive qualities of the computer medium. It is interactivity, above all, which will play a major role in the future development of motion picture arts.

Today, film, for a long time the sole art endowed with the attribute of the moving image, must seek its identity in an unusual situation. Namely, it has become only one of the many media for which the motion picture, combined with sound, forms the basis of communication. It must therefore make choices that will define its place in the complex, varied group of media and multimedia audiovisual arts.

At this point, one could risk the hypothesis that in the near future the heretofore heterogeneous (despite its internal diversity) evolutionary process of the cinema will diverge into at least two separate currents: one attempting to cultivate traditional principles and forms (new technologies being used merely to enhance or refresh the existing conventions; after Christine Paul 2003 we may call digital technology used in such a way a digital tool) and another, comprising interactive cinema, obliterating current conventions and offering the recipient a strikingly different type of experience (in this case we may talk about digital medium). Another possible differentiation, overlapping with the abovementioned one, will involve a development of interpersonal relations within the group of recipients in the case of films presented in public

spaces and will strengthen intrapersonal communication, where the reception turns into an intimate, individual interaction with the filmic hypertext. Both tendencies are already represented by examples both numerous (especially with regard to the first trend) and valuable. The recent interactive film performances by Chris Hales show the possibility of merging both types into one—a collective interactive film experience.

The sine qua non for understanding this process is the analysis of the very phenomenon of interactivity. Such an analysis ought to be more than a reflection on the strictly phenomenal dimensions of interactivity, its variants, its artistic applications and their prehistory, the structure of individual interactive works and the first emergent poetics; it should also delineate the methodological context and justify the choice. It is hardly necessary nowadays to emphasize the importance of the choice of language used to describe the object of study.

Cinema and Film—The New Media

All media and multimedia that have followed after cinema are a result of the development in electronic technologies, which are currently becoming the main factor behind the transformations in audiovisual culture and art, and which are consequently—because audiovisuality plays a major role in the world of today—the primary source of transformations in culture as a whole. The so-called digital revolution is transforming nearly all areas of human activity. Therefore, it is also responsible for transforming the domain of art and for creating new fields of artistic practice, in addition to transforming its traditional variants, some of which boast a history dating back thousands of years.

As a result of the developments in information-communication technologies and the emergence of electronic media and multimedia, the situation of cinema/film[1]—the first form of moving image media art—is changing to an extent that far outweighs the intensity of all its previous transformations, which consisted mainly in the additions of sound or color, or perhaps modifications in image parameters or audio standards. Those past transformations did not violate the basic determinants of the cinematic apparatus, but rather enriched it by adding several new qualities and modifying certain existing ones. In contrast, the current changes in cinema/film are profound and fundamental; most importantly, they occur in several distinct dimensions.

First, cinema itself is changing, assuming a new shape: we are witnessing the birth and development of electronic cinema and film. The first and most immense impact of this transformative process seems to be sustained by the textual-artistic aspect. Image structures, editing codes, and narrative discourse systems are acquiring a form largely defined by electronic technologies and techniques. Simultaneously, while the analog diegetic systems—the result of the reproductive representing machinery, which is the cornerstone of the traditional cinematic apparatus[2]—are being replaced by digital simulations, a product of synthesis technologies, we witness changes in the ontology of the film text, the diegetic structure and the epistemological function of the cinema. Instead of the image of the world, electronic cinema offers the image-as-world. In consequence, considering the gravity of this transformation, it may seriously influence the character of the dispositive, including the course and the qualitative organization of perception (even if the basic apparatus in electronic cinema does not undergo in this case particularly significant changes). Nevertheless, for the film's dispositive and perception to attain a new character, to accomplish the "unreality effect" or perhaps the "new reality effect" produced by simulation, its appeal must be stronger than that of the traditional function of cinema, that is, creating an impression of reality. This, however, is not the case as far as most of the electronic cinema is concerned, from which one might infer that many qualities ascribed directly to the cinematic apparatus in fact derive from textual processes or relations invoked individually (in particular films or film types) between the apparatus in a general sense and the textual instance.[3]

More and more frequently, cinema employs electronic means, perfecting the possibilities of editing and—most importantly thus far—expanding the domain of audiovisual effects. This latter application of new technologies developed the aesthetics of film (chiefly the visual aspect), which accounts for the attention given them by countless filmmakers. These elements combined serve to move film toward the dispositive of television. Counter to this migration, however, numerous artists who eagerly employ electronic means in their work (Peter Greenaway seems to be the first who presented this opinion) believe that despite the emergence of the new forms of presenting film works, the best way to exhibit them is a cinema screening. According to Greenaway, electronic means were supposed merely to refresh and expand film art's possibilities of expression, to create new forms of shaping the image. The cinematic dispositive, however, should remain intact as far as possible.

