ArtMuseum.net

Multimedia
From Wagner to Virtual Reality

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Teachers' Guide

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Teachers' Guide

Douglas Engelbart lecturing at the Stanford Research Institute (SRI)

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subtext

About the Teachers' Guide

This Teachers' Guide provides a model for integrating the Web site and the book, a tool for teaching college level students the history, theory and practice of multimedia. The on-line syllabus below is organized thematically around key concepts that are introduced in *Multimedia: From Wagner to Virtual Reality*. It incorporates essays by artists and scientists from the book, while taking advantage of the Web site's extensive media resources with links to photo and video documentation.

The following syllabus is from the course taught by Randall Packer at the Maryland Institute, College of Art in Baltimore.

Multimedia: From Wagner to Virtual Reality

Course Description

Multimedia: From Wagner to Virtual Reality is an overview of the pioneering artists and scientists who have brought about the dissolution of boundaries that have traditionally existed between the artistic and technological disciplines. The course surveys the work and ideas of artists who have explored new interactive and interdisciplinary forms, as well as engineers and mathematicians who have developed information technologies and influential scientific and philosophical ideologies that have influenced the arts. Seminal artistic movements and genres will be explored, such as: the Futurists, Bauhaus, kinetic sculpture, Happenings, video art, electronic theater, etc. It is a study of the invention of information technologies and new human-machine paradigms that have come to define the medium of the personal computer, including: cybernetics, augmented intelligence, hypertext, human-computer symbiosis, graphical user interface, etc.

This broad historical analysis helps illuminate an understanding of the emerging digital arts and its aesthetics, strategies, trends, and socio-cultural aspirations. Central to this analysis is an understanding of key concepts for the interpretation of evolving multimedia forms: including integration, interactivity, hypermedia, immersion, and narrativity. The course reveal hows these primary elements of contemporary media have roots in electronic and performance art prior to the digital era.

Week 1 Overture

Review of course objectives, readings, assignments, projects, and grading.

Introduction to Multimedia: From Wagner to Virtual Reality through an overview of the interactive timeline, that covers 17,000 years of historical precedence and pioneering work and ideologies by artists and scientists, from the Caves of Lascaux to the present.

Assigned Reading

• Randall Packer and Ken Jordan, "Overture," Multimedia: From Wagner to Virtual Reality

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Weeks 2 - 3 Integration

Definition: Integration - The blurring of traditional boundaries between

disciplines – such as the arts and science – or between discrete media.

A discussion of key 19th and 20th Century developments in the integration of the arts and technology, beginning with the work of composer Richard Wagner and his idealized notion of the Gesamtkunstwerk (Total Artwork), followed by Bauhaus artist László Moholy-Nagy, who began working with electronic and kinetic forms in the 1920s, and Bell Labs engineer Billy Klüver, who was a central figure in the New York art world during the 1960s with the formation of E.A.T. (Experiments in Art and Technology).

Assigned Reading

• Richard Wagner, "The Artwork of the Future," 1848
• László Moholy-Nagy, "Theater, Circus, Variety," *The Theater of the Bauhaus*, 1929
• Billy Klüver, "Northeastern Power Failure" 1966

Weeks 4 - 5 Interactivity

Definition: Interactivity - Reciprocal exchange between the viewer and the artwork, the ability to manipulate media and objects intuitively and with immediacy.

This topic explores the evolution of the technical, aesthetic, and cognitive concepts behind human-computer interactions, and their influence on the art, design and application of interactive media. Beginning with the fundamentals of cybernetics as conceived by engineer Norbert Wiener in the late 1940s, we will discuss subsequent scientific breakthroughs in human-computer interaction including Douglas Engelbart's oNLine System and invention of the mouse. We will then explore parallel cybernetic and interactive tendencies emerging in the arts during the 1960s through the writings and work of John Cage and Roy Ascott.

Assigned Reading

• Norbert Wiener, "Cybernetics in History," *Human Use of Human Beings : Cybernetics in Society*, 1954
• Douglas Engelbart, "Augmenting Human Intellect: A Conceptual Framework," 1962
• John Cage, "Diary: Audience 1966," *A Year From Monday*, 1966
• Roy Ascott, "Behavioral Art and the Cybernetic Vision," 1967

Weeks 6 - 7 Hypermedia

Definition: Hypermedia - The non-sequential linking of information, events, and discrete media.

A discussion of the evolution of hypermedia and the non-linear association of information resulting in the collapse of traditional spatial and temporal boundaries. We will begin with Vannevar Bush's seminal investigation into the concept of the hyperlink through his design of the Memex in 1945, the prototypical multimedia workstation. This will be followed by Ted Nelson's coining of the term hypertext in the early 1960s, in which non-linear associative thinking was applied to human-computer interaction, concluding with Alan Kay's creation of the graphical user interface and the first hypermedia system for a personal computer at Xerox PARC in the 1970s.

Assigned Reading

- Vannevar Bush, "As We May Think," Atlantic Monthly, 1945
- Ted Nelson, Computer Lib / Dream Machines" 1974
- Alan Kay and Adele Goldberg, "Personal Dynamic Media," 1977

Weeks 8 - 9 Immersion

Definition: Immersion - The experience of entering a multi-sensory representation of three-dimensional space.

An exploration of the evolution of virtual reality and 3D virtual space: multimedia as an immersive experience that engages all the senses. We will overview the research of artists and scientists dating back to the 1950s, including Morton Heilig, Ivan Sutherland, Myron Krueger, and Scott Fisher, who have pioneered the tools and aesthetics of virtual reality, stereoscopic imaging, and telepresence, leading to the creation of digital, immersive environments.

Assigned Reading

- Morton Heilig, "The Cinema of the Future," 1955
- Ivan Sutherland, "The Ultimate Display" 1966
- Scott Fisher, "Virtual Environments," 1989

Weeks 10 - 11 Narrativity

Definition: Narrativity - Interactive, branching forms that lend the user control over the narrative, diminishing the traditional primacy of the author's voice.

This final investigation focuses on the reshaping of narrative with new nonlinear,

interactive, and electronic forms of media and communication. We will discuss the pioneering interactive media art of Lynn Hershman, text-based virtual realities (MUDs) as discussed by Pavel Curtis, and video artist Bill Viola's critique of emerging new possibilities for artistic creation in the context of interactive, immersive, and hypermediated forms. This analysis includes a survey of the installations of Bill Viola from his 25th year retrospective exhibition.

Assigned Reading

• Bill Viola, "Will There be Condominium's In Dataspace?," 1983
• Lynn Hershman, "The Fantasy Beyond Control," Art and Technology, 1990
• Pavel Curtis, "MUdding: Social Phenomena in Text-Based Virtual Realities," 1992

Weeks 12 - 13 The Future is Under Construction

Definition: Future of multimedia - A telematic society collectively producing an expanded intelligence and knowledge through new forms of art and social engagement through digital technologies.

"Human intelligence? Its space is dispersion. Its time, the eclipse. Its knowledge, the fragment. Collective intelligence realizes its reintegration... Through the intermediary of virtual worlds, we can not only exchange information but think together, share our memories and our plans to produce a cooperative brain." – Pierre Lévy, from Collective Intelligence

This final session brings together a selection of scientific, artistic, and cultural theorists whose writings have influenced our perception and understanding of new media, its socio-cultural impact, its technical possibilities, its artistic implications. Roy Ascott, Marcos Novak, and Pierre Lévy agree that through the pervasive assimilation of networked media, there will be new potential for aesthetic, scientific and social transformation.

Assigned Reading

• Roy Ascott, "Is There Love in the Telematic Embrace," 1990
• Marcos Novak, "Liquid Architectures in Cyberspace," 1991
• Pierre Lévy, "The Art and Architecture of Cyberspace", *Collective Intelligence*, 1995

Multimedia From Wagner to Virtual Reality In Depth

Vintage documentation of artistic and technological innovation: source material for interpretation and inspiration. *Click and explore.*

Billy Klüver

Douglas Engelbart

Alan Kay

Scott Fisher

Lynn Hershman

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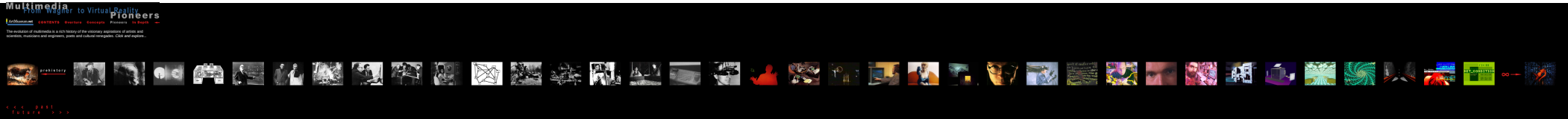
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In Depth
The evolution of multimedia is a rich history of the visionary aspirations of artists and scientists, musicians and engineers, poets and cultural renegades. Click and explore...
prehistory
< < < past
future > > >

Multimedia
From Wagner to Virtual Reality
Concepts

The following concepts determine the scope of multimedia's capabilities for expression, out of which have grown ideas, speculation, and invention. *Click and explore.*

Introduction

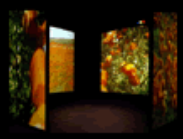
Integration

Interactivity

Hypermedia

Immersion

Narrativity



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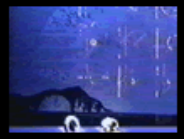
Multimedia
From Wagner to Virtual Reality
Overture

Broad themes that underscore an "untold" story behind the evolution of multimedia: its precedents, unsung heroes, and the extraordinary creative work and visionary thinking of artists and scientists. *Click and explore.*

Prologue

Birth of a New Medium

Integration of the Arts



Through the Looking Glass

Integrated Datawork

Future is Under Construction

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Pioneers

F.T. Marinetti | Futurist Cinema <1916>

'Portrait of FT Marinetti' by FC Coletti

"We shall set in motion the words-in-freedom that smash the boundaries of literature as they march towards painting, music, noise-art, and throw a marvelous bridge between the word and the real object."

< < < subtext > > >

F.T. Marinetti | Futurist Cinema <1916>

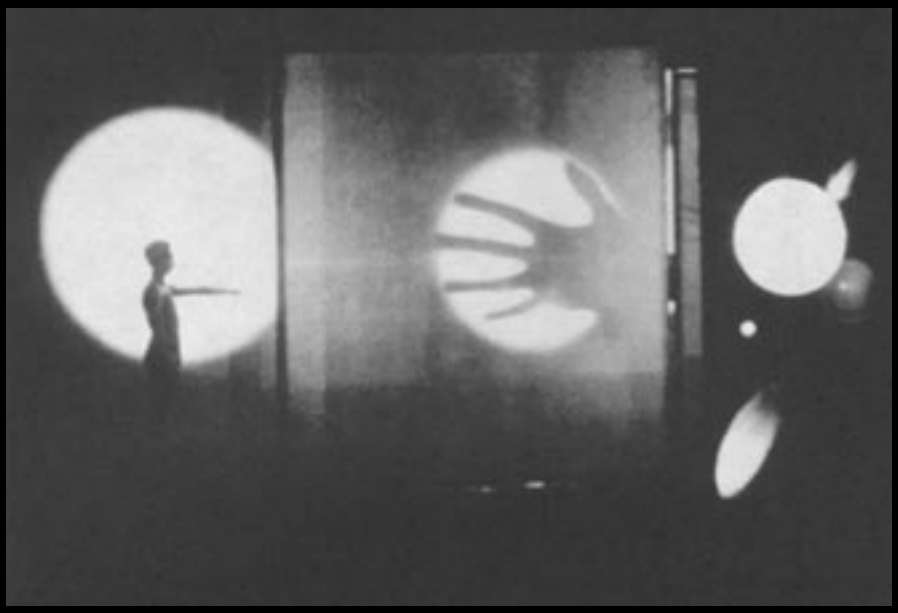
The Italian poet F.T. Marinetti, chose the Parisian public as the target for his 1909 Futurist Manifesto of "incendiary violence," calling for an end to all art that refused to embrace the social transformation brought by technology in the new century. It was in cinema that Marinetti and his colleagues saw the potential for a form of expression that reflected the speed and energy of the times.

In the *Futurist Cinema* manifesto of 1916, they declared cinema could be the most dynamic of human expressions because of its ability to synthesize all of the traditional arts, unleashing a form that was totally new. The Futurist cinema would free words from the fixed pages of the book and "smash the boundaries of literature," while it would enable painting to "break out of the limits of the frame."

Pioneers

László Moholy-Nagy | Theatre of Totality <1924>

"The Theater of Totality with its multifarious complexities of light, space, plane, form, motion, sound, man – and with all the possibilities for varying and combining these elements – must be an ORGANISM."



Light Play with Projections from Bauhaus Theater

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László Moholy-Nagy | Theatre of Totality <1924>

Bauhaus artist László Moholy-Nagy undertook a wide range of aesthetic investigations, using the school as a laboratory to examine the formal principles of abstraction in painting, photography, and sculpture. He also explored the influence of technology, which had a profound impact on his work and ideas. These experiments led Moholy-Nagy to develop a new kind of theater based on these principles. Underlying this approach was an effort to synthesize the theater's essential components – space, composition, motion, sound, movement, and light – into a fully integrated, abstract form of artistic expression.

