Presented at the Electronic Media Group Session, AIC 35th Annual Meeting May 15–20, 2009, Los Angeles, CA.

HEART BEATS DUST: THE CONSERVATION OF AN INTERACTIVE INSTALLATION FROM 1968 AND AN INTRODUCTION TO E.A.T (EXPERIMENTS IN ART AND TECHNOLOGY)

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ABSTRACT

This paper begins with a short historic overview of installations including electric and electronic components in works of art from the United States. The roots of this work go back to the 1960s, when artists and engineers started to collaborate and create installations, eventually forming the pioneering group E.A.T. (Experiments in Art and Technology). Today, these early technology-based artworks made by E.A.T.—mainly in the 1960s—are relatively little known, primarily as a result of the complexities of preserving, displaying, and properly maintaining them. While technologically advanced at the time when they were created, some components have become outmoded or obsolete and are hard to preserve (Davidson 1997, 290). Keeping these artworks "alive" without changing their technological and functional integrity is possible, to some degree, but there is a fine line between preservation, conservation, and re-creation, which will be addressed and discussed in more detail.

COLLABORATION BETWEEN ARTISTS AND ENGINEERS IN THE UNITED STATES

In 1960, Billy Klüver (1927–2004), a Swedish-American engineer at Bell Telephone Laboratories and the Swiss artist Jean Tinguely (1925–1991) started their collaboration in building the self-destroying machine *Homage To New York* (1960) in the garden of the Museum of Modern Art (MoMA) in New York City (figs. 1, 2). Jean Tinguely and Billy Klüver worked on the machine for several weeks, collecting materials from a garbage dump located in New Jersey. At night, they hauled bicycle wheels, kitchen appliances, and other materials, hoisting them over the wall on

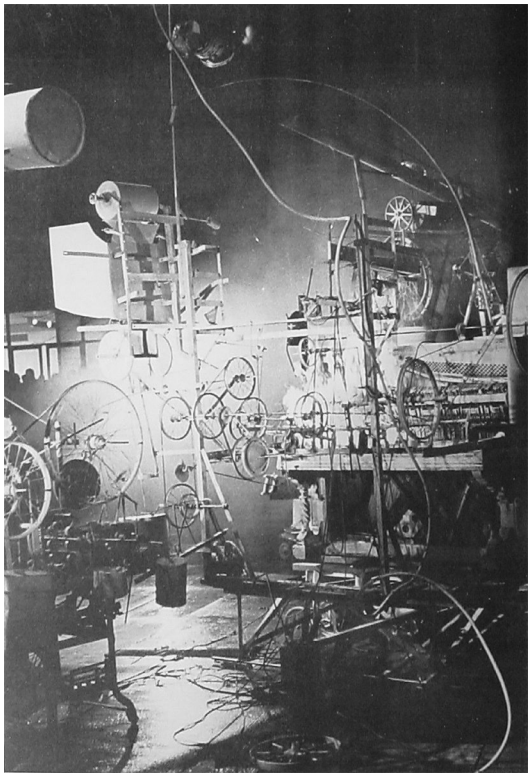

Fig. 1. Jean Tinguely, *Homage To New York*, 1960, installation view at the Museum of Modern Art, New York, March, 17, 1960.

East 54th Street into MoMA's garden in order to assemble the machine.

Klüver and his assistant, Harold Hodges, designed special step relays that closed eight electrical power circuits at different intervals over the course of 27 minutes. The incorporation of these relays permitted the machine to play a piano, turn on a radio, activate a chain saw, cut the playing radio in half, start one of Tinguely's metamatic drawing machines, operate an Addressograph machine, trigger a chemical reaction that produced smoke, and so forth (Klüver and Martin 1997, 311).

> Billy Klüver, the engineer, saw many parallels between contemporary art and science, both of which he considered to be concerned basically with the investigation of life. . . . [He had] a vision of American technological genius being humanized and made wiser by the imaginative perception of artists. . . . Klüver seemed to speak two languages, contemporary art and contemporary science. (Lovejoy 1997, 73)

Robert Rauschenberg (1925–2008) was in the audience and an eyewitness to the performance of *Homage To New York*. "Rauschenberg thought that the H.T.N.Y. was so real, so interesting, so complicated, so vulnerable, and so lovely as life itself" (Klüver and Martin 1997, 311).

