

Foundation and Development of Robotic Art

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Source: *Art Journal*, Vol. 56, No. 3, Digital Reflections: The Dialogue of Art and Technology (Autumn, 1997), pp. 60-67

Published by: [College Art Association](#)

Stable URL: <http://www.jstor.org/stable/777838>

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# Foundation and Development of Robotic Art

Eduardo Kac

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As electronic media become more pervasive in today's culture, the role of robotics in contemporary art, along with video, multimedia, performance, telecommunications, and interactive installations, needs to be considered. In this article I propose to define a framework for the understanding and analysis of robotic art. I will discuss three pivotal artworks from the 1960s that outlined the genesis of robotics in art and that formed the basis of the three main directions in which robotic art has developed. This article will also elucidate the new issues raised by current robotic artworks and clarify their relationship to the main paths defined by those three early works.

One of the most problematic issues of robotics in art is the very definition of what a robot is. Complicating matters, on the one hand, we have mythological traditions of various cultures. These traditions have given rise to fantastic synthetic creatures, such as the ancient Greek story of Galatea—a statue brought to life by the goddess Aphrodite—or the Jewish legend of the Golem, a speechless anthropoid made of clay by humans. On the other hand, we find more recent literary traditions offering fictional profiles of automata, robots, cyborgs, androids, tele-robots, and replicants. Intriguing literary artificial beings have excited the imagination of readers worldwide: Mary Shelley's *Frankenstein*, Gustav Meyrink's *Golem*, Karel Capek's robots in the play *R.U.R.* (which introduced the world to the Czech word "robot"), Robert Heinlein's *Waldo*, Isaac Asimov's Cutie—to name a few. The literary robotic canon is further expanded by the presence of robots in film: Fritz Lang's *Metropolis*, Fred Wilcox's *Forbidden Planet*, George Lucas's *Star Wars*, Ridley Scott's *Blade Runner*. Television further popularized the image of the computing companion (Irwin Allen's *Lost in Space*), the cyborg (Harve Bennett's *The Six Million Dollar Man*), and the sophisticated android and the evil mixture of flesh and electronics (Gene Rodenberry's *Star Trek*).

Another aspect of the problem is the operational definition of robots as found in scientific research and industrial applications. The first commercial robots appeared in the

early 1960s in the United States and in about twenty years had developed a stronghold in industrial facilities around the world. Industrial robots, programmed to perform a specific task or set of tasks, were able to perform repetitive motions tirelessly. They increased productivity and prompted further research aimed at improving their efficiency. It is clear that from this perspective robots are advanced computer-controlled electromechanical appliances.

If artists working with or interested in robotics cannot ignore mythological, literary, or industrial definitions of robots and artificial life forms, it is also true that these definitions do not directly apply to any given robotic artwork. Each artist explores robotics in particular ways, developing strategies that often hybridize robots with other media, systems, contexts, and life forms. As artists continue to push the very limits of art, traditionally defined by discrete and inert handmade objects, they introduce robotics as a new medium at the same time that they challenge our understanding of robots—questioning therefore our premises in conceiving, building, and employing these electronic creatures. The fascination robots exert on the population at large has unexplored social, political, and emotional implications. These implications must be coupled, if they are to be properly understood in the contemporary art context, with the new aesthetic dimension of modeling behavior and developing unprecedented interactive communicative scenarios in physical or telematic spaces.

The works highlighted in this article often evade any narrow definition of robotics—except, perhaps, for the principle of giving precedence to behavior over form. Sticking to a narrow definition seems less important than the opportunity to trace parallels between strategies that foreground at times electronic creatures ("robotic art"), and at other times a combination of organic and electronic ("cybernetic art"), or the remote projection of a human subject onto a telerobot ("telepresence art"). Not only do these art forms seem directly related conceptually, but they also appear hybridized in several works.

Whereas prototypes of noncommercial robots were

developed in the 1950s, notably for entertainment and scientific research, it was not until the 1960s that the first robotic artworks were created. As developed in these decades, kinetic art helped to free sculpture from static form and reintroduced the machine at the heart of the artistic debate. Influenced by this context, but already opening up new directions that privileged interactivity and behavioral concerns, three artworks created in the mid- and late 1960s stand as landmarks in the development of robotic art: Nam June Paik and Shuya Abe's *Robot K-456* (1964), Tom Shannon's *Squat* (1966), and Edward Ihnatowicz's *The Senster* (1969–70). Although these works are significant in their own right, they acquire a particular meaning when reconsidered today, since seen together they also configure a triangle of new aesthetic issues that has continually informed the main directions in robotic art. With Paik and Abe's *Robot K-456* (fig. 1), a humorous and politically charged piece, the problem of remote control, free mobility, and interaction with the public is introduced. With Shannon's *Squat* we see the first interactive artwork that is an organic and inorganic hybrid, raising the question of cybernetic entities so relevant to current debates. In Ihnatowicz's *Senster*, also an interactive piece, we find the first instance of behavioral autonomy in art, in which a given personality is assigned to the robot, which then responds to humans and changing situations on its own.