Moholy-Nagy referred to this idea as the theater of totality, a reinterpretation of Wagner's concept of total theater. Moholy-Nagy's approach to the synthesis of the arts reduced the importance of the written word and the presence of the actor, placing them on an equal plateau with stage design, lighting, music, and visual composition. This interest in formal integration

included technology, which is reflected in his use of mechanical motifs in his work in other genres such as painting, photography, film and sculpture.

Pioneers

Billy Klüver | Collaboration <1960>

"The new interface I will define is one in which the artist makes active use of the inventiveness and skills of an engineer to achieve his purpose. The artist could not complete his intentions without the help of an engineer. The artist incorporates the work of the engineer in the painting or the sculpture or the performance."

Jean Tinguely, *Homage to New York*

< < < subtext > > >

John Cage discussing collaboration

Billy Klüver | Collaboration <1960>

In the late 1950s, the Swedish-born engineer Billy Klüver worked on laser systems for Bell Laboratories in Murray Hill, New Jersey. He became the chief catalyst for the art and technology movement that was launched dramatically in the spring of 1960, at the Museum of Modern Art, with Jean Tinguely's infamous self-destructing kinetic sculpture, *Homage to New York*. Klüver's participation in this work, with its paint bombs, chemical stinks, noisemakers, and fragments of scrap metal, inspired a generation of artists to imagine the possibilities of technology, as the machine destroyed itself, in Klüver's words, "in one glorious act of mechanical suicide."

Klüver proposed the active and equal participation of the artist and engineer in the creation of the artwork. In this collaboration, he believed that the engineer required the participation of the artist, who as a "visionary about life" and an active agent of social change, involved the engineer in meaningful cultural dialog. At the same time, he felt that the artist, in the spirit of Robert Rauschenberg's famous credo "to close the gap between art and life," had an obligation to incorporate technology as an element in the artwork, since technology had become inseparable from our lives.

In Depth

Pioneers

Allan Kaprow | Happenings <1964>

Performance of Kaprow's Household

"The images in each situation can be quite disparate: a kitchen in Hoboken, a pissoir in Paris, a taxi garage in Leopoldville, and a bed in some small town in Turkey... None of these planned ties are absolutely required, for preknowledge of the Happening's cluster of events by all participants will allow each one to make his own connections."

< < < subtext > > >

Allan Kaprow | Happenings <1964>

Allan Kaprow coined the term Happening in the late 1950s, and led the movement into the bright lights of popular culture that characterized the 1960s. Happenings are notoriously difficult to describe, in part because each was a unique event shaped by the actions of the audience that participated on any given performance. Simply put, Happenings, such as *Household* from 1964, were held in physical environments – loft spaces, abandoned factories, buses, parks, etc. – and brought people, objects, and events in surprising juxtaposition to one another. Kaprow views art as a vehicle for expanding our awareness of life by prompting unexpected, provocative interactions. For Kaprow, art is a continual work-in-progress, with an unfolding narrative that is realized through the active participation of the audience.

Kaprow developed techniques to prompt a creative response from the audience, encouraging audience members to make their own connections between ideas and events. These narrative strategies

relied on a non-linear sequencing of events, and the use of indeterminacy to shape the course of the Happening. The Happening was a constellation of events that could be distributed across once arbitrary temporal and spatial boundaries. The decentralization of authorship, location, and narrative – here united by the intent of the artist and the imagination of the participating audience members – foreshadows non-linear forms in digital media which makes use of interactive and networked technology to expand the boundaries of space and time.

Pioneers

Nam June Paik | Cybernated Art <1967>

"There is no rewind button on the Betamax of life."

Charlotte Moorman and Nam June Paik in *Opera Sextronique*

< < < subtext > > >

Nam June Paik | Cybernated Art <1967>

In the 1960s, Nam June Paik embraced the medium of television, and became the founding father of video art. His long and prolific relationship with electronic media began notably with the cellist Charlotte Moorman, in controversial performance works such as *Opera Sextronique* from 1967. Paik's oeuvre later included television sculpture, satellite art, robotic devices, and giant video walls with synthesized imagery pulsating from stacks of cathode-ray tubes.

Paik suggests that art should embrace the technologies of the information society. Paik presents himself as artist-shaman, synthesizing art and technology in an effort to exorcise the demons of a mass-consumer, technology obsessed society. Paik uses rejected media artifacts in his work, such as vintage television sets. His video works, with their liberal doses of "cybernated shock and catharsis," are poignantly cynical pieces that comment on an American techno-culture dominated by

starry-eyed optimists.

Pioneers

Robert Wilson | Visual Theater <1976>

"Go like you would to a museum, like you would look at a painting. Appreciate the color of the apple, the line of the dress, the glow of the light... You just enjoy the scenery, the architectural arrangements in time and space, the music, the feelings they all evoke. Listen to the pictures."

Einstein on the Beach **by Robert Wilson and Philip Glass**

< < < subtext > > >

Robert Wilson | Visual Theater <1976>

Out of the ferment of the 1960s, Robert Wilson brought performance art to Wagnerian scale in the 1970s with his epic "visual operas." Originally trained as a painter, Wilson was frustrated with the images in his head that were so much richer than anything he could get on canvas. Together with his collaborators who varied from the autistic child Christoper Knowles, to musical celebrities David Byrne and Jessye Norman, to some of the great artists of our time including poet Allen Ginsberg, composer Philip Glass, and playwright Heiner MŸller, Wilson created an inexplicable music theater experience from the integration of non-narrative drama, scenic spectacle, music, sound, silence, and dance.

Influenced by the work of John Cage and Merce Cunningham, Wilson's concept of visual theatre set movement and staged events free in time and space, as the surrealist writer Louis

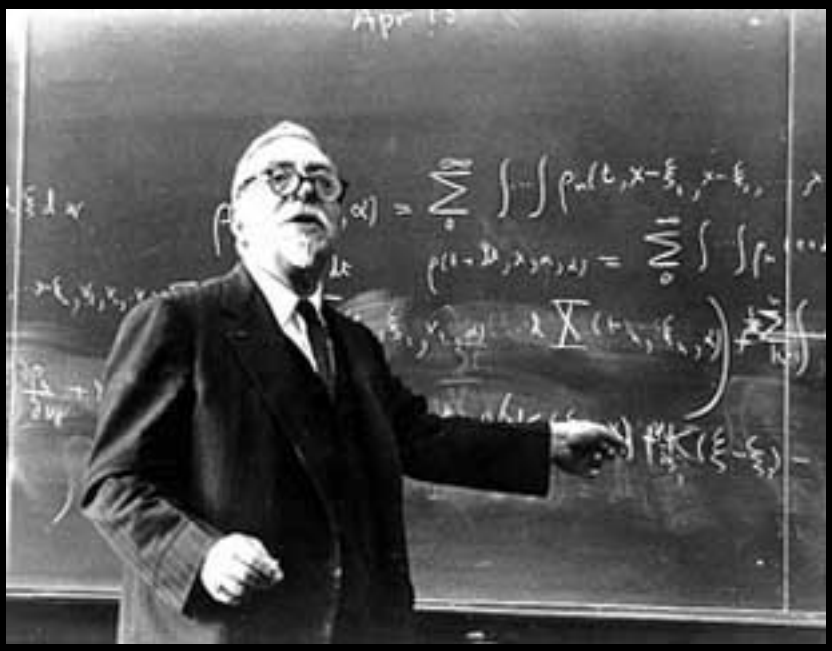
Aragon declared, "an extraordinary freedom machine." Large scale works such as Einstein on the Beach and The Life and Times of Sigmund Freud were biographical sketches of the mind, generating for the spectator an "intuitive" experience drawn from suggestive actions, slow-motion, and repetitive, non-sensical texts. Unlike the linear flow of time in traditional theater, Wilson's music-visual interface frees the spectator, allowing the mind to freely explore and participate, "rather than the usual virtuoso tools used to project some play's predetermined energies and meanings."

When Einstein on the Beach was given its American premiere at the New York Metropolitan Opera in 1976, the two principal collaborators, Robert Wilson and composer Philip Glass were totally unprepared for the impact this work would have on the contemporary performing arts. Based on the creative genius of Einstein, and his fascination for numbers, technology, music, and philosophy, the four hour "science-fiction opera" includes a trial, a steam locomotive, and a futuristic spaceship. Contrary to traditional opera, there is no linear narrative, no orchestra in the pit, the libretto is replaced with numerical and syllabic counting, while a small instrumental ensemble supported by electronic keyboards is placed right on stage.

Pioneers

Norbert Wiener | Cybernetics <1948>

"Society can only be understood through a study of the messages and the communication facilities which belong to it."



Norbert Wiener **lecturing at MIT**

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Norbert Wiener | Cybernetics <1948>

Norbert Wiener defined "cybernetics" as the science of transmitting messages between man and machine, or from machine to machine. The term cybernetics has its roots in the Greek word for "steersman" or "governor," and Wiener's use of it suggests how people interact with machines through a controlling device, such as a steering mechanism. Wiener's remarkable insight, which is the premise behind all human-computer interactivity and interface design, is that human communication should be a model for human-machine and machine-to-machine interactions.

Wiener claims that the quality of man-machine communication influences man's inner well-being. His theory of cybernetics was meant to improve the quality of our existence in a technological society, where people are increasingly reliant on machines, and where interactions with machines are the norm. The design of machines, and their ability to respond effectively to us, has a direct impact on the social condition.

Pioneers

Douglas Engelbart | Augmentation <1968>

"Our goal of augmenting the human intellect... will exhibit more of what can be called intelligence than an unaided human could... by organizing his intellectual capabilities into higher levels of synergistic structuring."

oNLine System (NLS) **demonstration at the 1968 Fall Joint Computer Conference**

< < < subtext > > >

On the Augmentation of Human Intellect

Douglas Engelbart | Augmentation <1968>

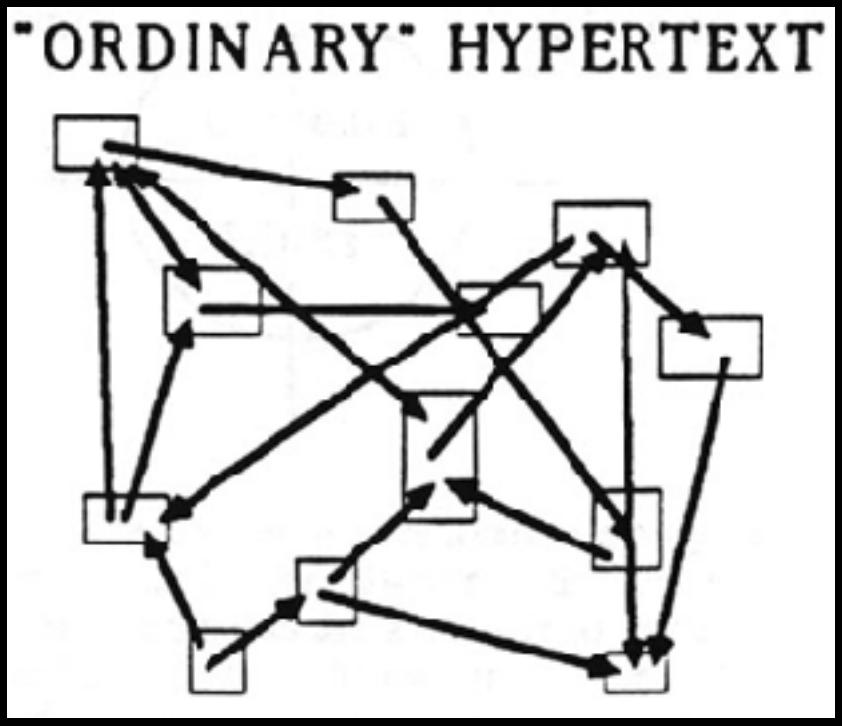
Douglas Engelbart is one of the most influential thinkers in the history of personal computing. He is best known as the groundbreaking engineer who invented such mainstays of the personal computer as the mouse, windows, e-mail, and the word processor. Engelbart led one of the most important projects funded by ARPA (Advanced Research Projects Agency) in the 1960s: a networked environment designed to support collaborative interaction between people using computers. It was dubbed the NLS (oNLine System). This historic prototype, developed at the Stanford Research Institute, and unveiled in 1968 at the Fall Joint Computer Conference in San Francisco, influenced the development of the first personal computer and the graphical user interface at Xerox PARC in the early 1970s.

Engelbart reasoned that networked computing would not only make individuals more intellectually effective; it would enable a collaborative method of sharing knowledge. The linking of people and computers using this approach to interactivity would result in the use of computers to "solve the world's problems" by augmenting the capacities of the mind's intellectual faculties.

In Depth

Ted Nelson | Hypertext <1963>

"Everything is deeply intertwingled"



Hypertext diagram from Ted Nelson's *Literary Machines*

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Ted Nelson | Hypertext <1963>

As a graduate student in philosophy in the late1950s and early 1960s, Ted Nelson had two critical intellectual encounters that led him to become one of the most influential figures in computing. One was with Vannevar Bush's article *As We May Think*, which convinced him that emerging information technologies could extend the power of human memory. The second was with Samuel Taylor Coleridge's poem *Xanadu*, "a magic place of literary memory," in Nelson's words, that provided him with the image of a vast storehouse of memories, and which served as the inspiration for his life's work. From these influences, Nelson began his quest to build creative tools that would transform the way we read and write, and in 1963 he coined the words "hypertext" and "hypermedia" to describe the new paradigms that these tools would make possible.