Combining images of photographic nature with those generated by electronic means within the confines of a single film work brings results that extend well beyond the domain of film poetics. After all, the two forms of imaging are fundamentally different. A photographic image is a kind of analogue of the reality that precedes it, whereas an electronically generated image is free of such restrictions: the reality presented may just as well emerge simultaneously with the image. In actual fact, a complete reversal of the relation described earlier may occur, with reality acting as an analogue to the image. When the two image types, the photographic and the digital, appear alongside each other, the upshot is an upsetting of the relation between reality and its representation as well as between fiction and the systems constructing it. The relations between reality and fiction are also affected thereby. Not only do digital synthesis and photographic film differ in their ontology, but they are also subject to different metaphysics.

Second, as mentioned above, the context in which cinema functions is undergoing deep change. Film (and indirectly its assigned apparatus) enters the domain of television broadcasting, the videotape, the laser disc, or—in response to our requirements—it reaches the display, integrated with a multimedia computer, via a fiber-optic telephone line. The consequences of entangling film in dispositives alien to it extend beyond the simple effects resulting from a transfer into new dimensions and require a separate analysis of each case type. The properties of the dispositives integrated in this way are mutually influential, leading to modifications and often—ultimately—merging to form intermedial, hybrid dispositive structures (e.g., a video projection). The frequency with which these processes occur, as well as the range of their influence, is responsible for the contemporary multimedia being dominated by the intermediality syndrome. The deep structure of the multimedia—the basic contemporary form (and institution) of communication—is essentially an intermedial system, which, in further consequence, gives the multimedia phenomena the character of a dynamic palimpsest.

The abovementioned functioning of film and, consequently, also of cinema, in new contexts leads to even further changes, which transcend the borders of substantial and ontological transformations. They certainly do not remain confined to the limits of film poetics, but instead reach toward film structure as a medium, transforming the methods of reception in addition to offering new forms of experience and comprehension. The previous paragraph emphasized the processes of the media dispositive integration, and the subsequent

emergence of hybrid structures; as a consequence of this gravitating toward hybridity, the cinematic dispositive—if one attempts to grasp its peculiarity and realize it in extracinematic perception—reveals numerous fissures and deformations. In this transformed situation in which the cinematic apparatus is now functioning, the films themselves are also experienced differently; similarly, the new situation influences the textual orders.

The new audiovisual media, developing parallel to cinema/film and entering into various relations with it, affect its structures and forms, as has been said above, but also undergo transformations themselves. As a result of this interference, film transcends its borders, appearing in video realizations, various forms of virtual reality and computer games. I have mentioned already the transformations of the cinematic dispositive, resulting from its intrusion into other dispositives; however, we ought to remember that film textuality has also proliferated beyond the domain of cinema. Artistic realizations belonging to the domain of video art, or the diverse multimedia art, as well as popular computer games, draw on the resources of cinema. The film-specific codes of image construction, editing, narration, dramaturgy, character development, and plot structuring constitute the basic articulation system of contemporary media and multimedia audiovisuality.

Third, the development of interactive computer technologies calls into existence various forms of interactive cinema/film that are spiritually rooted in the theory and distancing practices of Brechtian cinema, but divergent from it both on the level of actually created structures and in the character of the demands imposed on the recipient. The basic apparatus of interactive cinema and its dispositive differ immensely even from the unconventional varieties of the traditional cinematic apparatus.

What must be strongly emphasized at this point is the fact that "interactive cinema" is essentially a term comprising an array of discrete varieties, which often differ radically. The mainspring of this differentiation is the invariance of the dispositive, conditioned by the abundance of interfaces[4] and the profusion of applicable techniques. This diversity means that interactive cinema retains close intermedial relations with installation art, CD-ROM/DVD art, and computer games.

Progress (however disappointedly slow) in the field of interactive technologies of virtual reality (VR) creates certain prospects of further, profound transformations in the structure of film experience, allowing the recipient/user (now frequently termed "interactor" or "visitor") to immerse himself or herself

interactively[5] in the telematic (i.e., creating an illusion of bodily presence in remote locations) virtual world of the work. The basic attributes of VR apart from real-time interactivity, that is, immersivity and telematicity, expand certain vital properties of the cinematic apparatus; thus, virtual reality—enhanced by the textual qualities of film—potentially becomes the most crucial continuation of cinema in the field of multimedia.