He was also fascinated by the process of the collaboration between an artist and an engineer in the construction of the machine (Klüver and Martin 1997, 311). Exactly seven minutes after the Homage To New York machine started its self-destruction, some gunpowder exploded in Robert Rauschenberg's little mascot for the machine,

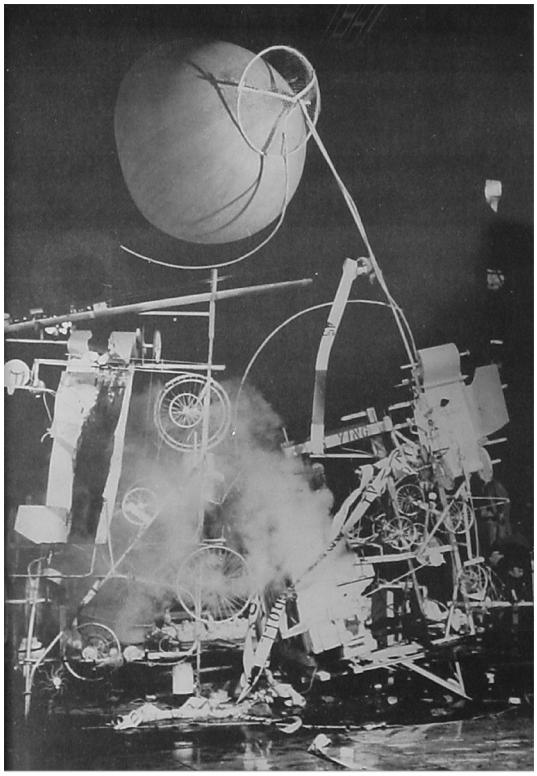

Fig. 2. Jean Tinguely, *Homage To New York*, 1960, installation view at the Museum of Modern Art, New York, March, 17, 1960.

which he called *Money Thrower for Tinguely's H.T.N.Y.* (1960) (fig. 3).

Money Thrower for Tinguely's H.T.N.Y. consisted of a small, rectangular metal box with a perforated top and

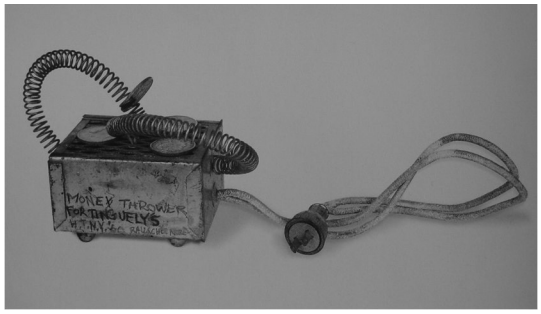

Fig. 3. Robert Rauschenberg, *Money Thrower for Tinguely's H.T.N.Y.*, 1960, electric heater with gun powder, metal spring, twine, and silver dollars, 17.1 x 57.2 x 10.2 cm. Moderna Museet, Stockholm. Courtesy of Dorothy Zeidman.

heating wires at the bottom, where Rauschenberg put gunpowder. Two large, spiral binding wire coils were fastened to the top of the box, one at each end, with their free ends bent together and intertwined. Rauschenberg inserted 12 silver US dollar coins into the coils. When the artwork was plugged into a power circuit,[1] the heating wires were activated, igniting the gunpowder and causing the coils to spring apart, throwing the silver dollars into the audience.

Rauschenberg always wanted to implement thinking and action in his artistic work. He saw his work as an active participant of its own environment and the viewer as an active participant in the work. The final piece was the result of the collaboration between its materials, the artist, and the viewer. Rauschenberg stated in 1963:

> Getting the room into the picture was important because I always felt a little strange about the fixedness of a painting. . . . The use of mirrors and putting open areas in the painting for the wall. . . . To come through and be part of the active image was a way to counteract that kind of stillness. (Klüver 1981, 42)

The mechanical and electrical investigations motivated Robert Rauschenberg—as many other artists at that time—to move away from two-dimensional surfaces (Davidson 1997, 290). Rauschenberg's perception of the world began to include new technology. Technology was the new material on his palette. Billy Klüver gave him the suggestion that the possibilities in technology were endless. And of course, he was right (Rose 1987, 67 and Klüver and Martin 1997, 311).

E.A.T.: HOW IT ALL BEGAN

The collaboration between Billy Klüver and Robert Rauschenberg began shortly after the Homage to New York performance. Rauschenberg asked Klüver if it was technically possible to create an interactive environment that would allow the viewer to manipulate temperature, sound, smell, and light. In the following years Rauschenberg and Klüver worked on the idea of an interactive—or better, reactive—environment. Given the technology available at that time, it was hard to meet Rauschenberg's visions. By 1962, Rauschenberg's original idea was refined with the focus concentrated on the development of a "sound environment," in which the sounds emanating from five AM radios could be manipulated by the viewer. With the use of a separate unit provided the viewer could control the volume and change the channels wirelessly.