Nelson was particularly concerned with the complex nature of the creative impulse, and he saw the computer as the tool that would

make explicit the interdependence of ideas, drawing out connections between literature, art, music and science, since, as he put it, everything is "deeply intertwingled."

Nelson's critical breakthrough was to call for a system of non-sequential writing that would allow the reader to aggregate meaning in snippets, in the order of his or her choosing, rather than according to a pre-established structure fixed by the author.

Pioneers

J.C.R. Licklider | Symbiosis <1960>

"The hope is that in not too many years, human brains and computing machines will be coupled together very tightly, and that the resulting partnership will think as no human brain has ever thought."

J.C.R. Licklider, Albert Vezza and an early mini-computer

< < < subtext > > >

J.C.R. Licklider | Man-Machine Symbiosis <1960>

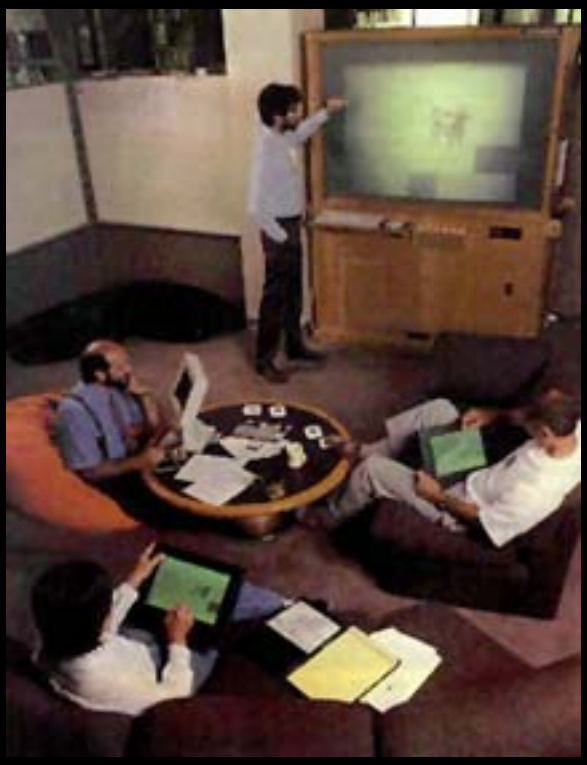
In 1960, J.C.R. Licklider was one of the few scientists who saw the computer's potential as a collaborative partner in the creative process. During his tenure as Director of the U.S. government's Advanced Research Projects Agency (ARPA), Licklider had the vision to support controversial but critical research that led to the rise of human-computer interactivity and the personal computer.

He saw the potential for a dialog between man and machine, a symbiotic partnership that would unleash tremendous creative potential, made possible by the ease, immediacy and flexibility of a keyboard and real-time graphics display.

Licklider considered the computer as an intelligent partner. It was his intent to engage in meaningful reciprocity with the computer, to endow it with increasingly responsive behavioral attributes, that led to the emergence of the computer as a collaborator in the creative process.

Pioneers

Alan Kay | Interface <1972>



"Therefore, let me argue that the actual dawn of user interface design first happened when computer designers finally noticed, not just that end users had functioning minds, but that a better understanding of how those minds worked would completely shift the paradigm of interaction. "

Researchers at Xerox PARC

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Alan Kay discussing user interface

Alan Kay | Interface <1972>

In 1972, after forming the Learning Research Group at the newly founded Xerox PARC (Palo Alto Research Center), Alan Kay led what is considered the most crucial advancement of human-computer interactivity, the graphical user interface (GUI). Kay introduced the idea of iconic, graphical representations of computing functions – the folders, menus, and overlapping windows found on the desktop – based on his research into the intuitive processes of learning and creativity. Kay came to understand, as he put it, that, "doing with images makes symbols." This was the premise behind the GUI, which enabled viewers to formulate ideas in real-time by manipulating icons on the computer screen.

Computers, Kay recognized, might one day replace books. This led him to design the prototype of the first personal computer, the *Dynabook*. The *Dynabook*, was conceived as a "dynamic medium for creative thought," capable of synthesizing all media – pictures, animation, sound, and text – through the intimacy and responsiveness of the personal computer.

Kay's research took root in the conviction that hypermedia, or "dynamic media" as he called it, represented a profound departure from static media such as painting, television, photography, print publishing, and film. He saw in hypermedia the radical interactivity that would characterize communications in the future.

Overture

Integration of the Arts

"And so the arts are encroaching one upon another, and from a proper use of this encroachment will rise the art that is truly monumental." – Wassily Kandinsky

Robert Wilson's Einstein on the Beach

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subtext

By proposing that the Dynabook be a "meta-medium" that unifies all media within a single interactive interface, Alan Kay had glimpsed into the future. But he may not have realized that his proposal had roots in the theories of the19th century German opera composer, Richard Wagner. In 1849, Wagner introduced the concept of the Gesamtkunstwerk, or Total Artwork, in an essay called "The Artwork of the Future." It would be difficult to overstate the power of this idea, or its influence. Wagner's description of the Gesamtkunstwerk is one of the first attempts in modern art to establish a practical, theoretical system for the comprehensive integration of the arts. Wagner sought the idealized union of all the arts through the "totalizing," or synthesizing, effect of music drama Ð the unification of music, song, dance, poetry, visual arts, and stagecraft. His drive to embrace the full range of human experience, and to reflect it in his operas, led him to give equal attention to every aspect of the final production. He was convinced that only through this integration could he attain the expressive powers he desired to transform music drama into a

vehicle capable of affecting German culture.

Twentieth century artists have continued the effort to heighten the viewer's experience of art by integrating traditionally separate disciplines into single works. Modern experience, many of these artists believed, could only be evoked through an art that contained within itself the complete range of perception. "Old-fashioned" forms limited to words on a page, paint on a canvas, or music from an instrument, were considered inadequate for capturing the speed, energy and contradictions of contemporary life. In their 1916 manifesto "The Futurist Cinema," F.T. Marinetti and his revolutionary cohorts declared film to be the supreme art because it embraced all other art forms through the use of (then) new media technology. Only cinema, they claimed, had a "totalizing" effect on human consciousness.

Less than a decade later, in his 1924 essay describing the theater of the Bauhaus, "Theater, Circus, Variety," László Moholy-Nagy called for a theater of abstraction that shifted the emphasis away from the actor and the written text, and brought to the fore every other aspect of the theatrical experience. Moholy-Nagy declared that only the synthesis of the theater's essential formal components Ð space, composition, motion, sound, movement, and light Ð into an organic whole could give expression to the full range of human experience.

The performance work of John Cage was a significant catalyst in the continuing breakdown of traditional boundaries between artistic disciplines after World War II. In the late 1940s, during a residency at Black Mountain College in North Carolina, Cage organized a series of events that combined his interest in collaborative performance with his use of indeterminacy and chance operations in musical composition. Together with choreographer Merce Cunningham and artists Robert Rauschenberg and Jasper Johns, Cage devised theatrical experiments that furthered the dissolution of borders between the arts. He was particularly attracted to aesthetic methods that opened the door to greater participation of the audience, especially if these methods encouraged a heightened awareness of subjective experience. Cage's use of indeterminacy and chance-related technique shifted responsibility for the outcome of the work away from the artist, and weakened yet another traditional boundary, the divide between artwork and audience.

Cage's work proved to be extremely influential on the generation of artists that came of age in the late 1950s. Allan Kaprow, Dick Higgins and Nam June Paik were among the most prominent of the artists who, inspired by Cage, developed non-traditional performance techniques that challenged accepted notions of form, categorization, and composition, leading to the emergence of genres such as the Happenings, electronic theater, performance art, and interactive installations.

Allan Kaprow, who coined the term "Happening," was particularly interested in blurring the distinction between artwork and audience. The ultimate integrated art, he reasoned, would be without an audience, because every participant would be an integral part of the work. As he wrote in his 1966 primer, "Untitled Guidelines for Happenings," "The line between art and life should be kept as fluid, and perhaps indistinct, as possible." This approach led to a performance style that pioneered deliberate, aesthetically conceived group interactivity in a composed environment. Happenings artists devised formal elements that allowed participants the freedom to make personal choices and collective decisions that would affect the performance.

In this climate, artists became increasingly interested in integrating technology into their work. While technology clearly played a significant role in 20th century arts (such as photography, film, and video, as well as various fine arts genres), it was not until Bell Labs scientist Billy Klüver placed the potential of advanced engineering into the hands of artists in New York that integrated works of art and technology began to flourish. Klüver conceived the notion of equal collaboration between artist and engineer. He pioneered forms of art and technology that would have been unimaginable to the artist without the engineer's cooperation and creative involvement. With Robert Rauschenberg, Klüver created several of the earliest artworks to integrate electronic media and to encourage a participatory role for the audience, including Oracle (1963-65) and Soundings (1968).

In 1966 Klüver co-founded E.A.T. (Experiments in Art and Technology) to bring artists and engineers together to create new works. E.A.T.'s most ambitious production was the Pepsi-Pavilion, designed for the Osaka Expo '70 in Japan Ð a tremendously ambitious collaborative, multimedia project that involved over 75 artists and engineers. As Klüver explained, audience participation

was at the heart of their interests: "The initial concern of the artists who designed the Pavilion was that the quality of the experience of the visitor should involve choice, responsibility, freedom, and participation. The Pavilion would not tell a story or guide the visitor through a didactic, authoritarian experience. The visitor would be encouraged as an individual to explore the environment and compose his own experience."

During this period, the British artist and theorist Roy Ascott began to explore the use of computers in artistic expression. One of the first theoretical attempts to integrate the emerging fields of human-computer interactivity and cybernetics with artistic practice is Ascott's article, "Behavioral Art and the Cybernetic Vision," from 1966-67. Ascott noted that the computer was "the supreme tool that... technology has produced. Used in conjunction with synthetic materials it can be expected to open up paths of radical change in art." Ascott saw that human-computer interaction would profoundly affect aesthetics, leading artists to embrace collaborative and interactive modes of experience.

When Alan Kay arrived in Xerox PARC in 1970, the foundation was in place for a multimedia that synthesized all the existing art forms, and presented them in an environment that allowed for meaningful interactivity. With the Dynabook, the interactive Gesamkunstwerk was brought into the digital realm, and put on-line.

Through the Looking Glass > > >

Pioneers

Richard Wagner | Total Artwork <1849>

"Whereas the public, that representation of daily life, forgets the confines of the auditorium, and lives and breathes now only in the artwork which seems to it as Life itself, and on the stage which seems the wide expanse of the whole World."

Richard Wagner with manuscript

< < < subtext > > >

Richard Wagner | Total Artwork <1949>

German opera composer Richard Wagner believed that the future of music, music theater, and all the arts, lay in an embrace of Gesamtkunstwerk or total artwork, a fusion of the arts that had not been attempted on this scale since the classic Greeks. In 1849, Wagner wrote the essay, *The Art-work of the Future*, defining the synthesis of the arts in which opera served as a vehicle for the unification of all the arts into a single medium of artistic expression.

The Festpielhaus (Festival House) Theater opened in 1876 in Bayreuth, Germany, where Wagner applied his theatrical innovations including: darkening the house, surround-sound reverberance, and the revitalization of the Greek amphitheatrical seating to focus audience attention on stage. This approach to opera foreshadowed the experience of virtual reality, immersing the audience in the imaginary world of the stage.

In Depth Billy Klüver | E.A.T. <1966>

"Rauschenberg and I decided to form Experiments in Art and Technology as a service organization for artists, engineers and scientists."

Billy Klüver speaking at the first meeting of E.A.T.

< < < subtext > > >

E.A.T. (Experiments in Art and Technology) <1966>

9 Evenings raised an enormous interest in using new technology among the artists in New York. Robert Whitman, Fred Waldhauer, Robert Rauschenberg and I called a meeting at the Central Plaza Hotel. Three hundred artists came to the meeting and we collected eighty immediate requests for technical help.

We began to publish a newsletter and spell out what E.A.T. was going to do. Rauschenberg's and Whitman's involvement in creating E.A.T. were crucial to the organization. Their belief that technology is "a challenge and what can be created if two or three people in diverse fields become collaborators?" This idea of one-to-one collaboration between individual artists and engineers or scientists was the basis of E.A.T. To this was added my belief that artists' ideas and concerns could influence the way we engineers approached the technological or social problems we faced day to day. The principal activity was to match artists who had technical problems or projects with engineers or scientists who could work with them.

The collaborations could lead technology in directions more positive for the needs, desires, and pleasures of the individual.

The Great Northeastern Power Failure <1966>

"Well, to begin with, the title of my talk is not going to be entirely unrelated to what I am going to say. What I will discuss is a new mode of interaction between science and technology on the one hand and art and life on the other. To use a scientific jargon that is currently in, I will try to define a new interface between these two areas.

