ART AND ELECTRONIC MEDIA

EDITED BY EDWARD A. SHANKEN
Artists have always used the most advanced materials and techniques to create their work. When their visions required media and methods that did not exist, they invented what was needed to realize their dreams. Sometimes, as with oil paint in the 1400s and with photography five centuries later, a new technology became so widely adopted that it gained acceptance as a conventional artistic medium. In our own time, electronic technologies have become so pervasive that it is hard to imagine contemporary music produced without electric instruments or to imagine an author writing or an architect designing without the aid of a computer. Yet, with few exceptions, electronic art has remained under-recognized in mainstream art discourses. This is true despite the deeply entwined histories of technology and art, and the impressive accomplishments of contemporary artists whose practices have both embraced and contributed to the development of emerging technologies. That lack of recognition has begun to change.

This book aspires to demonstrate the formidable albeit short history of artistic uses of electronic art media, a history that parallels the growing pervasiveness of technology in all facets of life. Over two hundred artists and institutions from more than thirty countries are represented. Seven thematic streams organize nearly a century of extraordinarily diverse material, de-emphasizing technological apparatus and foregrounding continuities across periods, genres and media.

The centrality of artists as theorists, critics and historians is reflected in the focus on artists’ writings in the Documents section. The goal is to enable the rich genealogy of art and electronic media in the twentieth century to be understood and seen – literally and figuratively – as central to the histories of art and visual culture.
The serious artist is the only person able to encounter technology with impunity, just because he is an expert aware of the changes in sense perception.
The Industrial Revolution that began in the late 1700s was fuelled primarily by steam engines physically connected to the machine being powered. This was practical only for large devices with adequate ventilation, such as locomotives and mills. Although battery-powered telegraphy emerged in the 1830s, another fifty years passed before the first local telephone exchange was established. As municipal utilities emerged in the 1880s to generate and deliver AC power, the stage was set for the proliferation and use of electrical appliances by the general public.

Following the popularity of electric lighting and telephony in urban centres in the late nineteenth century, the first electronic household items, such as vacuum cleaners, washing machines and refrigerators, came to market in the 1910s. The market for radios exploded in the 1920s together with the growth of commercial broadcasting. Technologies that were developed during the lean years of the Second World War precipitated another outpour of electronic consumer goods during the prosperity of peacetime. Television became wildly successful in the 1950s, while the 1960s and 1970s brought hi-fi stereo sound-systems, video cameras, remote controls, cable television and satellite telecasts. In the 1980s and 1990s, the advent of personal computing, public access to the Internet and the multimedia capabilities of the World Wide Web, along with broadband Internet and cellular mobile phones, sparked the E-commerce boom and fuelled globalization, flooding world markets with an unprecedented deluge of consumer electronics.

This nutshell history only begins to scratch the surface of the wondrous and ingenious devices that have inspired artists to expand the ability to see the present and to envision and create the future. Indeed, artists use, re-purpose and invent electronic media in ways that delight the senses, baffle the mind and offer profound insights into the implications – both positive and negative – of techno-culture. Although electricity has become so ubiquitous as to be mundane,
artists continue to discover its poetic significance, if not magic. In doing so, they simultaneously humanize and mythologize electronic media, transforming it through artistic alchemy to stretch the imagination, expand consciousness and inspire others to new levels of creativity and invention. 

Motion, Duration, Illumination

Traditional visual art is static: it captures or represents a moment in time. Moreover, it typically depends on a light source for illumination. Electronic media facilitate the liberation of art from conventional stasis and provide a means for it to consist of light itself. Since the early twentieth century, artists have used neon, fluorescent, laser and other forms of electric light as bona fide artistic media, often in ways that incorporate motion and time. Paralleling the intrinsic temporality of music and cinema, artists increasingly liberate art from conventional stasis and provide a means for it to consist of light and time. Paralleling the intrinsic temporality of music and cinema, artists increasingly liberate art from conventional stasis and provide a means for it to consist of light and time. 

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In the 1930s, Harold ‘Doc’ Edgerton synchronized a camera’s shutter with a high-intensity electronic flash unit, which enabled significantly faster shutter speeds as in Milk Drop Coronet (1935). These technological developments, occurring in a broad range of artistic, scientific and commercial contexts, have widely influenced art in the twentieth and twenty-first centuries, including cubist and futurist painting and sculpture, kinetic art, performance, video and more contemporary time-based media. 

Metaphors from chronophotography and cinema were employed by philosophers Henri Bergson and Henry James to theorize vitality and duration with respect to human perception and consciousness. In particular, Bergson’s Matter and Memory (1896) and Creative Evolution (1907) have singularly influenced philosophical texts among artists, many of whom, associated with Cubism and Futurism, have used dramatic increases in the speed of production, transportation and the general flux of daily life, questions pertaining to the nature and perception of time, space, motion and light form a nexus at which the inquiries of art, science and philosophy have become increasingly interwound. Rapid advances in computing, telecommunications, nanotechnology and genomic science hint at further conceptual shifts at this complex interdisciplinary crossroads.

Alongside the visual exploration of motion and time, artists have studied the way light falls on objects creating shadows, as well as the way light illuminates artworks in the particular settings where they are installed. The chiaroscuro technique of light and dark shading that reached maturity during the Renaissance emulates three-dimensionality on a two-dimensional plane by mimicking how light falls on solid objects. In The Conversion of St. Paul on the Way to Damascus (1601), Caravaggio depicts the instant of the saint’s epiphany (1601) when a shaft of light wrinkles the saint’s robe as he is struck by a vision of divine light. His technique, a high-contrast form of chiaroscuro known as tenebroso, achieves effects that bear an uncanny resemblance to Edgerton’s high-speed flash photography. Bernini designed the Ecstasy of St. Theresa (1647–52) so that gilded bronze rays would shimmer in natural light that shines through a small window above the altar in the Cornaro Chapel in Rome. Actual light thus becomes an integral part of the work, functioning as a protagonist in the dramatic scene.

A combination of technological and scientific developments in the nineteenth century resulted in new understandings of light and visual perception, provoking significant changes in art. Amidst the popularization of photography, many artists shifted focus from rendering likenesses of objects and the effects of light on them to capturing and giving visual form to the sense experience of how light affects the human eye. Impressionist painting, for example, was bound up in contemporary views on the physiology and phenomenology of perception that emphasized the mediation of vision through the eyes and brain, suggesting an element of subjectivity. 

Whereas cubist and futurist art theories sought to draw the frame of art by breaking with two forms of stasis: spatial and temporal. Art no longer stood still in space or time. Freed of the faddish success of stereo-photography in the 1870s and 1880s, the popular understanding of vision shifted from a simple 1:1 correspondence between an object and its perception by the viewer to a conception of vision as the result of light reflecting off an object, entering each of the viewers’ eyes from slightly different angles and being processed by their brains into a single, composite image that offered a sense of depth. In this way, Impressionism, and later, Pointillism, demanded that viewers play an active role in the perception of art, a prevailing ethos of contemporary interactive art.

Similarly, contemporary artists including Olafur Eliasson, Robert Irwin, Ulf Langheinrich and James Turrell have created work that examines the perceptual limits of the human visual system. Despite this preoccupation with light and illumination, it was not until around 1920 that artists made works that moved or that were sources of light. Such kinetic artworks extended the frame of art by breaking with two forms of stasis: spatial and temporal. Art no longer stood still in space or time. Freed of frame and pedestal, animated by electricity, it could move about in the space of the viewer or the environment, modulate between various states or take on a new identity that required four dimensions to envision and experience. Artists who seized upon electric light as an artistic medium similarly liberated art from its dependency on external light sources and made it the source of its own illumination. Whereas cubist and futurist art theories sought to draw the viewer into an aesthetic experience that implied movement and time, around 1920 Thomas Wilfred, Marcel Duchamp,
Naum Gabo and László Moholy-Nagy began using electronic elements to make motion and duration explicit and essential characteristics of their work. Building on an enduring fascination with synaesthesia and light organs, notably those of precursor Louis-Bertrand Castel in the eighteenth century, the first public demonstration of Wilfred’s Clavulux in 1922 was performed using a keyboard that controlled six projectors and an array of reflectors, enabling the artist to modulate the movement, hue and intensity of light on the screen. Wilfred later created and sold individual Luminia cabinets, the visual equivalent of player-pianos, that displayed predetermined arrangements of coloured light that he composed, such as Aprosion, comprised of 357 variations with a total duration of 42 hours, 14 minutes and 11 seconds. These devices anticipated the kinetic paintings of Abraham Palatnik and Frank Malina in the 1930s, light shows at rock concerts beginning in the 1960s and visualization software that transforms MP3 files into undulating patterns on PCs in the 2000s. Gabo’s Kinetic Construction (1920) produced a virtual volume only when activated, thereby making motion a necessary feature of the art object and further emphasizing temporality. Indeed, the term ‘kinetic’ was first used in connection with visual art by Gabo and his brother Anton Pevsner in their Realistic Manifesto dating from the same year (Documents, 193). Duchamp’s Nude Descending a Staircase (1912) and Nahum Tschacbasov’s Mouvement (1935) anticipated subsequent research on the perception of actual movement, hue and intensity of light on the screen. Wilfred – in other words, time is added. With respect to light, he noted that ‘light – as time-spatial energy and its projection – is an outstanding aid in propelling kinetic sculpture and in attaining virtual volume.’ He continued: ‘Ever since the introduction of the means of producing high-powered, intense artificial light, it has been one of the essential factors in kinetic art, though it has not yet been elevated to its legitimate place... The reflections and neon tubes of advertisements, the blinking letters of store fronts, the rotating colored electric bulbs, the broad strip of the electric news bulletin are elements of a new field of expression, which will probably not have to wait much longer for its creative artists.’

