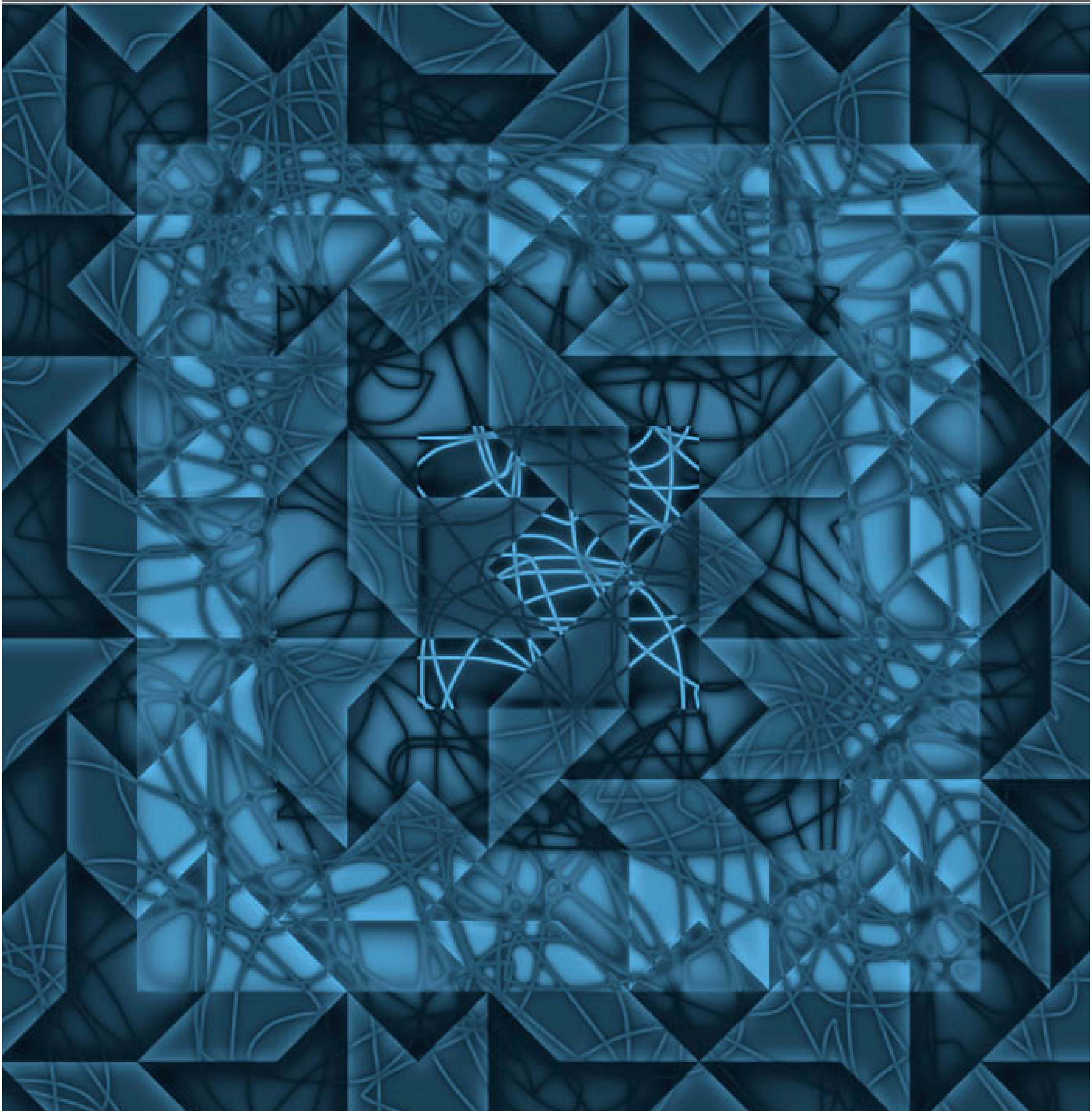
The Mechanical Mind in History



EDITED BY
Philip Husbands, Owen Holland, and Michael Wheeler

The Mechanization of Art
Paul Brown

Chapter 11, pp. 259 – 282 of

The Mechanical Mind in History

edited by Philip Husbands, Owen Holland, and Michael Wheeler

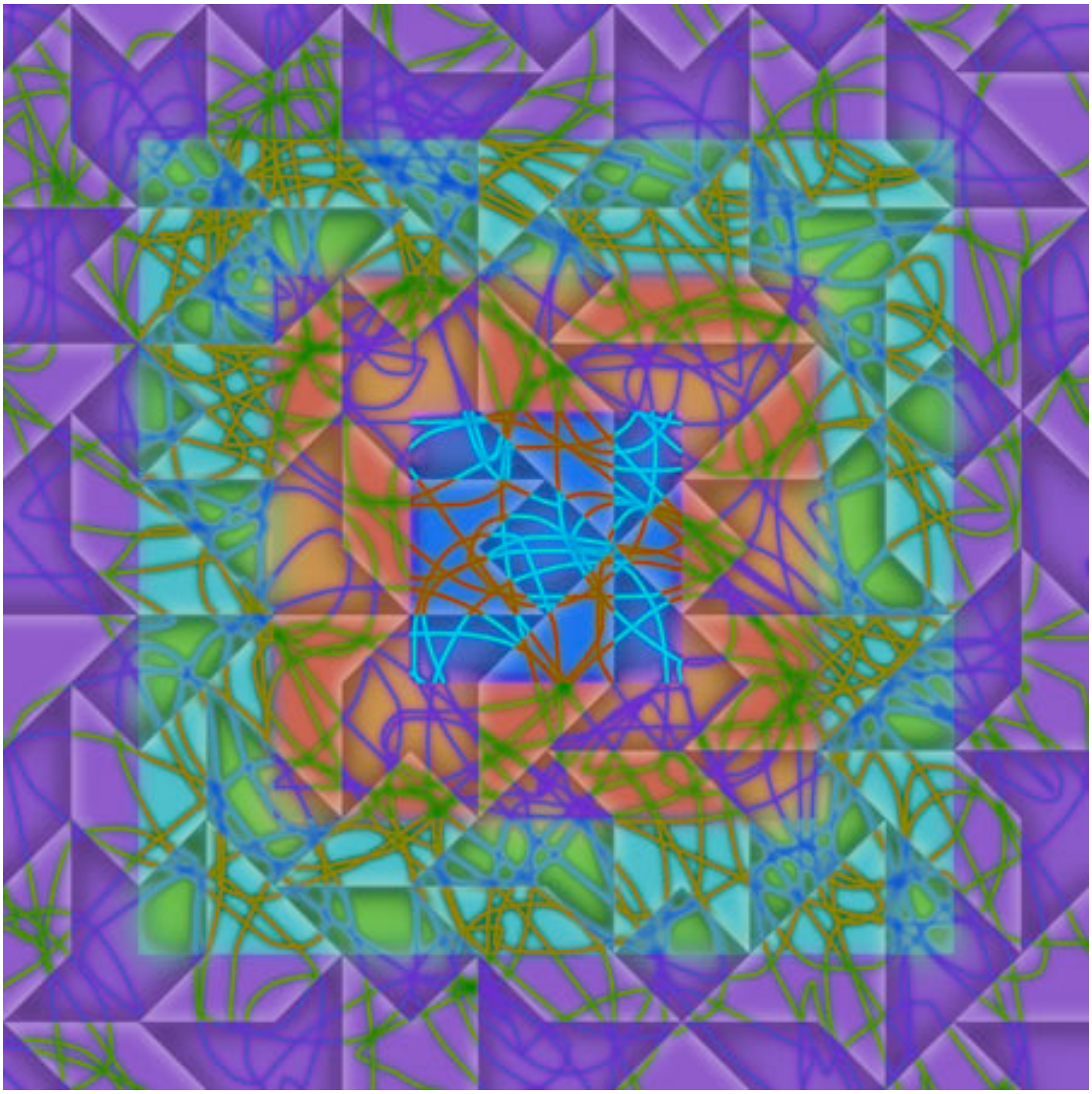
A Bradford Book The MIT Press Cambridge, Massachusetts, London, England

Cover Image

A Hunting of the Quark

Giclée Print, 50 x 50 cm, 2006

Paul Brown



11 The Mechanization of Art

Paul Brown

Sorry miss, I was giving myself an oil-job.
—Robby the Robot, in *Forbidden Planet*

I'm sorry Dave, I can't do that.
—HAL 9000, in *2001: A Space Odyssey*

This chapter is an idiosyncratic account of the development of "the mechanization of art." I am an artisan, a maker of art, and neither an historian nor a scholar, and so it describes only those parts of the narrative with which I am familiar. As the German Dadaist Kurt Schwitters, the architect of Merz (a movement embracing dance, theater, visual art, and poetry), once claimed, "I am the meaning of the coincidence." I have also chosen to end my account in the late 1970s. By then the personal computer had arrived and the world was changed forever. The ensuing proliferation of artworks and ideas are still difficult, for me at least, to record and contextualize.