Fourth, and finally, the Internet—by introducing networks into VR technologies—creates new directions of development for the potential net-based form of interactive, virtual cinema. The principal aim seems to be to establish the possibility of a telematic, multiuser participation in the virtual world thus conjured, which would turn all recipients into active, reciprocally interactive film characters. Today, such a vision seems to belong more in the cyberpunk novel[6] than in the domain of serious research. It must be observed, nonetheless, that although multimedia technologies are still in their infancy, the rapid pace of their development can let us assume that what we regard as merely potential nowadays—a futurological project—may actually be realized sooner than expected. Making predictions in this field, as long as it is based on a correct analysis of the development possibilities available to the multimedia apparatus, an analysis conducted in the context of its history, is not entirely unfounded. The joint research project of British Telecom, Illuminations Television, and the University of Nottingham, known as "Inhabited Television" and conducted under the supervision of John Wyver, which combines television broadcasts with virtual reality, allowing the viewers to telematically inhabit the bodies of the characters participating in the events that occur in one particular virtual spacetime, might be considered the first attempt at merging television, the Internet, cinema, and virtual reality into one coherent whole.[7]

Let me conclude this fragment of the discussion at hand with the following remark. All the processes detailed above contribute to a severe detachment of film (and predominantly cinema) from its previous, "unexpanded" structure. Traditional cinema is losing its former, dominant position in the landscape of contemporary audiovisuality. At the same time, scattered in a diaspora of sorts, the properties of cinema and film not only persist, but are even developing, practically unperturbed. In consequence, we are currently facing not so much the final obliteration of cinema and film, but rather an ever more likely possibility of its further dispersion and dissolution among the plethora of the media increasingly remote from it, in forms marked by less and less similarity. Cinema—the source of audiovisual art—is slowly ceasing to be its goal,

losing the autonomy of defining and delineating its paradigm. Nevertheless, cinema is still active in shaping new forms of audiovisual arts.

Television and Video

As stated above, television and other new electronic media and multimedia carry their own distinct ontology and logic of structural organization, in addition to inspiring new recipient behavior. The range of these innovations depends on the particular medium, since they manifest themselves in various aspects of the work and vary according to the situation in which the reception occurs; likewise, the transformations in different media are often incomparable. The video, or computer-generated animation, while introducing a new ontology into the domain of audiovisuality, retains the domination of the work's structure over the process of reception that is characteristic for film, whereas the art of interactive multimedia overturns this hierarchy, offering entirely new methods of organizing the process of artistic communication.

Television and the video share the ontology of the image. The remaining aspects of the two, such as the dispositive, bear a limited resemblance to each other (their possession of common features alongside the qualities that are decidedly dissimilar results in the entire system's attaining a different character in each instance). The image serves different purposes in the two media: in the case of video, it is "within reach," and touch unexpectedly becomes the sense of fundamental importance. Video is a medium of intimacy, of close contact, encouraging intrapersonal communication. As far as television is concerned, the substance of the image and sound, as well as their ontic structure, serves the function of transmitting (transferring between remote points) audiovisual information concerning events occurring in distant locations but made manifest in real time, or of presenting previously prepared programs. Telepresence—the basic quality of television as a medium of communication—is becoming one of the crucial qualities (i.e., categories) of electronic art. A television presentation (transmission) of a film transforms the medium into a sort of home cinema (telecinema).

The emergence and development of video has influenced the situation of the cinema theater more than that of film as such: the most fundamental changes offered by video, as a new medium of cinema/film, concern the dispositive, while the least important transformations have occurred in the area of film textuality. The range of innovations introduced by video proves to be much

broader when one considers the reception process rather than the structure of the work and the poetics of film. The invention of the videotape introduced new possibilities of its reception in private space, at home, in circumstances far removed from the classical cinematic reception, and yet entirely different from the standard television-watching (i.e., viewing a film included in the program). In the case of video, the cinematic spectacle—the presentation of the film—has been replaced by a process that might be described as "reading" the film. The condition of the viewer in the cinema has been compared to that of a person immersed in a dream; this, among other things, accounts for the specificity of the cinematic processes of identification-projection. In contrast, the reception in domestic circumstances is characterized by dispersed attention, observed already by Walter Benjamin. As a result, the consciousness of someone watching a film on a video display is far less dominated by the cinematic world and the magic of participation than if he were viewing the same film during a cinema projection.

The liberation of the viewer from the sway of the cinema screen is facilitated by the susceptibility of tape-recorded film to various kinds of manipulation: stopping, fast-forwarding, playing the film in slow motion or rewinding it. The recipient has therefore acquired a means of influencing the course of his experience ("living" the film). Thus, the structure of a film viewed with recourse to the video dispositive loses—within the limits of the recipient's experience—its finality and inviolability (although the finality of the film's shape is still invariably inscribed into its definition).

