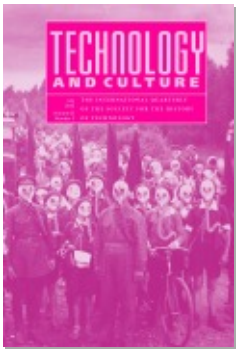
Art Out of Order: Jack Burnham, the 1970 *Software* Show, and the Aesthetics of Information Systems



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Art Out of Order

Jack Burnham, the 1970 *Software* Show, and the Aesthetics of Information Systems

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ABSTRACT: In 1970, curator Jack Burnham debuted the lavish exhibition *Software* at the Jewish Museum in New York. Conceptual artists displayed information-oriented pieces, while technical experts deployed computers, image-making, and multimedia technology in their works. Burnham's goal was to showcase contemporary techniques of computer-based command and control, allowing viewers to respond in real time to the "programmatic situations" artists presented. While critics dismissed *Software* as a technical and aesthetic disaster, today it stands as a touchstone for efforts to integrate technology with artmaking. This article takes us back to *Software*'s gallery spaces and Burnham's aim of showcasing the potential of interactivity and "real-time systems." More broadly, it situates *Software* as a provocation to a public unfamiliar with computer technology yet at the threshold of a new postindustrial era, where the power and performative aspects of computing would predominate.

Introduction

Our story starts in 1969 with a conversation between a museum director in New York and "representatives from the art and the computer fields" about a possible art exhibition.[1] They discussed abstract concepts such as cybernetics, systems theory, and contemporary aesthetics, which became the basis for an international art show generously funded by a major automobile manufacturer. Our story ends with accusations of sabotage, curatorial regrets, photogenic gerbils, and the museum director's dismissal.

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1. Burnham, "Notes on Art and Information Processing," in *Software*, 11. Hereafter, essays and the catalog accompanying Burnham's show are designated *Software*. This essay is apparently the first to use the *Software* collection at the Jewish Museum as a primary source.

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The exhibition was *Software*—subtitled *Information Technology: Its Meaning for Art*—which the Jewish Museum in Manhattan hosted in the fall of 1970.[2] Jack Burnham, an artist, art writer, and professor of art at Northwestern University, organized the show to demonstrate "the effects of contemporary control and communication techniques in the hands of artists." Burnham, having completed a fellowship at the Massachusetts Institute of Technology, was especially keen to break down the traditional distinctions "between art and non-art" and those separating technology and art.[3]

Software's planning and premiere overlapped the technological spectacle of the first humans walking on the moon as well as images of a high-tech war, broadcast into homes worldwide, from Southeast Asia. Loudly and sometimes violently, a growing ensemble of people and organizations challenged the trust that society had placed in science and technology for decades.[4] Around the planet, citizens voiced concerns about the mortal dangers of the escalating arms race and an increasingly polluted environment, while questioning the values of a society that prized conformity, consumerism, and planned obsolescence.

Software was one of several initiatives designed to foster collaborations and "hybrid practices" between artists and engineers.[5] Artists around the globe wanted to work with engineers and engage in varying ways with new technologies, as had groups of artists decades earlier, such as the Italian Futurists, Russian Constructivists, and German Bauhaus. What made the 1960s art-and-technology wave especially notable was advocates' reliance on large, institutionally supported formal efforts, often funded by major corporations, as well as generous publicity and reportage in art journals and mainstream newspapers.[6]

Some collaborations between artists and engineers proved fleeting, while others spanned decades and profoundly altered people's careers. By working together, engineers and artists produced scores of thoughtful, aesthetically sophisticated, and visually arresting artworks. These activities suggested a solution for the "two cultures problem"—the idea that humanists and scientists were drifting dangerously far apart—famously identified by C.P. Snow in 1959. The British scientist-turned-novelist's bestseller appeared just as momentum for large-scale art-and-technology initiatives were forming.[7] Throughout the 1960s, now unmoored from its original

2. The show ran from September 16 to November 8, 1970.

3. Burnham, "Notes on Art and Information Processing," 10.

4. The literature on 1960s technological enthusiasm and pessimism is expansive; representative is ch. 9 of Hughes, *American Genesis*, while McCray's *The Visioneers* explores radical reactions to the idea of technological limits.

5. Cateforis, Duval, and Shiner, *Hybrid Practices*.

6. On this surge of enthusiasm for the art-and-technology wave: McCray, *Making Art Work*.

7. Snow, *The Two Cultures and the Scientific Revolution*.

British setting, "the two cultures" became a phrase in the United States that helped generate research funds, launch government-funded studies of creativity, and provoke calls to revise university curricula, especially for engineering students.[8] Art-and-technology supporters imagined their intervention could help solve the "two cultures problem" or at least establish an armistice between artists and technologists. Advocates claimed these collaborative experiments would enable artists to explore the potential of technologies such as lasers, microprocessors, and computers. These same activities could also rehabilitate the public's increasingly negative view of technology and its presumed masters, engineers.

Computing and information technologies were especially suspect. Throughout the 1960s, a slow but steady stream of publications drew attention to the increased computerization of society and the threats it posed to employment, personal autonomy, and privacy.[9] Even as companies, universities, and government agencies rapidly adopted smaller and more capable computers, the general public still felt unfamiliar and uncertain about information technologies. A 1963 survey revealed considerable variation in citizen awareness of computers' uses and capabilities. A substantial portion of people saw computers as "superhuman thinking machines" that challenged humans' "previously unique significance." And, as late as 1975, while personal computers were becoming consumer goods for the burgeoning hobbyist community, a significant number of respondents still believed computers were "beyond the understanding of the typical person."[10]

Jack Burnham's *Software* exemplified the many high-profile efforts showcasing artists' engagement with modern technology, then bursting forth from corporate laboratories, artists' lofts, publishing houses, museum galleries, and university campuses. Fusing engineering with art was not solely an American project during the "long 1960s." Diverse projects, communities, and exhibitions appeared in the United States, Europe, Japan, and elsewhere. Together, these efforts reshaped public perceptions of both technology and art. *Software* was also the most extensive art effort to date that specifically presented information technologies, in their broadest interpretation, to a large audience of gallery-goers. The thousands of visitors to *Software* could interact directly with minicomputers, teletype equipment, high-speed copy machines, and closed-circuit television. Thus, *Software* provided an educational as well as aesthetic experience.

This period also represented an apogee for "systems thinking" and its

8. Wisnioski's *Engineers for Change* details American engineers' attempts to address their public reputation, pursue educational reform, and make their profession more socially responsible. On creativity: Cohen-Cole, "The Creative American."