Vladimir Tatlin’s design for the Monument to the Third International (1919–1920) proposed a 400 metre spiral structure comprised of three levels revolving at different speeds: a cube-shaped conference centre turning at the rate of one revolution a year; a pyramid for administrative offices revolving once a month; and an information centre revolving one revolution per day. This durational aspect of kinetic art has been taken to an extreme in the work of Tatsuo Miyajima, whose Clock for 300 Thousand Years (1987; Works, 72) will continuously count off a seeming eternity.

The idea of putting art in motion began to spread in the early 1920s, when Alexander Calder’s mobiles were first exhibited in Paris and New York. By the 1920s and 1960s artists throughout North and South America and Eastern and Western Europe began experimenting with duration, light and motion. 1955 bore two important exhibitions: ‘Man, Machine, and Motion’, curated by artist Richard Hamilton at the Institute of Contemporary Arts (ICA) in London; and ‘Le Mouvement’, curated by K.G. Pontus Hultén at the Galerie Denise René in Paris and including work by a highly diverse array of artists from around the world, such as Duchamp, Calder, Victor Vasarely, Agam, Pol Bury, Jesús Rafael Soto, Jean Tinguely, György Kepes and Robert Breer. The latter exhibition was also the occasion for the publication by Vasarely and Hultén of the Yellow Manifesto, which played an important role in popularising the term, ‘Kinetic Art’, to refer to this growing international movement.

‘Le Mouvement’ exemplifies the considerable global exchange between artists, curators and institutions engaged in the creation and presentation of works that examined the artistic frontiers of motion, duration and light in the 1920s, 1930s and 1950s. Originally from Hungary, Moholy-Nagy, a Bauhaus master from 1923–28, emigrated from Germany to Chicago to direct the New Bauhaus in 1937. Kepes, also Hungarian, assisted Moholy in Berlin and London between 1930–37 and joined the New Bauhaus as head of the Light and Color Department. In 1946, Kepes became Professor of Visual Design at MIT and in 1957 founded the Center for Advanced Visual Studies, subsequently directed by German artist and ZERO co-founder Otto Piene from 1974–93. Working in Czechoslovakia, Zdenek Pesnak made perhaps the first work of art employing neon in 1936 and Gyla Kissice began working with neon in Argentina in 1948. In Brazil, Abraham Palatnik, who had been working with light and motion in 1945, exhibited a ‘cinechromatic’ artwork at the First International Biennial in Sao Paulo in 1951.

The growing acceptance of electric light as an artistic medium can be observed through an exploration of recent art history. From Neo-Constructivism and New Tendency to Arte Povera, Postminimalism and Conceptual Art, artists have used the vernacular of neon to yield the eye-catching brilliance of the Las Vegas strip, as in Kepes’ commissions for Radio Shack (1950) and KLM (1955; Works, 58). Fontana’s ceiling installation at the Ninth Milan Triennale in 1959 (Works, 58), Joseph Kosuth’s Five Words in Blue Neon (1965), Bruce Nauman’s The True Artist Helps the World by Revealing Mystic Truths (1966) and Mario Merz’s Gas’s Glow (1969; Works, 65) on the symbolic significance of neon as an artistic medium, Merz wrote: Light is near the threshold of technological energy in the making. If it is to be controlled by electric light, it is dressed up, where as fire is uncontrollable and naked. Light is a comprehensible representation of the human mind, whereas flame is incomprehensible and hence difficult to represent. So the decision to use neon represents the possibility of mental control.

Artists have energized public spaces with light and sound, as in PULSA’s Boston Gardens Demonstration (1968; Works, 100), and also employed lasers to connect vast urban areas, as in Rodune Krebs’ Walker Night Passage (1937; Works, 68) in downtown Minneapolis and Horst Burmann’s Laser-Environment (1937) for Documenta 6 in Kassel. More recently, light has been used as an artistic medium to illuminate a metaphorical passage between the earth and the heavens, as in Jaume Plensa’s Blade in Gatehead (1995) at the BALTIC Centre for Contemporary Art in England and in Julian Larpérette and Paul Myoda’s memorial to the victims of 11 September, 2001, at the former site of the World Trade Center, Tribute in Light (2002). Exploring the perceptual relationship between light and sound by eliminating the former, Yolande Hamlin’s A Collection of Circles (or Pharyngia) (2005), translates the rotating field of illumination that emanates from lighthouse lamps into a 3-D sound installation in which the viewer triggers and experiences only the sonic spectre of light, as its audible apparition revolves around a central axis, changing in response to its environment.

Developments in science and engineering deeply influenced the work of artists exploring the potential of motion and light. The interdisciplinary science of cybernetics, which conceived of both animals and machines as systems of interconnected feedback loops, became a model for kinetic art that was responsive to its environment. Nicolas Schöffer’s CVSP! (1960; Works, 66) was developed in collaboration with Dutch electronics corporation Philips. An ‘electronic brain’, sensors, controls and motors enabled the work to interact with its environment by physically responding to sound and movement. The viewer thus became an active participant in the experience of the work. Schöffer later incorporated these concepts into monumental architectural structures, including the Spatiodynamic Tower in Liège (1961), a fifty-two-metre tower that incorporated sixty-four revolving mirrors, seventy projectors, 120 coloured spotlights, five half-hour music...
first of several related manifestos, including proposals for interdisciplinary art with science and technology and using cybernetics and computers to create self-destructing civic monuments that would exist ‘from a few minutes to twenty years.’ In 1960, German-born art historian Peter Selz, then chief curator at The Museum of Modern Art, New York, invited Swiss artist Jean Tinguely to construct Homage to New York, a mechanical work of art that self-destructed in the museum’s sculpture garden on 17 March, 1960. Dr. Billy Klüver, a laser researcher at Bell Labs in nearby Murray Hill, New Jersey, collaborated with Tinguely on the technical aspects of the work, and American artist Robert Rauschenberg added a component that literally threw money from the sculpture.

Several important exhibitions took place in the early and mid-1960s, exposing popular audiences in Europe and the US to electronic art employing motion and light. ‘Beweging’ (to electronic art employing motion and light. ‘Bewogen’ component that literally threw money from the sculpture. Tinguely and Romanian/Swiss artist Daniel Spoerri at the Signals Gallery in London in 1964 and edited the catalogue essay by French art historian F. Rémi. Hultén, curator of light art, ‘Kunst Licht Kunst’ (Art Light Art) in 1966, with a catalogue essay by French art historian Frank Popper, whose comprehensive book, Origins and Development of Kinetic Art, was published in French in 1967 and translated into English in 1968. Kinetic Art not only became identified as a movement, but motion and light transcended stylistic categories and were employed by artists around the world.

Sharing an affinity with Wilfredo Clavílos and eighteen and nineteenth century experiments with light organs, the desire to combine sound and image to create the experience of synesthesia reached a culminating point in the mid-1960s, when it became popular fare at rock concerts. Scottish artist Alister Mackenzie produced his first public Liquid Light shows in 1964 (Works, 142). In 1965, he and John Hollis formed the Sensual Laboratory and began collaborating with The Soft Machine, Pink Floyd and Jimi Hendrix. In 1965, Metzger began producing his Liquid Crystal Light Projections, which were used as light shows for rock bands Cream and The Who in London. Light shows in combination with concerts and Happenings were also taking place in the US, including the Trips Festival in San Francisco in 1966 (produced by Stewart Brand and featuring the Grateful Dead), Andy Warhol’s Exploding Plastic Inevitable, which toured with the Velvet Underground in 1966–7, and the mind-expanding, communal multimedia environments created by USCO. These psychic experiments laid the foundation for early video performances and laser-light shows in the 1970s and 1980s and were reincarnated in the raves of the 1990s (the video equivalent of DJs, or disk-jockeys) in rave-culture in the 1990s. In this lineage, the American Museum of Natural History teamed with MTV2 to produce SonicVision (2005), which joins popular music and digital animation in an immersive multimedia spectacle for domed theatres.