A comprehensive overview of the historical developments that led to the flowering of the mechanization of art in the twentieth century is beyond the scope of this chapter. However, a few examples are worthy of note, since they give a context and demonstrate that this pursuit of knowledge has a long and intriguing pedigree that stretches back even into prehistory. The Chinese *I Ching*, or *Book of Changes*, is believed to have first taken form in about 1800 B.C.E. and is attributed to the legendary "founder" of China, Fu Hsi. The book was restructured and derived its modern format in the early Chou dynasty, following revisions attributed to King Wen and his son Tan, the Duke of Chou, around 1100 B.C.E. Further commentaries were added by Confucius (511–479 B.C.E.) and his school and are known as the Ten Wings. Although the book has been perceived in the West as a divination system or oracle, Joseph Needham and later scholars emphasize its importance in the history of Chinese scientific thought and philosophy and describe its method as "coordinative" or "associative," in contrast to the European "subordinate" form of inquiry.[1] The book may be interpreted as a cosmology where the unitary "one" first divides into the binary principles—the yin and the yang, represented by a broken or whole line, respectively—which are then permutated to form the eight trigrams. These, as the name suggests, are three-line structures that may also be interpreted as the vertices of a unit cube—the three dimensions of the material world. The trigrams are then permutated with each other to form the sixty-four hexagrams (or archetypes) and then each (any and all) of the six lines that make up the hexagram can flip into its opposite (yin to yang, broken to whole, and vice versa), which enables any hexagram to change to any other and so give the final 4,096 changes to which the title refers. The book may be "consulted" by a process of chance operations, flipping coins or dividing groups of yarrow stalks, a process that identifies the unique "time" of the consultation. Jesuit missionaries sent a copy of the book to Gottfried Leibniz, who introduced the binary mathematical notation system to Europe, and the *I Ching* has had an ongoing effect on Western scientific and artistic thought ever since. This gained momentum after a scholarly translation by Richard Wilhelm and Cary F. Baynes, with an introduction by Carl Jung, was published in 1968, coinciding with the cognitive experimentation of the psychedelic movement.[2]

During the first century C.E. the Greek engineer Hero of Alexandria designed and constructed sophisticated automata that were powered by water, gravity, air, and steam. As the Christian Dark Ages closed in over Europe, the ancient Greek and Egyptian knowledge was preserved and developed in the Arab world. Al Jaziri's *Al Jami' Bain Al 'Ilm Wal 'Amal Al Nafi Fi Sina'at Al Hiyal*, or *The Book of Knowledge of Ingenious Mechanical Devices* (about 1206) describes many of al Jaziri's automata and has been recently placed in the context of art and science history by Gunalan Nadarajan.[3] Among the devices that al Jaziri describes is an automatic wine server that was used at royal parties at the Urtuq court of Diyar-Bakir, who were his patrons. It randomly selected guests to serve so some got very intoxicated while others remained completely sober, to the great amusement of all.

Not long after this, Ramon Lull (1235–1315) was born in Palma, Majorca. He was a Christian writer and philosopher living in Spain when it was part of the Islamic Moorish empire, which included Portugal and parts of North Africa. Unlike his Northern European contemporaries, who were still living under the repressive Catholic rule appropriately named the Dark Ages, Lull had access to Arab knowledge dating back to Greece and culled from around the rapidly expanding Islamic sphere of influence. Although his contribution to knowledge was broad, of particular interest here are his Lullian Circles. Described in his *Ars Generalis Ultima*, or *Ars Magna*, published in 1305, these consist of a number of concentric disks that can be rotated independently on a common spindle. Each disk is scribed with symbols representing attributes, or archetypes, that can be permutated together to form compound expressions. The system forms a combinatorial logic that is remarkably similar in concept (though not in implementation) to the generative method employed by the much earlier *I Ching*. Two centuries later Leibniz (who, as mentioned, knew about the *I Ching*) developed Lull's idea for his investigations into the philosophy of science. Leibniz named the method *Ars Combinatoria*. Machines like Lull's appear in literature: in *Gulliver's Travels* (1721) Jonathan Swift describes a system that creates knowledge by combining words at random, a passage that is believed to be a parody of Lull's work. More recent fictional combinatorial knowledge machines appear in books such as Hermann Hesse's *The Glass Bead Game* and Umberto Eco's *The Island of the Day Before*.[4]

The Christian reconquest of Spain during the fifteenth century enabled the European rediscovery of the long-suppressed knowledge preserved by Islam, and this was a major cause of the flowering of the Renaissance (literally "rebirth"). The polymath Leonardo da Vinci (1452–1519) is known for his lateral and experimental approach to both art and science. Among his prolific output, around 1495 he recorded in a sketchbook a design for an anatomically correct humanoid automaton; there is no record that Leonardo's Robot, as it is now known, was ever built. The German artist Albrecht Dürer (1471–1528) was another polymath who made significant contributions to both mathematics and the visual arts. In his *Treatise on Measurement* (1525) he included several woodcut prints of perspective-drawing systems that can be retrospectively acknowledged as early precursors of analogue computing machines.

By the seventeenth century the French mathematician and philosopher René Descartes (1596–1650) proposed that animals were nothing more than complex machines. By suggesting a correspondence between the mechanical and the organic, Descartes laid the groundwork for a more formal study of autonomy. The production of automata flourished with ever more complex and sophisticated examples. The Jesuit alchemist Athanasius Kircher (1602–1680) is reputed to have made a statue that could carry on a conversation via a speaking tube (he's also credited with building a perpetuum mobile!). However, it was in 1737 that the French engineer and inventor Jacques de Vaucanson (1709–1782) made what is considered the first major automaton of the modern age. His Flute Player was not only intended to entertain but was also a serious investigation into human respiration. As such it stands as an early precursor of the art-science collaborations that developed in the twentieth century. Vaucanson's automated loom of 1744 did not use the punch cards proposed by Falcon in 1728, but instead used the paper-tape control system invented by Basile Bouchon in 1725. By 1801 Joseph Marie Jacquard had created a robust card-driven loom, a design that was still in use in the late twentieth century. Jacquard's card system had another major and arguably more influential outcome when Charles Babbage (1791–1871) selected it as the control and storage mechanism for his Analytical Engine. Later, Herman Hollerith (1860–1929) took up the idea and went on to found the company known today as IBM. It's an early and excellent example of how research in the arts can have a profound effect on science and technology and demonstrates how the modern science of computing has clearly defined roots in the art of weaving, which is, after all, an ancient system for the codification, manipulation, storage, and reproduction of pattern.

Religious warnings about human intervention in the work of God accompanied many of these developments and emerged in literature. The archetypical text is Mary Shelley's wonderful *Frankenstein* (1818).[5] Similar concerns continue to this day in many of the detractors and critics of artificial intelligence and artificial life, as well as many other aspects of science and technology such as evolution, nanotechnology, and stem-cell research.

Developments continued throughout the nineteenth century. The paper-tape and punch-card control systems developed for weaving were adapted for use in other applications. Orchestral machines such as steam organs toured the fairs, and pianolas and music boxes were mass-produced. Paper pianola scrolls enabled people to hear performances by contemporary virtuosi, and also formed a valuable historical record. They created a demand for pre-programmed music that would later be satisfied by shellac and vinyl gramophone recordings and contemporary compact disks and MP3 players. In the visual arts and sciences the invention of photographic recording by Joseph Niépce in 1827 was improved by Louis Daguerre. In 1835, William Henry Fox Talbot devised a method to duplicate images by printing multiple positives from one negative. The Renaissance experiments into perspective, Dürer's drawing systems, and other devices such as the camera obscura were automated—image making was now a mechanical process. By 1888 Kodak's founder, George Eastman, could coin the slogan "You press the button, we do the rest." During the same decades French Postimpressionist artists such as Paul Cézanne (1839–1906) and Georges Seurat (1859–1891) challenged the role of painting as representation, a function that had in any case been usurped by photography, and emphasised instead its analytical role. Both artists were concerned with a proto-semiological exploration of the relationship between the flat plane of the canvas, the representation, and the three-dimensional world, the represented. Neither would break completely with the figurative. That would happen early in the twentieth century, when the Russian artist Wassily Kandinsky (1866–1944), a theosophist, recalled some illustrations he had seen in a book called *Thought Forms*, by Annie Besant and C. W. Leadbeater (1888) and painted what he (amazingly, in retrospect) titled *First Abstract Watercolour* in 1910.[6] The visual arts had been freed from their anchor in "the real" and a colossal explosion in creativity ensued, causing ripples throughout the art world.