9. Rosenberg, *The Death of Privacy*; Warner and Stone, *The Data Bank Society*; and Igo, *The Known Citizen*.

10. From a 1963 survey published as Lee, "Social Attitudes and the Computer Revolution." Also, Ahl's "Survey of Public Attitudes Toward Computers in Society."

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cognate subject, cybernetics. Whether for building giant rockets or managing the complexity of sprawling urban areas, proponents insisted that success required mastering complex and interdependent systems.[11] Likewise, cybernetics—the mid-1940s study of relationships between people and machines based around communication, control, and feedback—had migrated far from its origins to take hold in all sorts of new contexts. Despite scientists' declining interest in cybernetics, the 1960s and 1970s saw a broader "culture of feedback" where "systems thinking" assumed prominence outside the military-industrial complex.[12] Based on research by people like Claude Shannon at Bell Laboratories and Norbert Wiener at MIT, basic communication and control concepts diffused into academic disciplines such as physics, physiology, anthropology, economics, linguistics, and cognitive psychology.[13] To this list, we can add professional artists and experimental musicians. This spread of cybernetics and systems thinking lets us explore how and where certain histories of technology and art overlap.

Unlike unabashed promoters of cybernetics from nontechnical fields, Jack Burnham was well aware that, by 1970, the term had acquired a less-than-sterling reputation. His essay for *Software* acknowledged cybernetics was a "very complicated and important field" but had already become "a little too general and passé to computer specialists." While cybernetics provided an initial touchstone for planning *Software*, Burnham was more interested in how artists and museum-goers might explore new technologies such as "real-time computing" and "interactivity" in a gallery setting. For years prior to *Software*, Jack Burnham had cultivated a fluency in systems design, cybernetics, and information theory and had adapted these concepts as tools to better understand contemporary art.[14] With *Software*, Burnham sought to move beyond a purely intellectual approach to what he called "system esthetics" in the form of an art exhibition.

By focusing on *Software*, this article explores a particular intersection of modern art and postwar technology.[15] The main goals are threefold. First, I

11. The literature on systems thinking in the Cold War is extensive, including: Hughes and Thomas, *Systems, Experts, and Computers*; Johnson, *The Secret of Apollo*; Light, *From Warfare to Welfare*. An alternative view—on systems thinking in social science: Heyck, *Age of System*.

12. Belgrad, *The Culture of Feedback*. Likewise, in ch. 6 of his *Age of Contradiction*, Brick labeled systems theory the "watchword of the 1960s" with a "deep-seated distrust of order." On the decline of practitioners' interest in cybernetics: ch. 7 of Kline's *The Cybernetics Moment*.

13. Kline, *The Cybernetics Moment*, chs. 4 and 5.

14. Burnham, "Systems Esthetics."

15. Unlike historians of technology, art historians have considered Burnham's take on "systems": Shanken, "Art in the Information Age"; Jones, "System Symptoms"; Terranova, "Systems and Automatisms." Shanken analyzes how conceptual art and the art-and-technology movement, though seen as antithetical by art historians, were willing to critique contemporary technology. Lee's *Chronophobia* offers an art historian's perspective on systems thinking, including Burnham and *Software*.

examine the place that cybernetics, systems thinking, and information theory assumed within the late 1960s art world.[16] Although beyond the focus of this article, the questions *why* and *how* seemingly esoteric subjects like cybernetics migrated from their technoscientific contexts to find purchase in new and unexpected places, are fascinating. As historians of technology well know, escaping the pull of materiality, even when studying cybernetics or the ephemerality of computer software, is challenging.[17] Likewise, while offering creative interpretations of "interactivity" and "real-time systems," Burnham's artists—many from the emerging Conceptual Art movement—were still grappling with the often-messy *thingness* inherent in their works.

Second, I situate *Software* within a broader history of computing and information technologies. The exhibition occurred at a pivotal point when computers were poised to become personal as well as more prevalent and computer programming was transforming into an independent profession. The period when Burnham achieved his ideas for *Software* was bookended by hardware development milestones: from the widespread adoption of IBM's iconic System/360 mainframe family circa 1965, to the early 1970s, when hobbyists' interest in personal computing took off. "Software" was a relatively new technical term, having achieved common usage around 1960, according to the *Oxford English Dictionary*. Ubiquitous today, it would be unfamiliar to many who witnessed *Software* in 1970.

Especially relevant for Burnham's thinking were the 1950s and 1960s time-sharing and real-time computing projects such as Project Whirlwind, the Semi-Automatic Ground Environment, and MIT's Multics initiative. Burnham's plans for *Software* were animated by his interest in this coming era of "interactivity" and desire to show museum visitors how artists might use the latest computer technologies to create information-rich "environments." Artists and museum-goers certainly had very different reference points for "interactivity" than computer experts. But Burnham and his artists saw an opportunity to comment on the current and future place of information technology in modern society. *Software* therefore shows how a prominent, well-publicized, and expensive art exhibition reflected, anticipated, and perhaps even challenged larger technological trends and developments. Art, to paraphrase Claude Lévi-Strauss, is good for historians of technology to think with.

16. Pickering's *The Cybernetic Brain* and Kline's *The Cybernetics Moment* explore how cybernetics engaged with other American and British research and artistic activity, as does Dunbar-Hester on cybernetics and postwar experimental music, "Listening to Cybernetics." Turner's influential but selective *From Counterculture to Cyberculture* explores how a wing of the American counterculture, led by Stewart Brand, absorbed and rebroadcast cybernetics. For a techno-scientific context, Bowker's "How to be Universal"; and Medina, *Cybernetic Revolutionaries*; Heim takes a prosopographical approach in *The Cybernetics Group*.

17. Rankin grapples with both thingness and the intangible in "The Geography of Radionavigation and the Politics of Intangible Artifacts."

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Finally, this article places *Software* in dialogue with larger social and economic trends in the United States and western Europe, chiefly the predictions of a future "postindustrial society." Throughout the 1960s, academics and futurists like John Kenneth Galbraith, Daniel Bell, and Alvin Toffler wrote that intellectual-oriented institutions would gradually occupy a more central place in society and supplant the power of corporations engaged in traditional manufacturing.[18] Burnham was exploring the "conceptual and process relationships" where abstracted information and ideas took a more central role.[19] Not coincidentally, a significant trend in the late 1960s art world was Conceptual Art. A precise definition is elusive but the term referred to artworks where the finished "product" might simply (or not so simply) be an artist's concept instead of a discrete objet d'art that could be shown in a gallery and easily sold as a commodity.[20] Similarly, *Software*'s debut coincided with predictions about a future of work based less on making *things* and more on manipulating ideas and information. Here, again, an example pulled from the realm of art history connects with a significant moment of thinking about the future of technology and industry.