Technology has always been closely tied in to the development of art. For Aristotle, Techne means both art and technology. As they became different subjects they still fed on each other. New technological discoveries were taken up and used by artists and you are all familiar with the contributions of artists to technology. The contemporary artist reads with ease the technical trade magazines. The new chemical material is hardly developed before it gets used by an artist. Today the artist tends to adopt the new material or the new industrial process as his insignia. We talk about artists in terms that he works in such and such a way or that he uses such and such materials. We hear about artists being poisoned and hurt in their work. In this century, artists have also embraced technology as subject matter: the enthusiasm of the Futurists, the experiments of Dada, the optimism of the Bauhaus movement and the Constructivists, all have looked at technology and science and found material for the artists. But for all this interest, art remains a passive viewer of technology. Art has only been interested in the fallout, so to speak, of science and technology. The effect of technology on art can apparently be even a negative one: the invention of the camera helped kill off representational painting, and we are now witnessing how the computer is about to take care of music and non-representational painting.

The new interface I will define is one in which the artist makes active use of the inventiveness and skills of an engineer to achieve his purpose. The artist could not complete his intentions without the help of an engineer. The artist incorporates the work of the engineer in the painting or the sculpture or the performance. A characteristic of this kind of interaction is that generally only one work of art results. In other words, the engineer is not just inventing a new

and special process for the use of the artist. He does not just teach the artist a new skill which the artist can use to extract new aesthetic variations. Technology is well aware of its own beauty and does not need the artist to elaborate on this. I will argue that the use of the engineer by the artist is not only unavoidable but necessary.

Before I try to justify why I believe that this interface exists and why the interaction between artists and engineers will become stronger, let me give you a few simple examples of what I mean in terms of works that already exist. I shall be modest and limit myself to use examples from my own experience. But there exist several others.

You probably have heard about Jean Tinguely's self-destroying machine, "Homage to New York", which more or less destroyed itself on March 17, 1960, in the sculpture garden of the Museum of Modern Art in New York. In retrospect I think my modest contribution to the machine was tot visit garbage dumps in New Jersey to pick up bicycle wheels and to truck them to 53rd Street. However,there were a few technical ideas hidden in Tinguely's machine which incidentally were mainly the contributions of my technical assistant at the time, Harold Hodges. there were about eight electrical circuits in the machine which closed successively as the machine progressed toward its ultimate fate. Motors would start, smoke would come out, smaller machines would leave the big one to escape. In order to make the main structure collapse, Harold had devised a scheme using supporting sections of Wood's metal which would melt from the heat of overheated resistors. At another point this method was used to light a candle. Contrary to what I hear frequently said, Tinguely's machine did not contain many of these technical links. It was mostly Tinguely's motors that did it.

A better example is two neon light power supplies that we made for two paintings by Jasper Johns. In one case, the light was the letter A, in the other the letter R. What was new was that Johns wanted no cords to the painting. To stack up batteries to 1200 volts would have been messy, dangerous and impractical. So we started out with 12 volts of rechargeable batteries and devised a multivibrator circuit which, together with a transformer, would give us 1200 volts. The technical equipment, all 400 dollars worth of it, was mounted behind John's painting.

My final example is Rauschenberg's large sculpture, "Oracle" which was shown in New York last year. It was the result of work carried out over three years during which time two complete technical systems were finished and junked. The final system enables the sound from five AM radios to be heard from each of the five sculptures in the group, but with each radio being controlled from a central control unit, in one of the sculptures. There are no connecting wires between the sculptures and they are all freely movable, on wheels.

All these examples have on thing in common: they are ridiculous from an engineers point of view. Why would anyone want to spend 9000 dollars to be able to control five AM radios simultaneously, in one room? I want to emphasize that the examples contain very simple engineering and should not be taken as very original. But each of the projects required an engineer or a technically skilled person to achieve what the artist wanted. And an important point is that the artist could not me quite sure about the outcome.

We have been taught by Robert Rauschenberg that the painting is an object among other objects, subjected to the same psychological and physical influences as other objects. During a musical piece by John Cage, we are forced to accept the equality of all the sounds we hear as part of the composition. In his happenings, Claes Oldenburg lets the actors play themselves although in most instances the actors are unaware of this. He writes his happenings with a particular person in mind, allowing the specific shyness, nervousness, sensuality of the person to become part of the happening. The tradition in art can, therefore, not tell us anything else but that the technical elements involved in the works I have described are just as much a part of the work of art as the paint in the painting. It is impossible to treat the sound as part of "Oracle" and not the radios. Jasper Johns has already shown us the backside of the canvas and I am afraid he will have to accept the not-so-elegant backsides of "Field Painting" and "Zone" as well. But if the radios and the amplifiers are part of the work - what about the engineer who designs them? In the same way as Oldenburg works with the peculiarities of people in his happenings, the artist has to work with the peculiarities and the foreign mode of operation of the engineer. On the basis of this observation, I hereby declare myself to be a work of art - or rather an integral part of the works of art I have just described. I am definitely not a violin player who interprets and feels for the work of his master. I know nothing about art or the artists involved. I am an engineer and as such, only raw material for the artist.

But how can I claim that this new interface between art and technology does in fact exist? Maybe I wanted to become a work of art and devised this ingenious scheme for my own ends? Well, I think that we don't have to look too far. We all know how technology has become part of our lives. And now we can see absolutely no reason why it should not become more so. No sound has been heard from another culture to oppose Western technology. The faster the underdeveloped countries can have it, the faster they want it. On the other end of the spectrum, we now have systems where we don't know quite where the machine ends and the human being begins. I am thinking of the space program which has introduced the new and maybe inhuman objective: the system has to work, no failures are allowed, no personal emotions or mistake may interfere with the success of the project. The space program is developing a new managerial type which is totally responsible. I read recently that President Johnson has let the contract to solve the Appalachian problem to the electronics industry. We are now getting the fallout from cape Kennedy and can expect more.

The great initiator of all this technological soul-searching is the computer. Laboriously we are translating every aspect of human activity into computer language. In fact, I believe the computer will turn out to be the greatest psychoanalyst of all times. Now where does all this leave us? The engineers may be psychoanalysts but they are not visionaries. John Cage has recently written a wonderful article called "How to Improve the World". As a blind engineer, one of his observations gave me a real jolt. Cage points out that there exist systems of interaction between human beings which work without any police or power structure whatsoever. In fact, there are hundreds of agreements between the countries of the world that work perfectly well. In particular, technological questions are dealt with without any complications. It seems that technology breeds agreement. This is such a simple observation that it frightens you that you did not think of it. I believe that Cage's discovery fully justifies the statement that technology will force the solution of such problems as food distribution and housing. There is no other stable optimum but to give people food and housing. The Dadaists' suggestion of free food and Buckminster Fuller's suggestion of free housing for the people of the world will happen. But the alternatives that the engineer can imagine for the full use of the fantastic capacity of technology are even so few and limited. He is, as I said, no visionary about life. But the artist is a visionary about life. Only he can create disorder and still get away with it. Only he can use technology to its fullest capacity. John Cage has suggested: Let the engineer take care of order and art (in the traditional sense) and let the artists take care of disorder

and life. And I am adding technology. This to sum up: First the artists have to create with technology because technology is becoming inseparable from our lives. "Technology is the extension of our nervous system," as McLuhan says. Second, the artists should use technology because technology needs the artists. Technology needs to be revealed and looked at - much like we undress a woman.

The artist's work is like that of a scientist. It is an investigation which may or may not yield meaningful results, in many cases we only know many years later. What I am suggesting is that the use of the engineer by the artist will stimulate new ways of looking at technology and dealing with life in the future.

What about power failure? I wish we knew more about what happened. We heard a lot about how people became friendly and helped each other out. The whole thing could have been an artist's idea - to make us aware of something. In the future there will exist technological systems as complicated and as large as the Northeastern power grid whose sole purpose will be to intensify our lives through increased awareness."

Overture

Birth of a New Medium

"Let us now extend everything we do to be part of a grand collaboration - with one's self, one's tools, other humans..."
– Alan Kay

Douglas Engelbart demonstrating the oNLine System in 1968

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subtext

New technology has always been used to make media. George Lucas shot his latest Star Wars epic with digital cameras, though the audience experience was no different than if it had been shot on celluloid. But while not all computer-based media is multimedia, today's multimedia starts with the computer, and takes the greatest advantage of the computer's capability for personal expression.

Digital computers were initially designed as calculating machines. The first fully electronic computer, the ENIAC, was built by the U.S. military during World War II to produce ballistics tables for artillery in battle. Computers then were clumsy, hulking devices – the ENIAC had 18,000 vacuum tubes, and measured 50 x 30 feet – that did calculations for scientific research. Only a handful of scientists considered the possibility of personal computing for creative purposes by non-specialists.

The first scientist to think seriously of this potential was Vannevar Bush. In his 1945 article "As We May Think," he outlined "a future device for individual use, which is a sort of mechanized private file and library." Before the ENIAC was completed, Bush was already contemplating how information technology could enhance the individual's capability for creative thought. "The human mind... operates by association," Bush observed. The device that he proposed, which he named the Memex, enabled the associative indexing of information, so that the reader's trail of association would be saved inside the machine, available for reference at a later date. This prefigured the notion of the hyperlink. While Bush never actually built the Memex, and while his description of it relied on technology that predated digital information storage, his ideas had a profound influence on the evolution of the personal computer.

In the years immediately after the War, under the shadow of the atomic bomb, the scientific establishment made a concerted effort to apply recent advancements in technology to humanitarian purposes. In this climate, Norbert Wiener completed his groundbreaking theory on cybernetics. While Wiener did not live to see the birth of the personal computer, his book, The Human Use of Human Beings, has become de rigeur for anyone investigating the psychological and socio-cultural implications of human-machine interaction. Wiener understood that the quality of our communication with machines effects the quality of our inner lives. His approach provided the conceptual basis for human-computer interactivity and for our study of the social impact of electronic media.

Bush and Wiener established a foundation on which a number of computer scientists associated with the Advanced Research Projects Agency (ARPA)– a U.S. government funded program to support defense-related research in the1960sÑbegan to build. Leading ARPA's effort to promote the use of computers in defense was the MIT psychologist and computer scientist J.C.R. Licklider, author of the influential article "Man-Computer Symbiosis." Defying the conventional wisdom that computers would eventually rival human intelligence, rather than enhancing it, Licklider proposed that the computer be developed as a creative collaborator, a tool that could extend human intellectual capability and improve a person's ability to work efficiently.

While at ARPA, Licklider put significant resources towards the pursuit of his vision. Among the scientists he supported was Douglas Engelbart, who since the mid-1950s had been seeking support for the development of a digital information retrieval system inspired by Bush's Memex. APRA funding enabled Engelbart to assemble a team of computer scientists and psychologists at the Stanford Research Institute to create a "tool kit" that would, as he phrased it, "augment human intellect." Dubbed the oNLine System (NLS), its public debut in 1968 at the Fall Joint Computer Conference in San Francisco was a landmark event in the history of computing. Engelbart unveiled the NLS before a room of 3,000 computer scientists, who sat in rapt attention for nearly two hours while he demonstrated some of his major innovations, including the mouse, windows for text editing, and electronic mail. Engelbart was making it possible, for the first time, to reach virtually through a computer's interface to manipulate information. Each of his innovations was a key step towards an interface that allowed for intuitive interactivity by a non-specialist. At the end of his presentation, he received a standing ovation.

However, the contributions of the NLS went beyond innovation regarding the computer interface. Engelbart and his colleagues also proposed that creativity could be enhanced by the sharing of ideas and information through computers used as communications devices. The oNLine System had its computers wired into a local network, which enabled them to be used for meaningful collaboration between co-workers. Engelbart understood that the personal computer would not only augment intelligence, but augment communication as well. In 1969 his research in on-line networking came to fruition with the creation of the Internet.

Engelbart's NLS pioneered some of the essential components necessary for the personal computer, but it would be up to a new generation of engineers to advance computing so it could embrace multimedia. As a graduate student in the late 1960s, Alan Kay wrote a highly influential Ph.D. thesis proposing a personal information management device that, in many ways, prefigured the laptop. In 1970, as research in information science was shifting from East Coast universities and military institutions to private digital companies in Silicon Valley, Kay was invited to join the new Xerox PARC in Palo Alto. PARC's mandate was no less than to create "the architecture of information for the future."

At PARC, Alan Kay conceived the idea of the Dynabook – a notebook sized computer that enabled hyperlinking, was fully interactive, and integrated all media. With the Dynabook, digital multimedia came into being. Echoing Licklider, Engelbart and colleagues at PARC, Kay declared the personal computer a medium in its own right,. It was a "meta-medium," as he described it in his 1977 essay "Personal Dynamic Media," capable of being "all other media." While the Dynabook remained a prototype that was never built, the work that came from its development, including the invention of the Graphical User Interface (GUI) and subsequent breakthroughs in dynamic computing, was incorporated into the first true multimedia computer, the Xerox Alto.

Integration of the Arts > > >

Pioneers

John Cage | Indeterminacy <1965>

"What'll art become? A family reunion? If so, let's have it with people in the round, each individual free to lend his attention wherever he will."