A decade later Karel Čapek (1890–1938) wrote the play *Rossum's Universal Robots*, or *R.U.R.* It was first performed in Prague in 1921, then in New York City, in 1922. Karel's brother, Josef, had coined the term *robot*: *robota* is Czech for "drudgery" or "servitude," and a *robotnik* is a peasant or serf. The play is either a utopia or dystopia, depending on your point of view. Robots are created as cheap labor who ultimately revolt and kill all the humans except one. The robots learn to replicate themselves and the play closes when two of them, Helena and Primus, fall in love and are dubbed Adam and Eve by Alquist, the last human (see chapter 12 for a detailed discussion of the play). Responding to criticism by George B. Shaw and G. K. Chesterton, among others, Čapek stated that he was much more interested in men than in robots. He predicted the sentiments of William Gibson who, over sixty years later, would express his concern when he discovered that computer graphics enthusiasts at the annual SIGGRAPH Conference were busy implementing the dystopian virtual reality he created for his Orwellian-style Cyberspace Trilogy: *Neuromancer*, *Count Zero*, and *Mona Lisa Overdrive*.[7] In 1927, five years after *R.U.R.*, Fritz Lang (1890–1976) wrote and directed his legendary film *Metropolis* (restored in 2002). Based on the novel by his wife, Thea von Harbou, it's a parable of socialist class struggle where the Lord of Metropolis, Johann Fredersen, wants to replace his human workers with robots. Their leader, Maria, is cloned by the evil scientist Rotwang into a robot "femme fatale" as part of a plot to incite a revolution that Johann hopes will give him the excuse to eliminate the workers and replace them with Rotwang's machines. A decade later, in 1936, the German Marxist historian and cultural theorist Walter Benjamin (1892–1940) published his essay "The Work of Art in the Age of Mechanical Reproduction," in which he argued that the artwork is democratized by mass-production technology but the result is that its unique intrinsic value is threatened.[8] The essay was influential, particularly in the latter half of the twentieth century, when the concept of the art object gave way to art as process.

The French artist Marcel Duchamp (1887–1968) is recognized as one of the major intellects of twentieth-century art. As a key member of the Dada movement he questioned the entire nature of the artwork when he introduced his ready-mades with *Roue de Bicyclette* (*Bicycle Wheel*) in 1913. During the 1920s Duchamp worked on a number of "Rotoreliefs," and some were recorded in his film *Anémic Cinéma* (1925–1926). The rotating disks produced 3-D illusions and progressed Duchamp's interest in both art-as-machine and as cognitive process. László Moholy-Nagy (1895–1946) created his light-space modulator in 1930 after some years of experimentation. It's a kinetic sculpture that he described as an "apparatus for the demonstration of the effects of light and movement." These effects are recorded in his film *Lichtspiel, schwarz-weiss-grau,* (Light-play, black-white-gray), made the same year. The original light-space modulator is preserved in the collection of the Busch-Reisinger Museum in Cambridge, Massachusetts, and a number of working reconstructions have been made. Alexander Calder (1898–1976) was a Paris-based American sculptor best known for the kinetic sculptures, dubbed "mobiles" by Duchamp, that he started constructing in 1931. Though his early experiments were motor-driven, he soon developed the graceful wind- and gravity-powered mobiles for which he is now best known.

The Swiss artist Jean Tinguely (1925–1991) belonged to a later generation of artists who were influenced by both Dada and these early kinetic experiments. In 1944 he began making his Metamechanics, or Metamatics, eccentric machines that often expended high energy doing nothing. Although his early work is playful and entertaining, there is always a dark undercurrent. By the 1960s the early whimsy had evaporated, to be replaced by a more somber mood reflective of the times. Among Tinguely's best-known work of this period is *Homage to New York* (1960), an ambitious autodestructive installation in the courtyard of New York's Museum of Modern Art, which was documented in Robert Breer's film *Homage to Jean Tinguely's "Homage to New York."* It is further notable because it was the first collaboration with an artist of the Bell Telephone Lab engineer Billy Klüver (1927–2004), who went on to cofound the influential EAT, Experiments in Art and Technology.

Takis (1925–) was born in Athens but, like Calder and Tinguely, based himself in Paris and began making his illuminated Signaux—Signals—in 1955. They become kinetic in 1956 and in 1958 Takis integrated electromagnetic elements that gave his works chaotic dynamics. Frank Malina (1912–1981) was an American aerospace engineer who did pioneering work on rocketry and was a cofounder and the first director of Caltech-NASA's Jet Propulsion Lab in Pasadena. Disillusioned with the increasing military application of his research, he left in 1947 to join UNESCO before committing himself full-time to his art practice in 1953. He based himself in Paris, where many of the European kinetic artists were congregated. His son, Roger, has recently commented that he "was amazed that artists created so little artwork depicting the new landscapes we now see, thanks to telescopes, microscopes and robots that explore the ocean and space."[9] In 1954 Malina introduced electric lights into his work and in 1955 began his kinetic paintings. In 1968 he founded the influential publication *Leonardo*, the journal of the International Society for Arts, Science and Technology (ISAST).[10]

It was in Paris in the 1950s that the artist Nicolas Schöffer (1912–1992) formulated his idea of a kinetic art that was not only active and reactive, like the work of his contemporaries, but also autonomous and proactive. He developed sculptural concepts he called Spatiodynamism (1948), Luminodynamism (1957), and Chronodynamism (1959) and was influenced by the new ideas that had been popularized by Norbert Wiener and Ross Ashby.[11] His *CYSP 1* (1956, figure 1) is accepted as the first autonomous cybernetic sculpture. Its name is formed from CYbernetic SPatiodynamism. It was controlled by an "electronic brain" (almost certainly an analogue circuit) that was provided by the Dutch electronics company Philips. In addition to its internal movement, *CYSP 1* was mounted on a mobile base that contained the actuators and control system. Photosensitive cells and a microphone sampled variations in color, light, and sound (see figure 11.1). It was

> . . . excited by the colour blue, which means that it moves forward, retreats or makes a quick turn, and makes its plates turn fast; it becomes calm with red, but at the same time it is excited by silence and calmed by noise. It is also excited in the dark and becomes calm in intense light.

On its second outing *CYSP 1* performed with Maurice Béjart's ballet company on the roof of Le Corbusier's Cité Radieuse, as part of the Avant-Garde Art Festival held in Marseilles in 1956. Schöffer said of his work: "Spatio-dynamic sculpture, for the first time, makes it possible to replace man with a work of abstract art, acting on its own initiative, which introduces into the show world a new being whose behaviour and career are capable of ample developments."[12]

Figure 11.1
Nicolas Schöffer, CYSP 1, 1956. © ADAGP, Banque d'Images, Paris 2007. Printed with permission.

Schöffer worked closely with composers and choreographers, including Pierre Henry and Alwin Nikolais. These three together created *KYLDEX*, the first experimental cybernetic show, at the Hamburg Opera House in 1973. Schöffer is also credited with making the first video production in the history of television, *Variations Luminodynamiques 1*, for Télévision Française in 1960 and so in addition to his considerable contribution to the world of kinetics and autonomous arts he is also remembered as the "father" of video art.

The same year that *CYSP 1* danced in Marseilles, 1956, across the Channel in the United Kingdom the Independent Group—consisting of artists, architects, designers, and critics who challenged prevailing approaches to culture—put together a show at London's Whitechapel Gallery, "This Is Tomorrow," which became an influential landmark in the history of the contemporary arts in the UK. Charlie Gere has pointed out that the catalogue contains what is possibly the first reference to punch cards and paper tape as artistic media.[13] Robby the Robot, star of Fred Wilcox's then recently released (1956) film *Forbidden Planet*, attended the opening and the show received a high popular profile in the British press. *Forbidden Planet* bucked the trend of most American sci-fi movies of the time—where Communists disguised as aliens are taught that freedom and democracy come out of the barrel of a gun—with a thoughtful script that was loosely based on Shakespeare's *The Tempest*. But in the film the spirit world is a product of cybernetic amplification of the human subconscious. The film was influenced by the popular science and psychology of the day and also contains echoes of Shelley's *Frankenstein*.