Named after one of Mozart's piano concerti (Köchel number 456), Paik and Abe's twenty-channel remote-controlled anthropomorphic robot first performed in a private space (Robot Opera, at Judson Hall, in collaboration with Charlotte Moorman) and on the streets, both as part of the Second Annual New York Avant-Garde Festival, in 1964. As Paik guided it through the streets, *K-456* played a recording of John F. Kennedy's inaugural address and excreted beans. *K-456*, which is now in the Hauser and Wirth private collection, in Zurich, was reactivated once again in 1982, when the Whitney Museum of American Art hosted Paik's retrospective exhibition. On that occasion, the artist staged an accident in which *Robot K-456* was hit



FIG. 1 Nam June Paik and Shuya Abe, *Robot K-456*, 1964. Courtesy George Hirose.

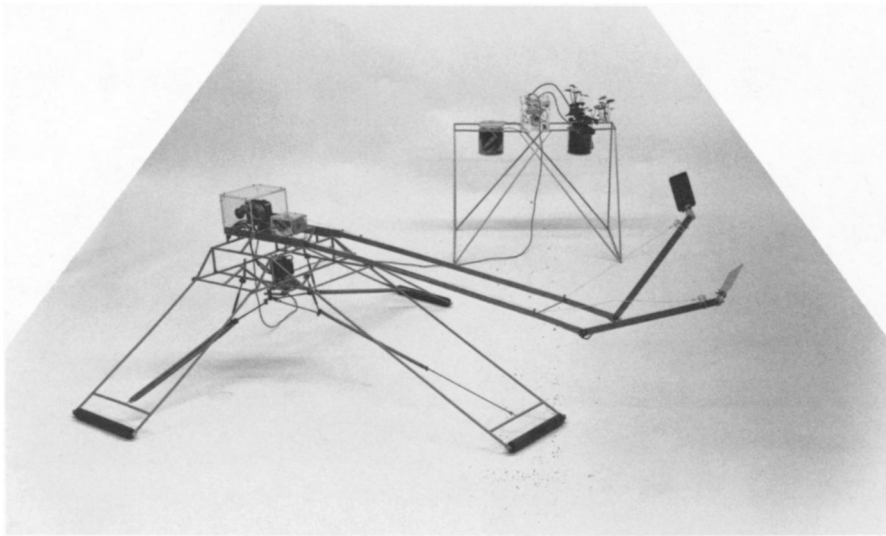


FIG. 2 Tom Shannon, *Squat*, 1966. Courtesy the artist.

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by a car. For this performance, titled *The First Catastrophe of the Twenty-first Century*, *K-456* was removed from its museum pedestal and guided by the artist down the street to the intersection of 75th Street and Madison Avenue. When crossing the avenue, the robot was “accidentally” hit by an automobile driven by the artist William Anastasi. With this performance Paik suggested the potential problems that arise when technologies collide out of human control. After the “collision,” *K-456* was returned to its pedestal in the museum.

Less traumatic is the kind of contact enabled by Tom Shannon’s work. Created only two years later, Shannon’s *Squat* (fig. 2) was a cybernetic system wiring a live plant to a robotic sculpture. In this early form of cybernetic interactive art, Shannon allowed the electric potential of the human body to trigger an organic switch. When viewers touched the plant, the electricity was amplified and turned on the motors of the robotic sculpture, which then moved. On human-plant contact, *Squat* retracted and extended its three legs as well as its two arms, creating undulating motion and humming and chirping sounds. If the viewer touched the plant again, the piece returned to its resting state.

Whereas tactile participation is crucial to *Squat*, the voice and proximity of viewers prompt responsive behavior in Ihnatowicz’s work. Working in relative isolation in England, after emigrating from his native Poland and studying at the Ruskin School of Drawing and Fine Art at Oxford, Edward Ihnatowicz (1926–1988), perhaps the least known of the three pioneers, created *The Senster* (fig. 3), a biomorphic computer-controlled robotic creature with shy behavior that was shown at Evluon, the permanent showplace of the manufacturing firm Philips, in Eindhoven, Holland, from 1970 to 1974, when it was dismantled. Based on the articulation of a lobster’s claw, *The Senster* was about fifteen feet long and eight feet high, occupying

one thousand cubic feet. Its head had sensitive microphones and motion detectors, providing sensorial input that was processed by a digital Philips minicomputer in real time. *The Senster*’s upper body consisted of six independent electrohydraulic servo-mechanisms with six degrees of freedom. Responding to motions and sounds within one or two seconds, *The Senster* gently moved its head toward quieter and more subtle viewers. Loud and agitated viewers saw the creature shy away and protect itself from potential harm. In its sensual, and apparently intelligent, behavior, the piece was very engaging to a wide audience. While the debate on the use of computers in art at the time revolved around the creation of still or sequential images, and the use of static or mobile plotters to produce such images, Ihnatowicz merged software-based parametric behavior with physical presence in a real space as he introduced the first computer-controlled artwork.