By the 1970s, motion, light and time had become increasingly mainstream elements of artistic expression. Artists, drawing on a range of stylicic influences, have continued to explore their potential as the means and subject of their work. One of the most interesting developments over the last four decades has been the use of electronic media by artists to transform or translate between various forms of energy – what Robert Moilary referred to in 1969 as ‘transductive art’ (Documents, p. 205). Dupuy’s Heart Beats Dust (1968) translates one’s pulse into kinetic energy that vibrates a membrane, causing fine red dust to dance. In Gary Hill’s video Soundings (1979; Works, 70), a loudspeaker is subjected to the effects of fire, earth, air and water, revealing transformations of its sonic and visual presence in relation to a spoken text. In the tradition of physicist Ernst Chladni’s early experiments in visualizing harmonic vibrations and physicist Hans Jenny’s studies of wave phenomena or ‘cymatics’ from the 1960s, Casten Nicolaisen’s MKR (2009) reveals how various frequencies of sound energy alter patterns of disturbances they caused in a vat of milk. Similarly, in Portraits/Flow (2001) by Sachiko Kodama and Minoru Takeno, sounds in the exhibition space, including those of the audience, interactively transform three-dimensional patterns in black magnetic fluid, which appears to be choreographed to its sonic environment. Light has been the primary force in several intriguing transductive works. By focusing ultra high-intensity light in a vacuum chamber, Shawn Brixey and Laura Knott’s Photon Voce (1996; Works, 73) made graphic images emerge from kinetic sculptures, altered by a dancer, whose movement broke the voice. In Paul DeMarinis’s Edison Effect (1989–93; Works, 73), a laserbeam shone through a fibreglass and onto an Edison
cylinder, a nineteenth century recording device. The beam of light relayed the sound encoded in the cylinder to a computer, which translated the information from analogue to digital, then reproduced the analogue sound, interrupted sporadically by the fish, which occasionally crossed the beam.

Exploring the entropic effects of light, Mary Lucier’s Dawn Burn (1973) pushed the physical limits of video equipment. Videotapes of seven successive sunsets, each played on a separate monitor, revealed how the sun’s intensity slowly overwhelmed the recording apparatus, causing a progressively expanding burn over time in the series of tapes. Jochen Gerz’s performance Promethief (1973) incorporated a videocamera that, like the ill-fated mythological character, figuratively flew too close to the sun. As in Dawn Burn, the light intensity overloaded the camera’s sensor, causing its demise. Using electronic media in innovative ways that invoke the luminous, kinetic and temporal dimensions of art, artists explore the potential of these qualities to expand aesthetic experience and to enhance human perception.

**Coded Form and Electronic Production**


In ‘The Work of Art in the Age of Mechanical Reproduction’ (1935), Walter Benjamin argued that technologically reproduced images lacked the ‘aura’ of an individually handcrafted original. At the same time, he recognized the potential of technological reproduction to enable the democratization of imagery, a condition that he hoped would offer a means of resisting Fascism and promoting democratic values. In the wake of the individualistic bravura of Abstract Expressionism, by the late 1950s artists began to critically examine the distinctive, gestural signature that implied a symbolic connection between the hand of the artist and the surface of a canvas. Taking the ideological cluster of gesture, authenticity and originality as his foil, in the mid-1960s artist Roy Lichtenstein caricatured the abstract expressionist brush-stroke in a cartoon style with a background comprised of Ben-Day dots – a printing technique used by newspapers to reproduce cartoons. Paradoxically, he initially mocked this enshrined but iconic signifier in a series of unique paintings, only later reproducing them as serigraphs. Pushing this linearity further, Roman Verostko made the first robotic brush-stroke in 1978, using custom software and sumi brush mounted on a plotter to achieve remarkable gestural spontaneity from a series of algorithms.

Using closed-loop video to reflect on Benjamin’s critique of mechanical reproduction, in Richard Kiesche’s video performance Twins (1977) two identical twins in separate rooms read ‘The Work of Art.’ Adjacent to each performer was a monitor displaying live video of the other and a slightly modified quotation from the text: ‘The reproduced art-work (person) becomes to an ever increasing degree the reproduction of an art-work (person) that is designed to be reproduced.’ Parallel assaults on originality and reproduction were mounted by artists such as Sherrie Levine, whose rephotographed images of Walker Evans’ photographs for the US Works Progress Administration (WPA), to which she signed her name, spurred much debate when exhibited in New York in 1980. By the early 1980s art critics proclaimed that the ideal of originality associated with avant-garde art was a myth. Upping the ante, in 2001 artist Michael Mandiberg created the twin Websites, AfterWalkerEvans.com and AfterSherrieLevine.com (2001), offering free downloads of high-resolution digital files of the twenty-five Evans images that Levine rephotographed. Each maintains the same image files, distinguished only by their titles, which correspond to the images’ Website address or Uniform Resource Locator (URL).

After downloading the desired image and printing and framing it according to instructions on the Website, one may sign a downloadable certificate of authenticity that declares it to be an authentic work of art by Mandiberg. Although it may not have the cachet of an ‘original’ work by Evans or Levine, neither does it carry the price-tag. While Levine’s work and the artwork discourses surrounding it intended to put the death knell of originality, with few exceptions, the critics who championed this characteristic mantra of post-modern art and theory failed to address how concurrent developments in electronic art, such as Kiesche’s, offered equally potent critiques of originality, authenticity, institutions and cultural hegemony. As Margot Lovejoy has pointed out, ‘Electronic media challenge older, modernist modes of representation. New media have created postmodern conditions and have changed the way art itself is viewed.’

Indeed, artists utilizing electronic tools to produce form by duplication, or by using algorithmic and other generative approaches, have challenged conventional notions of originality, creativity and art itself. As Mandiberg recognizes and exploited the potentials of electronic signal processing, computer graphics and electronic photocopying in the 1950s and 1960s and high-resolution digital photography, printing,
MOTION, DURATION, ILLUMINATION

Defying the traditional conception of art as a static object, in the early twentieth century artists began to introduce actual motion into their work, making explicit the continuity of consciousness in the perception of art through time and space. Artists using artificial light such as neon or laser as a medium explored the immateriality of form and color, freeing art from its dependence on external illumination by making it an actual light source in its own right. In the 1920s and 1930s, László Moholy-Nagy joined motion and illumination, a combination that inspired artists associated with various nouvelle tendance collectives to create light-infused, kinetic environments. Later, in the 1950s, embracing the science of cybernetics, Nicholas Schöffer collaborated with engineers to incorporate electronic sensors, controls and motors into sculptures that responded to the movement of viewers, performers or atmospheric conditions. Such works laid a significant foundation for subsequent developments in interactive art incorporating digital multimedia.

**Light-Space Modulator**

1923–30

Light and movement, or the "light-requisite for an electrical stage." With the aid of an engineer and technician, the modulator was constructed to provide lighting effects for plays and other performances. It consists of a box with a circular opening at the front, stage and a second board with a parallel circular opening inside the box. The back of both of these openings is surrounded by bulbs of various colors, which flicker on and off at predetermined times, fan-to form moving patterns and textures of light and color. The wall can be tilted or removed, allowing the lighting proyect onto a backdrop of any size. A typical light and movement kinetic quality of this work was captured in a motion in Moholy-Nagy's film "Mémoire Future" (Black White Film, 1939). It is ideally situated for use in an electronic music performance. It is part with the larger context of temporal installations, in part to an electronic lightplay, whereby the behavior of an electronic light play which can be remotely controlled from the radio station or electronically controlled video filters.
Naum Gabo  
Kinetic Construction (Standing Wave)  
1919–20  
Metal, painted wood and electrical mechanism  
61.6 × 24.1 × 19 cm  
[22.25 × 9.5 × 7.5 in]  
Permanent Collection, Tate, London  
At rest, Kinetic Construction consists of a static vertical metal rod. When activated, an electronic motor causes the rod to vibrate, producing the appearance of virtual volume which can only be perceived through persistence of vision, an effect of moving parts. Its rapid, blurred oscillations interact with the surrounding space and add a sensory dimension of kinetic energy to the work. The sculpture’s design reflects Gabo’s desire to employ contemporary materials to create new forms of art that interact with space and time. These are fundamental elements in his works, many of which have moving parts. He made several kinetic sculptures throughout his career, often using them as instructional tools for his students. Such ideas are evident in his kinetic Abstakt, which he and his brother, artist Anton Pevsner, drafted in 1920. Gabo, one of the founders of Constructivism, preferred modern industrial materials such as glass, metal and plastic to traditional artist’s media like marble. He studied engineering in Munich before turning to art in 1914 and often his creations exhibit qualities of architecture or machinery. These tendencies are evident in large-scale outdoor commissions, including a 26-metre (85-foot) sculpture for Bijenkorf Department Store in Rotterdam and a fountain for St. Thomas’s Hospital in London.