There are obvious limitations to making robust historical arguments based on one exhibition and one artist-curator. However, other advantages accrue. *Software* was one of dozens of art-and-technology exhibitions in the United States, Europe, and Japan during the 1960s and early 1970s. But, unlike many shows, *Software* was curated around specific concepts and goals about both art and information technologies. Burnham was different, too. He had studied engineering and gained first-hand experience with computers and programming. These factors differentiated *Software* from other art-and-technology initiatives where the technology often remained an under-examined black box.[21] Burnham and the artists demonstrated critiques about the power and pervasiveness of information technologies in the art world. But to understand Burnham's goals for *Software*, we first have to appreciate how and where computers were situated within the artists' working world.

18. Brick, "Optimism of the Mind"; Bell, "The Post-Industrial Society."

19. Burnham, "Notes on Art and Information Processing," 12.

20. LeWitt's "Paragraphs on Conceptual Art" memorably stated the "idea becomes a machine that makes the art" (79). While the idea was the art, the accompanying images and documentation could be displayed, preserved, and collected. Artist Ursula Meyer wrote in 1972, "Conceptual Art is diametrically opposed to hardware art," in *Conceptual Art*, xvi. These texts will interest historians of technology studying the 1960s and 1970s.

21. The Art and Technology Program run by the Los Angeles County Museum of Art from 1967 to 1971 notably elided engineers' contributions, compared to participating artists and corporate sponsors: Tuchman, *Art and Technology*.

Portrait of the Computer as a Young Artist

In June 1965, one of the first and best descriptions of artists' engagement with computers appeared. It was not published in a technical bulletin or a glossy arts journal, but rather in the pages of *Playboy*. The article in the men's lifestyle magazine—which claimed three million monthly readers and was a respected venue for public intellectuals—was authored by John R. Pierce, an engineer and manager at Bell Labs who was famous for coining the word "transistor" and effectively lobbying for communication satellites. Pierce also wrote science fiction under the pseudonym J.J. Coupling and composed experimental electronic music with his Bell colleague Max Mathews.

Pierce was well positioned to write about computers and art. In the 1960s, Bell Labs, buoyed by the profits of its parent company AT&T, hosted a coterie of artists-in-residence including Nam June Paik, James Tenney, Lillian Schwartz, and Stan VanDerBeek. Moreover, Bell Labs conducted some of the first U.S. experiments making visual art with computers, which Pierce saw firsthand.[22]

Pierce's article—"Portrait of the Machine as a Young Artist"—focused on his engineering colleagues' experiments at the nexus of art, poetry, music, and computing.[23] Mathews, director of the lab's Acoustical and Behavioral Research Center, had helped program an IBM computer to "sing" the song "Daisy Bell." This composition later appeared in Stanley Kubrick's film *2001: A Space Odyssey* when HAL, the homicidal computer, mournfully plays it while being deactivated. Pierce also described an experiment in visual perception by his colleague A. Michael Noll. Using a computer and microfilm plotter, the engineer created an image similar to Piet Mondrian's 1917 painting *Composition with Lines*. Noll then asked lab staff to try and distinguish between his version and the original. Only 28 percent of the staff could correctly identify the Mondrian, and almost 60 percent preferred the computer-generated image.[24]

While the visual art in Pierce's article used sophisticated and expensive computers, the results resembled images artists had made for centuries. Consequently, many critics judged these early examples of computer art "exceedingly poor and uninspiring."[25] The "worst things," a *New York Times* critic wrote, "are pictures in which conventional art and the com-

22. Computer-generated art has attracted relatively more attention than other manifestations of art-and-technology. Representative book-length treatments include: Higgins and Kahn, *Mainframe Experimentalism*; Kane, *Chromatic Algorithms*; Taylor, *When the Machine Made Art*; Patterson, *Peripheral Vision*.

23. Pierce, "Portrait of the Machine as a Young Artist," *Playboy*, June 1965.

24. In 1965, Noll's graphic "Computer Composition with Lines" won a competition sponsored by *Computer and Automation* journal. Noll described it in a psychological journal as "Human or Machine."

25. Mueller, "Idols of Computer Art," *Art in America*, May/June 1972, 68.

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puter have been forced into the most intimate alliance."[26] As simulacra, these computer-generated images occupied an unusual ontological position, one that many art critics were uncomfortable with. What exactly were computers producing? Pierce asked in his *Playboy* article, "it's fascinating, but is it *art*?"[27] Just as troubling to some art writers was the issue of *who* was making the art. Robert E. Mueller, an artist who studied aesthetics at New York University after earning a degree from MIT in electrical engineering, opined that, because technologists who used computers to make art had "little or no detectable knowledge of the tradition of artistic visual work," their attempts were too often "entirely without artistic merit and completely sterile visually."[28]

Jasia Reichardt, a 35-year-old curator at the Institute for Contemporary Arts in central London, shared similar thoughts. Computers, she observed, "have so far neither revolutionized music, not art, nor poetry, in the same way they have revolutionized science."[29] Consequently, for her 1968 exhibition *Cybernetic Serendipity*, Reichardt decided to showcase the "possibilities" of computers and other "cybernetic devices" as well as the "relationships between technology and creativity."[30] She wanted to demonstrate the often-unseen linkages between computers, cybernetics, and creativity, with examples of "machine-aided creative processes."[31]

Some 60,000 people saw *Cybernetic Serendipity* during its two-and-a-half-month run in London. For many visitors, the show was likely the first time they had seen modern digital computers, even if they were just models, so Reichardt's exhibition was, in part, educational. The accompanying publication included explanations about cybernetics and computers by Norbert Wiener and other experts, along with a technical glossary. The interpretive text purposefully did not specify whether the artworks were by engineers or artists (only 43 of the show's 130 contributors self-identified as artists), further dissolving boundaries between the two creative cultures.

There was diversity in the kind of works displayed as well. Reichardt included computer-generated music, films, and poetry along with an eclectic assortment of "cybernetic devices as works of art," which, taking their cue from the exhibition's moniker, incorporated varying degrees of randomness.[32] A highly complex example was *Colloquy of Mobiles*, designed and executed by British cybernetician Gordon Pask, as an experiment in

26. Canaday, "Less Art, More Computer Please," *New York Times*, August 30, 1970.
27. Pierce, "Portrait of the Machine as a Young Artist," *Playboy*, June 1965, 150.
28. Mueller, *The Science of Art*, 276.
29. Reichardt, "Introduction."
30. Reichardt, ed., *Cybernetic Serendipity*, 5. For the history of *Cybernetic Serendipity*: Reichardt, "Cybernetics, Art, and Ideas"; Usselmann, "The Dilemma of Media Art"; MacGregor, "Cybernetic Serendipity Revisited"; and Fernández, "Detached from HiStory."
31. Reichardt, "Cybernetics, Art, and Ideas"; Reichardt, ed., *Cybernetic Serendipity*.
32. Reichardt, "Introduction," 5.

sociology. His team created five free-hanging fiberglass sculptures—two larger ones designated "males" and three "females"—equipped with lights and photosensors. The "males" emitted light beams that made the "females" glow brighter while also reflecting light back to the "males" with their mirrors. Pask described how "the males compete amongst themselves" while also "cooperating" with the "females" via a "simple but many-levelled language of light flashes and sounds."[33] Visitors with flashlights could participate with the mobiles' "conversation," getting first-hand experience of cybernetic principles like communication, control, and feedback.