Rauschenberg wanted the visitor to be able to vary the speed of scanning from station to station but to be prevented from staying at or tuning in to any given station. The engineers came up with the solution: the turning dial was operated by a small, variable speed, DC motor, and the visitor controlled the speed of the motor (Klüver and Martin 1997, 312). However, two complete versions were built and rejected because interferences between the control signals from the homemade AM transmitters and the AM radio signals generated a nightmare of noise

(Klüver and Martin 1997, 312). In the summer of 1964, the technology caught up with Rauschenberg's vision with the development of the first crystal-controlled, fully transistorized wireless microphone system, the Comrex system, with a transmitter and receiver (General Electric transistor radios) operating in a 30MHz range.

The five sculptural elements of the interactive or reactive environment *Oracle*, (1962–65) are a metaphor for a gift of the street. *Oracle* was basically made from a car-door, a typewriter desk, a concrete mixing container (including the pump for the circulating water shower), an air flue (vent) pipe, and a window frame (fig. 4). Many choices in the creation of *Oracle* were not made purely on the basis of engineering considerations but were aesthetic choices: Rauschenberg chose the size and shape of the control knobs, the size of the speakers, and where to

Fig. 4. Robert Rauschenberg, *Oracle*, 1962–65, Five-part found-metal assemblage with five concealed radios: ventilation duct; automobile door on typewriter table, with crushed metal; ventilation duct in washtub and water, with wire basket; constructed staircase control unit housing batteries and electronic components; and wood window frame with ventilation duct, installation dimensions variable, Musee National d'Art Moderne, Centre Pompidou, Paris, France, gift of São and Pierre Schlumberger, 1976, acc. no. AM1976-591. Courtesy of Centre George Pompidou.

place the technical components in each piece (Klüver and Martin 1997, 312–313).

By the time *Oracle* was created, Klüver had already made numerous contacts with artists, inviting them to Bell Labs. In 1965, a group of New York-based artists prepared a proposal for an Art and Technology festival. Rauschenberg and Klüver invited the composers John Cage (1912–1992) and David Tudor (1926–1996), the

Fig. 5. Press conference for *9 Evenings: Theatre and Engineering* at the chapel of Rauschenberg's Lafayette Street studio, New York City, September 27, 1966. Pictured: John Cage, Steve Paxton, Alex Hay, Robert Whitman, Yvonne Rainer, Billy Klüver, David Tudor, Rauschenberg, Lucinda Childs, Deborah Hay, and Öyvind Fahlström. Courtesy of Fred W. McDarrah.

choreographers Lucinda Childs (b. 1940), Deborah Hay (b. 1941), Steve Paxton (b. 1939), and Yvonne Rainer (b. 1934), and artists Öyvind Fahlström (1928–1976) and Robert Whitman (b. 1934) to participate. The resulting group-planned performances took place in 1966 at the 69th Regiment Armory Hall in New York and were entitled *9 Evenings: Theatre and Engineering—A Series of Performances by 10 Artists Collaborating with 30 Engineers* (fig. 5).

At the first meeting for the event, Klüver asked the artists to present their questions and concerns relating to their technological needs. In return, he asked the engineers to respond to these and come up with ideas and solutions.

9 Evenings intensified interest among New York artists in using new technologies and created so much enthusi-

Fig. 6. Robert Rauschenberg and Lucinda Childs discussing the capabilities of the theater electronic environmental modular (TEEM) system with Herb Schneider, L.J. Robinson, Per Biorn, and Billy Klüver. Courtesy of Experiments in Art and Technology.

asm among both artists and engineers that, in response, Billy Klüver, Robert Rauschenberg, Robert Whitman and Fred Waldhauer (1927–1993) founded the non-profit organization Experiments in Art and Technology (E.A.T.) on October 10, 1967 (fig. 6).

Art and Science Proclaim Alliance in Avant-Garde Loft

By HENRY R. LIEBERMAN

In a sound-drenched Lower Manhattan loft building that was enlivened by revolving painted disks, film projections, floating pillows and miniskirted girls in paper smocks, representatives of industry and labor joined a number of artists and scientists yesterday to proclaim a "working alliance" between art and technology.

This modest and uncertain merger seeks to bridge the gap between the two worlds. It is intended to bring modern technological tools to the artist for creating new art forms and fresh insights and viewpoints to the engineer for creating a "people-oriented" technology.