Thomas Wilfred  
Opus 161  
1965–6  
‘More and more artists of our generation have begun to contemplate light with the eyes of a sculptor gazing upon a block of marble – seeing in light a new and basic medium of expression with unlimited possibilities’ – Thomas Wilfred. Wilfred coined the term ‘Lumia’ to describe the fluid kaleidoscopes of light projected by the Clavilux (literally, ‘light keyboard’) he invented in 1921. The machine consisted of moving lamps, a double-cone reflecting system and changeable colour discs, together with a keyboard that controlled tempo, a shutter and lights that created the images. Wilfred gave his first performances on this new instrument in New York in 1922 and toured with the Clavilux in US and Europe often drawing audiences in the thousands during the 1920s. In the 1930s, he shifted his focus from performance to compositions for his recently invented Lumia box, an automatic device that looks similar to a television but functions like a player-piano. The Lumia slowly unrolls the light patterns recorded on its rolls without repeating. This shift from performance to exhibition, re-contextualized Wilfred’s work from the domain of music to the domain of art. In 1942, The Museum of Modern Art in New York purchased Vertical Sequence, 137, which was included in its 1952 exhibition 15 Americans alongside the work of Jackson Pollock and Mark Rothko. His Lumia Suite, a light organ encased in a tall metal cabinet, was permanently on display near the film theatre at The Museum of Modern Art in the mid-1960s, around the time he created Opus 161.
Lucio FONTANA

Ninth Triennial of Milan Grand Staircase
1951 (destroyed)
100 m of neon light

Besides being renowned for his boundary-breaking, and canvas-ripping, conceptions of space and art, Fontana was also a pioneer of electronic art using light as a medium. In the tradition of futurist and constructivist manifestos, his White Manifesto of 1946 (Documents, 194) states, ‘What is necessary is to overcome painting, sculpture, poetry and music. We need a more comprehensive art that meets the requirements of the new spirit.’ In the late 1940s, he began slitting and punching holes through canvases, a dynamic gesture that symbolically opens a portal to the infinite potentialities of time and space. Beginning in 1947, he titled all of his works Concetto Spaziale, or Spatial Concept, seeing them as extending into and interacting with the space around them. In 1947, he first exhibited three-dimensional environments that could better express his spatial theories. In his first, Ambiente Spaziale a Luc Nera, he painted an abstract shape with phosphorescent varnish and lit it with a neon lamp. Pushing this concept further, the Grand Staircase can also be interpreted as an echo of Pablo Picasso’s 1949 photographs of ‘spatial art’. Indeed, Fontana stated that he wanted the installation to suggest ‘the trail left by a flashlight waved in the air.’ Although more gestural than many of its antecedents, Fontana’s immersive, site-specific light environment in Milan anticipated the work of subsequent generations of artists, including Dan Flavin, James Turrell, and others.

Gyula KOSICE

Estructura Lumínica Madí ‘F’
1946
Neon
55 × 40 × 18 cm [21.7 × 15.8 × 7.1 in]

This influential work is perhaps the first to consist exclusively of unadorned neon. A geometric maze that appears to emit a white glow casts a blue reflection around itself. The neon’s sharp angles fill the frame that juts out toward the viewer. This piece is an essential manifestation of Art Madí, the movement that Kosice founded in 1946, on the same year Estructura was created. The artist’s Madí Manifest (Documents, 195) emphasizes fluidity and movement, instinct over intellectualization, and unconventional explorations of time and space. Above all, it comes across as an inwardly motivated and essential art, one that should not be bound by academics, logic or history. Kosice’s other works involve light and moving water in public spaces. All reveal his interest in the integration of science, technology, art, and the use of natural elements or concepts – light, water, movement, space and time.

Gyorgy KEPES

Light Mural for KLM
1959

Kepes shared his mentor László Moholy-Nagy’s fascination with parallels between nature, art and science, particularly with respect to visual patterns. True to his Bauhaus heritage, he was also a strong proponent for utilizing art, science and technology which he did in many books and works of art. Joining the MIT faculty in 1946, Kepes was an early advocate for the use of light in art and produced major environmental light installations over several decades, including the Experimental exhibition at the Smithsonian Institution in 1970. Critic Jack Burnham described his 1950 light mural for Radio Shack in Boston, which consisted of neon shapes in rows and circles, as one of the most imaginative commercial displays of the period. In 1959, for Knoll on 5th Avenue in New York City, Kepes programmed an immense kinetic mural, in which abstract Basho shapes in light traveled according to Barthes’s ‘poetry of a cityscape’ as seen from an airplane at night. Superimposed on the thousands of key points of light are colored arabesques illuminated at different tempos.
Otto Piene

Light Ballet
1959–60
Electric light, cardboard, motors, steel

In the lineage of Moholy-Nagy’s Light Space Modulator, Piene developed three different forms of Light Ballet. In Archaic Light Ballet (1959), electric light shone through perforated cardboard. In Mechanical Light Ballet (1960), cranks operated by the audience made light-objects move slowly. In Automatic Light Ballet, electrically powered motors accomplish the same effect.

Abraham Palatnik

Cinechromatic
1951

Palatnik’s Cinechromatic was initially rejected at the First International Biennial in Sao Paulo in 1951 because there was no category for it. A last-minute withdrawal of another artist’s work led to its inclusion and a warm reception by an international jury who considered it an important manifestation of modern art. An “important manifestation of modern art” was invited to show his work at future Biennials but was still barred from competing, as it works defied the existing classifications. Art critic Mario Pedrosa coined the term “cinechromatic,” and encouraged the artist’s further study of movement and light. He commented extensively on Palatnik and his new direction for art in his introductory remarks for the Biennial. In order to be able to control light, the artist needs new instruments and familiarize with the advances of modern optics. […] With [Cinechromatic] the artist opens for the first time possibilities to kinetic colours. In order to create yellow, for example, one does not need cadmium anymore: because projected light can generate the kinetic mixture of green and crimson and offer us a certain perception of yellow. Light becomes a means for plastic expression.

Frank Malina

Point Counter Point
1956
Lights, motor, glass, paint, plastic
57 × 57 cm [22.4 × 22.4 in]

This work is the first picture created through Malina’s Système Lumidyne, a complex mechanism that blurs the line between art and engineering. He created more than 100 artworks with this versatile system, producing the bulk of his oeuvre between 1956–1963. The system is composed of lights, motors, a translucent diffusing screen and a transparent plate, all made of glass, that hold them all together. The motors contain moving, usually plastic, discs of various painted colours. Transparency, angles, rotation directions and speeds. Transparent oil paint is used on these for bright light effects, while opaque paint blocks out light. The disc may work and multiplify the possible color-light effects, as in Point Counter Point. First shown in 1955 at the Salon des Réalités Nouvelles in Paris, it is centered on the idea of the spatial orbits of the stars, though human representations, through lines and rhythms, are present as well. Malina founded the international journal Leonardo in 1968 (Works, 182).
Collaborating with engineers from the Philips Corporation, Schöffer created CYSP 1 (an acronym for Cybernetic Spatiodynamic) and several other cybernetic works that combined the fields of robotics and responsive environments, with kinetic art and constructivism. The robot-like sculptures were connected to a fixed base and designed with sensors that responded to changes in sound, light and colour and movement. Consequently, they also reacted to the presence of observers, recalling the uncertainty principle and second-order cybernetics, both of which state that the act of observing alters the phenomena that is being observed. These kinetic sculptures were landmark developments in the field of robotics and constituted the first example of cybernetic art. CYSP's list of exhibitions and performances, both formal and informal, includes the first public performance in the Avant-Garde Festival at the Theatre de la Ville, Paris in 1956 and the First Avant-Garde Festival in Marseille, where it danced with Maurice Béjart’s ballet company in the roof of Le Corbusier’s Cité Radieuse. Twenty-one years later, CYSP 1 toured the United States with the first large exhibition of computer art, ‘Digital Visions: Computers and Art’.
Dan Flavin

Greens Crossing Greens: to Piet Mondrian Who Lacked Green
1966
Fluorescent lights, fixtures
105.4 x 58.4 x 38.1 cm [41 1/4 x 23 x 15 in]
Solomon R. Guggenheim Museum, New York

Calling them situations or proposals rather than sculptures, Flavin created environments using tubes of fluorescent lighting of varying length. They posed questions about space, barriers and access, and also reflected his life-long fascination with light, space and colour—primary concerns among many new media artists. The first of its kind, Greens Crossing Greens was exhibited in the exhibition ‘Kunst Licht Kunst’ (a play on words: Art/Artificial Light Art) in the Netherlands and later installed at the Guggenheim Museum in New York. Two crossing fence-like structures of green fluorescent tubes turned the asymmetrical walls and floor of the gallery a vivid kelly green, while the bulbs themselves appeared strangely white. Blasting a space already disorienting through a lack of parallel walls, the plane horizon vanishes out rather than limiting them in. Flavin repeated this structure and approach in subsequent works that further explored the phenomena of light and space. Greens Crossing Greens was dedicated to Mondrian, an act consistent with Flavin’s habit of paying homage to significant people in his life through his titles. The name seems particularly appropriate in this case, given the perceptual absence of green in the tubes and the work’s first exhibition in the Netherlands, the birthplace of both Mondrian and Flavin.