The mood of the time was strongly pro-science—the public action of the Campaign for Nuclear Disarmament (founded 1958) and televized atrocities of the Vietnam War, which would alienate people from science's perceived military agenda, were still a decade in the future. *Eagle* was a popular comic book of the day geared toward middle-class boys, one issue of which featured a car powered by a small nuclear power pack that would never need refueling and was expected on Britain's roads before the turn of the century! In 1963 the Labour prime minster Harold Wilson promised that the "white heat of technology" would solve the country's problems, and a golden age of plenty, delivered by science and its machines, seemed imminent.

In Germany Herbert Franke produced his first Oszillogramms in 1956. The mathematician, physicist, and philosopher Max Bense (1910–1990) proposed his concept of Information Aesthetics the next year, when he

Figure 11.2
Galerie Wendelin Niedlich, Stuttgart. Screenshot of virtual reconstruction of the gallery room with exhibition of computer art by Frieder Nake and Georg Nees, Nov. 1965. Courtesy Yan Lin-Olthoff.

brought together aspects of information theory, cybernetics, and aesthetics.[14] At about the same time the French theorist Abraham Moles (1920–1992) published his work in the area.[15] A decade later, in 1965, Bense curated what is believed to be the first public exhibition of computer art in the world when he invited the computer-graphics artist Georg Nees to show his work at the Studiengalerie der Technischen Hochschule (Technical University) in Stuttgart. The exhibition ran February 5 to 19. This encouraged the artist Frieder Nake to show his work, along with Nees later that year from November 5 to 26 at Stuttgart's Galerie Wendelin Niedlich (figure 11.2). Many of the European artists working in the new field congregated in Zagreb in August 1968 for a colloquy, "Computers and Visual Research," that was part of the New Tendencies Movement; it led to a major exhibition called "Tendencies 4," which ran May 5 to August 30, 1969. Rainer Usselmann has suggested that these meetings confronted sociopolitical issues associated with the new technologies (and especially the military agendas) that were absent from the more playful British debate—especially the signal event that has come to epitomize the period.[16]

A suggestion from Max Bense in 1965 inspired writer and curator Jasia Reichardt to organize the exhibition that now stands as a defining moment in the history of the computational arts. The show "Cybernetic Serendipity" opened at London's Institute of Contemporary Art on August 2, 1968 and ran until 20 October 1968.[17] Reichardt recently described it as

> . . . the first exhibition to attempt to demonstrate all aspects of computer-aided creative activity: art, music, poetry, dance, sculpture, animation. The principal idea was to examine the role of cybernetics in contemporary arts. The exhibition included robots, poetry, music and painting machines, as well as all sorts of works where chance was an important ingredient.

The show coincided with and complemented the release of one of the major cultural artifacts of the period, Stanley Kubrick's enigmatic film *2001: A Space Odyssey*. It features a self-aware artificial intelligence—HAL 9000—that has a psychotic breakdown when it is unable to resolve conflicting data.

Among work by over three hundred scientists and artists at "Cybernetic Serendipity" was a piece by the British cybernetician Gordon Pask (1928–1996). The *Colloquy of Mobiles* (figure 11.3) consisted of five ceiling-mounted kinetic systems—two "males" and three "females." Using light and sound they could communicate with each other in order to achieve "mutual satisfaction." The system could learn, and the mobiles optimized their behavior so that their goal could be achieved with the least expenditure of energy. Members of the public, using flashlights and mirrors, could also interact with the mobiles and influence the process.[18]

Pask also worked with the architect John Frazer, the artist Roy Ascott, and others as an adviser to the Fun Palace Project, conceived by Archigram's Cedric Price and the socialist theatrical entrepreneur Joan Littlewood.[19] Although the Fun Palace, a dynamically reconfigurable interactive building, was never built, it had a wide influence; for example, it inspired Richard Rogers and Renzo Piano's Centre Georges Pompidou in Paris. In the seventies Frazer worked closely with Pask at the Architectural Association and is notable for his concept of the Intelligent Building.[20]

"Cybernetic Serendipity" also included Edward Ihnatowicz's (1926–1988) sound-activated mobile, or SAM. Ihnatowicz would later describe himself as a Cybernetic Sculptor.[21] SAM consisted of four parabolic reflectors shaped like the petals of a flower, on an articulating neck. Each reflector focused ambient sound on its own microphone; an analogue

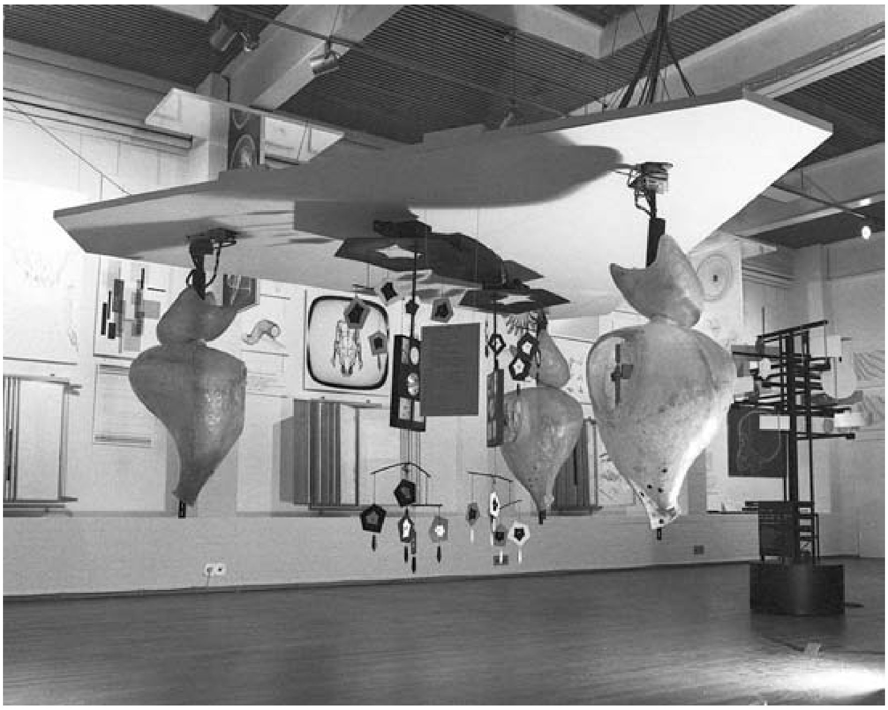


Figure 11.3
Gordon Pask, Colloquy of Mobiles, installation shot from Cybernetic Serendipity (1968). Courtesy Jasia Reichardt.

circuit could then compare inputs and operate hydraulics that positioned the flower so it pointed toward the dominant sound. SAM could track moving sounds, and this gave visitors the eerie feeling that they were being observed. Not long after, Ihnatowicz was commissioned by Philips to create the Senster (figure 11.4) for the company's Evoluon science center in Eindhoven. The Senster was a twelve-foot ambitious minicomputer-controlled interactive sculpture that responded to sound and movement in a way that was exceptionally "life like" (it was exhibited from 1970 to 1974, when it was dismantled because of high maintenance costs).[22] Ihnatowicz was an early proponent of a "bottom-up" approach to artificial intelligence—what we would now call artificial life. His reading of the work of the developmental psychologist Jean Piaget inspired him to suggest that machines would never attain intelligence until they learned to interact with their environments.[23]

The socialist techno-utopian vision that played a major role in European politics and culture of the period was less influential in the Communist-phobic United States. In consequence, developments there were less centralized, more sporadic, and often linked to artists' initiatives or the