Further contributing to this nascent field in 1974, Norman White created *Ménage*, an installation with five light-scanning robots. This installation was composed of four robots moving back and forth along separate ceiling tracks and a fifth robot positioned on the floor. Each creature had a scanner (which caused each robot to point to strong light sources) and a spotlight mounted at its center. Because of the central position of their own light source, the ceiling robots tended to stare at one another. However, despite the apparent simplicity of this arrangement, a more dynamic behavior emerged once their motors pulled them apart and the gaze-locking interplay resumed. If in the three pioneering works discussed, Paik, Shannon, and Ihnatowicz worked with individual robots, and if their contribution to robotic art can be said to be circumscribed to these pieces, White’s position is different. He tried to create a small community that would exhibit collective behavior and is the first artist to have consistently championed



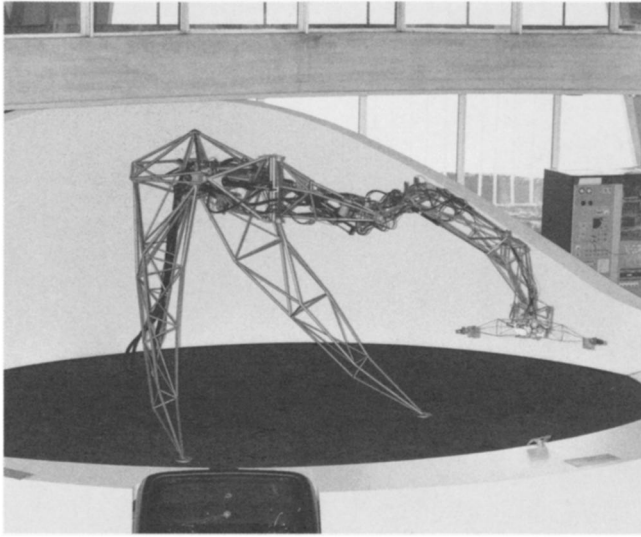


FIG. 3 Edward Ihnatowicz, *The Senster*, 1969–70. Courtesy Olga Ihnatowicz.