This property of the video dispositive is perhaps what makes it essentially different from the cinema. Seen from this perspective, video art appears as yet another stage in a transformation process tending toward interactive art. As has been said above, the reception of film has transmogrified into reading, a linear (yet irregular in its course), multifunctional process of perception and comprehension.

Similarly as in the past, when, after valiant efforts seeking to negate the new medium, cinema finally acknowledged television as an alternative method of disseminating film production parallel to cinema distribution, it has now accepted video as yet another cinematic medium (a film medium, to be precise). The expansion of the domain in which film functions has caused a peculiar split (stratification) in video textuality, leading to the appearance both of genuine video realizations (effected by means of this medium) and the transfer of cinema films onto videotape. It is here that one can trace the origins of the

process that has ultimately led to the blurring of the borders between the two media (i.e., between a film work and a video work). In addition, it is worth emphasizing the consequences of the invention of the video projector: with its help, video realizations may be shown to large audiences, in spacious rooms, in the conditions resembling a cinema séance (involving screening rather than emission). Although the image quality in video projections is still far removed from cinema standards, perfectly credible promises of eliminating this obstacle are currently being made. In this way, among others, the cinematic system is attempting to absorb the video and make it the future of cinema. As stated above, this type of intermedial connection is encountered very frequently in the contemporary world.

Interactivity/Deconstruction—Cyberculture

Placing computer technologies at the disposal of the motion-picture arts has created entirely new possibilities. Moreover, if we assume that the essence of each art form is defined by its distinctive features (or a system of features), then computer art begins a new chapter in the history of artistic culture.[8]

Interactivity—appearing in its very rudimentary form in the case of video, or perhaps appearing merely as proto-interactivity, a possibility of recipient behavior, motivated not so much by the work's structure as by the manifold needs of the viewer (including extra-aesthetic ones)—may acquire its full-fledged form in computer art. This means that interactivity is becoming the internal principle of the work, and the recipient—if he or she is willing to concretize it—must undertake actions that will result in forming the object of his or her perception. Interactivity in art, understood as a dialogue of sorts, communication between the interactor and the artifact,[9] occurring in real time and mutually influential, is becoming one of the essential features of contemporary culture.[10] Interaction calls into being a peculiar work of art—theoretically (and, with increasing frequency, also practically) unique in every instance of an individual, creative activity of the recipient-interactor. We are faced with a reversal of the ontological order of the elements constituting the process of artistic communication. What is created in the first place and as a result of the artist's activity is the context of the work and not the work itself (in the traditional sense). The artwork emerges afterward, as the product of the recipient, created by him or her within the context delineated by the artist.

One may assume that both objects, that is, the artifact and the work of art, connected by the interactor's receptive-creative actions, jointly constitute the final product of complex, multisubject artistic practices. Thus, the product acquires a processual character, becoming a complex communicative situation rather than a subject structure, while its organization may possess the character and order of a game (in the broad sense of the term). This final creation may be called—in keeping with tradition—a (broadly understood) work of art. Alternatively, it may, more adequately to the character of interactive art, be termed a field of interactive artistic communication. The situation also occasions the following question: to what extent, if any, is the process that has driven artistic practice toward its present state the peculiar apex of the tendencies leading toward the dematerialization of art, toward substituting the art object with a (hyper)text or a complex of (hyper)textual practices?

In reflecting on cyberculture and the assorted phenomena that constitute it (the most prominent among which is interactivity as such, as well as the interactive media arts), one may observe two radically opposing tendencies.[11]

The first current draws together those who would like to consider interactive art in the context of earlier concepts of art and with reference to the basic categories that construct the traditional, modernist aesthetic paradigm. The principal dogmas of this system are representation, expression, and the conviction that the artist-author dominates over both the artwork itself (the most characteristic view being that art equals whatever is designated as such by an artist) and its meaning (content), which is ultimately tantamount to the domination over the recipient and the perceptive-interpretative process. As a result of such an attitude toward interactive art, the experienced interaction is discussed not in terms of communication with the apparatus/artifact (or an artificial, intelligent system), but is seen as an intermediary interaction with the human (or humans) who made the work or its software. The communicative possibilities of such an interaction ought to be evaluated—according to Margaret Morse (1993)—by the standards of human communication. This kind of attitude can be identified in countless remarks on the subject of interactive art, regardless of the language used by the authors and the amount of new terminology they employ (which is constructed and used primarily to point out and describe the new properties of the contemporary condition of art and culture). Very frequently the inventive, innovative character of these categories is annulled in an attempt to adapt them to the requirements of the traditional aesthetic paradigm.