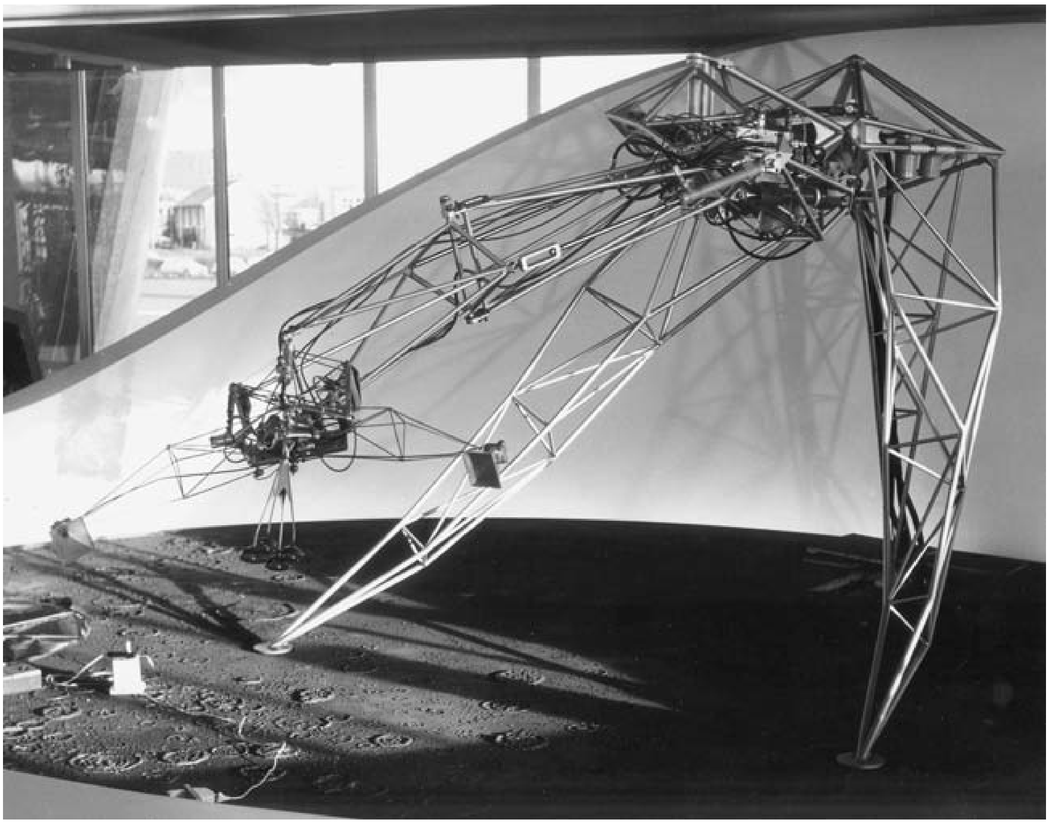


Figure 11.4
Edward Ihnatowicz, The Senster, 1970. Courtesy Olga Ihnatowicz.

commercial art world rather than state-patronized social agendas. Ben Laposky (1914–2000) began to make his analogue Oscillons in 1950, the same year the composer John Cage (1912–1992) discovered the *I Ching*. This profoundly influenced Cage's career, which increasingly involved technology and chance elements. He used coin tosses to determine pitch, rhythm, dynamics, and duration of his "Music of Changes," written in 1951, and he created the masterpiece "4′ 33″" the next year. In this work the performer stands still on the stage and the audience listens to the ambient sounds and silence. In 1952 Cage began working with electronic music, and in 1967, with Lejaren Hiller, he produced the ambitious computer-assisted "HPSCHD." The name reflects the contemporary use of a "high level" programming language, FORTRAN (FORmula TRANslation), that allowed only six-character names, in uppercase, and that often omitted vowels. The year before, in 1966, Cage was one of many artists who contributed to the defining event of art-technology collaborations in the United States. "9 Evenings: Theater and Engineering" was produced by

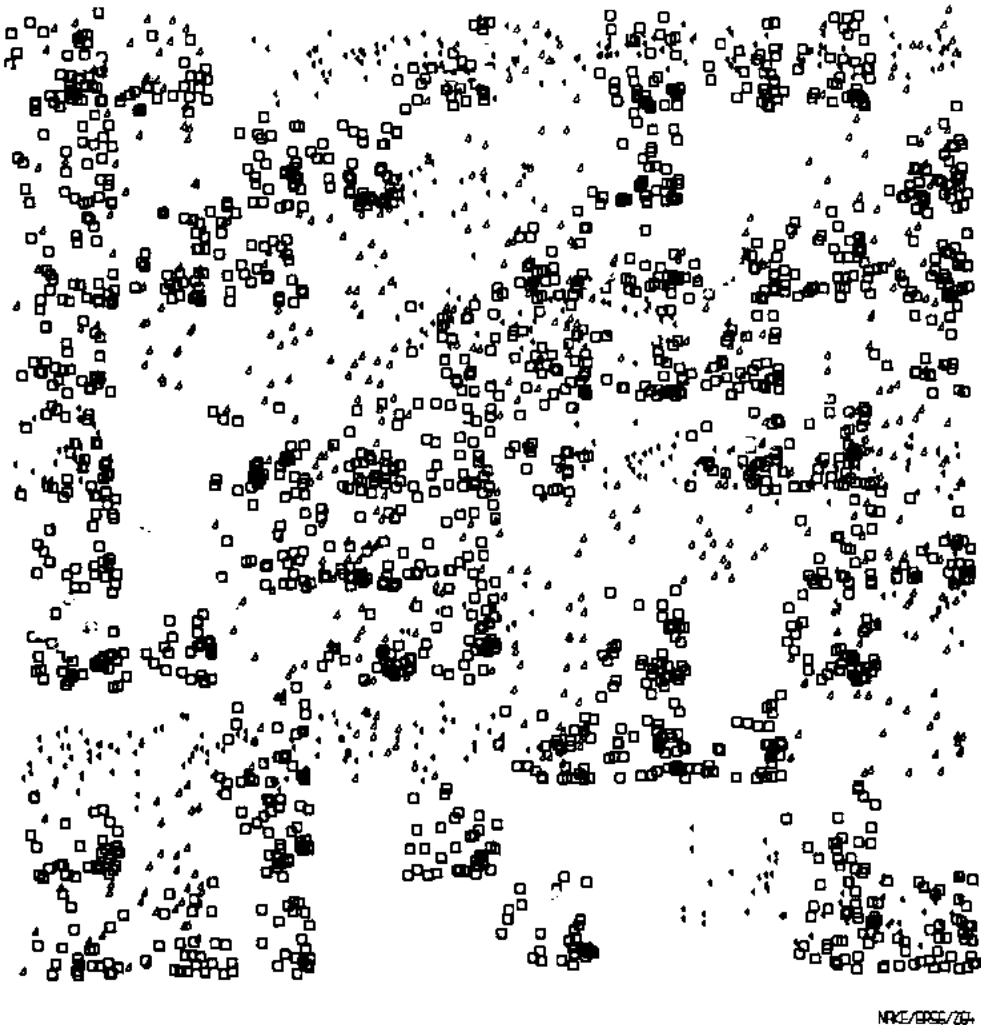


Figure 11.5
Frieder Nake: 13/9/65 Nr. 5, "Random distributions of elementary signs," China ink on paper, 51 × 51 cm, 1965. Possession of Sammlung Etzold, Museum Abteiberg, Mönchengladbach. First prize Computer Art Contest 1966, Computers and Automation. Printed with permission.

the Experiments in Art and Technology (EAT) group, and was set up by Billy Klüver and Fred Waldhauer with the artists Robert Rauschenberg and Robert Whitman.[24]

Starting in 1963, the journal *Computers and Automation* sponsored a computer art competition; in 1963 and 1964 the winning entries were visualizations from the U.S. Ballistics Research Lab at the Aberdeen Proving Ground in Maryland. Michael Noll won in 1965 and Frieder Nake in 1966 (see figure 11.5). Noll had produced the first computer graphics artwork in 1962. The United States' first computer art exhibition, "Computer Generated Pictures," was held April 6 to 24, 1965 at the Howard Wise Gallery in

New York (just three months after the pioneering Stuttgart show) and featured work by Noll and Bela Julesz (1928–2003). Charies "Chuck" Csuri, a sculptor, established a pioneering computer arts lab at Ohio State University, where Tom Defanti completed his Ph.D. before collaborating with the artist-engineer and video art pioneer Dan Sandin. In 1974 together Defanti and Sandin established the Electronic Visualization Lab at the University of Illinois, Chicago Circle, and later the world's first M.F.A. program in computer arts. It's believed that Copper Gilloth was the first graduate. A year earlier, Myron Kruger, who had collaborated with Sandin, coined the term "artificial reality" to describe his interactive immersive computer-based art installations.