The event was celebrated at a news conference "happening" in the six-story loft building at 381 Lafayette Street used for studio purposes by Robert Rauschenberg, the avant-garde artist.

Kheel's 'Biggest Mediation'

Mr. Rauschenberg, along with Dr. Billy Klüver, an electronics engineer who is specializing in laser research at the Bell Laboratories, and Theodore W. Kheel, the lawyer-labor mediator, are prime movers in the art-technology merger.

"For me," said Mr. Kheel, "this is the biggest mediation I've ever undertaken."

Among the art objects on display was a large drawing of a nude generated by a computer. Masterminded by two engineers, L. D. Harmon and K. C. Knowlton, this project involved the making of a transparency from a photograph and scanning it with a device operating like a television camera.

The information on the transparency was then stored on magnetic tape in the form of pulses standing for digits, with the brightness level of the picture elements represented by numbers ranging from 0 to 7. After processing all the numbers, the computer printed a drawing of micropatterns formed by clusters of symbols used in electronic design.

Visitors at the studios were intrigued by a sculptural representation of a woman taking a shower. As droplets of water dripped from the shower-head in a white stall, moving-picture images of the woman were registered by a projector behind the stall on a sand-blasted Plexiglass panel.

Rauschenberg's 'Oracle'

Another sculptural construction was a sound-emitting assembly consisting of a tire, truck door, window frame, bathtub and air vent. This is Mr. Rauschenberg's "Oracle."

Five radios are used, with the tuning dial of each being rotated by motor. Thus, each radio picks up snatches of the broadcasts of all the local radio stations. To eliminate wiring from assembly components to the central pick-up point, signals from the radios are relayed to the components by small FM transmitters.

Last year an artist-engineer collaboration called "Nine Evenings: Theater and Engineering" left the art critics bewildered. A few visitors at the Lafayette Street show also looked with puzzlement on "Oracle." But the show sponsors emphasized that it was the idea of collaboration, and not a specific art work, that counts most.

Contributions Are Listed

While 20 helium-filled pillows floated eerily in a two-story room called "the Chapel," the need for bringing artist and technologist together was stressed in speeches by Senator Jacob K. Javits, a traditionalist who sees merit in modern art; Ralph C. Gross, president of the Commerce and Industry Association; Edwin Langsam, film projection supervisor of the American Telephone and Telegraph Company; Herman D. Kenin, head of the A.F.L.-C.I.O.'s new Scientific, Professional and Cultural Employes Council, and Dr. Warren Brodey, a psychiatrist, of the Massachusetts Institute of Technology.

A.T. & T., the International Business Machines Company, the Atlantic Richfield Corporation and various labor groups are among the organizations that have made $1,000 contributions for furthering the cooperation between artists and engineers. But Mr. Gross urged industry to enlarge "the less than 3 cents of each corporation-contribution dollar that goes to the arts."

"Along with its obligation to be a profit-maker for its owners, the modern business corporation has an obligation to be a good citizen in the community," he said. "As a basic part of this obligation, the corporation must examine carefully its responsibility to support the arts."

In explaining the unions' interest in art and engineering, Mr. Kenin, who is head of the musicians' union, said that union members were concerned about a "growing chasm" between disciplines, the "growing impersonalization" of work and the frustrations faced by many individuals in seeking to make "valuable contributions."

He noted that union members were also consumers, members of audiences and citizens concerned with the quality of society.

The event served to dramatize a drive to win organizational support for the art-technology merger and to mark the transfer of Experiments in Art and Technology, Inc., a nonprofit organization of artists and engineers, to the new Automation House being prepared at 49 East 69th Street.

Automation House will be the center of the American Foundation on Automation and Employment, headed by Mr. Kheel and concerned with human problems caused by automation—notably the problem of individual "isolation."

Dr. Brodey, who heads M.I.T.'s science camp for underprivileged youngsters, noted that new technologies had opened large new areas of creativity. While the industrial revolution "averaged the people," he said, the great strides made in science and engineering had opened "a new potential for living in a personalized environment if we merely can think our way out of the old mass-production mentality."

He added:

"It is the artist who has the capacity to make personalized products that grow in meaning as they become more familiar. The artist has learned to use as his material the familiar that is outside the 'accepted system.' By his slight shifts, relevance and meaning emerge from the hackneyed."

Dr. Klüver, the laser specialist, stressed his belief that the art-technology merger should primarily be aimed at "catalyzing the individual's responsibility for the shaping of the new technology." In pursuing this end, the 40-year-old scientist, a thin, blond man who came here from Sweden in 1954, has long assisted artists in developing new modes of expression.