Despite the enthusiastic reactions, there was no escaping that Reichardt's exhibition remained largely oriented around things. It was this materiality—the art world's continued focus on objects—that Jack Burnham reacted to in his writings circa 1966. Painting and sculpture, he claimed, had moved "away from art objects" to embrace "concerns with natural and man-made systems, processes, [and] ecological relationships." All of these must "deal with art which is transactional" and be more structured around "communication or energy exchange instead of abstract appearances." *Software* would, ironically, serve as a physical instantiation of Burnham's conviction that the art world was increasingly moving toward the ephemeral and the informational.

Portrait of the Artist as a Systems Engineer

Born in New York City in 1931, Jack Wesley Burnham, after a stint with the Army Corps of Engineers, studied art at the Boston Museum of Fine Arts as well as engineering at the Wentworth Institute. More art studies followed at Yale University, culminating in Burnham's Master of Fine Arts degree in 1961. Burnham's artistic specialty was sculpture, an exciting choice as the medium was rapidly breaking free of traditional constraints. In the 1950s, Robert Rauschenberg, for example, began mingling painting and three-dimensional objects to produce "combines" while American and European artists were experimenting with various kinetic approaches that animated their work.[34]

As a young artist, Burnham produced a series of "programmed" works using movement, sound, and electrical technologies such as fiber optic wires, neon tubing, and electroluminescent tape.[35] Shows followed, but

33. Pask, "The Colloquy of Mobiles." The piece was made with electronics experts Mark Dowson and Tony Watts, and with choreographer Yolanda Sonnabend. For Pask's approach to cybernetics: Pickering, *The Cybernetic Brain*.

34. *Robert Rauschenberg*, eds. Hopps and Davidson; Rickey, "The Morphology of Movement."

35. Biographical material is from an anthology of his writings edited by Ragain (Burnham, *Dissolve into Comprehension*) and including materials at CAVS/MIT. Some of the collection is online at http://act.mit.edu/cavs.

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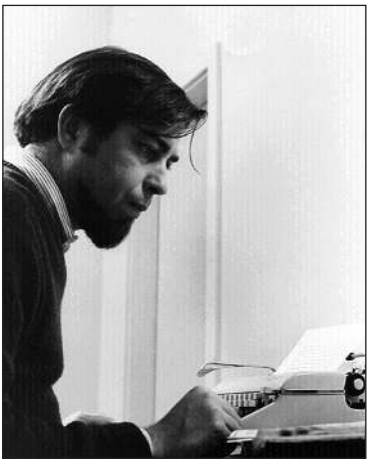

FIG. 1 Jack Burnham at work, c. 1969, while a fellow at MIT's Center for Advanced Visual Studies. The firsthand experience there with computers and programming influenced his vision for the *Software* exhibition. (Courtesy of the MIT Program in Art, Culture, and Technology.)

Burnham's interests were already shifting. "As an artist, my personal feelings are quite mixed about the business of objects versus systems. I sense the inevitability of systems and in my own work I try to capture some of their complexity and life," Burnham said soon after becoming assistant professor at Northwestern University."[36] Burnham's statement captured him in the midst of his transition from fabricating physical objects to advocating what he termed "systems esthetics" via an *Artforum* article of the same name in September 1968. (Figure 1 captures Burnham at his typewriter in the midst of this transformation.) A month later, Burnham published his first book, *Beyond Modern Sculpture*. In it, he explored contemporary art-making being "overtaken by the dynamics of technological change."[37] In these and subsequent publications, Burnham described how modern artists increasingly recognized that modern technology was "focused on information theory, systems analysis, data processing, and similar activities, all stemming from the invented science of cybernetics."[38]

In his writings, Burnham displayed familiarity with an eclectic array of literature related to systems theory and cybernetics as well as computer design, ecology, economics, and neurophysiology. Some of this he read in advance of teaching a new undergraduate course at Northwestern called "Art and Systems" (later an elective for engineering students). "Systems Esthetics" has references to media studies guru Marshall McLuhan, Thomas Kuhn's *Structure of Scientific Revolutions*, Ludwig von Bertalanffy's "General Systems Theory" (Burnham and Bertalanffy shared the same

36. Jack Burnham, "Sculpture, Systems, and Catastrophe," in *Symposium 66/Prologue* (Winter 1966), published as part of the Northwestern Student Symposium proceedings.

37. Quote from Burnham's proposal for his book *Beyond Modern Sculpture*, c. 1967, CAVS/MIT.

38. Quote from a review, interestingly, of Burnham's book in *Technology and Culture*: Vaczek, "Review."

publisher), John Kenneth Galbraith's reflections on how "esthetic decision-making" will be essential for any "future technocracy," and research briefs from RAND, the defense think tank where avant-garde modernism and apocalyptic futurism mingled.[39]

Cognizant of systems engineering's deep military roots, Burnham was committed to exploring how this methodology could help explain the making of contemporary art and its function in modern society. Since becoming a professional artist, Burnham had come to see the art world, and society in general, transitioning "from an *object-oriented* to a *systems-oriented culture*." Creative change, he said, came "not from *things*, but from the way *things are done*." Consequently, the artist was becoming less a maker of stuff than a "maker of esthetic decisions."[40] Burnham's ideas about the artist's changing professional identity anticipated pronouncements about the factories of the future, where "knowledge workers" would manage immaterial flows of data. In these scenarios, whether in art or industry, the key factor was the circulation of information.