London in the 1960s was "swinging" and the art world was fertile anarchistic ground for any and all new ideas. Jim Haynes set up the London Arts Lab on Drury Lane and the London Filmmakers Coop was established. Later the Arts Lab moved to Camden as an artist-run space called the Institute for Research into Art and Technology; from 1969 it included the Electronics and Cybernetics Workshop (possibly a single mechanical teletype and a 300-baud modem) that was organized by John Lifton and offered free and exclusive computer access to artists for the first time. At Ealing College in 1961 the recently graduated Roy Ascott was appointed head of Foundation Studies, where he developed the influential Groundcourse.[25] He recruited an impressive team of young artists as teachers, and visitors included Pask and the linguist Basil Bernstein. Ascott and others believed that it was the process, rather than the product, that provided the essential content of the artwork. This became a dominant aesthetic of the arts in the latter part of the twentieth century, influencing the formation of several movements including Art & Language, Conceptual Art, and Systems Art.[26] Stephen Willats was a student of Ascott's who went on to produce some major works linking art and technology with a social agenda; his contribution has recently been reassessed.[27] Stroud Cornock, a colleague of Ascott's, moved to the City of Leicester Polytechnic, where he met the artist and mathematician Ernest Edmonds. They coauthored the influential paper "The Creative Process Where the Artist is Amplified or Superseded by the Computer," and Edmonds went on to establish the Creativity and Cognition Lab (originally at Leicester, then at Loughborough, and now at the University of Technology, Sydney), as well as found the ACM Creativity and Cognition conference series.[28] Ascott later pioneered the use of communication networks in the arts and more recently has established the Planetary Collegium as a global initiative intended to encourage scholarly research in the field of art, technology, and consciousness.[29]

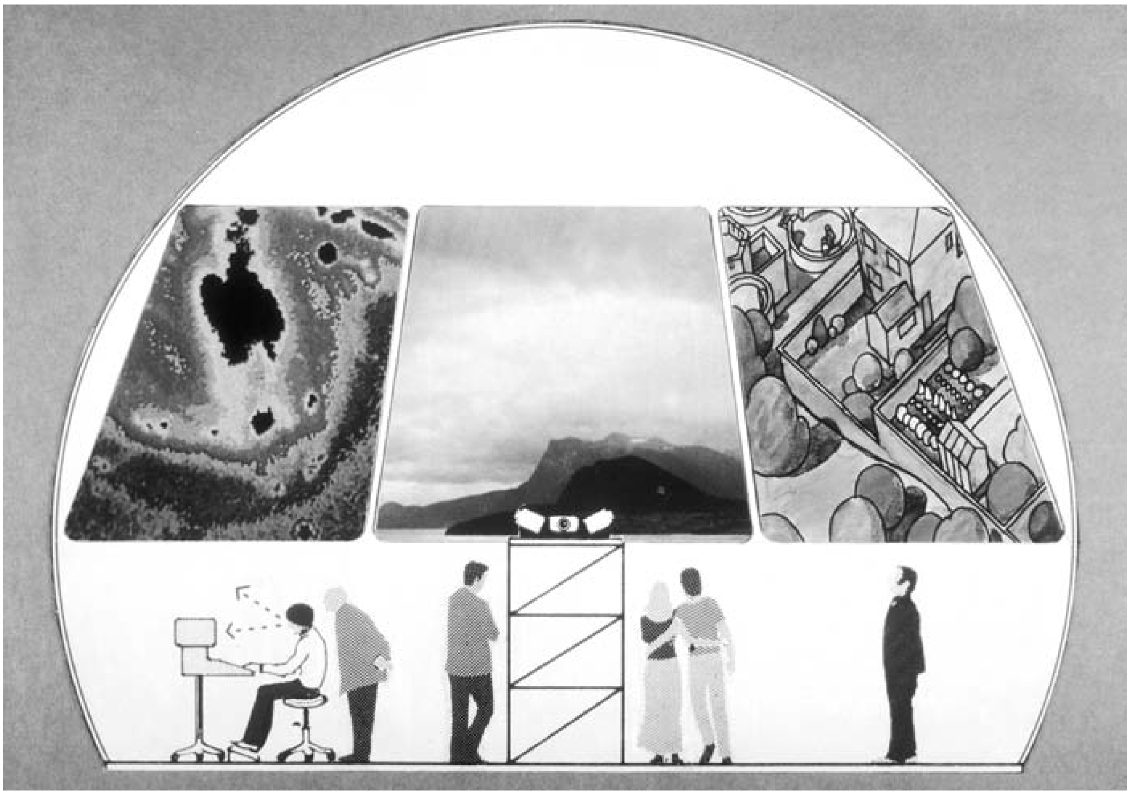


Figure 11.6
George Mallen, The Ecogame, 1969. Courtesy the Computer Arts Society.

In 1969 the Computer Arts Society was cofounded by Alan Sutcliffe, John Lansdown, and George Mallen.[30] Mallen had worked closely with Gordon Pask at his company Systems Research, and for the CAS launch—Event One, an exhibition at the Royal College of Art—he produced a remarkably sophisticated (especially considering the rudimentary technology of the time) interactive computer artwork called *The Ecogame* (figure 11.6).[31] The CAS bulletin, *PAGE*, originally edited by Gustav Metzger, is still in print and forms a valuable historical record.[32] The same year that CAS was formed, Penguin published a book called *Systems Thinking*, edited by an Australian, Fred Emery, as an inexpensive paperback special.[33] It contained chapters by W. Ross Ashby and Geoff Summerhoff, among others, and because of its accessibility it was widely influential throughout the art world in the UK, being on the recommended book list for many foundation and undergraduate fine arts courses in the UK. Two books by the left-wing cybernetician Stafford Beer, *Designing Freedom* and *Platform for Change*, were also influential as the 1970s progressed.[34] Although the systems art movement was pan-European, the Systems Group was primarily based in the UK. Malcolm Hughes, a member, was also head of postgraduate studies at

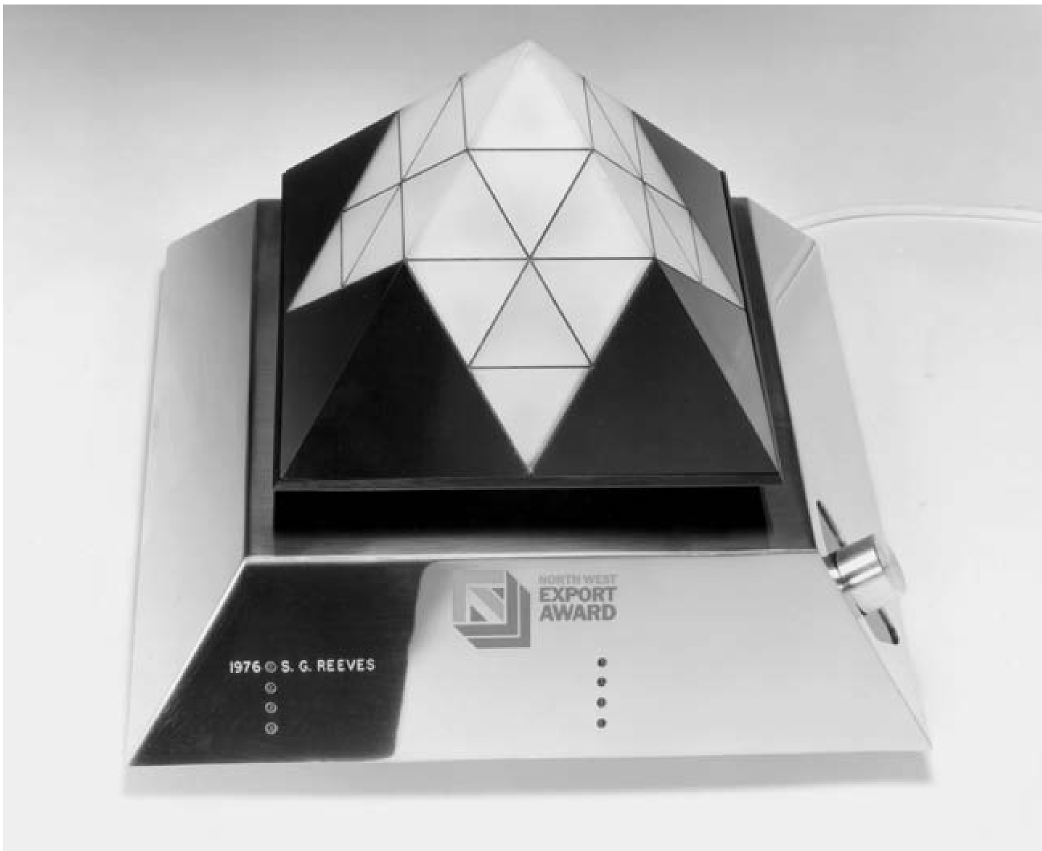


Figure 11.7
Paul Brown, CBI North West Export Award, 1976. An early alife work by the author that was driven by a dedicated digital circuit.