The representatives of the other trend are characterized by a proclivity to overemphasize those aspects of the new artistic phenomena which transcend traditional canons and which tend toward their cancellation. According to these critics, the crucial feature of cyberart and cyberculture is the abandonment of the idea of representation. Such a view leads to a radical transformation of the role assigned to the artist, who—instead of creating, expressing, and communicating content or meaning—becomes a designer of contexts in which the recipient is to construct his or her experiences, their references and meanings (Ascott 1993).

A significant philosophical-methodological context for a discussion of interactivity and interactive art, particularly useful in analyzing the above juxtaposition of the tendencies in cyberculture research, is provided by the deconstructivist philosophy of Jacques Derrida.

One of the principal assumptions in Derrida's theory is the claim that the logophonocentric attitude (logocentrism—a tendency toward meaning, sense; phonocentrism—the prevalence of spoken language over written text) as a method of approaching text, language, communication, and interpretation, has thus far been the dominant—if not the only—mode in Western culture (Derrida 1972). This stance is expressed in a conviction that the meaning of everything that exists was defined once and for all as presence (only what exists can be thought and expressed), and therefore remains eternally precedent and superior to any attempts at objectification or materialization (Derrida 1967). Thus, an interpretation of a text is reduced to decoding the sense already present, which differs from the text and essentially "extraneous" to it. The meaning dominates over the text and conditions it; the text functions merely as a neutral (more or less transparent) vehicle for the meaning prior to it.

Generally speaking, a classical logophonocentric interpretation reduces a given work, employing categories of representation and expression, in search of the work's ultimate truth or the intentions of the creator. Communication is therefore understood as conveying readymade meanings by various methods. The identity and presence of the subjects of the communication process (the author-sender and the recipient) are assumed before the communicative operation commences. The object of communication—the message and its meaning—cannot be established or modified during the communicative process. The notion of communication is inextricably linked to the function of representation and expression, since representational thinking precedes and

governs communication, which merely transmits ideas, meanings and content. Thus, communication equals conveying what is already known.

The attitude toward interactive art that was presented above as constitutive for the first of the two tendencies is rooted in this above theory, which is here termed "modernist." Obviously, nowadays it seldom manifests itself in its extreme form; the majority of the theoreticians asserting their connection with the traditional aesthetic paradigm agree that the meaning offered to the recipient by an interactive work is largely modified in the course of the reception (the same researchers, however, are reluctant to accommodate the notion of meaning as a never-ending process). In their theories applying to interactive art, the domination of meaning over the work's relational (i.e., communicative) structure is not as pronounced as in more traditional artistic forms; their proponents draw the line at accepting meta-interactivity as a sine qua non of a work's artistic dimension.[12] The interpretation of an artwork is also liberated from the supremacy of meaning established or communicated *a priori*, while the rigors of communication are considerably softened, producing what one is tempted to call open communication. The "softening" and "openness" notwithstanding, the essence of the phenomenon remains unchanged: according to the theoreticians of this tendency, the process of interactive artistic communication occurs predominantly in the shadow of the author and his primal, fundamental presence. Not only does the authorial presence transform an object into art, but it also suffuses the work with meaning and value, defining—in a somewhat softened form—all aspects of the interaction.

Derrida's deconstructivism, on the other hand, appears as a methodological matrix for the type of reflection championed by the second tendency outlined above. This theory releases the artwork from all dependency (derivativeness) in relation to any communicated (a priori) meaning: the work occupies the primary position. Attention is paid to its structure, the process of its formation. Understood in this way, the work of art requires a different type of reception—an "active interpretation," resembling a game, promoting a transformative activity oriented toward "nonfinality," "nonultimacy." The reading of the sense is replaced by a creational reception of the work, that is, navigating through the artifact (hypertext). The work, therefore, as a communicative process, assumes the character of a game (the rules and the roles, nonetheless, need not be ultimately or explicitly defined). The epistemological function is here complemented by the auto-epistemological aspect, while comprehension

assumes the form of coparticipation. Creative reception–communication is a process of creating meaning, a significantly creative activity. Ultimately, both processes merge into one common syndrome.

Interactive media art appears to be the perfect example of the new, deconstructive, postmodernist, cybercultural understanding of an artwork and of artistic communication. Rejecting traditional dogmatism, it does not substitute it with a new scheme, which petrifies the world of art. Derrida did not replace logocentric ideology with graphocentrism, but reduced the role of the author to one of the interpretative contexts; similarly, interactive art has demythologized the role of artist-as-demiurge, ascribing to him the function of context designer who prepares the ground for creative reception. Currently, the notion of the author is being replaced with the notion of dispersed authorship—the joint aim of the so-called artists and the so-called recipients. Seen from this angle, art is no longer a form of presenting a readymade, finalized and a priori given world. To construct art in cybersphere, according to Roy Ascott, is to construct reality, to design cyberspatial communication systems, which support our desire to strengthen human collaboration and interaction in an endless process of constructing the world (Ascott 1993).