Burnham could reflect more deeply on these ideas during a year-long fellowship starting in 1968 at MIT's newly created Center for Advanced Visual Studies (CAVS). Burnham's main objective, as noted in his CAVS application, was "applying systems theory to contemporary art."[41] During the Cold War, MIT had become an obligatory passage point for engineers-in-training to work on large-scale, system-oriented projects. While at MIT, Burnham made a concerted effort to learn more about the information technologies he referred to in his art writings. He sought tutorials with Marvin Minsky, an expert in artificial intelligence, and Joseph C.R. Licklider, a psychologist studying human-computer interactions. When Burnham met with them, both men were influential leaders in their respective fields. And, to learn firsthand about real-time interactivity with computers, Burnham visited technologists at MIT's Lincoln Laboratory. A photograph taken in 1969 shows him typing away in front of a monitor connected to a mainframe computer. While Lincoln researchers took it as a fait accompli that computers would become essential tools for artists, Burnham was more circumspect. What intrigued him most in his programming experiments was how he "conceptualized an entirely abstract model of the program" then watched how a "dialogue *evolves*" between the machine and the human.[42]

One result from his time at CAVS was a new essay for *Artforum*, "Real Time Systems." The title suggests to what degree Burnham benefited intel-

39. These appear on the first two pages of Burnham's "Systems Esthetics." On RAND: Lee, *Think Tank Aesthetics*; Skrebowski, "All Systems Go."

40. Burnham, "Systems Esthetics," 31, emphasis in original.

41. "Biographical Data for Jack W. Burnham," c. 1968, CAVS/MIT.

42. The photograph and quote appear in Burnham's essay, "Aesthetics of Intelligent Systems," based on his 1969 lecture at the Guggenheim Museum; emphasis in original.

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lectually from the computing-rich environment at MIT. His essay referenced the Semi-Automatic Ground Environment, the air-defense network MIT researchers contributed to, which necessarily worked in real time. He compared artists to "programs and subroutines" functioning within a larger "metaprogam" of art trends, galleries, and the art business.[43] Borrowing the concept of positive feedback from cybernetics, which can send systems out of control, he branded artists as "'deviation-amplifying' systems" who were "compelled to reveal psychic truths at the expense of the existing societal homeostasis."[44] All artists "produce data by making art," which art critics and museum curators then attempt to make sense of. The entire art world in fact now functioned as a system that could be analyzed.[45] Moreover, just as more business and military networks were operating in real time, so too must artists. "Making, promoting, and buying art are *real time* activities," Burnham explained.[46]

Burnham extended his analogic reasoning with references to specific artists already creating responsive information environments that performed in real time. Burnham pointed to recent works by German-born artist Hans Haacke. Pieces like *Condensation Cube* were hermetically-sealed clear Plexiglas boxes that Haacke made between 1963 and 1965. Haacke poured water in them, which evaporated and condensed in response to humidity, light, and temperature.[47] While still an object ("hardware"), Haacke's art primarily generated information (in this case, about the cube's ambient environment). Although Burnham did not explicitly refer to it as such, *Condensation Cube* suggested what would become known as "second-order cybernetics." In this version, the focus was less on feedback and homeostasis. Attention shifted to reflexivity and self-organization, as systems responded to stimuli in often-unpredictable ways and the observer functioned as a component of the overall system.[48]

Burnham believed that by the late 1960s, the work of making art as well as the art works themselves had entered a new state of flux. As more artists engaged with "the area that engineers call 'systems,'" they would be encouraged "to consider viewer interaction and environmental conditions" more directly. The traditional autonomous art object was rapidly becoming "a closed system—an inert body which shared practically no exchange

43. Burnham, "Real Time Systems," 50.

44. Burnham, "Real Time Systems," 55. A classic example of "positive feedback" in cybernetics is the high-pitched screech when a microphone is incorrectly oriented near a speaker. Burnham deviated from traditional approaches in cybernetics that focused on negative feedback to achieve equilibrium.

45. This idea was later picked up on and expanded in Alloway, "Network."

46. Burnham, "Real Time Systems," 50, emphasis in original.

47. Burnham, "Hans Haacke"; Jones, *Hans Haacke—1967*.

48. In the words of advocate Heinz von Foerster, "a cybernetics of cybernetics" (von Foerster, *Cybernetics of Cybernetics*). For a historical analysis: Kline, *The Cybernetic Moment*, ch 7.

of energy or information with its surroundings." In contrast, Burnham envisioned new art works functioning as "open systems," allowing exchange of information and energy in real time that could be "enjoyed on the level of constant interaction."[49] With *Software*, Burnham seized an opportunity to put his theories of systems aesthetics into practice.

Planning and Programming *Software*

As Jack Burnham later recounted, his involvement with the exhibition started in early 1969, when Karl Katz, the Jewish Museum's director, decided to present a show "based on computer technology" and invited him to curate it. Rather than focusing on computer hardware, Burnham opted to create a "computerized art environment" within a museum setting.[50] Burnham believed, like many in the art world, that a significant fraction of "computer art" consisted of "computer programs designed to simulate existing art styles." Any exhibition done in this fashion would inevitably be very object focused and lack the degree of interactivity he wanted. Burnham also felt no need to reprise Jasia Reichardt's earlier *Cybernetic Serendipity*. His goal was to "use computers in a museum environment, a sizable technical feat" which Reichardt's show did not attempt.[51]

In March 1969, Burnham collected his nascent thoughts in a short planning document and settled on *Software* as the exhibition's title (artist Les Levine suggested it). He started with the premise that the key justification for new art works was sending information by "transmitting and communicating symbols." (It's perhaps no coincidence that *Software*'s planning happened when "semiotics" was acquiring greater currency in academic circles.) For almost all of art history, he said, "symbols have been invested in inert objects." But new "automatic information processing systems" had begun to "hold real possibilities for artists." When it came to information technology, software (which he defined as "the writing of stored programs") had assumed equal, if not greater, importance as hardware. Moreover, the definition of software was malleable and could be expanded to include "the process of system-design itself."[52]

Burnham proposed that the show's "emphasis be directed away from machinery" to focus on the "quality of information exchange transpiring between people and an art-oriented program." This information wouldn't just be visual, but "should involve all or any mixture of the senses." However, Burnham was keen to ensure *Software* did "not approach overkill" in

49. Burnham, "Some Thoughts on Systems Methodology Applied to Art," probably late 1967, CAVS/MIT. The parallels to ideas in Edwards, *Closed World*, are striking.

50. Burnham, "Art and Technology."

51. Burnham, *Software*, 11.

52. Burnham, "Software Exhibition," March 13, 1969, planning document, folder 2, SE/JM.

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the same manner as many kinetic and psychedelic-oriented art shows popular with museum-goers.[53] By aspiring to a "subtle and multi-sensual transmission of information," *Software* could demonstrate a "degree of intelligent involvement and behavior not found in previous art forms."[54]

Achieving these ambitious aesthetic goals would not come cheap. Burnham initially suggested a budget of about $40,000 to Katz. The primary donor was, like many of the era's art-and-technology efforts, a major corporation. American Motors Corporation's participation was facilitated by Ruder and Finn Fine Arts, a high-powered New York public relations firm. By the show's end, American Motors contributed $75,000 (about $550,000 in today's currency), with the museum and other companies augmenting Burnham's budget. Company chairman Roy D. Chapin justified the investment because the connection "between art and science" is the "same link we must explore and strengthen in our automotive styling and engineering."[55] Money alone wasn't sufficient to make the exhibition happen, and *Software* would, in fact, require a lot of hardware. IBM offered to provide this, but the museum and American Motors, Burnham recalled, balked at giving Big Blue a "prime-time commercial." In the end, several companies provided materiel and technical support, including a PDP-8 minicomputer from Digital Equipment Corporation (DEC).