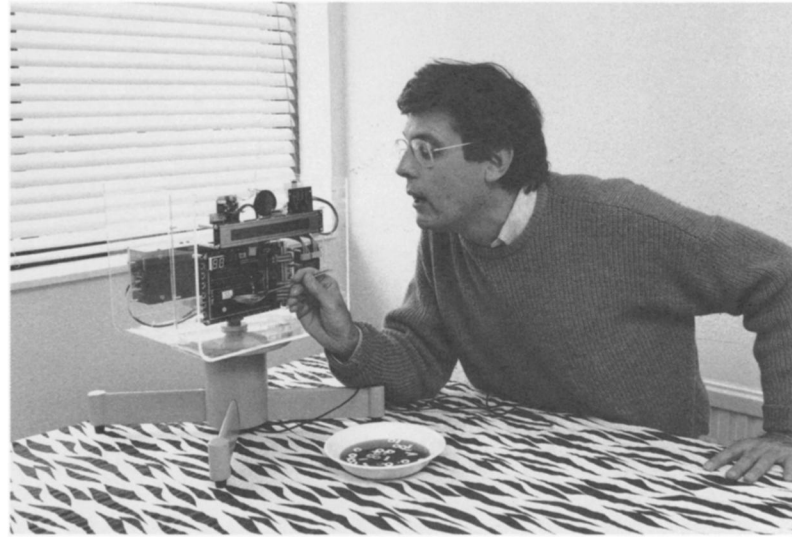


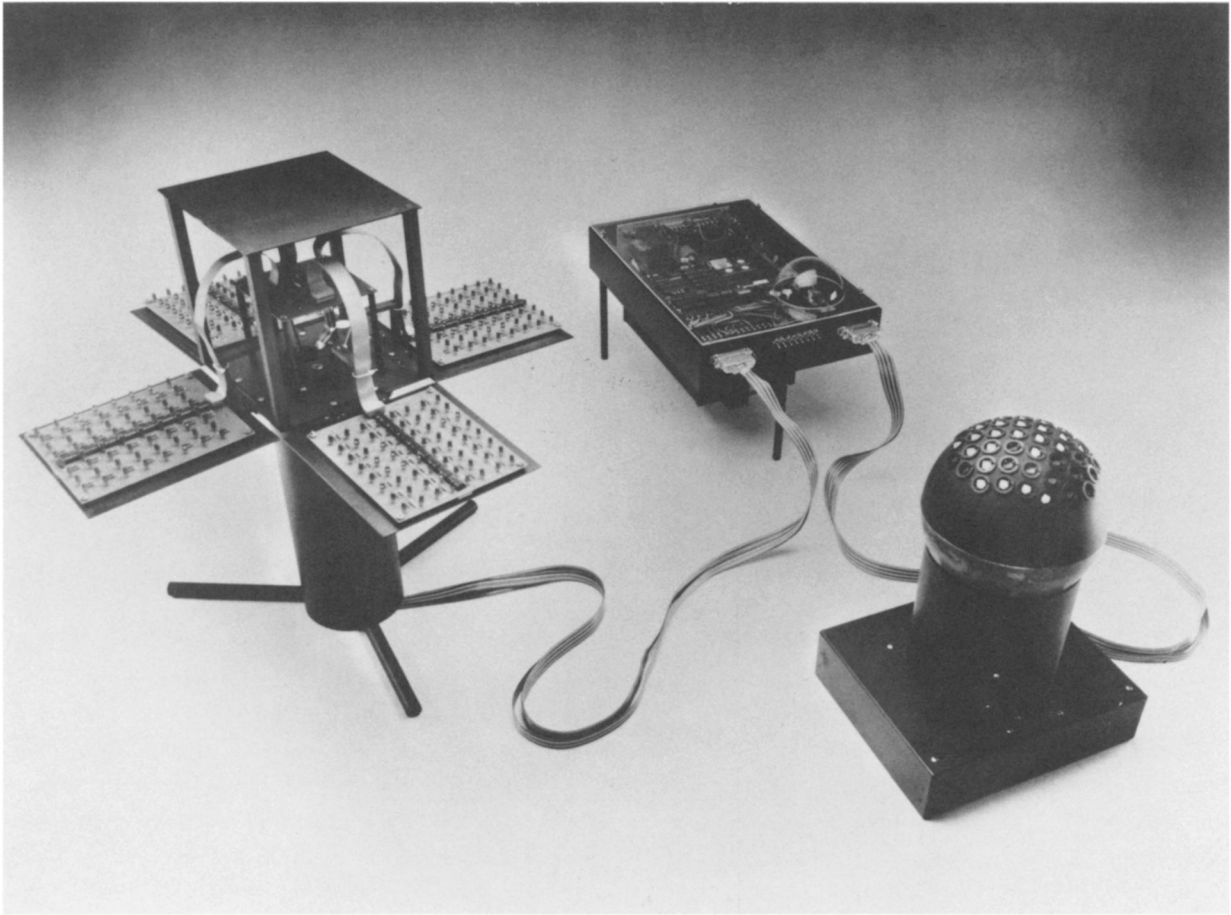
FIG. 4 Norman White, *The Helpless Robot*, 1985. Courtesy the artist.

robotics as an art form throughout the years. He has produced a number of different and intriguing pieces, most notably *The Helpless Robot* (fig. 4), a robot originally made in 1985 that converses with viewers and requests their assistance to spin it, changing its behavior in time if it gets more or less help. White considers *The Helpless Robot* unfinished (possibly unfinishable), and since 1985 he has modified it many times. *The Helpless Robot* was shown publicly for the first time in 1988. In its current state (1997), it is controlled by two cooperating computers, both programmed by White. One computer is responsible for tracking the angular position of the rotating section and detecting human presence with an array of infrared motion detectors. The other computer analyzes this information in relation to past events and generates an appropriate speech response. This work humorously reverses the polarity of robot-human relationships, asking humans to help an electronic creature conventionally designed to be a human aid.