John Cage, David Tudor, Gordon Mumma (foreground), and Carolyn Brown (background) in *Variations V*

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Performance of *Variations V*

John Cage | Indeterminacy <1965>

As a musician, composer, artist, poet, and philosopher, John Cage's work rarely fit within the traditional boundaries of artistic practice. In the late 1940s, during a residency at Black Mountain College, he developed his provocative "theater of mixed-means" in collaboration with the artists Robert Rauschenberg and Jasper Johns, and the choreographer Merce Cunningham. These experiments gave birth to an explosion of performance art in the1950s and 1960s that introduced all types of actions, artifacts, noises, images, and movement into the performance space, such as in his own electronic theater work, *Variations V* from 1965.

The anarchic nature of Cage's work, with its bold acceptance of indeterminacy (chance) as an integral part of its composition, later encouraged the composer to extend this new found freedom to include the participation of the audience. Cage, inspired by Zen Buddhism, revels in an anarchy that dethrones the artist as the heroic, all-powerful arbiter of creative expression. He proposes instead a shift to an inclusive, participatory art that encourages interaction between artist, performer and audience.

Pioneers

Roy Ascott | Cybernetic Vision <1966>

"If the cybernetic spirit constitutes the predominant attitude of the modern era, the computer is the supreme tool that its technology has produced. Used in conjunction with synthetic materials it can be expected to open up paths of radical change and invention in art."

Viewer-participants interacting with *Aspects of Gaia: Digital Pathways Across the Whole Earth* at Ars Electronica

< < < subtext > > >

Roy Ascott | Cybernetic Vision <1966>

Since the 1960s, the British educator, artist and theoretician Roy Ascott has been one of Europe's most active and outspoken practitioners of interactive computer art. Ten years before the personal computer came into existence, Ascott saw that interactivity in computer-based forms of expression would be an emerging issue in the arts. Intrigued by the possibilities, he built a theoretical framework for approaching interactive artworks, which brought together certain characteristics of the avant-garde (Dada, Surrealism, Fluxus, Happenings, and Pop Art, in particular), with the science of cybernetics championed by Norbert Wiener.

Ascott's thesis on the cybernetic vision in the arts, "Behaviourist Art and the Cybernetic Vision" from 1966, begins with the premise that interactive art must free itself from the modernist ideal of the "perfect object." Like John Cage, he proposes that the artwork be responsive to the viewer, rather than fixed and static.

But Ascott takes Cage's premise into the realm of computer-based art, suggesting that the "spirit of cybernetics" offers the most effective means for achieving a two-way exchange between the artwork and its audience.

Overture

Integrated Datawork

"Today, after more than a century of electric technology, we have extended our central nervous system itself in a global embrace, abolishing both space and time as far as our planet is concerned."
– Marshall McLuhan

Title screen from Lynn Hershman's interactive laserdisc, *Lorna*

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subtext

It was Vannevar Bush who, in 1945, determined the chief narrative characteristic of multimedia by proposing a mechanical device that operated literally "as we may think." The challenge, as he saw it, was to create a machine that supported the mind's process of free association. Bush noted how ideas tend to evolve in a non-linear, idiosyncratic fashion. His Memex would be a tool that could supplement this aspect of human creativity by organizing its media elements to reflect the dynamics of the mind at play.

Douglas Engelbart expanded on Bush's premise. His quest to "augment human intelligence," as he aptly phrased it, was based on the insight that the open flow of ideas and information between collaborators was as important to creativity as private free association. The personal computer, as he envisioned it, would

not only allow for the arrangement of data in idiosyncratic, non-linear formats. By connecting workstations to a data-sharing network and turning them into communications devices, Engelbart's oNLine System allowed for a qualitative leap in the collaboration between individuals -- almost as if colleagues could peer into one another's minds as part of the creative process. In the early 1960s, experiments with networked personal computing promised the non-linear organization of information on a grand scale.

While few recognized this possibility at the time, it inspired a series of influential theoretical writings by the rogue philosopher Ted Nelson. Working outside of the academic and commercial establishments, following his own strongly held convictions, Nelson devised an elaborate system for the sharing of information across computer networks. Called Xanadu, this system would maximize a computer's creative potential. Central to Nelson's approach was the "hyperlink," a term he coined in 1963, inspired by Bush's notion of the Memex's associative trails. Hyperlinks, he proposed, could connect discrete texts in non-linear sequences. Using hyperlinks, Nelson realized, writers could create "hypertexts," which he described as "non-sequential writing" that let the reader make decisions about how the text could be read in other than linear fashion. As he observed in his landmark book from 1974, Computer Lib/Dream Machines, "the structures of ideas are not sequential." With hypertext, and its multimedia counterpart, "hypermedia," writers and artists could create works that encouraged the user to leap from one idea to the next in a series of provocative juxtapositions that presented alternatives to conventional hierarchies.

Nelson's insights were paralleled by experiments in the literary avant-garde that challenged traditional notions of linear narrative. In his book, he refers to Vladimir Nabokov's Pale Fire and Julio Cortazar's Hopscotch as two novels that use unconventional branching structures to encourage the reader's active collaboration in the construction of the story. As we have already seen, experimental performances inspired by John Cage – including Happenings, interactive installations, and performance art – also gave rise to a variety of non-linear narrative strategies. But perhaps the most prescient explorer of this terrain was the novelist William S. Burroughs.

Like Ted Nelson, Burroughs was deeply suspicious of established hierarchies. He was especially interested in writing techniques

that suggest the spontaneous, moment-by-moment movement of the mind, and how non-linear writing might expand the reader's perception of reality. Through his use of the cut-up and fold-in techniques, which he described in his 1964 essay, "The Future of the Novel," Burroughs treated the reading experience as one of entering into a multi-directional web of different voices, ideas, perceptions, and periods of time. He saw the cut-up as a tool that let the writer discover previously undetected connections between things, with potentially enlightening and subversive results. With the cut-up, Burroughs prefigured the essential narrative strategy of hypertext and its ability to allow readers to leap across boundaries in time and space.

Since the invention of the electric telegraph by Samuel Morse in the 1830s, commentators have been noting the transformation of our concepts of space and time by wired technology. From the telegraph to the telephone to television to satellite communications, modern telecommunications has eradicated geographic borders, and made speed a central factor in modern life. This effect was commonly acknowledged as long ago as 1868, when, at a banquet held in honor of Morse's life achievement, he was toasted for having "annihilated both space and time in the transmission of intelligence. The breadth of the Atlantic, with all its waves, is as nothing."

Artists have grappled with the implications of this technology since its inception; the narrative experiments of literary authors reflects this current in modern art. Ted Nelson's concept of hypertext represented a profound effort to put this technology toward the service of personal, idiosyncratic expression. Nelson became an evangelist for hypertext, publishing articles, speaking at conferences, spreading the gospel wherever he could. One of those places was Brown University, which during the 1980s became a hotbed of literary explorations of the form. At Brown, the literary critic George Landow and his colleagues developed hypertext tools, such as Intermedia, which allowed authors with little experience in programming to invent new genres of creative writing. In his own work, Landow applied a trained critical eye to the formal aspects of hypertext, making connections to the post-structural textual analysis of critics like Roland Barthes and Jacques Derrida. Just as academic theoretical discourse was questioning the centrality of the author in the production of texts, hypermedia suggested that, in a future of networked digital media, responsibility would shift from author to reader, actively encouraging

During this period, media artists whose roots lay in performance and video also began investigating hypermedia as a means of exploring new forms for telling stories. Artists such as Lynn Hershman and Bill Viola were drawn to the computer's ability to break down linear narrative structures. Viola approached the medium as a repository for evocative images that could be projected on screens in installations, "with the viewer wandering through some three-dimensional, possibly life-sized field of prerecorded or simulated scenes evolving in time," as he described it.

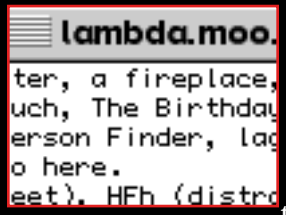
Lynn Hershman was among the first to create digital artworks using interactive media, in such pieces as Deep Contact, from 1989. She introduced interactivity into her work to combat the loss of intimacy and control brought about by the dominance of media such as radio and television. Her use of hypermedia allowed the viewer to choose directions inside the artwork's complex branching structure, and shape a personal experience of it.

By the late 1980s, multimedia, which had been at the fringe of the arts and sciences, reached critical mass and went mainstream. Marc Canter, who developed the first commercial multimedia authoring systems, was a chief catalyst. Canter pioneered software tools that artists and designers used to create multimedia on their personal computers. His authoring systems synthesized text, images, animation, video and sound into a single integrated work, using hyperlinks and other hypermedia techniques to connect its various elements.

In 1974, Ted Nelson had declared that "The real dream is for 'everything' to be in the hypertext." It was a proposal that echoed Marshall McLuhan's influential observation that, "after more than a century of electric technology, we have extended our central nervous system itself in a global embrace, abolishing both space and time as far as our planet is concerned." But despite his best efforts, and many advances in the fields of hypermedia and computer-based telecommunications, the global hypermedia library he envisioned remained more dream than reality. Most innovations in hypermedia focused on closed systems, such as the CD-ROM and interactive installations, rather than on open systems using a computer network.

In 1989 Tim Berners-Lee, a young British engineer working at CERN, the particle physics laboratory in Geneva, Switzerland, circulated a proposal for an in-house on-line document sharing system which he described modestly as "a 'web' of notes with links." After getting a grudging go-ahead from his superiors, Berners-Lee dubbed this system the World Wide Web. The Web, as he designed it, combined the communications language of the Internet with Nelson's hypertext and hypermedia, enabling links between files to extend across a global network. It became possible to link every document, sound file or graphic on the Web in an infinite variety of non-linear paths through the network. And instead of being created by a single author, links could be written by anyone participating in the system. Not only did the open nature of the Web lend itself to a wide array of interactive, multimedia experiences, but by hewing to a non-hierarchical structure and open protocols, Berners-Lee's invention became enormously popular, and led to an explosion in the creation of multimedia. By 1993 the Web had truly become an international phenomenon.

The success of the Web seemed to confirm the intuition of artists engaging in digital media that in the future, a global media database would inspire new forms of expression. Roy Ascott, for example, had already been exploring the creative possibilities of networking since the 1980s. He was interested in the notion of "dataspace," a territory of information in which all data exists in a continual present outside the traditional definitions of time and space available for use in endless juxtapositions. Ascott considers dataspace a new type of Gesamtkunstwerk, or a Gesamtdatenwerk as he calls it, in which networked information is integrated into the artwork. In such an environment, Ascott wrote, "meaning is not something created by the artist, distributed through the network, and received by the observer. Meaning is the product of interaction between the observer and the system, the content of which is in a state of flux, of endless change and transformation."



This notion of the artwork as a territory for interaction, as a locus of communications for a community, echoes the Happenings of a previous generation. On-line role-playing games have become laboratories for exploring this form of interactivity. As the social theorist Sherry Turkle has pointed out, on-line communities, such as Multi-User Dungeons (MUD), "are a new genre of collaborative writing,

with things in common with performance art, street theater, improvisation theater, Commedia dell'Arte, and script writing." Pavel Curtis created one of the earliest MUDs, LambdaMOO, in 1990 at Xerox PARC. Though it consisted only of text, its interactive quality, made possible through intricate storytelling devices via the Internet, gave participants the illusion of immersion in a virtual environment. Interaction in the on-line environment, Curtis claimed, creates a kind of social behavior which "in some ways it is a direct mirror of behavior in real life."

Throughout history, art has often been referred to as a mirror of life. But by building upon the concepts of association and collaboration, computer-based multimedia may well become more than a mirror of life. Already we have seen how multimedia blurs the boundaries between life and art, the personal and the mediated, the real and the virtual. The implications of these tendencies we are only now beginning to grasp.

The Future is Under Construction > > >

Pioneers

Vannevar Bush | Memex <1945>

"He [mankind] has built a civilization so complex that he needs to mechanize his records more fully if he is to push his experiment to its logical conclusion and not merely become bogged down part way there by overtaxing his limited memory."

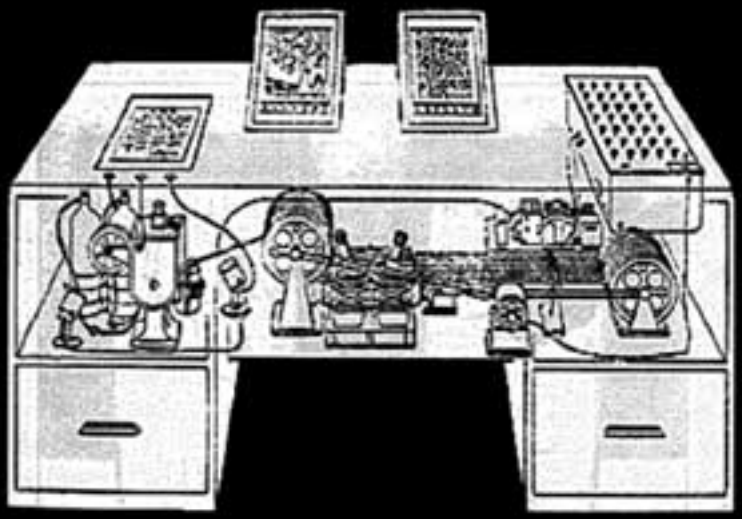


Illustration of the Memex

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Vannevar Bush | Memex <1945>

Vannevar Bush rose to prominence during World War II as chief scientific advisor to Franklin Roosevelt and director of the government's Office of Scientific Research and Development, where he supervised the research that led to the creation of the atomic bomb and other military technologies. His contribution to the evolution of the computer ranges far and wide: from the invention in 1930 of the Differential Analyzer, one of the first automatic electronic computers, to his concept of the Memex, the prototypical hypermedia machine.