James Turrell

Catso, Red
1967, 1994
Drywall, paint, xenon projector
Permanent Collection, The Mattress Factory, Pittsburgh, Pennsylvania

While many artists employ light projection to create ethereal, weightless spaces, in this work Turrell uses a careful diagonal projection of red light into a corner to give the appearance of a solid form. The result suggests a red cube floating in space in a dark room, until the viewers’ eyes adjust and they are close enough to see that the light actually follows the concave contour of the wall. Like holograms or virtual reality, the cube creates a space and suggests a substance that does not really exist, though Turrell prefers not to refer to such installations as optical illusions. Still, one can shift one’s perception back and forth to see the cube as a solid object, then a flat projection. The artist’s interest in this duality is connected to his early studies of perceptual psychology, along with other scientific disciplines, at Pomona College in California. The piece is one of several that Turrell designed as part of the ‘Cross-Corner Projections’ series. Other works in the group push the limits of one’s perception further, giving the illusion of a flat space when light is actually projected into a deep recession.

Mario Merz

Igloo di Giap (Se il nemico si concentra perde terreno se si disperde perde forza) [Giap’s Igloo (If the enemy concentrates he loses ground, if he scatters he loses force)]
1968
Metal frame, wire mesh, bags of dried mud, neon
Merz energized objects with electric light to explore biological and culturally oriented systems that are simultaneously organic and technical. His first experiment with neon was Bottle and Neon, 1966–67 and this medium subsequently became a central material in his work. Igloo di Giap, the first of many archetypal, nomadic domiciles that represent mythical places of refuge, was created amidst increasing bloodshed during the Vietnam War. Joining primitive and modern technologies—mud and electricity—he-who-must-not-be-named—Viet Cong General Vo Nguyen Giap. A key figure of Arte Povera, Merz’s use of so-called ‘poor’ materials is predominantly conceptual and focuses attention on the intrinsic nature of organic and inorganic matter and on the relationship of materiality and immateriality, elements he weaves together with an alchemical flourish.

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Jean Dupuy

Heart Beats Dust
1968
Wood, stethoscope, latex, lithium battery, speaker, light bulb, human pulse sensor

Permanent Collection, The Museum of Modern Art, New York

Looking through the eye-level window into this black rectangular box, one is confronted with a chilling juxtaposition of life and death. One’s heartbeat is measured by placing a finger into a cylinder and then it is amplified through a stethoscope and speaker. The speaker sits under a latex membrane stretched tightly across the bottom of the black box. The membrane is covered with lithium rubine, a bright red dust of such low density that it can remain suspended in air for unusually long periods of time. A light beam shining down from the top of the box creates a pyramid-shaped cone of light that illuminates the dust, which pulses as the heartbeat vibrates the rubber membrane. The work incorporates multiple complementary and contrasting layers: organic and inorganic, sound and light, and time. The rhythm of the pulses, along with space, time, and emotion, evokes the participation of the viewer, yet the box separates the viewer from the work itself. It is the first of several works by Dupuy that rely on the viewer’s involvement, blurring the division between artist and audience. The piece won first prize for artist-engineer collaborations coordinated by the E.A.T. collective for the exhibition ‘The Machine: As Seen at the End of the Mechanical Age’, held at The Museum of Modern Art in New York (1968).

Vladimir Bonacic

G.F.E. (16,4)
1969–71
Computer-controlled light and sound installation

The ‘Galois field’, named for mathematician Evariste Galois, was an important inspiration for Bonacic. In 1974 the artist wrote, ‘One of the most interesting aspects of this work [in Galois fields] is the demonstration of the different visual appearances of the patterns that had not been noted before by mathematicians who have studied Galois fields.’ The dynamic object G.F.E (16,4) is 178 x 178 x 20 cm in size and half a tonne in weight. The front panel shows a relief structure made of 1,024 light fields in 16 colours. Three Galois field generators are in operation to light the grid in different patterns. Those generators interact with other generators controlling the sound played via four loudspeakers. The viewer can influence both sound and image either manually or by remote control. Sound can be manipulated by the exclusion of some tones. The speed of the visual output can be adjusted as well, by looping the selected sequences. The observer cannot, however, change the logic. The entire composition of the audio-visual spectacle, which consists of 1,048,576 different visual patterns and 64 sound oscillators, can be played within 3 seconds, or with a duration of 24 days.

James Seawright

Electronic Peristyle
Sound synthesizer, digital circuits, lights, fans, speakers, electronics
1968
Permanent Collection, New Jersey State Museum, Trenton, New Jersey

First shown at the William Nelson Rockhill Gallery of Art in Kansas City as part of the ‘Magic Theater’ exhibition in 1968, Electronic Peristyle is one of the first uses of digital circuits to control a sound synthesizer. This interactive art installation, or ‘reactive environment’, took the artist’s terminology, allows users to trigger sequences of sound by simply breaking a beam of light. With the assistance of Robert Moog, known for his design of music synthesizers, Seawright assembled many of the circuit boards used in the piece on a kitchen table. The sculptural core consists of twelve electronic columns that surround a transparent globe placed on a circular base, from which light rays are emitted. Inside the globe is a series of wiring in a manner similar to the columns. The viewers discover that, by breaking the beams, they can influence the sound, as well as the light patterns and wind effects. As the viewer’s activity becomes more complex, so does the piece’s behaviour. Electronic Peristyle was an early demonstration of the potential of art to raise questions about the interaction between human and machines.
Laser art agencies for Light Amplification by Stimulated Emission of Radiation was invented in 1960. It was not long until artists began using it, and Rockne was among the first, creating environmental laser works in Washington, D.C., in 1968 and at the Walker Art Center in Minneapolis in 1971. Day Passage was produced in collaboration with Hewlett-Packard as part of the Art and Technology Program (A&T) organized by the Los Angeles County Museum of Art (LACMA). Designed for installation in an interior space, the special lasers it employed produced dazzling, multicolored light effects. It was shown at the US pavilion at Expo ’70 in Osaka and the A&T exhibition at LACMA (1971).

**Alejandro and Moira SIÑA**

**Spinning Shaft**

1978

40.6 × 33 cm [16 × 13 in]

David Bermant, Collection, Santa Barbara, California

Similar to Gabo’s Kinetic Sculpture, Spinning Shaft creates the perception of a cylinder or a virtual image of light. As its turning at constant speed, a neon without electrodes pulses on and off with varied timing. The rhythms and speeds are determined by analogue electronics and programmed patterns that take approximately two minutes to cycle. This creates a large, dynamic light image 1.7 m [5.5 ft] in diameter by 3 m [10 ft] long. The work offers the spectator many views, one can see a hollow light cylinder by its side as well as a view of the inside of this generated light tunnel. Several versions of this work have been produced and exhibited widely in Europe, Japan, and South America.
Gary HILL

**MOTION, DURATION, ILLUMINATION**

Photograph, 1986

Black and white video projection, seven video monitors, seven television sets, plywood, paint, iron, sand, oil, dye, wax, plastic, metal, wood, cloth

Permanent Collection, The San Francisco Museum of Modern Art

This video work captures seven rainstorms over New York's East River. They are shown on seven television screens of increasing size within a single pedestal. The horizon runs along the bottom of each screen. The sky was recorded in real time and slowly moved the image from the left to the right, revealing the magnetic fields and surpassing the thunder. Over time the sky burned a line in the tubes, resulting in a gradual stroke similar to what an artist might make with a brush. In this or other conventional media, what one sees is much more complex. In some way this work expands the one on the preceding it, due to an additional day's exposure to the rain. The raindrops image and tube cell attract and direct the creative and destructive potential of natural and technical processes and the fragility of media. The work's simple video impacts a documentary quality to the exhibition. It reflects on time and transience, events and decay, and the relationship between technology and the natural world.