A Natural Marriage

He has advised sculptors on how to build self-exploding contraptions, helped painters add neon lights and motors to their works, and provided them with amplifiers, oscillators, speech synthesizers, image producers and various kinds of electronic detectors to extend their range. To Dr. Klüver, it is a natural marriage.

Technology supplies new materials, new techniques and new imagery to the artist. In return, technology gets from the artist new outlooks that make it "more human, more reasonable, more varied, more lifelike, if you wish."

Robert Rauschenberg, the 41-year-old soft-spoken ex-Texan who has been called an artistic enfant terrible, agrees that technology has bountiful gifts to offer the artist. Far from fearing it, he finds it an "exciting challenge."

'No Place Is Safe'

"If you don't accept technology you better go to another place because no place here is safe," he said. Asked what made technology so exciting for him, he replied: "Nobody knows the kind of art that will be created if two or three men in diverse fields become collaborators."

About 370 artists already have written to Dr. Klüver and Mr. Rauschenberg seeking technical assistance for projects they have in mind. The letters include requests for information on synthetic fabrics, pigments, enamel finishes, translucent spheres, micro-organisms, electromagnetics, "slow chemical destruction of objects," "extending the range of sensory perception" and an "efficient way" to make paintings appear and disappear.

Mr. Rauschenberg himself has a project in mind with problems that he has not yet been able to solve technically. He envisages a room "that would be responsive to weather, to people viewing it, to traffic, noise and light."

This he sees as the art of the future.

"Nobody wants to paint rotten oranges anymore," he said.

The New York Times (by Neal Boenzi)

Dr. Billy Klüver, electronics engineer specializing in laser research, arranges helium-filled pillows.

Drawing of nude above was generated by a computer under direction of L. D. Harmon and K. C. Knowlton, engineers. Black square encloses the detail shown.

Senator Jacob K. Javits speaking yesterday at gathering at 381 Lafayette Street. A traditionalist, the New York Republican nevertheless finds merit in modern art.

Robert Rauschenberg, the artist, says, "If you don't accept technology, you better go to another place."

The New York Times
Published: October 11, 1967
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Fig. 7. Newspaper clipping of Henry Lieberman's article, "Art and Science Proclaim Alliance in Avant-Garde Loft" in *The New York Times* (1967).

E.A.T. was formally launched at Rauschenberg's studio—or more precisely in his studio chapel, a building that had at one time been used as a catholic orphanage.[2] To show the possibilities of artists and engineers working together, a one day exhibition of artworks incorporating technology was held in Rauschenberg's house and included such pieces as: Andy Warhol's (1928–1987) helium filled *Silver Clouds* (1966); a large computer generated nude by Ken Knowlton (b. 1931) and Leon Harmon (1922–1982); Robert Whitman's film sculpture *Shower* (1964); and a roomful of noisy environment like Rauschenberg's *Oracle*.[3]

In an interview with *The New York Times* in 1967, Robert Rauschenberg was asked about his motives to engage with E.A.T. He responded in a very provocative way for that time, saying, "If you don't accept technology you better go to another place, because no place here is safe. . . . Nobody wants to paint rotten oranges anymore" (Lieberman 47) (fig. 7).

Like many other artists of the time, Rauschenberg thought that art that eliminates and factors out technology consequently loses its social relevance. While he wasn't as radical in his thinking as the constructivist and futuristic artists of the 1920s, he strongly supported the collaboration of artists and engineers.

At the time E.A.T. was founded, Rauschenberg reiterated his idea for a room that would be responsive to weather, noise, light, and to the people viewing it. Soon after, he expressed interest in making an artwork with proportionally controlled lights. The realization of this vision was possible due to innovations made during *9 Evenings* in which the participating engineers developed a system that changed the intensity of illumination of a light bulb in proportion to the loudness of a sound signal by using a silicon controlled rectifier, or SCR, circuit that had just appeared on the market at that time. The first artwork to incorporate this technology was made by Rauschenberg in collaboration with E.A.T. members, called *Soundings* in 1968.

Soundings is an eight foot high and thirty-six foot long wall made of three layers of acrylic sheeting (fig. 8). The front layer has a mirrored surface and behind it are two layers of acrylic with black and white screenprinted images showing a chair in different angles. *Soundings*

Fig. 8. Robert Rauschenberg, *Soundings*, 1968, mirrored acrylic sheeting and silkscreened ink on acrylic sheet, with concealed electric lights and electronic components, 238.8 x 1,097.3 x 137.5 cm, Museum Ludwig, Cologne, Ludwig Donation. Courtesy of Ritchie Müller.

is an interactive room installation created to envision Rauschenberg's desire to have the viewer interacting and talking to the artwork. When the visitor walks into the room silently, the person will see nothing but the mirrored image of themselves. If the visitor starts clapping their hands or starts speaking or singing, microphones above the installation pick up the audio signal and different lights illuminate the inner layers of acrylic in relation to the frequency of the individual voice.