In 1945 the Atlantic Monthly invited Bush to contribute an article on this theme, and the result was the landmark essay, *As We May Think*. He used this high profile forum to propose a solution to what he considered the paramount challenge of the day: how information would be gathered, stored, and accessed in an increasingly information-saturated world. This article had a profound influence on the scientists and theorists responsible for the evolution of the personal computer and the Internet.

Overture
Through the Looking Glass

"A display connected to a digital computer gives us a chance to gain familiarity with concepts not realizable in the physical world. It is a looking glass into a mathematical wonderland."
– Ivan Sutherland

Scott Fisher testing the head-mounted display developed at NASA-Ames in the 1980s

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subtext

The fantasy of being transported into another world, to be taken wholly into an imaginary realm, is a primal desire. With computer-based multimedia, encounters with immersive, virtual worlds will soon become commonplace. Virtual reality, after all, is a logical extension of the integration of the arts. It is also an ideal environment for applying our knowledge of human-computer interactivity.

There is an evocative echo in virtual environments of the earliest known form of human expression – the prehistoric cave paintings found at such sites as the caves of Lascaux in the south of France. These immersive environments, dating from 15,000 BC, are thought by scholars to have been theaters for the performance of rituals that integrated all forms of media and

engaged all the senses. On the walls were painted animal images and shamanist scrawls, but the environment in which the paintings appeared was surely as significant as the paintings themselves. As Joseph Campbell described it, "these magical spots occur far from the natural entrances of the grottos, deep within the dark, wandering chill corridors and vast chambers, so that before reaching them one has to experience the full force of the mystery of the cave itself." To encounter the cave paintings was to immerse the self in an otherworldly domain, which would heighten consciousness and trigger altered states of perception.

There are many examples of immersion in the history of art. The Dyonisian rituals of Greek Theater, and the construction of the great cathedrals of Europe, are two obvious examples. Richard Wagner's Gesamtkunstwerk was driven by a vision of theater in which the audience loses itself in the veracity of the drama, creating an immersive experience. As he wrote in "The Artwork of the Future," "the spectator transplants himself upon the stage, by means of all his visual and aural faculties." To facilitate his vision, Wagner reinvented the conventions of the opera house, and in 1876 opened the Festpielhaus Theater in Bayreuth, Germany, with the first complete production of The Ring cycle. The Festpielhaus, with its employment of Greek amphitheatrical seating, surround-sound acoustics, the darkening of the house, and the placement of musicians in an orchestra pit, focused the audience's undivided attention on the dramatic action. His intent was to maximize the suspension of disbelief, to draw the viewer into an illusionary world staged within the proscenium arch.

In the 1950s, a similar vision inspired the American cinematographer Morton Heilig to propose a "cinema of the future" that would surround the audience with facsimiles of life so convincing they would believe themselves to be transported to another domain. Such a cinema, he wrote, "would faithfully reproduce man's outer world as perceived in his consciousness, it will eventually learn to create totally new sense materials for each of the senses... [that] they have never known before, and to arrange them into forms of consciousness never before experienced by man in his contact with the outer world."

While Heilig devised a theoretical framework that applied the technologies of his day toward the achievement of virtual experience, it was only as a consequence of advances in computer science that the immersion his work suggested became possible. By 1965, Ivan Sutherland had already achieved legendary status among computer scientists as the inventor of Sketchpad, the first interactive graphics software. In a short paper published that year, Sutherland mused over the options available to the engineer to display computer data, to create a "a looking glass" into what he described as a "mathematical wonderland." It seemed reasonable for him to suggest that "The Ultimate Display" (as the paper was titled) would represent this data in 3-dimensional form, allowing the construction of entirely believable 3-dimensional, computer controlled, virtual worlds. However, like Heilig before him, Sutherland took this suggestion one step further. "The ultimate display," he wrote, "would É be a room within which the computer can control the existence of matter." He suggested that such a display could present realities heretofore only imagined, as if seen through Alice's looking glass. Sutherland's proposal was startling, but it launched an entire field of scientific inquiry.

It also fueled the imagination of a generation of artists. One of the first to consider the possibilities of digitally-constructed virtual experiences was Myron Krueger. In the early 1970s, Krueger created the pioneering works Metaplay and Videoplace to explore the potential of computer-mediated interactivity. These works were interactive artistic environments, influenced by Happenings, designed to give participants freedom of choice and opportunities for personal expression. Videoplace also connected participants in different locations through networked technologies, creating the illusion of shared space. As Krueger later wrote about the piece, "our teleconference created a place that consisted of the information we both shared... a world in which full physical participation would be possible. This world is an 'artificial reality.'"

During the 1970s and 1980s, several engineering projects pursued virtual environment display systems that could represent such an "artificial reality. Perhaps the most significant of these in the mid-1980s was led by Scott Fisher at the NASA-Ames Research Center. Fisher's intent was to engage the entire nervous system in a multi-sensory presentation of virtual space Ð extending multimedia beyond the screen. The Ames VIEW system (an

acronym for Virtual Interface Environmental Workstation) included a headset with two small liquid crystal display screens, a microphone for speech recognition, earphones for surround-sound effects, a head-tracking device, and dataglove to recognize the user's gestures and place them within the virtual environment. The direction this work pointed in was clear. As Fisher wrote in his 1989 article "Virtual Interface Environments," "with full body tracking capability, it would also be possible for users to be represented in this [virtual] space by life-size virtual representations of themselves in whatever form they choose." Immersive environments, Fisher observed, could give birth to a new form of participatory, interactive electronic theater.

The possibility of such a theater had already taken hold of the public's imagination. In Neuromancer, his widely read novel from 1984, William Gibson described in palpable detail a future in which virtual reality was a fact of life. Echoing Myron Krueger's notion that teleconferencing created a "place" that consisted of shared information, Gibson's characters inhabited a virtual environment made possible by the networking of computers, which he named "cyberspace." Gibson's cyberspace provided the first literary definition for the computers, hubs, servers, and databases that make up the matrices of the network. His discussion of cyberspace was so tangible Ð and seductive, with its suggestion that any computer hacker could "jack-in to the matrix" with an encounter with a sexy avatar – it became a touchstone for every engineer, artist and theorist working in the field.

Marcus Novak took Gibson's description of virtual environments as the starting point for his own theoretical and artistic explorations. In his essay from 1991, "Liquid Architecture in Cyberspace," he follows the pioneering work of Sutherland, Fisher, and Gibson, et al, to its logical conclusion, and notes its profound implications for architecture, our notions of space, and our attitudes towards the organization of information. He notes that in cyberspace, since all structure is programmable, all environments can be fluid. The artist who designs these immersive digital habitats will be able to transcend the laws of the physical world. As a consequence, architectural forms built in cyberspace can respond to the viewer, encouraging provocative and illuminating interactions. In cyberspace, architecture becomes a form of poetry.

While most research in virtual reality aims to project the viewer into a digital environment by means of a head-mounted display, some engineers have taken an alternative approach. In the early 1990s, Daniel Sandin and Thomas DeFanti conceived of a virtual reality system that places the human body directly inside a computer-generated environment. They describe their system, called the CAVE (an acronym for Cave Automatic Virtual Environment) in their article "Room With a View": "Unlike users of the video-arcade type of virtual reality system, CAVE 'dwellers' do not need to wear helmets, which would limit their view of and mobility in the real world... to experience virtual reality." Instead, participants in the CAVE are surrounded by an immersive, digital "cave painting" -- which brings the evolution of immersion full circle, back to the prehistoric caves of Lascaux, and humankind's earliest efforts at personal expression.

The Integrated Datawork > > >

Pioneers

Morton Heilig | Sensorama <1962>

Sensorama arcade

"Thus, individually and collectively, by thoroughly applying the methodology of art, the cinema of the future will become the first art form to reveal the new scientific world to man in the full sensual vividness and dynamic vitality of his consciousness."

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Morton Heilig | Sensorama <1962>

In the 1950's it occurred to cinematographer Morton Heilig that all the sensory splendor of life could be simulated with "reality machines." He proposed that an artist's expressive powers would be enhanced by a scientific understanding of the senses and perception. His premise was simple but striking for its time: if an artist controlled the multi-sensory stimulation of the audience, he could provide them with the illusion and sensation of first-person experience, of actually "being there."

Inspired by short-lived curiosities such as Cinerama and 3D movies, it occurred to Heilig that a logical extension of cinema would be to immerse the audience in a fabricated world that engaged all the senses. He believed that by expanding cinema to involve not only sight and sound, but also taste, touch, and smell, the traditional fourth wall of film and theater would dissolve, transporting the audience into a habitable, virtual world. He called this cinema of the future "experience theater,"

constructing a quirky, nickelodeon-style arcade machine in 1962 he aptly dubbed Sensorama, that catapulted viewers into multi-sensory excursions through the streets of Brooklyn, as well as other adventures in surrogate travel.

Pioneers

Ivan Sutherland | Ultimate Display <1970>

"The ultimate display would, of course, be a room within which the computer can control the existence of matter. A chair displayed in such a room would be good enough to sit in. Handcuffs displayed in such a room would be confining, and a bullet displayed in such room would be fatal. With appropriate programming such a display could literally be the Wonderland into which Alice walked."

Head- Mounted Display worn by Donald Vickers

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Demonstration of the head-mounted display

Ivan Sutherland | Ultimate Display <1970>

Ivan Sutherland, while conducting his initial research in immersive technologies, Sutherland wrote *The Ultimate Display* in 1965 in which he made the first advance toward marrying the computer to the design, construction, navigation and habitation of virtual worlds.

Sutherland predicted that advances in computer science would eventually make it possible to engineer virtual experiences that were convincing to the senses. Sutherland believed in the ineffable potential of computers to transform the abstract nature of mathematical constructions into habitable, expressive worlds in the spirit of Lewis Carrol's Alice in Wonderland.

Although it was several years before the invention of the personal computer, in 1970, Sutherland took a crucial step towards the implementation of his vision by creating the head-mounted display – a helmet shaped apparatus designed to immerse the viewer in a visually simulated 3D environment.

Pioneers

Myron Krueger | Responsive <1970>

"The responsive environment has been presented as the basis for a new aesthetic medium based on real-time interaction between men and machines. "

Projection from *Videoplace*

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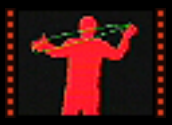

Excerpts from *Videoplace*

Myron Krueger | Responsive <1970>

Originally trained as a computer scientist, Myron Krueger, under the influence of John Cage's experiments in indeterminacy and audience participation, pioneered human-computer interaction in the context of physical environments. Beginning in 1969, he collaborated with artist and engineer colleagues to create artworks that responded to the movement and gesture of the viewer through an elaborate system of sensing floors, graphic tables, and video cameras.

At the heart of Krueger's contribution to interactive computer art was the notion of the artist as a "composer" of intelligent, real-time computer-mediated spaces, or "responsive environments," as he called them. Krueger "composed" environments, such as Videoplace from 1970, in which the computer responded to the gestures of the audience by interpreting, and even anticipating, their actions. Audience members could "touch" each other's video-generated silhouettes, as well as manipulate the odd, playful assortment of graphical objects and animated organisms that appeared on the screen, imbued with the presence of artificial life.

Pioneers

Scott Fisher | Telepresence <1985>

"The possibilities of virtual realities, it appears, are as limitless as the possibilities of reality. They can provide a human interface that disappears – a doorway to other worlds."

VIEW **virtual reality workstation from NASA-Ames**

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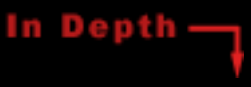
Demonstration of the *VIEW System*

Scott Fisher | Telepresence <1985>

Scott Fisher's seminal research in virtual reality was conducted in the late 1980s at the NASA-Ames Research Center in Mountain View, California, where he worked on the Virtual Environment Workstation (VIEW) project. Fisher set out to develop an interface that would engage all the senses, thrusting the viewer into a realm of full sensory immersion. The NASA system included an updated version of the head-mounted display, with stereoscopic images that provided stereoscopic depth of field, a major advancement over the monoscopic vision of Ivan Sutherland's earlier device. Fisher added headphones for 3D audio, a microphone for speech recognition, and, in collaboration with Tom Zimmerman, adapted the "dataglove" – the wired glove worn by the user that makes it possible to grasp virtual objects in cyberspace.

This multi-sensory interaction with cybernetic devices created the powerful illusion of entering a digitized landscape. By pursing Morton Heilig's concept of experience theater, Fisher made a significant advance toward what he termed "telepresence" – the projection of the self into a virtual world.