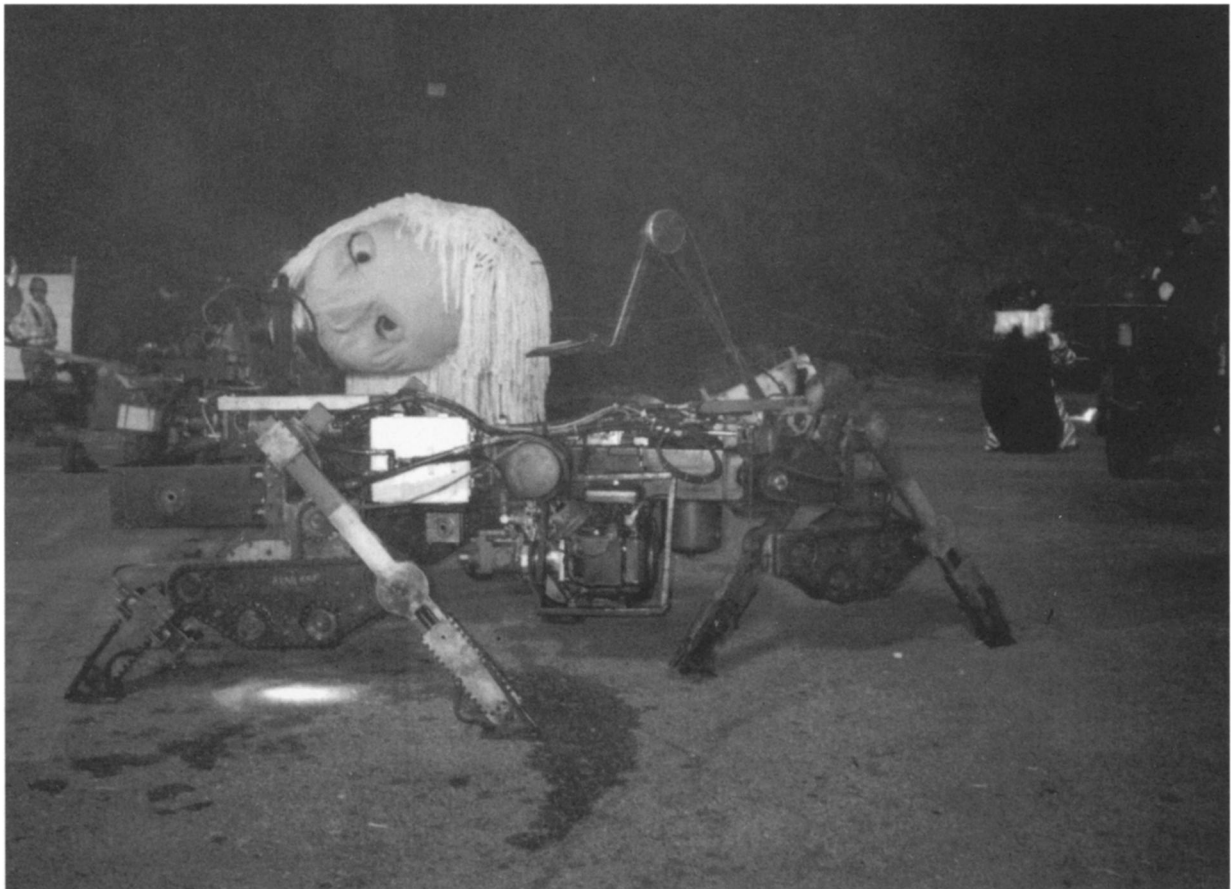
Also working with sensors and microcontrollers in interactive situations, James Seawright—known for responsive kinetic sculptures such as *Watcher* (1965–66) and *Searcher* (1966) and for early interactive installations (which he termed “reactive environments”) such as *Electronic Peristyle* (1968) and *Network III* (1971)—developed computer-controlled robotic works in which the software-based comportment of the piece seems to achieve a sophisticated level of behavior as it interacts with the environment and the public. His *Electronic Garden #2* (1983) is composed of five computer-controlled robotic flowers. Responding to climate parameters, such as temperature and humidity, these electronic flowers were originally installed in a public space as an indoor garden. Viewers could also alter the flowers’ behavior by pushing buttons that modified the program installed in the custom-built microprocessor. These electronic flowers suggest the

possibility of a harmonious integration between humans, nature, and technology, at the same time that they poeticize responsive electronics in analogy with ornamental plants. Taking this concept further, in 1984 Seawright created *House Plants* (fig. 5), two computer-controlled robotic flowers. *House Plants* used a computer (a custom-built microprocessor) to give the electronic plants their environmentally responsive behavior. While the taller plant opened its four petals at night reacting to changing light levels, the shorter, domed plant produced a peculiar sound pattern as small disks opened and closed. Both plants displayed dynamic blinking light patterns: on the inside of the petals of the taller one (made visible when opened), and on the surface of the spherical top of the shorter one. If placed in a gallery setting, both plants were programmed to exhibit their behavior simultaneously. Cybernetic botany is a theme that has been explored by the artist in multiple pieces and in different versions of single pieces.

With its emphasis on behavior, it was only a matter of time for robotic art to expand its realm of possibilities into theatrical and performative events. Two of the most prominent artists of the generation that emerged in the 1970s who work with robotics are Mark Pauline and Stelarc. In 1980 Pauline cofounded, with Matthew Heckert and Eric Werner, the Survival Research Laboratories, or SRL, a collaborative team that since then has created multiple-machine performances combining music, explosives, radio-controlled mechanisms, violent and destructive action, fire, liquids, animal parts, and organic materials. In the seventeen years that stand between its foundation and the present, SRL has developed machines and robots and has staged performances in Europe and the United States, all too numerous and varied to be fully covered here. These works are marked by visceral violence and entropic choreography, often culminating in a cathartic self-destructive



**FIG. 5** James Seawright, *House Plants*, 1984. Courtesy the artist.



**FIG. 6** Survival Research Laboratories, scene from *Crime Wave*, realized in San Francisco on November 28, 1995. This image shows the Running Machine attacking a victim prop. Courtesy Mark Pauline.