The system is so sensitive to different ranges of the human voice, using four frequency bands that respond individually, that different people who speak the same words will cause different visual effects. Rauschenberg's intent was to create a one-to-one response between the art and the viewer, reinforcing and making tangible the concept that art literally "talks" to individuals differently.

Fig. 9. Cover to the exhibition catalog of *The Machine as Seen at the End of the Mechanical Age*, Museum of Modern Art, 1968.

In the instance of *Soundings*, the complexities of preserving an interactive installation can be discussed in more detail. While installing and de-installing this artwork at four venues during *Robert Rauschenberg: A Retrospective* by the Solomon R. Guggenheim Museum, New York City, from 1997 to 1998, the author realized how extremely vulnerable those artworks are.

As discussed above, upon the creation of E.A.T., the participating engineers developed a method for altering the intensity of illumination of a light bulb in proportion to the loudness of a sound signal. This was and continues to be a highly vulnerable system as any degree of disconnection or incorrect wiring of the audio intake can result in an installation that could be considered fatally improper in its contradiction to the artists' intent and destruction of its sensitivity. Conserving an interactive installation means knowing how to put it together in every single detail, a factor that stresses the importance of meticulous documentation as being essential for the preservation of the authenticity of the work and an active part of conservation.[4]

THE MACHINE AS SEEN AT THE END OF THE MECHANICAL AGE AND SOME MORE BEGINNINGS

In 1968, the exhibition *The Machine as Seen at the End of the Mechanical Age* was held at MoMA in New York, addressing the developments in art and technology over time and documenting the vibrant contemporary forces of E.A.T. For this exhibition, MoMA specifically invited E.A.T. to collaborate on a section dedicated to new technology (fig. 9).

E.A.T addressed this invitation by organizing a competition encouraging both engineers and artist to submit current contemporary artworks that reflected collaborations in art and technology. The winning artworks where selected and included in the exhibition, curated by the Swedish curator and art historian Pontus Hulten (1924–2006), who intended to show 10 medium size E.A.T. artworks in the MoMA show.

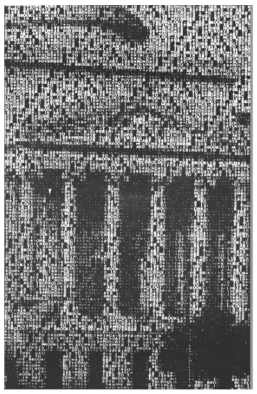

Fig. 10. Cover to the exhibition catalog of *Some More Beginnings*, Brooklyn Museum, Brooklyn, New York, 1968.

The overwhelming response to the competition announcement resulted in the submission of approximately 200 works from nine countries. While only ten artworks were slated for the MoMA exhibition, the remaining submissions were of such interesting artistic variety, that the decision was made to exhibit them concurrently with MoMA's *The Machine* exhibition. In very short notice, exhibition space was found at the Brooklyn Museum. This additional show for the roughly 200 technology-based artworks was entitled *Some More Beginnings: An Exhibition on Submitted Works Involving Technical Materials and Processes, New York, E.A.T., 1968* (fig. 10).

HEART BEATS DUST

The winning entry of the competition, shown at the MoMA exhibition, was Heart Beats Dust (1968) by artist Jean Dupuy (b. 1925) and the collaborating engineer Ralph Martel (b. 1935) (fig. 11). The jurors issued their statement for the first prize as follows:

> In each of the winning entries a spectrum of technology was used with great impact on the art forms. Evident is the realization that neither the artist nor the engineer alone could have achieved the results. Interaction must have preceded innovation. . . . The unexpected and extraordinary, which one experiences on viewing these pieces, result from inventiveness and imagination, stimulated not by the brute force of technical complexity but by probing into the workings of natural laws. (Lovejoy 1997, 72)

Heart Beats Dust is an interactive sculpture of dust, with a propulsion system that is activated by sound. The physical structure of the artwork is a black rectangle box with a window at eye level. A bright cone of light behind this window is supplied by a stage light from overhead of the black box. The dust contained within is Lithol Rubine, a brilliant red pigment of low specific gravity, chosen for its ability to remain suspended in air for long periods. The audio intake is archived from an electronic stetho-