There is much adjacency between deconstructivist philosophy and the logic of interactive multimedia arts. One may infer that deconstructivism could become the methodological context for the research of interactive arts and cybernetic culture. Deconstructivist categories seem capable of grasping and enabling the analysis of all new features found in interactive multimedia arts. With their help, interactive communication may free itself from the traditionally understood notions of representation and expression, from the idea of meaning preceding communication, as well as from the modernist interpretations of concepts such as the author and the recipient. Interactive artistic communication could thus become a multidimensional, multiform, unceasing process in which values and meanings, as well as new realities, are created in cooperation.

Both strategies of comprehending interactive art, discussed above, ought to be perceived in terms of theoretical models. As models, they may indicate the most general properties of cyberculture and of the interactive media arts, as well as the most universal methods and techniques of their interpretation. Nonetheless, the space delimited by these two polarized perspectives contains a plethora of notions, theories, actions, and works. One can encounter there artists working in the area of interactive arts and concurrently believing their

duty to be the expression of their own views and the shaping of human minds; one can also find critics and theoreticians who, by analogy, claim that every artwork (the interactive ones included) is exclusively (or primarily) an extension of the artist's imagination, sensitivity, knowledge, and desires. However, there is no shortage of artists and researchers who contend that interactivity is tantamount to sharing the responsibility with the viewer and liberating the work of art from all its ties, including that to the artist.

It ought to be emphasized that the juxtaposition of the two models proposed above is not explicitly crypto-evaluative. We are faced with two different projects of introducing interactivity into the realm of culture; concerning their value, we may only state that the project allowing the recipients to act in a space characterized by reduced authorial restrictions respects the internal logic of interactivity and leads to the emergence of "pure" interactive artifacts. Concurrently, we may observe that this is the only way that could lead the recipient toward a truly creative position, one that fulfills the expectations regarding interactive art. The other project, on the other hand, is an endeavor to situate interactivity in the context of the modernist theory of art and culture, with all its attendant categories and principles. In this case, nevertheless, the creativity of recipient behavior—perceived as broadly as it is customary with regard to interactive art—appears to be little more than wishful thinking.

Interactive Art—Hypertext Art

The new media (multimedia), functioning in accordance with the principle of interactivity, have therefore accomplished an interiorization of deconstructivist logic. As a result, considerable shifts have occurred as regards the roles and the range of their respective competences. The artist-author ceases to be the sole creator not only of the work's meaning, but also of its structure, its shape; the work is thus being cocreated by the recipient in a process of interacting with the artifact. The artist's task is now the creation of this artifact: a system/context in which the recipient/interactor constructs the object of his or her experience as well as its meaning. The recipient is no longer merely an interpreter of readymade meaning that awaits comprehension, or a subject perceiving a finalized material artwork; it is on his or her activity and creativity that the structure of the renewed aesthetic experience hinges. Let us therefore restate that both the structure of the work and the evoked meanings are cocreated by the recipient, who thus becomes a cocreator.

However, the interactive works currently created, like our entire culture, exist under the influence of both paradigms: the modernist and the postmodernist. As a consequence, and depending on which of the two is more prominent in a particular case, the resulting works are to a greater or lesser extent the artist-author's form of expression and (in an inverse proportion) the outcome of the recipient-cocreator's activity. Despite this duality of paradigmatic references and the resulting compromises, the influence of interactivity is broad enough for researchers to admit that the situation encourages the establishment of new research tools and their accompanying rules of application. Within the framework of this freshly designed research, particular attention would be paid to those features and ingredients of the new aesthetic situation that concern the relation between the individual participants of artistic communication, and to the questions of artwork analysis and interpretation.

Interactivity is the fundamental feature of the general process that leads to transformations both in the substantial and the semantic status of art. As mentioned above, the process occurs as a result of—among other things—separating the work from the artifact and the latter becoming hypertextual in character.

Regardless of the complexity of its internal organization, the text always offers a determined (linear) direction (route) of exploration. Above, this method of interpretation has been called "reading"; its ultimate goal is the discovery (or negotiation) of the work's (text's) meaning and the revealing of its as yet sort of hidden entirety. Conversely, hypertext—a multilevel, multielement structure—does not determine or privilege any direction of analysis or interpretation (i.e., comprehension). The journey through it is termed "navigation" (see, e.g., Barrett 1989; Berk and Devlin 1991; Bolter 1991; Aarseth 1997).