Mary LUCIER

**Dawn Burn**

Video and performance with mirrors, vacuum tube, graphite, video tape

1986

Dimensions variable

Permanent Collection, Hirshhorn Museum and Sculpture Garden, Smithsonian Institution

Brixey conceived this collaborative project in order to make visible the energy potential of sunlight. Directing their lights through a large mirror, they shone the light on a chip of graphite and set it on fire. Over time, the rising sun burned the graphite particles, creating a visible pattern. As the graphite burned away the light rose and moved. When the dancer interrupted the beam, the graphite rose again when the beam was interrupted, dancing in unison. Brixey's flavour of art is Albert Einstein—a man whose ideas still influence artists and changed the way humans perceive reality. Brixey notes that while most of his projects and consider there science, while scientists laugh and see it as art.

Nam June PAIK

**Video Flag**

1985

84 25.4cm \[10-in\] television sets, videotapes, electronics, Plexiglas

Hirshhorn Museum and Sculpture Garden, Smithsonian Institution

One of those initial Pop installations along with Allan Kaprow's The Happening, this work is the first of the new medium of television to recreate the stars and stripes of the American flag. It was exhibited for several years in the late 1980s in large roadside exhibits of Diane Von Buskirk down the corner of Houston and Broadway in SoHo, the center of the New York art scene at the time. The work employs Pai's signature video editing, with twin parallel edits and psychodrama effects produced with the Polaroid-video synthesizer. Its compositional nervousness feminism-in-overdrive and media culture is apparent. Pai's two groups of four television sets to recreate the Frei Flag to Tricorder Video: the Museum of Modern Art in Moscow in 1989. Around 1970, he wrote a letter to John Cage predicting that TV and art eventually would be the same. He began fulfilling this prophecy in the early 1970s, when he solicited focus from avant-garde music to performance art. Pauk's first use of the telescope was in 1970s for music performance. Pauk made his first performances involving spectators around 1970. These sculptural configurations were first shown in his 1970 exhibition. Exposition of Music-Electronic-Televised' in the Berliner Festspiele in West Berlin. Germany. They consisted of several local television sets that displayed the visual output of magnetically altered signals. Feedback, microphones, and other electronic devices, some of which permitted audience interaction.
Tatsuo MIYAJIMA
Clock for 300 Thousand Years
1987
Light Emitting Diode, IC, electric wire, line tape and other materials
178.7 × 629.9 × 5.1 cm [68 × 248 × 2 in]

Through this work, Miyajima refers to eternity, though his perception of this elusive concept is not the common one of continuity without change. The three principles that inspired his philosophy and guide his art are 'keep changing,' 'connect with everything' and 'continue forever.' He expresses this energy through a mechanism that keeps ticking for 300,000 years. These ideas are based in Buddhist philosophy and notions of time.

Paul DEMARINIS
Edison Effect
1989
EDC electronics (signboard), 17 granite benches

A sampling of Holzer's texts spiralled up 535 feet of the parapet in her combined retrospective and site-specific installation. Architect Frank Lloyd Wright's often-maligned circular walls became signboards, along which a helical, circular LED display scrolled selected phrases from Holzer's work since 1977. Varying typefaces and colors dictated messages ranging from hope and humour to despair. Some were imperative fragments, others complete sentences: 'forget truths,' 'a relaxed man is not necessarily a better man.' Beneath the climbing ribbon of light, seventeen lit, inscribed granite benches were arranged in a circle. Holzer likened the environment to a spectacle in a stadium or public architectural space, rather than a religious setting. The work inevitably evokes modes of mourning, and soul-searching associations, for the David Bowie Journals commented, 'the eternity of stone was matched with the mobility of information.'
Rebecca HORN
Concert for Anarchy
1990
Painted wood, piano, motors, metal, electronic components
166 × 137 × 178 cm [65.35 × 53.9 × 70.08 in]
Permanent Collection, Tate Modern, London

An open-lid grand piano hangs upside-down from the ceiling in this whimsical yet menacing kinetic installation, originally shown at the Nationalgalerie in Berlin in 1994. Suspended by three sturdy metal ropes, the instrument appears to be resting calmly in place until it unexpectedly begins to move. All of a sudden, its keys and hammers violently jut out of the front, causing the strings to resonate cacophonously while the side-rests at each end of the keyboard turn out like wings. The peculiar predicament is a play on Horn's film Buster's Bedroom, which features a piano hanging in a similar fashion without the chaotic disfigurement. Horn has taken this piano, which in the movie was confined to a psychiatric ward, and freed it to develop a new tonality. Her Rebel Moon (1991) also draws on this image, adding large metronomes on the floor. This piano's hammers and sheet stand are in place, but the keys are crooked, almost as if Horn is quietly snickering at her own joke.

Rafael LOZANO-HEMMER
Vectorial Elevation – Relational Architecture 4
1999–2004
This large-scale interactive installation in Mexico City is one of four that Lozano-Hemmer staged around the world. People from 89 countries logged on to the Internet and controlled 18 robotic searchlights placed atop buildings in Zócalo Square. The lights were manipulated with a three-dimensional Java interface, a virtual reality programme. The resulting light sculptures, generating 126,000 watts of power, could be seen from a 15-mile radius. The term 'relational architecture' refers to the transformation of a landmark building through interaction with technology. A webpage was made for each participant, showing comments, statistics and real and virtual views of their designs from three perspectives. The online archive has stored the hundreds of images that are searchable by image code number, creator and design. The project challenges the notion that an installation occupies a defined physical space, as the dimensions include the computer of every participant. The piece was first installed in Mexico City for the millennium celebrations in 1999 and later staged with site-specific modifications in Spain (2002), France (2003) and Ireland (2004).
Pierre HUYGHE
L’Expédition Scintillante, Act II: Untitled (light show)
2002
Motors, lights, fog machine, computer, software, sound
A small stage complete with a miniature, computer-controlled lighting rig and fog machine, produces a dazzling light show accompanied by the music of Erik Satie. The artist succeeds in his intention to produce the effect of a ‘psychedelic concert’, with the dilatation scale and impersonalistic music evoking the strain-exhaling experience of the encounter. Unlike precedent light compositions by Wilfred, Palatnik or Malina, which present themselves as scenes to be viewed, or the liquid crystal projections of Boyle or Metzger, which were vast in scope and served as backdrops for rock concerts, the scale and presence of this son et lumière produces an odd physical relationship with the viewer. It is neither one-dimensional surface nor an architectural environment, nor is it an installation space. It is a hybrid object that performs for the viewer, inviting interest, but at the same time resisting being seen or experienced, keeping the viewer at a distance.

Tavares STRACHAN
The Distance Between What We Have and What We Want
2005–06
Mixed media
In May 2005, the artist worked with a team of experts to cut a 4.5 tonne cube of ice from a frozen river in the Arctic. It was stored in Alaska for over a year. In July 2006, using a specially insulated container, it was transported to the Bahamas for its premier exhibition at the Albury Sayle Primary School in Nassau. The block of ice was transformed to a specially engineered, refrigerated silicone panel illuminated exclusively by solar energy and solar collectors, where ambient temperatures reached over 90 degrees Fahrenheit. During the opening ceremonies Strachan performed with students, re-creating the country’s first independence. The natural transformation of a flowing river of water to a static block of ice is the basis for the artist’s mediation on the cultural transformation of indigenous Bahamian culture through modernization and globalization – symbolized by the creation of ice, which does not naturally exist on the sub-tropical island.

Olafur ELIASSON
The Weather Project
2003–04
Mixed media installation in the Turbine Hall, Tate Modern, London
152 × 35 metres
Dominated by a giant semi-circular form that glows like the sun, this site-specific installation created an immersive environment in the massive Turbine Hall. The mirror ceiling – the metaphorical sky – doubled the solar arc, thus completing the circle, while reflecting everything with its own presence in a public space. Composed of mono-frequency lamps that emit a narrow range of light that only yellow and black are visible, the visual field illuminated by the golden arc became a vast duotone landscape. A palpably atmospheric presence was evoked by a fine mist that pervaded the space, forming ephemeral, cloud-like apparitions. Many viewers sat or lay down and basked in the sublime artifice of this electronic solarium. Eliasson gently plays with the tension between romanticized notions of transcendent encounters with natural phenomena and an art historical tradition of scientific objectivity and its related technological media. In The Weather Project, he allows viewers to peek behind the curtain, as it were, to see the construction and the misting mechanisms. As he states, ‘the benefit in disclosing the means with which I am working is that it enables viewers to understand the experience itself as a construction and, in a higher sense, allow them to question and evaluate the impact this experience has on them.’
CODED FORM AND ELECTRONIC PRODUCTION

Although it has been argued that technologically reproduced art lacks the aura of an individually handcrafted original, many uses of electronic technologies media to produce form algorithmically or by duplication confute conventional notions of originality, creativity and objecthood, demanding a reconsideration of the definition of, and of art itself. Photocopying, for example, facilitated the rapid creation of endless variations, and the process of generating copious amounts of visual information became a primary goal.