the Slade School of Fine Art, University College, London. He set up what became the Experimental and Computing Department, or EXP, in 1973 under Chris Briscoe, where the systems ethos was transferred into the computer domain. The emerging ideas of deterministic chaos, fractals, and cellular automata were influences and the output of EXP forms a root of both the computational and generative arts and the scientific pursuit of A-life (see figures 11.7 and 11.8).[35] Edward Ihnatowicz, who was then based in the Mechanical Engineering School at University College London, was a regular visitor, as was Harold Cohen who was working on an early version of his expert drawing system, AARON, at the University of California, San Diego.[36] From 1974 to 1982, when it closed, EXP was a major focus for artists from around Europe who were working in the computational domain.

In 1970 two important exhibitions took place in New York. Kynaston McShine's "Information" show at the Museum of Modern Art was an eclectic, idiosyncratic mix of conceptual formalism, linguistic and information

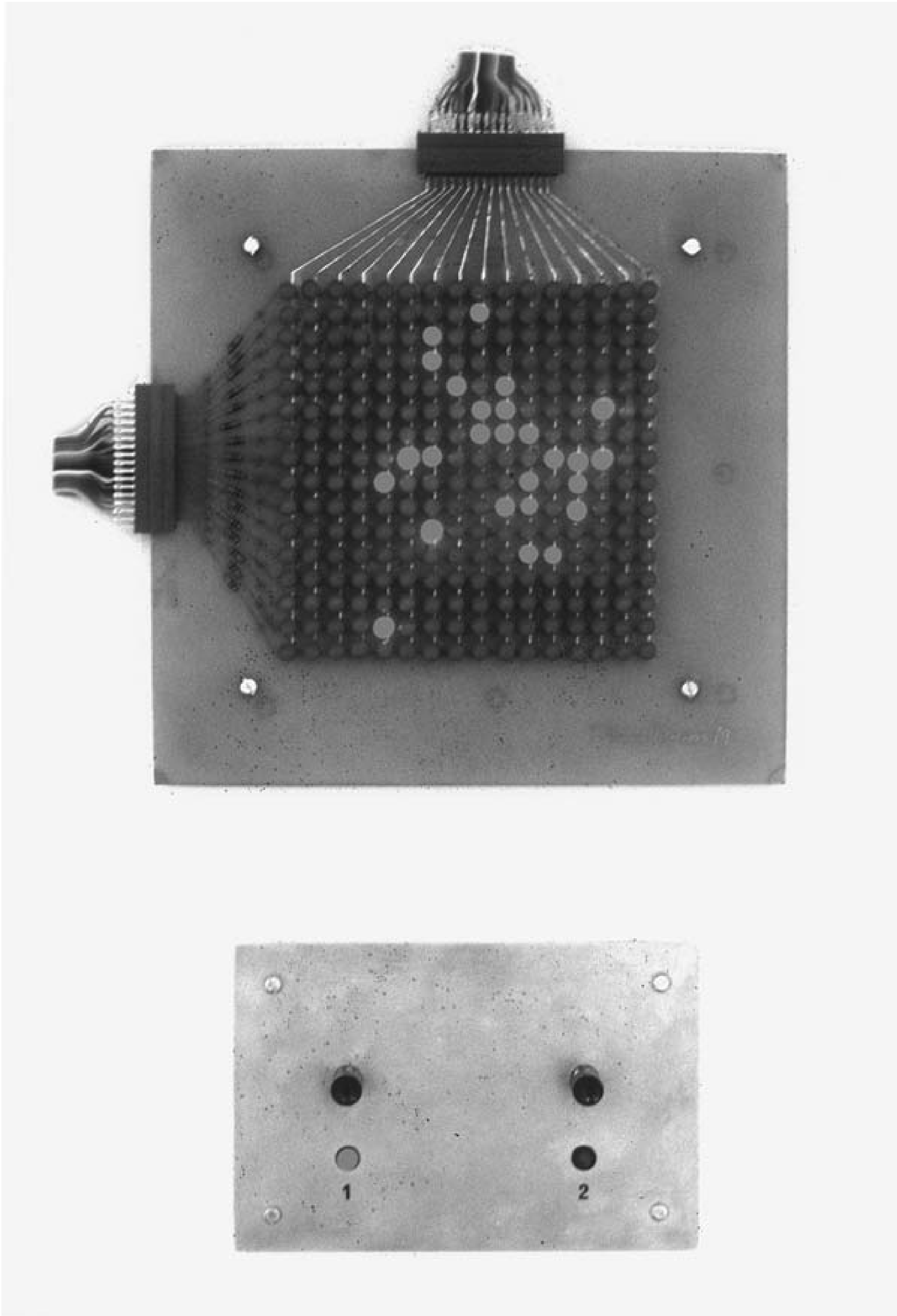


Figure 11.8
Paul Brown, Life/Builder Eater, 1978. An alife work by the author produced at EXP. Believed to be the first artwork to have an embedded microprocessor.

theories, and sociopolitical activism.[37] Jack Burnham's software show, "Software—Information Technology: Its New Meaning for Art," at the Jewish Museum, was intended to draw parallels between conceptual art and theories of information such as cybernetics. The show included work by a young architect named Nicholas Negroponte, who would later found MIT's Media Lab. Burnham, in his earlier influential book, *Beyond Modern Sculpture* (1968) had suggested that art's future lay in the production of "life-simulation systems."[38] Many artists of the time agreed and believed that the world of art would be radically transformed by an imminent revolution and undergo what the philosopher of science Thomas Kuhn had recently described as a "paradigm shift."[39] The art world did change, but not in the radical way these artists and theorists expected; by the 1980s it was being driven by humanities-educated graduates who identified more with the eclecticism of McShine than with the focused analytical vision of Burnham and the systems and conceptual artists. They adopted the emerging theories of postmodernism and tended to be unfamiliar with, and deeply suspicious of, computing and information technology, which they identified with the growth in power of what later became known as the military-industrial-entertainment complex. In my opinion they made a singular mistake: by identifying the kind of developments I have described with the absolute narratives of utopian modernism (which, to be fair, is not an altogether unreasonable association) they ignored aspects such as emergence, nonlinearity, hypermediation, interaction, networking, self-similarity, self-regulation that should have been seen—and more recently have been acknowledged—as central to the postmodern debate. It was a classic case of throwing out the baby with the bathwater.

The ongoing lack of support for computer art from the arts mainstream throughout the latter decades of the twentieth century led to the formation of an international "salon des refusés." The Computer Arts Society ran several exhibitions in the unused shells of computer trade shows in the late 1970s and early '80s in the UK and in 1981 in the United States the first SIGGRAPH Art Show was curated by Darcy Gerbarg and Ray Lauzzana; the latter also established the influential bulletin board "fineArt forum" in 1987.[40] The Austrian Ars Electronica convention and Prix was launched in 1979, and in 1988 the International Symposium on Electronic Arts series began in Utrecht, The Netherlands.[41] These international opportunities were, and most of them remain, important venues for debate and exhibition of work that until recently rarely found its way into the established gallery system. Thanks in major part to this "patronage," a younger generation of computational and generative artists emerged in the 1980s and early '90s, whose ranks include Stelarc, Karl Sims, Yoichiro Kawaguchi, William Latham, the Algorists, Michael Tolson, Simon Penny, Jon McCormack, Troy Innocent, Ken Rinaldo, Richard Brown, and many others.

Acknowledgments

My apologies to those whom I have left out because of space limitations. This essay would not have been possible without my participation in the CACHe project (Computer Arts, Contexts, Histories, etc.), which took place from 2002 to 2005 in the History of Art, Film, and Visual Media Department at Birkbeck College, University of London. I would like to thank my colleagues on that project: Charlie Gere, Nick Lambert, and Catherine Mason for their ongoing contributions and support, especially for their informed comments about early revisions of this chapter. I am indebted to Frieder Nake and Margit Rosen for helpful comments on an earlier draft. I must also thank the UK's Arts and Humanities Research Council, who funded the CACHe project, and Phil Husbands, the coeditor of this volume, for his valuable feedback.