It is predominantly the structure of the hypertext—along with the material that fills it: images, texts, sound—which becomes the object of the artist's creative work (in addition to the interface and the elements connected with the genre of the realization). Hypertext in its entirety, however, is never the object of the recipient's perception or experience, but rather—as mentioned above—the context of this experience. The technical-constructional characteristics and the properties of the medium employed by the hypertext artist delineate the standard circumstances of reception, in which the hypertext user, repeatedly faced with the necessity of choice-making and actualizing the selected elements, exploits only a slight portion of the work's potential.

The sum of these choices defines the work—the joint product of the artist (provider of material and choice rules) and the recipient (selector of material and creator of the work's final structure).

It is tempting to risk the statement to the effect that interacting with a hypertext transforms it into a text, since the ultimate result is invariably a complete, finalized structure—the upshot of the recipient's selections. Such a statement, nonetheless, would be incorrect: the recipient/hypertext-user, who perceives the outcome of his or her interaction, that is, the work, also experiences his or her own choices, as well as their contexts (the software, the interface, the spatial arrangement, etc.). When he or she considers the navigation concluded, and decides that the result is the final work, he or she also experiences (often consciously) the nonfinality, nonultimacy inscribed into the nature of interactive art.

It could therefore be validly argued, and that if the work were to be equated with the text, then in the case of interactive art we are not dealing with a work of art at all. Consequently, we must decide whether hypertext ought to be treated as an artwork (albeit one whose entirety cannot be grasped in an aesthetic experience), or perhaps agree with the verdict that the work does not exist, or, finally, assume that interactive art invokes a new type of artwork: one which materializes exclusively during a receptive (creative-receptive) interaction and is not identical with the result of the artist's creational actions. Moreover, it is not intersubjectively identical, seeing as each recipient experiences the unique outcome of his or her own interaction.[13]

One may also argue, as previously in this discussion, that the ultimate object of analysis is not the work itself, regardless of the definition, but the field of interactive artistic communication, where the work, along with other elements (the artist, the recipient/interactor, the artifact, the interface) becomes entangled in an intricate, multidimensional complex of communication processes. Such a perspective is the one I prefer.

In the domain of interactive art, which employs the structure of hypertext, the analytical-interpretative issues take an entirely different form. It is difficult to speak of analyzing a phenomenon that exists only during the process of reception, since one of the premises of analysis is a certain durability of the work under inspection, the repeatability of its experience, as well as the possibility of returning to the analyzed object. The same is true for interpretation; both procedures ought to be verifiable to a certain extent. What is more, both analysis and interpretation assume the immutability—even a limited one—of the

examined object, the persistence of its meaning. None of these requirements can be met, however, by a consistently interactive work, as it endures only at the time of the interactive process. A subsequent activation of the hypertext, even performed by the same recipient/interactor, is bound to conjure a new work. Both the analysis and interpretation of an artwork thus understood must be parallel to the process of its reception, its (co-)creation; it must be identical with it. Reception, creation, analysis, and interpretation become one and the same complex of processes, occurring in the field of artistic communication.

It is only natural, given the circumstances, to doubt the necessity and validity of analyzing and interpreting a work of interactive art. These procedures, understood traditionally, seek their justification in epistemological and educational needs. If the knowledge produced by them is not intersubjectively verifiable, and its object is not intersubjectively available, the same analytical-interpretative actions lose their status of isolated, autonomous critical or scientific procedures. They might then be treated merely as a peculiar manifestation of the work's autotelicity, a symptom and proof of its internal metadiscourse, since the work appears in the process of its creative reception, or—to formulate this hypothesis more radically—the work is identical with its reception. Therefore, logically, it is identical with its interpretation.

What remains as the possible object of analysis is the aforementioned field of interactive artistic communication. These problems, however, shall be discussed elsewhere.

The number of interactive works produced today is increasing with inconceivable speed. The works represent not only the two model attitudes discussed above; we are faced with a multitude of realizations resulting from the concurrent influence of the two indicated paradigms. Interactivity is becoming the essential and most representative property of contemporary culture. Both of its models affected very seriously the artistic practice of the twentieth century's last decade and the beginning of a new one, and there is no reason to suppose that either will disappear in the foreseeable future, since contemporary culture is becoming increasingly more, rather than less, diverse.

What this amounts to is not merely the coterminous functioning of a wide spectrum of interactive works, but also their coexistence with the works belonging to the noninteractive and proto-interactive culture. Among the latter, one may encounter numerous qualities, notions, and structures that prefigure interactive art and culture. From the contemporary perspective, we may

even observe a certain *sui generis* logic in the development of forms, attitudes, concepts, and theories which comprise the process leading from the neo-avant-garde (happening, conceptualism, Fluxus, etc.) toward the current paradigm of electronic, digital, interactive, multimedia culture.