FIG. 7 Stelarc, *The Third Hand*, 1981. Courtesy the artist.

extravaganza. These robotic spectacles of discomfort, fear, and actual destruction are meant as commentaries on social issues, particularly in regard to ideological control, abuse of force, and technological domination. In 1981, for example, Pauline mechanically animated dead animals, evoking Frankensteinian fears and suggesting the larger-than-human powers of technology. *Rabot*, for example, was produced by grafting a mechanical exoskeleton to the entire body of a dead rabbit, causing it to walk backward. These and many other large machines, animal-machine hybrids, and robotic or computer-controlled devices have animated SRL's loud and often controversial pyrotechnic events, such as *Crime Wave* (fig. 6), realized in November 1995 in San Francisco, or more recently, *The Unexpected Destruction of Elaborately Engineered Artifacts*, realized in March 1997 in Austin, Texas.

By contrast, Stelarc has focused his work on his own body, to which he first attached a third (robotic) arm, only to expand his suspension events into complex performances that have evolved cyborg and post-human metaphors, raising the issue of evolution and adaptation in our highly technological environment. *The Third Hand* (fig. 7), a five-finger robotic hand activated by abdominal and leg muscles, was built in 1981 with the assistance of Imasen Denki, based on a prototype by Ichiro Kato. Among

Stelarc's first robotic performances in 1981 were *The Third Hand* (Tamura Gallery, Tokyo) and *Deca-Dance* (Komai Gallery, Tokyo). In *The Third Hand* performance, the artist explored the possibility of writing THE THIRD HAND simultaneously with his right hand and his third hand. In *Deca-Dance*, he experimented with human and robotic choreographic gestures. Since 1981 Stelarc has been creating amplified body performances in which he expands the power and reach of the human body by wiring it to electronic devices and telecommunications systems. In these performances he has combined the third hand with many other technological components, including sensing devices conventionally used in medicine. On occasion Stelarc has also performed in the company of industrial robotic arms. More recently he has also used prosthetic technologies that physically wire his body and enable remote and direct muscle stimulation, which result in involuntary gestures and body motions uncontrollable by the artist.

Stelarc clearly understands that in the absence of the object that is being controlled, remote control and manipulation create a new situation for performance, robotic, and interactive art. As a consequence of my own desire to push telecommunications art into a more physical domain, since 1989 I have been developing, with Ed Bennett, what I call *telepresence art*, coupling robotics and telecommunications into new forms of communicative experiences that enable participants to project their presence into a geographically distant place. The word *telepresence* refers to the experience of having a sense of one's own presence in a remote space (and not the sense of somebody else's remote presence, as is common on the telephone). Telepresence art is hardly conceivable without the use of live video, but unlike video art, telepresence art emphasizes, not the video image itself, but the point of view defined by the intermediated gaze. Other artists have subsequently pursued this basic premise with very engaging results. In 1995 Ken Goldberg, Joseph Santarromana, George Bekey, Steven Gentner, Rosemary Morris, Carl Sutter, and Jeff Wiegley collaborated to create the *TeleGarden* (fig. 8), a Web telepresence

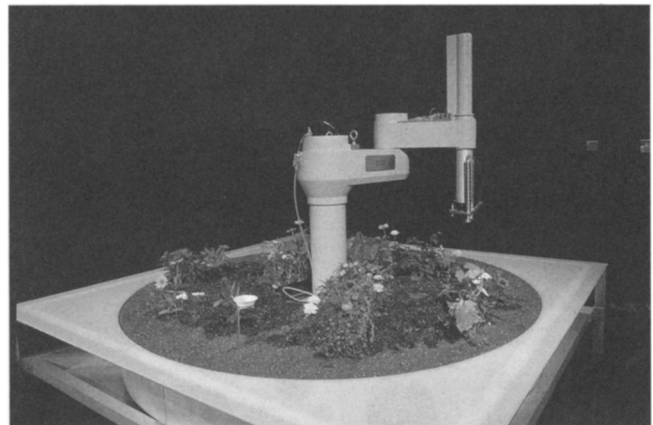


FIG. 8 Ken Goldberg and others, *TeleGarden*, 1995. Courtesy the artist.