Notes

1. J. Needham, *Science and Civilisation in China*, volume 2: *History of Scientific Thought* (Cambridge: Cambridge University Press, 1956).

2. R. Wilhelm, trans., *The I Ching or Book of Changes*, edited by Cary F. Baynes (London: Routledge & Kegan Paul, 1968).

3. Gunalan Nadarajan, "Islamic Automation: A Reading of Al-Jazari's *Book of Ingenious Mechanical Devices* (1206)," in *MediaArtHistories*, edited by Oliver Grau (Cambridge, Mass.: MIT Press/Leonardo, 2007).

4. Hermann Hesse, Das Glasperlenspiel [*The Glass Bead Game*; also *Magister Ludi*] (Zurich: Fretz & Wasmuth Verlag, 1943), and Umberto Eco, *The Island of the Day Before*, translated by William Weaver (Harcourt Brace, 1984).

5. Mary Shelley, *Frankenstein* (London: Lackington, Hughes, Harding, Mavor & Jones, 1818).

6. The illustrations as part of the e-book are available at "Thought Forms, by Annie Besant and C. W. Leadbetter," http://www.anandgholap.net/Thought_Forms-AB_CWL.htm.

7. William Gibson, The Cyberspace Trilogy: *Neuromancer* (New York: Ace Books, 1984); *Count Zero* (Arbor House, 1986); *Mona Lisa Overdrive* (Bantam Spectra, 1988).

8. Walter Benjamin, "The Work of Art in the Age of Mechanical Reproduction," in *Illuminations*, translated by H. Zohn, edited and with an introduction by Hannah Arendt (New York: Schocken Books, 1969).

9. Roger Malina, Fluid Arts website, "Educational Projects in Art, Science and Technology," at http://www.fluidarts.org/projects/space.html.

10. An obituary of Frank Malina, the founder of *Leonardo*, is available at the Fondation Daniel Langlois website, at http://www.fondation-langlois.org/html/e/page.php?NumPage=233.

11. Norbert Wiener, *Cybernetics or Control and Communication in the Animal and the Machine* (Cambridge, Mass.: MIT Press, 1948), and W. Ross Ashby, *Introduction to Cybernetics* (London: Chapman & Hall, 1956). The complete book can be downloaded from the Principia Cybernetica website, http://pespmcl.vub.ac.e/ASHBROOK.html.

12. Schöffer quoted in "CYSP 1. (1956), The First Cybernetic Sculpture of Art's History," at http://www.olats.org/schoffer/cyspe.htm.

13. Charlie Gere, "Introduction," in *White Heat Cold Logic: British Computer Art 1960–1980*, edited by Paul Brown, Charles Gere, Nicholas Lambert, and Catherine Mason (Cambridge, Mass.: MIT Press/Leonardo, forthcoming.

14. Max Bense, *Aesthetica* (Baden-Baden: agis Verlag, 1965). This volume contains four separate publications, *Aesthetica* I to IV, published by agis between 1954 and 1960.

15. A. A. Moles, *Théorie de l'information et perception esthétique* (Paris: Flammarion, 1958); published in English as *Information Theory and Esthetic Perception* (University of Illinois Press, 1966).

16. Christoph Klütsch, "The Summer of 1968 in London and Zagreb: Starting or End Point for Computer Art?," in *Proceedings of the Fifth Conference on Creativity and Cognition* (London, April 12–15, 2005), *C&C '05* (New York: ACM Press, 2005); and Rainer Usselmann, "The Dilemma of Media Art: Cybernetic Serendipity at the ICA," *Leonardo* 36, no. 5: 389–96 (MIT Press, 2003).

17. Jasia Reichardt, "In the Beginning," and B. MacGregor, "Cybernetic Serendipity Revisited," both in Brown, Gere, Lambert, and Mason, *White Heat Cold Logic*; Reichardt, "Cybernetic Serendity," press release, available at http://www.medienkunstnetz/de/exhibitions/serendipity.

18. Margit Rosen, "Gordon Pask—The Colloquy of Mobiles," available at http://medienkunstnetz.de/works/colloquy-of-mobiles.

19. Design Museum, "Cedric Price, Architect (1934 to 2003)," available at http://www.designmuseum.org/design/cedric-price.

20. James Frazer, "Interactive Architecture," in Brown, Gere, Lambert, and Mason, *White Heat Cold Logic*.

21. See Alex Zivanovic's comprehensive website on Ihnatowicz's work, "Senster—A website devoted to Edward Ihnatowicz, cybernetic sculptor," at http://www.senster.com.

22. Alex Zivanovic, "The Technologies of Edward Ihnatowicz," in Brown, Gere, Lambert, and Mason, *White Heat Cold Logic*.

23. Edward Ihnatowicz, personal communication with Paul Brown, mid-1970s.

24. Fondation Daniel Langlois, "Billy Klüver—Experiments in Art and Technology (E.A.T)," available at http://www.fondation-langlois.org/html/e/page.php?NumPage=306.

25. Roy Ascott, "Creative Cybernetics: The Emergence of an Art Based on Interaction, Process and System," in Brown, Gere, Lambert, and Mason, *White Heat Cold Logic*.

26. Lucy Lippard, *Six Years: The Dematerialization of the Art Object from 1966 to 1972* (London: Studio Vista, 1973); G. Howard, "Conceptual Art, Language, Diagrams and Indexes," in Brown, Gere, Lambert, and Mason, *White Heat Cold Logic*.

27. George Mallen, "Stephen Willats: An Interview on Art, Cybernetics and Social Intervention," *PAGE 60, Bulletin of the Computer Arts Society*, Spring 2005.

28. S. Cornock and E. A. Edmonds, "The Creative Process Where the Artist Is Amplified or Superseded by the Computer," *Leonardo* 6, no. 1: 11–15 (MIT Press, 1973); E. A. Edmonds, "Constructive Computation," in Brown, Gere, Lambert, and Mason, *White Heat Cold Logic*.

29. Roy Ascott and C. E. Loeffler, eds., "Connectivity—Art and Interactive Telecommunications," *Leonardo* (special issue) 24, no. 2 (MIT Press, 1991).

30. The Computer Arts Society is a specialist group of the British Computer Society. For more information on CAS, see http://www.computer-arts-society.org; Alan Sutcliffe, "Patterns in Context," in Brown, Gere, Lambert, and Mason, *White Heat Cold Logic*.

31. George Mallen, "Bridging Computing in the Arts and Software Development," in Brown, Gere, Lambert, and Mason, *White Heat Cold Logic*.

32. Issues of *PAGE* are accessible on-line at http://www.computer-arts-society.org/page/index.html.

33. Fred Emery, ed., *Systems Thinking* (Harmondsworth, UK: Penguin Books, 1969).

34. Stafford Beer, *Designing Freedom* (Toronto: CBC Learning Systems, 1974; London and New York: Wiley, 1975); Beer, *Platform for Change* (London and New York: Wiley, 1975; rev. ed., 1978).

35. Paul Brown, ''From Systems Art to Artificial Life: Early Generative Art at the Slade School of Fine Art,'' in Brown, Gere, Lambert, and Mason, *White Heat Cold Logic*; Brown, ''The CBI North West Award,'' *PAGE* 62 (Autumn 2005), pp. 12–14.

36. Harold Cohen, ''Reconfiguring,'' in Brown, Gere, Lambert, and Mason, *White Heat Cold Logic*.

37. E. Meltzer, ''The Dream of the Information World,'' *Oxford Art Journal* 29, no. 1: 115–35(2006).

38. Jack Burnham, *Beyond Modern Sculpture: The Effects of Science and Technology on the Sculpture of This Century* (New York: Braziller, 1968).

39. Thomas S. Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1962).

40. For more information on ACM SIGGRAPH (the Association for Computing Machinery's Special Interest Group on Graphics and Interactive Techniques) see http://www.siggraph.org; for more information on the fineArt forum, see their website, ''fineArt forum: art + technology net news,'' at http://www.fineartforum.org.

41. For further information about Ars Electronica, see their website at http://www.aec.at/en/index.asp; for further information on the Inter-Society for Electronic Arts, see their website at http://www.isea-web.org/eng/index.html.