Prominent corporate sponsors for *Software* did not come without difficulties. Belgium-born artist Jean Toche proposed an artwork called *Aggression Art: Air Pollution*. He wanted to build a passageway with a mixture of chemicals added, its composition determined by real-time data from New York City's pollution control center. However, with American Motors underwriting the show, Toche withdrew his piece.[56] Burnham came to see artists as unrealistic in their technical demands and hypocritical toward the patrons supporting their work. "The aesthetic illusion is that as long as artists don't know where the money is coming from," Burnham said, "many latently guilty consciences are relieved."[57] For Burnham, caught up in the hectic pace of organizing a major international exhibition, money was less about where it came from than it was about how much came in. He wrote to a junior curator at the Jewish Museum, "How do you think I can go about

53. On spectacle and "overkill": *Life* magazine's September 1966 issue featured "LSD Art." It highlighted USCO ("The Company of Us"), an art and entertainment collective that used a potent combination of audio and visual signals to create a dynamic and media-saturated environment. Oren, "USCO."

54. Burnham, "Software Exhibition," March 3, 1969, planning document, folder 2, SE/JM.

55. Final cost estimates ran as high as $125,000; Burnham, "Art and Technology," 205–7; Chapin's quote is from Burnham, *Software*, 5.

56. Burnham, December 3, 1969, memo, folder 2, SE/JM.

57. "Willoughby Sharp Interviews Jack Burnham," *Arts Magazine*, November 1970, 21–23; Burnham, "Art and Technology."

explaining to Karl that this show needs more money if it is going to escape being a disaster?"[58]

Presumably more pleasurable than fundraising was selecting the artists for *Software*. Like Reichardt's *Cybernetic Serendipity*, Burnham saw an opportunity to "provide the public with a profound educational experience. There is no better way to understand the effects of electronic technology than to allow artists to use such media unconventionally."[59] When the Jewish Museum announced *Software*'s final roster of artists, it was quite different from *Cybernetic Serendipity*. The catalog listed two dozen contributing artists—most based in New York City—and several computer experts. Many were characterized as "conceptual artists" whose work reflected an orientation toward flows of information and feedback. In some cases, this was quite literal. Hans Haacke contributed *Visitors' Profile*, based around a teletype terminal and display screen connected to the PDP-8.[60] Via a keyboard, visitors could respond in real time to questions. Varying from person to person, the queries solicited personal data and opinions on social and political issues. (One example: "Should the use of marijuana be legalized, lightly or severely punished?") Once compiled, analyzed, and correlated with visitors' demographics, the results were projected as a constantly-changing data stream onto a large television monitor.[61] Another piece Haacke presented, called *News*, spewed a constant stream of local, national, and international news via teletype printout onto the museum floor, creating an ever-growing pile of paper and a visceral sense of information overload.

Burnham faced his own overload of problems, right up to when *Software* opened to the general public on September 16, 1970. A film collaboration about the show foundered over accusations of censorship—two of the filmmakers wanted to insert provocative statements such as "the system promotes software to postpone its own collapse"—and their films were anonymously cut into ribbons, evidently an act of self-sabotage.[62] And the night before *Software* debuted, a janitor damaged the show's main computer, rendering pieces by Haacke and other artists inoperable until repaired and prompting Burnham to suspect more foul play.

Despite these setbacks, Ruder & Finn's publicity efforts primed art enthusiasts with 4,000 visitors expected each day.[63] A letter to museum members claimed *Software* gave "important insights into the esthetic and hu-

58. Letter Burnham to Susan Goodman, September 25, 1969, folder 2, SE/JM.

59. Letter Burnham to Karl Katz, September 8, 1969, folder 2, SE/JM.

60. Haacke had technical support from Art and Technology, Inc., a Boston-based group of artists and engineers that was a 1968 spin-off from the much larger New York-based group Experiments in Art and Technology. Burnham met them at MIT.

61. Burnham, *Software*, 34.

62. Fiore and Jarvis, "Software Battle."

63. Lupton, "To All the Artists in 'Software'," May 15, 1970, memo, folder 3, SE/JM.

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manistic possibilities of information processing techniques."[64] In a press release for the show's opening, Burnham explained his goal of defining technology as a "pervasive environment altering our consciousness vastly more than art." "Esthetic insight must become part of technological decision-making," even though longstanding divisions between art and technology would increasingly "seem nonsensical."[65] While many exhibits were "purely conceptual works," visitors could still experience, in real time, "time-sharing computers, teletype equipment . . . high-speed copying machines," and, improbably, "forty furry gerbils."[66] This eclectic assemblage takes us to the heart of Burnham's show: interactivity.

Three Approaches to Interactivity

With its origins in World War II, cybernetics addressed the feedback loops exchanging information between people and machines. Fundamentally, one can reduce this relationship to interactivity, as each system component engages with, monitors, and alters the state of others in real time. Just as cybernetician Gordon Pask highlighted the importance of real-time interactivity and information processing, Burnham prominently featured these themes in *Software*.

"Interactivity" meant something different, of course, depending on whether you were an electrical engineer or computer scientist in 1970 versus an inquisitive museum visitor or layperson with a vernacular understanding of the term. Burnham displayed an expansive understanding of the term. His introduction stated: "visitors to *Software* should have the opportunity to interact in varying degrees with the systems at hand. In all cases such 'interaction' falls short of the level of richness found in ordinary human conversation. Yet another goal of *Software* is to make it clear that art itself is a form of intermittent dialogue."[67] Three examples illustrate Burnham's flexible interpretation of interactivity between people, machines, and information at *Software*.

Visitors would, in principle, experience real-time interactivity as soon as they entered the museum via a piece called *Labyrinth*. It functioned as an "interactive text retrieval" system for the entire show, using the PDP-8.[68] A visitor sat at a terminal and read the displayed text. Keystrokes ("F" for "Forward," for example) allowed navigation around the text as if in a maze. For example, a visitor might read the statement: "The exhibition you are attending is called *Software*. It was organized by Jack Burnham with

64. "Dear Member" letter, August 13, 1970, folder 3, SE/JM.