VIRTUAL ENVIRONMENTS <1989>

1. MEDIA TECHNOLOGY AND SIMULATION OF FIRST-PERSON EXPERIENCE

" Watch out for a remarkable new process called SENSORAMA! It attempts to engulf the viewer in the stimuli of reality. Viewing of the color stereo film is replete with binaural sound, colors, winds, and vibration. The original scene is recreated with remarkable fidelity. At this time, the system comes closer to duplicating reality than any other system we have seen!"

For most people, "duplicating reality" is an assumed, if not obvious goal for any contemporary imaging technology. The proof of the 'ideal' picture is not being able to discern object from representation - to be convinced that one is looking at the real thing. At best, this judgement is usually based on a first order evaluation of 'ease of identification'; i.e. realistic pictures should resemble what they represent. But resemblance is only part of the effect. In summing up prevailing theories on realism in images, Perkins comments:

" Pictures inform by packaging information in light in essentially the same form that real objects and scenes package it, and the perceiver unwraps that package in essentially the same way."

What is most limited in contemporary media is the literal process involved in 'unwrapping' the image. Evaluation of image realism should also be based on how closely the presentation medium can simulate dynamic, multimodal perception in the real world. A truly informative picture, in addition to merely being an informational surrogate, would duplicate the physicality of confronting the real scene that it is meant to represent. The image would move beyond simple photo-realism to immerse the viewer in an interactive, multi-sensory display environment.

Methods to implement and evaluate these interdependent factors contributing to image realism lie in the emerging domain of Media Technology. Until recently, significant developments in this area have usually been dictated by economics, available technology

and, as mentioned, cursory ideas about what types of information are sufficient in image representation. For example, the medium of television, as most experience it, plays to a passive audience. It has little to do with the nominal ability to 'see at a distance' other than in a vicarious sense; it offers only interpretations of remote events as seen through the eyes of others with no capability for viewpoint control or personal exploration. And, although this second hand information may be better than no information at all, a 'first-person', interactive point of view can offer added dimensions of experience:

"We obtain raw, direct information in the process of interacting with the situations we encounter. Rarely intensive, direct experience has the advantage of coming through the totality of our internal processes - conscious, unconscious, visceral and mental - and is most completely tested and evaluated by our nature. Processed, digested, abstracted second-hand knowledge is often more generalized and concentrated, but usually affects us only intellectually - lacking the balance and completeness of experienced situations....Although we are existing more and more in the realms of abstract, generalized concepts and principles, our roots are in direct experience on many levels, as is most of our ability to consciously and unconsciously evaluate information."

In the past few decades, changing trends in Media Technology have begun to yield innovative ways to represent first-person or 'direct experience' through the development of multi-sensory media environments in which the viewer can interact with the information presented as they would in encountering the original scene. A key feature of these display systems (and of more expensive simulation systems) is that the viewer's movements are non-programmed; that is, they are free to choose their own path through available information rather than remain restricted to passively watching a 'guided-tour'. For these systems to operate effectively, a comprehensive information database must be available to allow the user sufficient points of view. The main objective is to liberate the user to move around in a virtual environment, or, on a smaller scale, to viscerally peruse a scene that may be remotely sensed or synthetically generated. In essence, the viewer's access to greater than one viewpoint of a given scene allows them to synthesize a strong visual percept from many points of view; the availability of multiple points of view places an object in context and thereby animates it's meaning.

2. THE EVOLUTION OF VIRTUAL ENVIRONMENTS

Matching visual display technology as closely as possible to human cognitive and sensory capabilities in order to better represent

'direct experience' has been a major objective in the arts, research, and industry for decades. A familiar example is the development of stereoscopic movies in the early 50's, in which a perception of depth was created by presenting a slightly different image to each eye of the viewer. In competition with stereo during the same era was Cinerama, which involved three different projectors presenting a wide field of view display to the audience; by extending the size of the projected image, the viewer's peripheral field of view was also engaged. More recently, the Omnimax projection system further expands the panoramic experience by situating the audience under a huge hemispherical dome onto which a high-resolution, predistorted film image is projected; the audience is now almost immersed in a gigantic image surround.

In 1962, the "Sensorama" display previously noted was a remarkable attempt at simulating personal experience of several real environments using state of the art media technology. The system was an elegant prototype of an arcade game designed by Morton Heilig: One of the first examples of a multi-sensory simulation environment that provided more than just visual input. When you put your head up to a binocular viewing optics system, you saw a first-person viewpoint, stereo film loop of a motorcycle ride through New York City and you heard three-dimensional binaural sound that gave you sounds of the city of New York and of the motorcycle moving through it. As you leaned your arms on the handlebar platform built into the prototype and sat in the seat, simulated vibration cues were presented. The prototype also had a fan for wind simulation that combined with a chemical smell bank to blow simulated smells in the viewer's face. As an environmental simulation, the Sensorama display was one of the first steps toward duplicating a viewer's act of confronting a real scene. The user is totally immersed in an information booth designed to imitate the mode of exploration while the scene is imaged simultaneously through several senses.

The idea of sitting inside an image has been used in the field of aerospace simulation for many decades to train pilots and astronauts to safely control complex, expensive vehicles through simulated mission environments. Recently, this technology has been adapted for entertainment and educational use. `Tour of the Universe' in Toronto and `Star Tours' at Disneyland are among the first entertainment applications of simulation technology and virtual display environments; About 40 people sit in a room on top of a motion platform that moves in synch with a computer-generated and model-based image display of a ride through a simulated universe.

This technology has been moving gradually toward lower cost 'personal simulation' environments in which the viewer is also able to control their own viewpoint or motion through a virtual environment - an important capability missing from the Sensorama prototype. An early example of this is the Aspen Movie Map, done by the M.I.T. Architecture Machine Group in the late 70's. Imagery of the town of Aspen, Colorado was shot with a special camera system mounted on top of a car, filming down every street and around every corner in town, combined with shots above town from cranes, helicopters and airplanes and also with shots inside buildings. The Movie Map gave the operators the capability of sitting in front of a touch-sensitive display screen and driving through the town of Aspen at their own rate, taking any route they chose, by touching the screen, indicating what turns they wanted to make, and what buildings they wanted to enter. In one configuration, this was set up so that the operator was surrounded by front, back, and side-looking camera imagery so that they were completely immersed in a virtual representation of the town.

Conceptual versions of the ultimate sensory-matched virtual environment have been described by science fiction writers for many decades. One concept has been called "telepresence," a technology that would allow remotely situated operators to receive enough sensory feedback to feel like they are really at a remote location and are able to do different kinds of tasks. Arthur Clarke has described `personalized television safaris' in which the operator could virtually explore remote environments without danger or discomfort. Heinlein's "waldoes" were similar, but were able to exaggerate certain sensory capabilities so that the operator could, for example, control a huge robot. Since 1950, technology has gradually been developed to make telepresence a reality.

Historically, one of the first attempts at developing these telepresence visual systems was done by the Philco Corporation in 1958. With this system an operator could see an image from a remote camera on a CRT mounted on his head in front of his eyes and could control the camera's viewpoint by moving his head. A variation of the head-mounted display concept was done by Ivan Sutherland at MIT in the late 60's. This helmet-mounted display had a see-through capability so that computer-generated graphics could be viewed superimposed onto the real environment. As the viewer moved around, those objects would appear to be stable within that real environment, and could be manipulated with various input devices that they also developed. Research continues at

other laboratories such as NASA Ames in California, the Naval Ocean Systems Center in Hawaii and MITI's Tele-existence Project in Japan: Here the driving application is the need to develop improved systems for humans to operate safely and effectively in hazardous environments such as undersea or outerspace.

3. VIEW: THE NASA/AMES VIRTUAL ENVIRONMENT WORKSTATION

In the Aerospace Human Factors Research Division of NASA's Ames Research Center, an interactive Virtual Interface Environment Workstation (VIEW) has been developed as a new kind of media-based display and control environment that is closely matched to human sensory and cognitive capabilities. The VIEW system provides a virtual auditory and stereoscopic image surround that is responsive to inputs from the operator's position, voice and gestures. As a low-cost, multipurpose simulation device, this variable interface configuration allows an operator to virtually explore a 360-degree synthesized or remotely sensed environment and viscerally interact with its components.

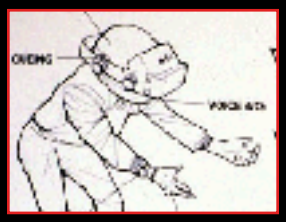
The current Virtual Interface Environment Workstation system consists of: a wide-angle stereoscopic display unit, glove-like devices for multiple degree-of-freedom tactile input, connected speech recognition technology, gesture tracking devices, 3D auditory display and speech-synthesis technology, and computer graphic and video image generation equipment.

When combined with magnetic head and limb position tracking technology, the head-coupled display presents visual and auditory imagery that appears to completely surround the user in 3-space. The gloves provide interactive manipulation of virtual objects in virtual environments that are either synthesized with 3D computer-generated imagery, or that are remotely sensed by user-controlled, stereoscopic video camera configurations. The computer image system enables high performance, realtime 3D graphics presentation that is generated at rates up to 30 frames per second as required to update image viewpoints in coordination with head and limb motion. Dual independent, synchronized display channels are implemented to present disparate imagery to each eye of the viewer for true stereoscopic depth cues. For realtime video input of remote environments, two miniature CCD video cameras are used to provide stereoscopic imagery. Development and evaluation of several head-coupled, remote

camera platform and gimbal prototypes is in progress to determine optimal hardware and control configurations for remotely controlled camera systems. Research efforts also include the development of realtime signal processing technology to combine multiple video sources with computer generated imagery.

4. VIRTUAL ENVIRONMENT APPLICATIONS

Application areas of the virtual interface environment research at NASA Ames are focused in two main areas - Telepresence and Dataspace:



TELEPRESENCE - The VIEW system is currently used to interact with a simulated telerobotic task environment. The system operator can call up multiple images of the remote task environment that represent viewpoints from free-flying or telerobot-mounted camera platforms. Three-dimensional sound cues give distance and direction information for proximate objects and events. Switching to telepresence control mode, the operator's wide-angle, stereoscopic display is directly linked to the telerobot 3D camera system for precise viewpoint control. Using the tactile input glove technology and speech commands, the operator directly controls the robot arm and dexterous end effector which appear to be spatially correspondent with his own arm. [FIGURE 2].

DATASPACE - Advanced data display and manipulation concepts for information management are being developed with the VIEW system technology. Current efforts include use of the system to create a display environment in which data manipulation and system monitoring tasks are organized in virtual display space around the operator. Through speech and gesture interaction with the virtual display, the operator can rapidly call up or delete information windows and reposition them in 3-space. Three-dimensional sound cues and speech-synthesis technologies are used to enhance the operators overall situational awareness of the virtual data environment. The system also has the capability to display reconfigurable, virtual control panels that respond to glove-like tactile input devices worn by the operator.

5. PERSONAL SIMULATION: ARCHITECTURE, MEDICINE, ENTERTAINMENT

In addition to remote manipulation and information management tasks, the VIEW system also may be a viable interface for several

commercial applications. So far, the system has been used to develop simple architectural simulations that enable the operator to design a very small 3D model of a space, and then, using a glove gesture, scale the model to life size allowing the architect/operator to literally walk around in the designed space. Seismic data, molecular models, and meteorological data are other examples of multidimensional data that may be better understood through representation and interaction in a Virtual Environment.

Another Virtual Environment scenario in progress involves the development of a surgical simulator for medical students and plastic surgeons that could be used much as a flight simulator is used to train jet pilots. Where the pilot can literally explore situations that would be dangerous to encounter in the real world, surgeons can use a simulated "electronic cadaver" to do pre-operation planning and patient analysis. The system is also set up in such a way that surgical students can look through the eyes of a senior surgeon and see a first-person view of the way he or she is doing a particular procedure. As illustrated in the following figure, the surgeon can be surrounded with the kinds of information windows that are typically seen in an operating room in the form of monitors displaying life support status information and x-rays.

Entertainment and educational applications of this technology could be developed through this ability to simulate a wide range of real or fantasy environments with almost infinite possibilities of scale and extent. The user can be immersed in a 360-degree fantasy adventure game as easily as he or she can viscerally explore a virtual 3D model of the solar system or use a three-dimensional paint system to create virtual environments for others to explore.

6. TELE-COLLABORATION THROUGH VIRTUAL PRESENCE

A major near-term goal for the Virtual Environment Workstation Project is to connect at least two of the current prototype interface systems to a common virtual environment database. The two users will participate and interact in a shared virtual environment but each will view it from their relative, spatially disparate viewpoint. The objective is to provide a collaborative workspace in which remotely located participants can virtually interact with some of the nuances of face-to-face meetings while also having access to their personal dataspace facility. This could enable valuable interaction between scientists collaborating from different locations across the country or even between astronauts on a

space station and research labs on Earth. With full body tracking capability, it will also be possible for each user to be represented in this space by a life size virtual representation of themself in whatever form they choose - a kind of electronic persona. For interactive theater or interactive fantasy applications, these virtual forms might range from fantasy figures to inanimate objects, or different figures to different people. Eventually, telecommunication networks will develop that will be configured with virtual environment servers for users to dial into remotely in order to interact with other virtually present users.