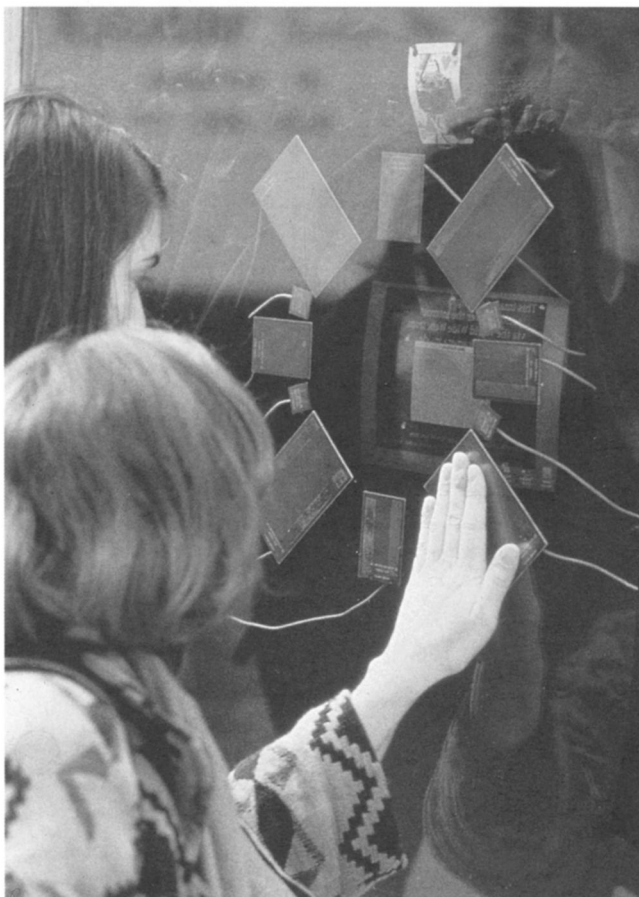


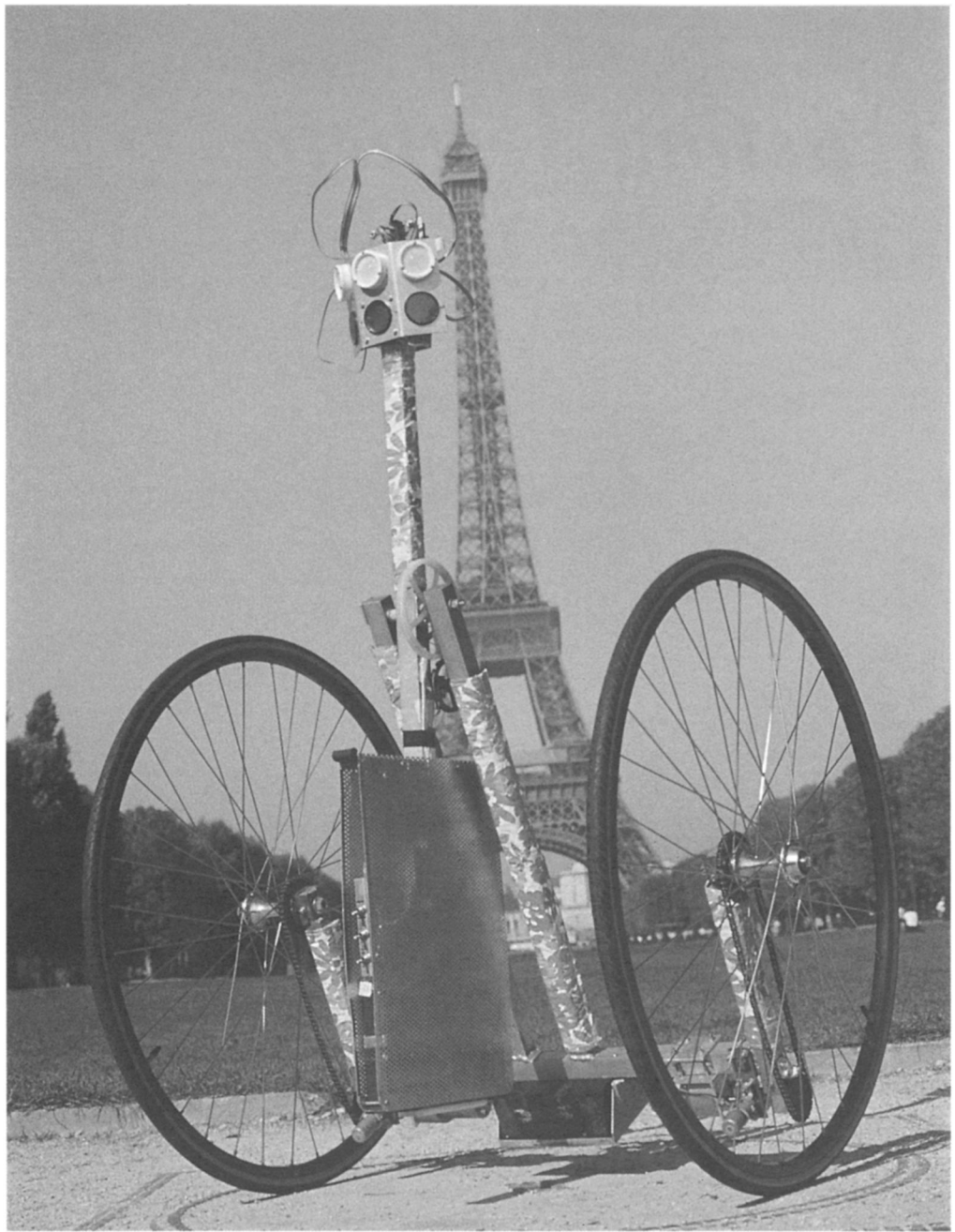
FIG. 9a, b Nina Sobell and Emily Hartzell, *Alice Sat Here*, 1995. Courtesy the artists.