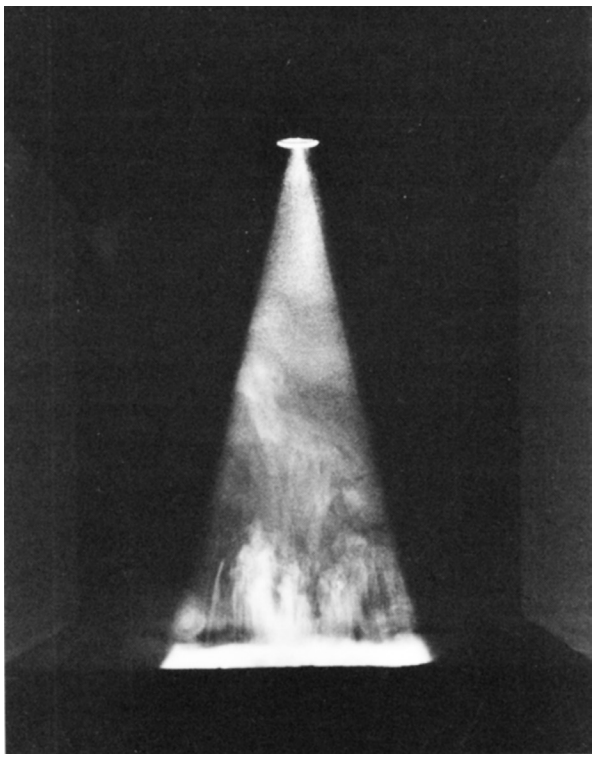

Fig. 11. Jean Dupuy, *Heart Beats Dust*, 1968, black plywood vitrine (213.4 x 60.9 x 60.9 cm), active cube (60.9 x 60.9 x 60.9 cm), ¼ in. glass, rubber membrane, lithol rubine red pigment, amplifier, electronic stethoscope, analog stethoscope, 12 in. coaxial speaker, Kiegl stage light (shuttered), and tungsten halogen lamp. The Emily Harvey Foundation, New York City. Courtesy of Harry Shunk.

scope that is placed on the heart of the visitor amplifying the heartbeat. A rubber membrane covers the speaker and the red pigment is placed on the membrane. The speaker makes the membrane vibrate which throws the pigment into the cone of light. The red pigment dances in the cone of light, some pigment shooting high and scattering, some falling heavily back.

When the author first examined the artwork in late 2006, it was in storage in a basement and, according to the owner, not in exhibitable condition. The owner, the Emily Harvey Foundation, New York, had received previous advice from an engineer to completely update all the technical components of the interactive installation. An update of the technical components from 1968 to 2006 technology would have resulted in a consequent loss of *Heart Beats Dust's* integrity within its authentic and historically important technology.

Consequently, the owner was convinced by the author to preserve the artwork with a more respectful approach that prioritized the authentic technological integrity of the work with the highest respect. After the first examination, the following components were identified: black plywood vitrine (84 x 24 x 24 in.); active cube (24 x 24 x 24 in.); ¼ in. glass, rubber membrane; Lithol Rubine red (reddish synthetic azo dye); CI Pigment Red 57; amplifier (20–20000 Hz); electronic stethoscope; analog stethoscope; 12 in. coaxial speaker; Kiegl stage light (shuttered); and tungsten halogen lamp (250W).

In preparation for testing and re-installation of the artwork, initial steps were performed in the order listed below:

1. Documentation of all components
2. Opening electronic components and cleaning off accumulated dust
3. Cleaning electronic connections and removal of corrosion products
4. Condition checking of the rubber membrane
5. Checking the acoustics created by the original amplifier and stethoscope provided (the author was not able to create a clear signal)
6. Checking the acoustics created by the original stethoscope on a different commercial amplifier (the author was able to create a clear signal)

Besides the essential problem of the audio signal, the other components (particularly the rubber membrane, the speaker, and the light) were in a good condition. So, the main question for further treatment was to identify the reason for the audio interferences.

Consequently, this lead the author to question which audio frequency range our hearts operate. A human heart produces an audio output in the 50–450 Hz range. A commercial amplifier, like the amplifier provided with the artwork, covers the range 20–20000 Hz. It became obvious, that pre-amplification was needed to create a clear audio signal. There was no preamplifier within the components of *Heart Beats Dust*; however, it was possible to identify the company that fabricated the electronic stethoscope, as Medetron, Electronic Stethoscopes, Tokyo, Japan.