Computers have enabled artists to develop algorithms that generate n-dimensional representations and animations or to create multiple versions of three-dimensional forms using computer-aided design and rapid-prototyping. In this case, the original might equally be said to be the data-file, its visualization, or any of the 2D or 3D prints that give the work a concrete physical presence.

Ben LAPOSKY
Oscillation #4
1956
Computer, cathode tube oscilloscope, film, light bulb

Computer art is often considered to begin with Laposky's oscilloscope images. A mathematician and artist, in 1950 Laposky became the first person to use an analogue computer to create graphic images, though he had previously experimented with mathematically-based systems. To create Oscillation #4, he sent images across the fluorescent face of a cathode tube (or oscilloscope) device, used to measure and graph the fluctuations in electric current. The voltage moves the beam up and down, tracing the shape of the current on a screen. Laposky recorded the mathematical curves and waveforms of the manipulated light beam onto high-speed film, producing artworks he called 'Electronic Abstractions' or 'Oscillons'. In 1953–4, fifty of Laposky’s ‘Oscillons’ were the subject of the exhibition ‘Electronic Abstractions’, which opened at the Sanford Museum in Cherokee, Iowa, and travelled to thirteen other venues across the US. An oscillon served as the cover illustration for Jack Burnham's book, Beyond Modern Sculpture: The Effects of Science and Technology on the Sculpture of Our Time (1968). Although Laposky did not employ a computer in his ‘Oscillons’, his use of algorithmic signals to programme and control imagery on a CRT monitor was an important precursor to computer art.
CHARGED ENVIRONMENTS  In contrast to the simulations of virtual reality, responsive environments and contexts such as intelligent architecture and interactive installations tend not to create a representation that corresponds with physical reality but rather utilize real space in a way that renders it virtual and enables alternative, expanded forms of experience and reality awareness. Such works might employ sensors that respond to environmental conditions or the behaviour of inhabitants to reconfigure the physical environment. They may use closed circuit video to transform the audience into the subject of the work or may employ multimedia that enable collaborative exchanges both in physical proximity and remotely. High voltage electricity has been used as a primary artistic medium revealing the awe-inspiring power and spectacular beauty of this energy form. Performances in electronic environments can enable audience feedback to influence the unfolding of various elements or demonstrate the politicized contexts in which electronic media, particularly if mass media, operate.

Le CORBUSIER, Iannis XENAKIS, Edgard VARÈSE
Philips Pavilion
1958
Built by the highly controversial and well-known modern architect and designer Le Corbusier for the 1958 Brussels World’s Fair, the Philips Pavilion showcased the array of technological skill of the Philips Company not through a collection of objects but, rather, a fully integrated site of technology that became the object itself. Insisting only that Le Corbusier use Philips products, the company gave him free rein in building the pavilion. Based on sketches of hyperbolic paraboloids executed by his assistant, architect and composer Iannis Xenakis, Le Corbusier created a stunning building that is at once geometric and expressionistic. It contained a ‘stomach’ floor plan, allowing for a larger audience in the middle. Once the building plans were finalized, Le Corbusier began creating the visual montage of projections and lighting effects within, accompanied by Varèse’s music composition, Poème Electronique, reproduced on some three hundred speakers. The event incorporated media that would highlight Philips’ technology while also stretching artistic and creative boundaries. The piece was destroyed soon after the fair was over but it remains a historically important landmark for its unprecedented integration of architecture, film, music and electronics.
collaborative creation of information has a long history in art prior to the advent of telecommunications. Public access cable, satellite transmissions and computer networking vastly expanded these capabilities. Building on the traditions of mail art, fax art and video, artists have used these technologies to create contexts for the decentralized, collaborative and distributed production of meaning. By commandeering the technologies of surveillance and control, they draw attention to the encroachment of privacy by corporations and governments. Through telematic culture-jamming, their agit prop appropriations and interventions confound traditional structures of value, legitimacy and power.

**Hans Haacke**

**News**

1969

Teletype machines, paper

Exhibited in 1969 at ‘Prospect 69’ in Dusseldorf and the ‘Software’ exhibition in New York in 1970,

is part of Haacke’s real-time systems series of works, inspired in part by Ludwig von Bertalanffy’s general systems theory. It consisted of Teletype machines that received and printed out local, national and international news in real time, as it was being generated by news services. The printouts accumulated in loose piles beside the machines, resembling the scatter-games of Robert Morris, Richard Serra and Barry Le Va, in which materials such as felt, lead and rubber were unrolled to fill a gallery space. In contrast to these more formal parallels, Haacke felt that artists must respond systematically to contemporary social issues and its wide range of informational contexts. ‘It would be bypassing the issue to say that the artist’s business is how to work with this and that material… The total scope of information he receives everyday is of concern. An artist is not an isolated system… he has to continually interact with the world around him…’

**Marta Minujin**

**Circuit Super Heterodyne**

1967

Happening with projectors, computer, television, videocamera

‘This happening took place at Sir George William University in Montreal as part of the 1967 Expo. Those interested in participating had to fill out a questionnaire published in the local newspaper. A computer selected three groups of participants based on common characteristics. Each group met in a particular space at the Youth Pavilion: the first group in the theatre; the second in the agora room; and the third at the entrance of the theatre. The group in the theatre simultaneously viewed its own situation, a television programme and what group three was doing – all projected on the walls of the theatre and transmitted on monitors. The third group observed what was happening inside the theatre as well as its own images taken with a Polaroid camera and projected on the walls. The second group observed what was happening with the others but was unaware by them and had no mediated projections of itself…’

-- Marta Minujin
BODIES, SURROGATES, EMERGENT SYSTEMS

Drawing on information theory, the interdisciplinary field of cybernetics drew striking parallels between the systemic processing of information in humans and machines, contributing greatly to the fields of artificial intelligence, robotics, and, subsequently, artificial life. Artists have joined their bodies, and their audiences, with electronic media or created robots and other forms of surrogate beings in order to examine the cyborgian nature of human existence and to ponder what a post-human existence might be. Others have used genetic algorithms or viral behaviour to create and study self-organizing systems that possess many qualities of life itself, including the replication and dissemination of information and survival and reproduction in competitive environments. In many cases, artists have attempted to bridge the apparent divide between carbon-based organisms and silicon forms of intelligence and life, between the real and the artificial, suggesting that these distinctions and social conventions are becoming increasingly blurred.

Atsuko TANAKA
Electric Dress
1956
Light bulbs, fluorescent tubes, electric cables

At the second exhibition of the Gutai artists in Tokyo in 1956, Tanaka appeared covered from head to foot in light bulbs, fluorescent tubes and electric cables. A statement on the ‘neonification’ of Tokyo that anticipated feminist concerns with the body and consumer culture in the 1970s, Electric Dress received much critical attention when it premiered and is now considered a seminal moment in the history of art for its audacious display of technology, the female body and the convergence of the two. A simple, formless dress made entirely of wires and flashing, multi-coloured light bulbs overwhelmed the artist’s body and has since been exhibited as a freestanding object rather than something to be worn, a disembodied decontextualization which some critics argue eviscerates the work’s vitality. Tanaka’s decision to wear the dress at a public art exhibition in Tokyo was a particularly brazen act in a culture where women were expected to stay in traditional roles and out of the spotlight. In 1957, Tanaka stopped making works that involved electric light and began to make paintings that consist of circles of vibrant colour connected by dripped and drawn lines, which suggest electronic circuitry, the body’s circulatory system and social systems.

Edward IHNATOWICZ
The Senster
1969–71
Computerized robotic device with radar, sonar, microphones

An ambitious and early experiment in combining sensor and robotic technology, Edward Ihnatowicz’s The Senster was a remarkable cyborg that responded to sound and motion in its environment, inspired by the joints of a lobster. Its structure moved in a remarkably organic way, delighting audiences. The computer-controlled piece used microphones to locate the direction of sound and itself turned to follow that direction, with the rest of the structure following if the sound persisted. Motion-sensitive radar devices also triggered The Senster’s movement in response to audience activity, stimulating the piece toward movement. Crowd noise reverberating in Philips Corporation’s domed Evoluon exhibition hall created a sonically confusing environment, generating complex and unpredictable behaviours. This groundbreaking work offered large public audiences an early opportunity to interact with responsive robots.
Myth and legend abound with accounts that attest to artists’ ongoing pursuit to achieve likenesses that fool the eye and convincingly conflate simulation with reality. Large-scale panoramic paintings, photography and especially stereo-photography in the nineteenth century provided persuasive illusions of being in the midst of an actual scene. The 1950s saw the initial development of virtual reality (VR). In such interactively navigable, computer-generated environments, there is typically a direct correspondence between real and virtual space and a causal relationship between behaviour in the former and experience in the latter. Since the early 1970s, artists have further employed a variety of technologies and techniques to engage audiences in increasingly interactive and immersive exchanges with simulated forms and environments.