Although the current prototype of the Virtual Environment Workstation has been developed primarily to be used as a laboratory facility, the components have been designed to be easily replicable for relatively low-cost. As the processing power and graphics frame rate on microcomputers quickly increases, portable, personal virtual environment systems will also become available. The possibilities of virtual realities, it appears, are as limitless as the possibilities of reality. It provides a human interface that disappears – a doorway to other worlds.

Pioneers

Lynn Hershman | Transgression <1982>

"Traditional narratives are being restructured. As a result, people feel a greater need to personally participate in the discovery of values that affect and order their lives, to dissolve the division that separates them from control, freedom... "

Guide Marion invites the viewer into *Deep Contact*

< < < subtext > > >

Excerpt from *Deep Contact*

Lynn Hershman | Transgression <1982>

Media artist Lynn Hershman divides her work into two categories: B.C. (Before Computers) and A.D. (After Digital). The line of demarcation occurred around 1980 as interactive technologies, including personal computers and laserdisc players, became commercially available. In her early performance works and site-specific installations (B.C.), Hershman had begun exploring themes that focused on issues of identity, alienation, and the blurring between reality and fiction.

The first of her interactive works was *Lorna* (1982), the seminal art videodisc; a labyrinthine journey through the mental landscape of an agoraphobic middle-aged woman. Lorna's passive relation to media and life is juxtaposed with the viewer's new found agency to select and reassemble the narrative's branching themes, stories, interpretations, and conclusions. In *Deep Contact* (1984-89), Hershman uses a touchscreen interface to suggest that the viewer can reach through the work's glass surface, the computer's "fourth wall." This type of interactivity constitutes a transgression of the screen, transporting the viewer into virtual reality.

In Depth

"The emergence of MUDs has created a new kind of social sphere, both like and radically unlike the environments that have existed before."

Pavel Curtis in his office at Xerox PARC

< < < subtext > > >

Pavel Curtis | World Building <1991>

Pavel Curtis, while a computer scientist at Xerox PARC, created one of the first popular on-line role-playing environments, *LambdaMOO* [requires Telnet], in 1991. Known as a MUD (Multi-User Dungeons), *LambdaMOO* is a text-only fantasy realm that is descended from sword and sorcery games from the 1970s such as "Dungeons and Dragons." While not the first of its kind, *LambdaMOO* is perhaps the most famous text-based virtual environment, dissected and analyzed by media theorists, sociologists and psychologists who see it as fertile breeding ground for a new hybrid form of literature, live performance, cinema, and interactive storymaking.

Through the freewheeling dynamics of improvised dialogue and unrehearsed interactivity, participants lose themselves in their roles and collaborate in a form of collective authorship. Shielded (and even liberated) by the anonymity of their characters, players improvise their own conversations, story lines, props, and

settings; they pursue their own adventures, and experiment with a myriad of alternate identities; sometimes they even switch gender and, occasionally, species. MUDs are characterized by a tightly knit – though globally dispersed – community of characters engaged in an ongoing dialogue that combines the aimlessness of nomadic wandering with the focused creativity of world building.

Pioneers

Bill Viola | Dataspace <1983>

"We can see the seeds of what some have described as the ultimate recording technology: total spatial storage, with the viewer wandering through some three-dimensional, possibly life-sized field of prerecorded or simulated scenes and events evolving in time."

Video installation *Room for St. John of the Cross*

< < < subtext > > >

Bill Viola | Dataspace <1983>

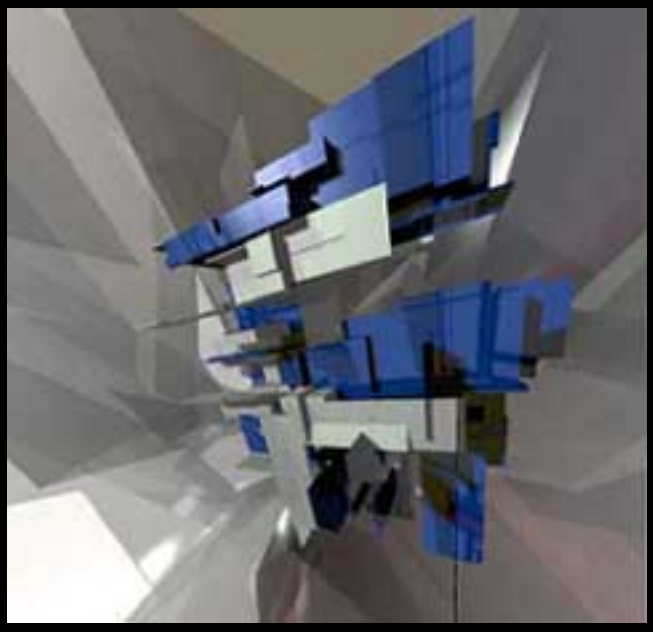
Since he began producing video art in the early 1970s, Bill Viola has explored ways to manipulate and restructure our perception of time and space through electronic media. In such video installations as *Room for St. John of the Cross* (1983), Viola has demonstrated the narrative potential of "dataspace," a territory of information in which all data exists in a continual present, outside the traditional definitions of time and space, available for use in endless juxtapositions.

Viola arrives at the notion of dataspace by considering the spaces that have been constructed over the ages to record cultural history in architectural form, from Greek temples to Gothic cathedrals. He compares these "memory palaces" to the personal computer, with its capacity for storage, instant access and information retrieval. The computer has introduced the "next evolutionary step," Viola claims, in which ancient models of memory and artistic expression are reborn through the fluid processes of information technologies.

Overture

The Future is Under Construction

"In the future, the only artwork that will survive will have no gravity at all."
– Nam June Paik



Marcos Novak's 3D construction,
Voice 3 + 4 Maze Blue

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subtext

The breadth and potential of multimedia lends itself to utopian proposals. The French media theorist Pierre Levy describes multimedia as belonging to a trajectory of planetary evolution that runs from DNA to cyberspace – an arc that follows pure information as it reaches towards its most evolved form of expression. He proposes that today's global networks will usher in an era of "collective intelligence," and suggests that "cyberspace constitutes a vast, unlimited field... designed to interconnect and provide interface for the various methods of creation, recording, communication and simulation." His enthusiastic perspective is full of intriguing possibilities.

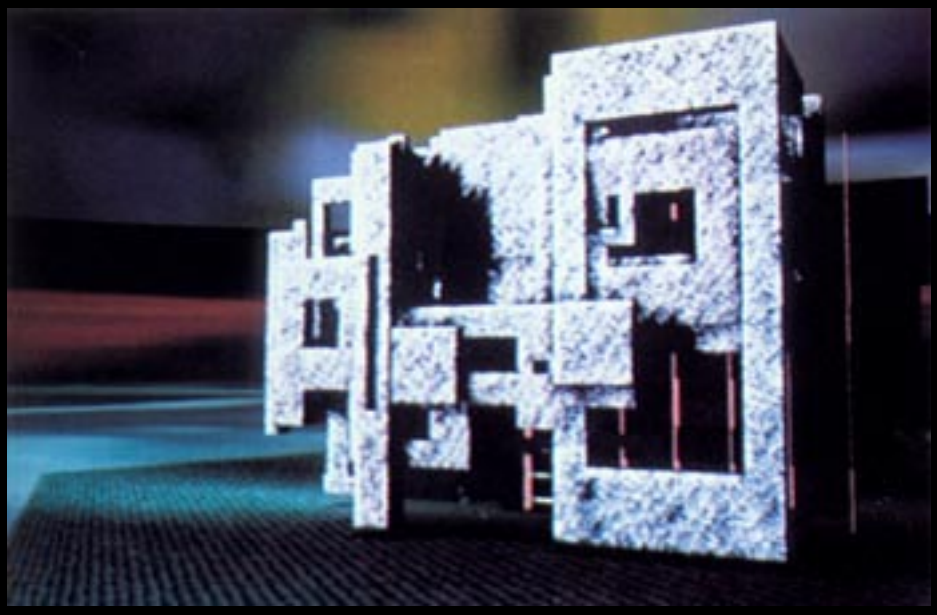
At the same time, we are all aware of the dystopian qualities of the 24/7 infotainment juggernaut that is being delivered across the globe through an ever more sophisticated telecommunications network. We read daily about the new media's encroachment on privacy, its opportunity for abuse, and the specter of centralized control that it might make possible. These dangers are real. There is a tension between opposing at the heart of the Internet – between those who prize its potential for an open, freewheeling exchange of art and ideas, and those who see its pervasiveness as an opportunity to expand upon the marketing-driven broadcast model of 20th century media – and it is not at all clear whether utopian or dystopian visions will ultimately prevail.

This project serves as a poignant reminder of the intentions of multimedia's pioneers. Their words, typically written during the heat of invention, convey a passionate involvement with higher ideals. To a remarkable degree, these scientists, artists, and theorists share a commitment to forms of media and communications that are non-hierarchical, open, collaborative, and reflective of the free movement of the mind at play. It is, in sum, an extraordinary vision. But whether we will achieve it is an unresolved question.

Pioneers

Marcos Novak | Liquid Architectures <1991>

"Liquid architecture is an architecture that breathes, pulses, leaps as one form and lands as another... it is an architecture without doors and hallways, where the next room is always where I need it to be and what I need it to be."



3D construction from series of Liquid Architectures

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***iso4D*, computer animation**

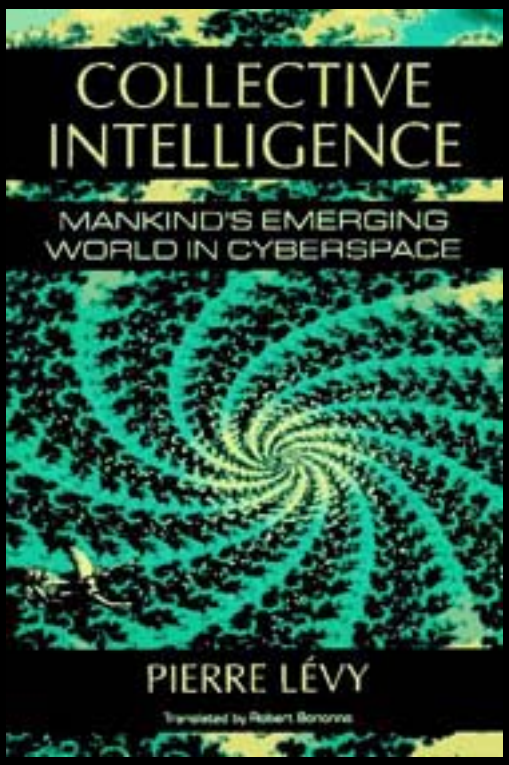
Marcos Novak | Liquid Architecture <1991>

Marcos Novak describes himself as a "trans-architect," due to his work with computer-generated architectural designs, conceived specifically for the virtual domain, that do not exist in the physical world. His immersive, 3-dimensional creations are responsive to the viewer, transformable though user interaction. Exploring the potential of abstract and mathematically conceived forms, Novak has invented a set of conceptual tools for thinking about and constructing territories in cyberspace.

Novak introduces the concept of "liquid architecture," a fluid, imaginary landscape that only exists in the digital domain. Novak suggests a type of architecture cut loose from the expectations of logic, perspective, and the laws of gravity, one that does not conform to the rational constraints of Euclidean geometries. He views trans-architecture as an expression of the "4th dimension" that incorporates time alongside space among its primary elements. Novak's liquid architecture bends, rotates, and mutates in interaction with the person who inhabits it. In liquid architecture, "science and art, the worldly and the spiritual, the contingent and the permanent" converge in a poetics of space.

Pioneers

Pierre Lévy | Collective Intelligence <1994>



From the book, Collective Intelligence

"Rather than distribute a message to recipients who are outside the process of creation and invited to give meaning to a work of art belatedly, the artist now attempts to construct an environment, a system of communication and production, a collective event that implies its recipients, transforms interpreters into actors, enables interpretation to enter the loop with collective action."

< < < subtext > > >

Pierre Lévy | Collective Intelligence <1994>

Pierre Lévy's *Collective Intelligence: Mankind's Emerging World in Cyberspace* (1994) has helped shape the dialogue about the aesthetic and social implications of multimedia, influencing artists and theorists alike. A counterpoint to the dystopic vision of William Burroughs and William Gibson, Lévy points to a digitally-conceived utopian universe, a virtual world in which vast repositories of information, decentralized authorship, mutable identity, and telematic interaction form an "endless horizon" of evolving forms of art and communication.

Lévy identifies an active role for the recipient of the artwork in tandem with a dramatic dissolution of authorial control on the part of its creator. For Lévy, art is becoming a dynamic, fluid, changing environment, a "deteriolized semiotic plane" in which "artist" and "recipient" unite in a consensual interplay in the formation, execution and interpretation of art. He views the digital medium as continuous and collaborative work-in-progress.

According to Lévy, the break from traditional notions of authorship is leading us towards cultural transformation. He envisions a collective society linked by electronic networks, with citizens actively engaged in the "continuous invention of the languages and signs of a community." Levy proposes that multimedia is a catalyst for social evolution. It is, he writes, "the architecture of the future" – or the language of the new era.