Notes

1. For the purposes of this study, the term "cinema" will denote, in keeping with the established tradition (owing to its heterogeneity and internal diversity, however, each reference to it inevitably becomes an interpretation, a choice of a variant) its basic apparatus and its dispositive (these two interconnected instances of cinema will henceforth be termed "apparatus in a general sense"), whereas the term "film" will apply to the textual-artistic aspect. The basic apparatus is the sum total of devices, techniques, and operations used in producing a film and creating its subject, and—in its broader meaning—an array of contexts that are connected with them, i.e., social, cultural, ideological, economic, etc. The dispositive, on the other hand, comprises the mechanisms, processes (technical as well as psychological), their arrangements and contexts, which jointly constitute the projection and perception of the film. Together they form the institution of cinema. See Baudry 1970; Comolli 1971–1972; Heath 1981; Kuntzel 1976.

2. The principal effect of this is the blurring of the distance from reality in order to conceal its being constructed rather than presented or reproduced.

3. Another aspect of this situation is a certain virtualization of reality, which appears to be the long-term effect of the media worlds' existence and their influence on the perception of reality.

4. This term is understood here as a channel of dialogic communication between the recipient/interactor and the artifact, as the device enabling interaction. The basic function of an interface is the creation of communication possibilities between parties employing different languages.

5. The immersion of the senses means that the subject assumes—within limits defined by the engaged senses—the internal (diegetic) point of view.

6. Contemporary researchers of cyberculture regard cyberpunk novels as a highly legitimate source of information concerning postmodernism and the social transformations occurring as a result of the emergence of new information-communication

technologies. An extreme opinion in the matter is held by Doug Kellner, who contends that cyberpunk fiction offers far more insight into postmodern processes than the work of cultural critics such as Jean Baudrillard (Kellner 1995). A more balanced view is that of Mike Davis, who argues that William Gibson's novels and short stories are excellent examples of science fiction functioning as a prefiguration of social theory (Davis 1992).

7. In the preface to the presentation of *Out of This World* (the first, prototypical realization employing the "Inhabited Television" technology, performed in the Green Room Gallery, Manchester, on 6–7 September 1998, as part of the 9th International Symposium of Electronic Arts), John Wyver himself remarked that the event was tantamount to the birth of a new medium.

8. Despite an ontological perspective distinct from cinema and the video, computer animation, restricted as it is—similarly to video—to producing moving images, remains part of the previous epoch, merely enhancing the expressive means characteristic for the two aforementioned media. This hypothesis was confirmed very forcibly, though perhaps unwittingly, by Yvonne Spielmann in her paper entitled "Is There an Avant Garde in Digital Art?," presented during the 9th International Symposium on Electronic Art, Liverpool-Manchester 1998. The attempt to isolate the defining qualities of digital arts by referencing exclusively the video and computer animation resulted in conclusions to the effect that there exists an aesthetic proximity (or even adjacency) between digital media arts and analog media arts.

9. An artifact, in reference to interactive art, is here taken to be the product of an artist's creative activity, a structural connection of selected elements (and aspects) of the dispositive and the interface. Seen from another perspective, the artifact is the structure of the hypertext, including the material constituting its basis: images, sounds, and texts, i.e., the foundation of a work's textuality. Therefore, the artifact also fulfills the function of the work's context. The context-artifact is the product of an artist, who—instead of presenting the viewer with a traditional artwork, a meaningful object of interpretation and a source of aesthetic experience—creates a space for interaction; see Kluszczynski 1997.

10. If "interaction" is interpreted more generally and the notion of the artifact is not restricted to artistic references, interactivity appears as the crucial feature of all communication processes; communication, in turn, attains the status of the principal social relation. As a result, the social structure itself must be termed "information society"; see, e.g., Lyon 1988; Jones 1995.

11. These tendencies are radically opposed on the theoretical plane as different models. In research practice, however, elements belonging to both models may appear within the same program. This may stem from a lack of theoretical precision on the part of the particular author, or—a more likely possibility—from a instability within the paradigm of the contemporary reflection on art as a result of its remaining at the stage of fundamental transformations.

12. Interestingly enough, this notion is accepted by representatives of both tendencies.

13. Obviously, these remarks refer to a model work that would fully respect the logic of interactivity. In the case of a realization influenced by both paradigms—the modernist and the postmodernist—the situation is more complex. To describe it adequately, one would be forced to combine the research tools specific to each of the indicated perspectives.

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