Myron KRUEGER

Video Place
1974–5
Computer, screen, sensors, light, camera
Dimensions variable

In 1973 Krueger coined the term ‘artificial reality’ to describe the responsive environments he created as part of his doctoral research on human-computer interface design. As he wrote, ‘An artificial reality is a graphic fantasy world in which a person uses her whole body to participate in an experience created by a computer. I realized this was more than a technology – it was a culture-defining concept.’ Although the term was not widely adopted, the idea was and is arguably the first work of art to employ what came to be known as virtual reality. In this work, participants face a video-projection screen that displays their live image (captured in silhouette by a surveillance camera) combined with computer graphics. In response to the participant’s actions (mirrored by the silhouette), the computer system modifies the location, motion, and other attributes of the graphic objects. As a result, the participant can interact with graphic objects – e.g., the participant plays a creature in Critter, interacts with a graphic string in Cat’s Cradle and draws with body parts in Finger Paint. Users need not wear sensors or head-mounted displays and can move freely in this unencumbered VR environment without being physically returned to the simulated world (Documents, 252).

Michael NAIMARK

Golden Gate Fly-Over
1987
Virtual reality installation
Permanent collection of the Exploratorium, San Francisco.

Using a trackball to control their speed and direction, virtual pilots can fly around San Francisco and the Golden Gate Bridge at unnaturally fast speeds. The misty monument and surrounding city were filmed from a low-flying helicopter with a gyro-stabilized 35-millimetre motion-picture camera system. The camera was always pointed at the bridge, so the helicopter traced its own path along a 10-by-10-mile grid, shooting one frame every 30 feet. As a result, each frame blends seamlessly into the next creating a smooth, constant motion. The co-ordinates were set according to LORAN satellite navigation calculations and the altitude and speed were fixed constant. These co-ordinates are visible to the viewer on a small monitor and the actual fly-over footage is projected on a large screen in response to the user’s commands. The intended effect is not one of simulated reality, but of a hyperreality that is otherwise impossible. It appears as though one is re-tracing one moment in time by moving the trackball forwards and backwards. Sweeping in and out exact steps, one can navigate through the present and view the past – from one navigates the past, reflecting on and exploring it.
EXHIBITIONS, INSTITUTIONS, COMMUNITIES, COLLABORATIONS

Although the history of art has cultishly celebrated the individual genius, the field increasingly has recognized the importance of exhibitions, institutions and communities in shaping the production, reception and historical contextualization of art. Significant exhibitions have provided a public context for popular audiences to experience innovative work and for that work to be the subject of critical analysis. Institutions, including universities, corporations, governments and foundations, have provided financial support and technical expertise that enabled facilities to be created and complex projects realized, and communities of artists, engineers, scientists, critics, historians and publishers have provided a nurturing environment in which ideas, experiences, and resources could be shared and expanded upon. Scientists increasingly have come to realize the value of artists not just as producers of attractive visualizations of data but as creative partners, whose insights and methods can fundamentally alter and expand their intellectual vision, spurring innovation and invention in the laboratory.
ROBERT ADRIAN
MARCEL LI ANTÚNEZ ROCA
ANTONIN ARTAUD
ROY ASCOTT
ASOCIACIÓN ARTE
CONCRETO INVENCIÓN
GEOFFREY BATCHEN
NATALIE BOOKCHIN
BERTOLT BRECHT
JACK BURNHAM
JOHN CAGE
JÜRGEN CLAUS
DONNA COX
PETER D'AGOSTINO
DOUGLAS DAVIS
STEVE DIETZ
BILL EDMONSON + SRL
MARIA FERNANDEZ
LUCIO FONTANA
HERBERT W. FRANKE
NAUM GABO
GRAV
MICHAEL JOAQUIN GREY
N. KATHERINE HAYLES
LYNN HERSHMAN LEESON

DICK HIGGINS
ERKKI HUHTAMO
EDUARDO KAC
BILLY KLÜVER
KENNETH KNOWLTON
GYULA KOSICE
MYRON KRUEGER
LA POCHA NOSTRA
BRENDA LAUREL
JANE LIVINGSTON
RAFAEL LOZANO-HEMMER
FRANCOIS LYOTARD
ROBERT MALLARY
STEVE MANN
LEV MANOVICH
MARIYLIN MCCRAY
LÁSZLÓ MOHOLY-NAGY
NECRO ENEMA
AMALGAMATED
NICHOLAS NEGROPONTE
MARCOS NOVAK
NAM JUNE PAIK
ANTON PEVSNER
OTTO PIENE
KEITH PIPER

FRANK POPPER
JANE PROPHET
NIRANJAN RAJAH
ROBERT RAUSCHENBERG
MICHAEL REES
JASIA REICHARDT
KEN RINALDO
DAVID ROKEBY
BILL SEAMAN
WILLOUGHBY SHARP
JEFFREY SHAW
SONIA LANDY SHERIDAN
ALEXEI SHULGIN
CHRISTA SOMMERER +
LAURENT MIGNONNEAU
STELARC
SUBROSA
VICTORIA VESNA
BILL VIOLA
PETER WEIBEL
HOWARD WISE
JUD YALKUT
GENE YOUNGBLOOD
MOTION, DURATION, ILLUMINATION

The broad, international scope that characterizes the exploration of motion, time, and light since the early twentieth century has spawned an equally diverse range of theoretical texts by artists. Many of these texts are manifestos that overflow with artists’ excitement and commitment to a spirit of inquiry, discovery, and innovation. These include Gabo and Pevsner’s classic treatise on joining art and science, Fontana’s insistence on using technological media to explore new conceptions of space and time and Ascott’s paradigm-shifting ode to process, context, and interaction. Piene discusses the emergence of using light as a primary medium in his work. Higgins theorizes the use of interdisciplinary works that join multiple media and Paik draws a parallel between the science of cybernetics and the philosophical principles of Buddhism as a convergent model for art-making.

Naum GABO & Anton PEVSNER

The Realistic Manifesto [1920]

The blossoming of a new culture and a new civilization [...] have made us face the fact of new forms of life, already born and active. What does Art carry into this unfolding epoch of human history? Does it possess the means necessary for the construction of the new Great Style? Or does it suppose that the new epoch may not have a new style? Or does it suppose that the new life can accept a new creation which is constructed on the foundations of the old? [...] Neither Futurism nor Cubism has brought us what our time has expected of them. [...] No new artistic system will withstand the pressure of a growing new culture until the very foundation of Art will be erected on the real laws of Life. Until all artists will say with us [...] only life and its laws are authentic and in life only the active is beautiful and wise and strong and right, for life does not know beauty as an aesthetic measure efficacious existence is the highest beauty. [...] Can art withstand these laws if it is built on abstraction, on mirage, and fiction? [...] The realization of our perceptions of the world in the forms of space and time is the only aim of our pictorial and plastic art. [...] we do not measure our works with the yardstick of beauty [...] with pounds of tenderness and sentiments. [...] we construct our work as the universe constructs its own, as the engineer constructs his bridges, as the mathematician his formula of the orbits. [...] We renounce the thousand-year-old delusion in art that held the static rhythms as the only elements of the plastic and pictorial arts. We affirm in these arts a new element the kinetic rhythms as the basic forms of our perception of real time. [...] We assert that the shouts about the future are [...] the same as the ears about the past: a renovated day-dream of romantics. [...] Today is the deed.

László MOHOLY-NAGY

The New Vision [c. 1928]

[...] Examples of [...] sculpture, which do not depend on [...] an illusion are, for the present, difficult to find. Such sculpture must effectively be kinetic as well, since only through the action of opposed forces can it be brought to balanced rest, to equipoise. [...] An actual realization of equipoised sculpture can be made through the application of magnetic forces, or with electric remote control. [...] The next stop beyond the equipoise is kinetic equipoise, in which the volume relationships are virtual ones, i.e., resulting mainly from the actual movement of the contours, rings, rods, and other objects. Here the material is employed as a vehicle of motion. To the three dimensions of volume, a fourth – movement – (in other words, time is added) [...] In every cultural period a phalanx of active forces presses forward in every field of creation, in art, science


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