installation. *TeleGarden* enabled anyone on the Web to plant and water seeds in a real living garden using an industrial robot arm. This garden, six feet in diameter, soon filled with marigolds, peppers, and petunias. Participants, who became “members” of this virtual cooperative, could also plant seeds, water the plants, and discuss co-op policy via an on-line chat system. The project explored the evolution of community on the Web, in particular the analogy with the agrarian revolution which established the conditions for cultural communities.

Also in 1995, Nina Sobell and Emily Hartzell, working in collaboration with New York University Center for Advanced Technology engineers and computer scientists, created *Alice Sat Here* (fig. 9a, b), originally shown at Ricco/Maresca Gallery in New York. In this piece a camera-equipped wheelchair was steered by local and remote participants, with sequential uploads to the Web. While local participants were able to sit on and steer Alice’s throne, remote visitors could control camera direction. A monitor in the gallery’s front window showed real-time video from the point of view of the wheelchair-mounted wireless camera, which was then displayed as sequential stills on the Web. Touchpads in the front window surrounded the monitor. Participants pressing the touchpads were caught in the act of controlling the throne’s camera: their images were captured by the small camera mounted atop the monitor. The throne itself was controlled not remotely, but by people actually driving it around. The small camera mounted on top of the monitor overlapped the street participant’s image with the image captured from the point of view of the wheelchair-mounted camera prior to the Web upload. This piece touched on the multiple levels of control as participants oscillated between physical space and cyberspace.

As telepresence art departs from “straight robotics,” many artists still pursue issues of autonomy of the robotic body in space beyond biomorphism. In 1996, Simon Penny, for example, created his autonomous robot *Petit Mal* (fig. 10). The title of this piece is a medical term that refers to a momentary loss of consciousness. Having first designed *Petit Mal* in 1989, Penny began to build it in 1992. As an autonomous robotic artwork, it explores architectural space and pursues and reacts to people. Its behavior is neither anthropomorphic nor zoomorphic but is unique to its electronic nature. It has three ultrasonic sensors and three body-heat sensors that allow it to recognize the presence of humans near it. *Petit Mal* was designed to be lightweight, durable, and mechanically efficient, which gave it a “laboratory prototype” physiognomy. By covering parts of the robot’s body with a printed vinyl tablecloth, the artist intended to change its appearance. *Petit Mal* consists of a pair of bicycle wheels that support a pair of pendulums suspended from a single axis. The top pendulum houses a processor, sensors,





**FIG. 10** Simon Penny, *Petit Mal*, 1992–95. Courtesy the artist.

and logic power supply. The bottom pendulum encloses motors and motor power supply. Sensors are kept in a vertical position despite the swing that results from acceleration. *Petit Mal* functions autonomously in a public environment for many hours before its batteries need to be replaced.

The works outlined here suggest that at the same time that robotics has matured into an art form since its introduction in the 1960s, it has been quickly appropriated and incorporated into other forms, such as performance, installation, dance, earthworks, theater, and telepresence pieces. Today artists such as Marcel.li Antúnez Roca, Margot Apostolos, Louis-Philippe Demers and Bill Vorn, Ulrike Gabriel, Ted Krueger, Chico MacMurtrie, Ken Rinaldo, and Martin Spanjaard, among many others, are developing a complex and fascinating body of work in robotic art, pushing it into new directions. Remote control,

cybernetic entities, and autonomous behavior, as first outlined by Paik, Shannon, and Ihnatowicz, define the three key directions that have informed the development of robotics in art. Today, as artistic freedom promotes robotic diversity, the understanding of this triangular framework is essential to enable us to continue to explore the history, the theory, and the creation of robotic art. —

Note

For their invaluable help I would like to thank Annick Bureau, Johanna Drucker, Anita Duquette, George Hirose, Olga Ihnatowicz, Barbara Moore, Jasia Reichardt, and Carl Solway.

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