On eBay.com a contemporary preamplifier produced by Medetron was identified for auction. The delivered preamplifier connected well to the existing stethoscope

Fig. 12. The replacement preamplifier. Medetron, Electronic Stethoscope, Medelec International Corp., Tokyo, Japan.

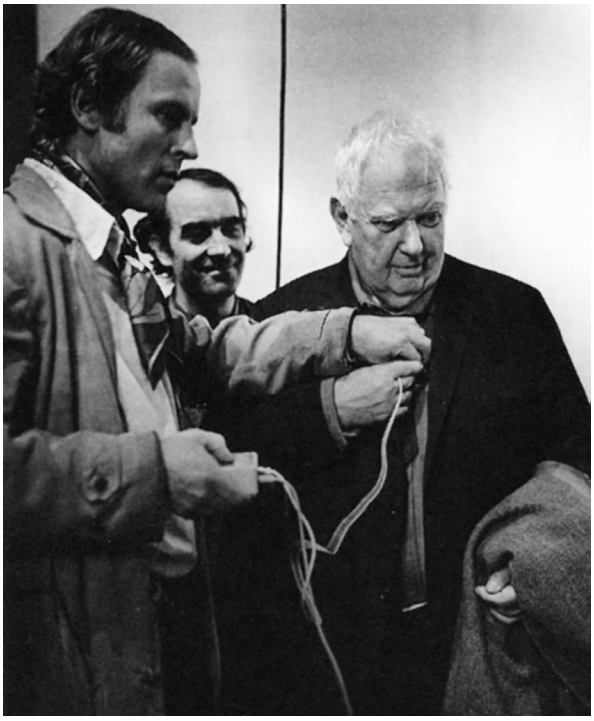

Fig. 13. Jean Dupuy (left), Jean Tinguely (center), and Alexander Calder (right) in front of *Heart Beats Dust*, 1968. Courtesy of Harry Shunk.

and covered two frequency ranges: low tone at 20–200 cycles and high tone at 50–1500 cycles.

Once the preamplifier was connected with the stethoscope and to the original amplifier, a clear acoustic signal was created resulting in dancing pigment in the cone of light of *Heart Beats Dust*. Every visitor had to adjust the frequency range on the preamplifier individually and maintain some distance to the artwork to avoid audio interferences.

After the completion of the conservation treatment, the author discovered the image in figure 13, which shows Jean Dupuy, Jean Tinguely, and Alexander Calder (1898–1976) in front of *Heart Beats Dust* in the Museum of Modern Art. Jean Dupuy is holding a small box in his hand—the missing preamplifier that was now replaced with an identical contemporary preamplifier.

The example of the conservation treatment of *Heart Beats Dust* clearly shows how vulnerable those early installations are to becoming inoperable and to unintentional modification, especially those early interactive installations using analog technology that was specifically modified according to the artist's intention. But *Heart Beast Dust* is also an example that there is a slight chance to keep those artworks functional in their historic and technological integrity if we conserve them today while analog components are still in existence as well as the knowledge of their use.

Conservators today cannot pass this responsibility on to future generations of conservators born into a digital age, who may lack the knowledge and hardware components necessary to preserve analog technology. From the author's point of view, this is one of the most pressing and challenging responsibilities electronic media conservators face today: to preserve those pioneering works—including their analog components—for future generations, while the knowledge and equipment is still available, so early technology-based artworks are not gone——in a heartbeat!

NOTES

1 It is questioned if the Money Thrower for Tinguely's H.T.N.Y. really worked the way as described in the literature.

2 Before Rauschenberg turned that part of the building into his studio, he had it deconsecrated by a priest.

3 *Oracle* reflected Rauschenberg's special sense of humor in its understatement, irony, and hilarious sense of absurd juxtaposition. At the very least, *Oracle* gave E.A.T a noisy send-off.

4 In 1997, Billy Klüver inspected *Soundings* with the intent of making technical modifications that would be more reflective of the artists' original desire at the time of creation: to make the installation as dynamic as possible. Between the time the work was last shown, in the early 1980s at the Museum Ludwig, Cologne, Germany, and when the modifications were made in 1997, the SCR (silicon controlled rectifier) was no longer available and had to be replaced by Billy Klüver.

Whether or not this replacement resulted in a dramatic increase in the responsiveness of this artwork has been discussed intensively. However, without sufficient video documentation of the first installation of *Soundings* and the in-depth documentation of all its hardware components at its inception, the degree to which the artwork has been changed may never be quantifiable. This points again to the importance of documentation of electronic media artworks as an active part of conservation.

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