65. "Software," September 14, 1970, press release from The Jewish Museum, folder 1, SE/JM.

66. "Software."

67. Burnham, *Software*, 12.

68. Burnham, *Software*, 18.

funding from American Motors." You could then decide if you wanted a technical definition of "software," preferred to get biographical details about a person named "Jack Burnham," or wanted to query "American Motors" for information about why an auto company was sponsoring an art exhibition. Before leaving the show, visitors could collect printouts and take home a personalized record of their experience.

Interesting in its own right, *Labyrinth* connects us to the history of computing in a curious way. It was designed by Theodor H. Nelson, a young sociologist and self-taught computer scientist, who championed a form of writing and text navigating he called "hypertext" in the mid-1960s.[69] Hypertext, of course, is an underlying concept of today's World Wide Web. In the show's catalog, Nelson defined hypertext as "writing that can branch and perform," differentiating it from the "cybercrud" (his term) the corporate computing world promoted. As he saw it, *Labyrinth* proved "computerization can take whatever form we wish."[70] In terms of aesthetics, Burnham judged that *Labyrinth*'s value as an artwork was in how it preserved "the memory of one's conversation with the computer program" as a type of information.[71]

Labyrinth enabled visitors with little experience or knowledge of computers and hypertext to experience the possibilities firsthand. Computing professionals would know hypertext and real-time interactivity via the work of Nelson, Doug Engelbart, and other technologists, but this was not *Software*'s primary audience. For many museum-goers, *Labyrinth* suggested a technological future—our present day—when people easily navigate the information-rich realm of cyberspace. But, in 1970, this turned out to be a missed opportunity. As Burnham lamented, the PDP-8 proved "a mystery to everyone and a source of embarrassment to DEC." Despite several engineers reprogramming it, more than a month passed before *Labyrinth* worked properly.[72]

Malfunctioning equipment posed less of a problem for artist Sonia Sheridan. Born in 1925, Sheridan joined the faculty of the School of the Art Institute of Chicago in 1961.[73] Sheridan focused on the nature of change over time, leading her to experiment with ever-fainter residual images via traditional printmaking. Around 1969, Sheridan experimented with copy machines, starting with the school's Xerox machine. She was frequently photographed—as in figure 2—wearing a white lab coat that gave her the air and authority of a scientific researcher. Soon, she acquired her own

69. Nelson, "A File Structure of the Complex."

70. Nelson, "The Crafting of Media," 17. Nelson expanded on these emancipatory ideals when critiquing the "computer priesthood" in his 1974 book, *Computer Lib/Dream Machines*.

71. Burnham to "Art Critics," May 18, 1970, memo, folder 1, SE/JM.

72. Burnham, "Art and Technology," 206.

73. Biographical information from Kirkpatrick, "Sonia Landy Sheridan" and "Sonia Landy Sheridan and the Evolution."

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FIG. 2 Artist Sonia Sheridan manipulating the "Color-in-Color" 3M copier in "Generative Systems" classroom, School of the Art Institute of Chicago, 1978. (Courtesy The Daniel Langlois Foundation for Art, Science, and Technology. Sonia Landy Sheridan fonds.)

machine (a 3M Thermo-Fax), which she and her students used to make images of two- and three-dimensional objects that could be combined into more complex visual art pieces. Just as *Software* was about to open, Sheridan launched her "Generative Systems" program at the Art Institute. She explained this was not about machines per se but was "an idea, an approach, and a process" that allowed artists to express themselves in new ways.[74]

For *Software*, Sheridan's contribution *Interactive Paper Systems* was based around the first commercially available color copier, loaned to her by the 3M company.[75] This could rapidly translate a modestly sized object into a color reproduction. An artist no longer needed to spend hours recreating an orange with watercolors or pastels but now could photograph the orange—whole or sliced, or even squeezed into a juice glass—and make images. For Sheridan, who saw modern artists as a "product of their time," these new interactive graphics tools enabled more rapid experimentation and therefore opened up more doors for creative thinking. As she wrote for

74. Sheridan, "Generative Systems," 2–3, and "Generative Systems at the School of the Art." Sheridan, along with Robert Whitman, Edward Meneeley, and Barbara T. Smith, were experimenting with commercially available copiers. In 2017, the Whitney Museum in New York organized a show around these and other artists labeled *Experiments in Electrostatics: Photocopy Art from the Whitney's Collection, 1966-1986*.

75. This was a "Color-in-Color" machine developed in 1965 by chemist Douglas Dybvig ("Sonia Sheridan on Interactive Graphics," September 1970 press release 3M, folder 4, SE/JM).

the *Software* catalog, "it is obvious that [the] work process becomes another kind of time for the artist as the distance from conception to conception is reduced to minutes and objects change as rapidly as thinking allows."

For curator Burnham, this emphasis on immediacy connected Sheridan's work to his broader interest in interactivity and real-time processes. Her engagement with rapid reproduction, he noted, "puts art on a real-time basis."[76] He certainly appreciated that Sheridan's equipment, maintained by 3M's technicians, had no malfunctions like other works. *Interactive Paper Systems* also proved popular with visitors, whom Sheridan invited to interact in real time with the copy machine and make their own creations.

Ironically, for many viewers, the most appealing part of *Software* was not real-time interaction with computers or machines. It was the gerbils. They were the prime movers in a piece called *SEEK*, created by Nicholas Negroponte and students from his Architecture Machine Group at MIT. More grounded in materiality than many *Software* pieces, the MIT group built *SEEK* around a large table surrounded by Plexiglas walls, as shown in figure 3. Overhead, they situated a roving electromagnetic grappler that a computer (not the troublesome DEC machine) controlled in real time. Inside, forty Mongolian gerbils "selected for their curiosity" shared space with hundreds of two-inch, polished metal cubes.[77] As the furry mammals pushed the blocks around to build a three-dimensional environment, the magnet attempted to restore order, in a continuous process that one art critic said left many visitors "endlessly fascinated."[78]

Negroponte, who would later direct MIT's Media Laboratory, expressed serious aspirations for *SEEK*. With gerbils acting as proxies for people, the architecture professor claimed that *SEEK* "metaphorically goes beyond the real-world situation where machines cannot respond to the unpredictable nature" of the contemporary city. By creating a simulacrum of an urban environment and its various information flows, Negroponte aimed to show "how a machine handled a mismatch between its world and the real world" that a community (albeit composed of gerbils) created in real time.[79] Burnham interpreted *SEEK* as "the first piece of computer art" that did not just "simulate previous art ideas." By repeatedly rearranging blocks like a sculptor rearranging forms, it served as a "paradigm for the idea of *making* art." Aesthetics constantly generate new arrangements, so *SEEK*'s resident rodents forced the computer "to model new environmental configura-

76. Burnham, *Software*, 24; Jack Burnham to "Art Critics," May 18, 1970, memo, folder 1, SE/JM.

77. Negroponte, *Soft Architecture Machines*, 47.

78. Grace Glueck, "Jewish Museum's 'Software' Confusing," *New York Times*, September 26, 1970.

79. From the description of *SEEK* in Burnham, *Software*, 23. For analysis: Wright Steenson, *Architectural Intelligence*, 184–87. Costing at least $5,000, *SEEK* was one of the most expensive works Burnham commissioned for *Software*.

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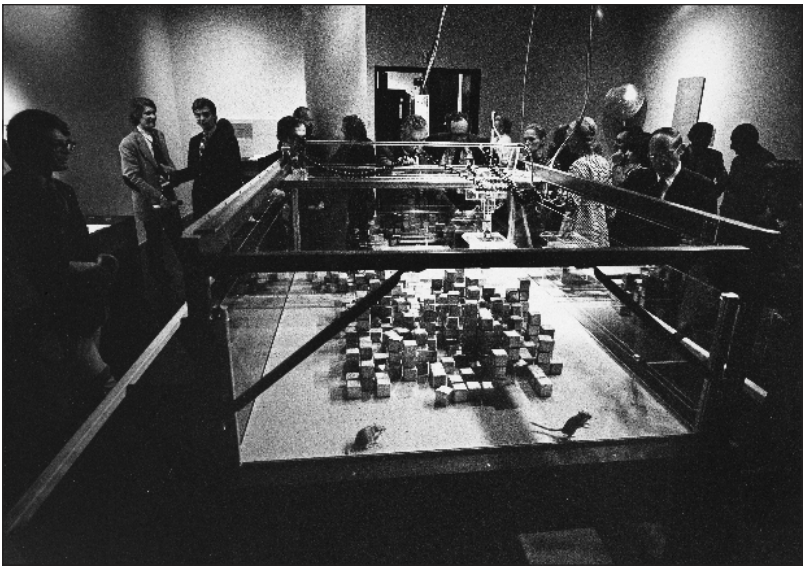

FIG. 3 Visitors observing the unusual activity inside *SEEK*, built by an MIT group for the 1970 *Software* show at New York's Jewish Museum. MIT's Nicholas Negroponte, who later founded the Media Lab, is on the left wearing a black suit. (Source: Photograph by Shunk-Kender, J. Paul Getty Trust, Getty Research Institute, Los Angeles.)

tions," suggesting a time when machines enabled with artificial intelligence might "cope with complex contingencies in a sophisticated manner."[80]

While its "triviality and simplicity" were easy to lampoon, art critics saw something disquieting, even sinister in *SEEK*'s metaphors and machinations. Thomas Hess, editor of *Art News*, described (in an essay "Gerbil ex Machina") how the animals, at first, "triumphed, totally, over the machine." However, when Hess revisited the show, he found the gerbils staring in fear at the grappler's motionless arm—"this Gestapo of a machine"—coated in rodent excrement. To him, this served as a warning: artists who decided to work with engineers and experiment with new technologies might be advised to recall the "charming gerbils" trying to collaborate with powerful, computer-controlled systems.[81] Computer expert Ted Nelson harbored similar thoughts. He recalled one gerbil "who stood motionless on his little kangaroo matchstick legs, watching the Great Grappler rearranging his world . . . I had a sense that he was worshiping it. He did not move until the block started coming down on him."[82] Surely some visitors, given their own experiences with inflexible and capricious

80. Jack Burnham to "Art Critics," May 18, 1970, memo, folder 1, SE/JM; and on *SEEK* in Burnham, *Software*, 23, emphasis in original.

81. Thomas Hess, "Gerbil ex Machina," *Art News*, December 1970.

82. Nelson, *Computer Lib/Dream Machines*, DM14.

technological systems, empathized with Negroponte's hapless, maze-bound rodents.

Unfortunately, many museum guests and critics often found artists' *Software* exhibits had signs saying, "Temporarily Out of Order."[83] Without properly functioning hardware, it was hard for viewers to fully appreciate the aesthetic vision Burnham had planned. A considerable amount of controversy accompanied the show, as well. For example, conceptual artist Agnes Denes publicly blasted the show's "overall incompetence," describing how she had been "caught in the gears of a system within which shows of this type are financed and publicized with complete cynicism."[84] Director Katz, meanwhile, found himself embroiled in a dispute with artist Les Levine, who included, Katz claimed, some "8 minutes of taped scenes of sexual intercourse" in a videotape work.[85] All this led Burnham to recall "Talmudic scholars and rabbis" were "heard to mutter darkly as to the inappropriateness of exhibiting *Software*" at the Jewish Museum in the first place.[86] When critic Willoughby Sharp asked Burnham about *Software*, he simply replied, "I can't really go into it because of possible litigation."[87]

Reordering Art

After *Software* ended, Katz lost his job. American Motors, on the other hand, received an award from the New York Trade Commission for sponsoring what Burnham in retrospect called "the most ambitious and interesting cultural failure" of 1970.[88] Failure, indeed, was Burnham's assessment of *Software* and the show was his last major exploration of "systems esthetics." "My feeling is that shows like *Software* are a thing of the past," he told critic Lucy Lippard; "I can only hope that *Software* remains an example of what not to do."[89] As his interest in fusing art and technology waned, he reflected that systems theory might just "be another attempt by science to resist the emotional pain and ambiguity that remain an unavoidable aspect of life."[90] With the benefit of several years' hindsight, Burnham

83. Grace Glueck, "Varied Problems Beset Opening of Jewish Museum's 'Software,'" *New York Times*, September 18, 1970.

84. Denes, "Software Battle Continued," 37.

85. Glueck, "Varied Problems Beset Opening."

86. Burnham's impressions are confirmed in Lubow, "How New York's Jewish Museum Anticipated the Avant-Garde," *New York Times Style Magazine*, July 26, 2020.

87. "Willoughby Sharp Interviews Jack Burnham," *Arts Magazine*, November 1970, 21.

88. Burnham, "Art and Technology," 207.

89. Letter Burnham to Lippard, November 2, 1970, Box 4, folder 47, LLP. After *Software*, Burnham became obsessed with Marcel Duchamp's *The Bride Stripped Bare by Her Bachelors Even (The Large Glass)* and his writings veered toward mysticism and the Jewish Kabbalah.

90. Burnham, *The Great Western Salt Works*, 11.

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reflected on working at the art-and-technology interface in an essay "Art and Technology: The Panacea That Failed."[91]

But what did he imagine that technology, when applied to the art world, would be a panacea for? To answer this, one must consider the rapidly changing nature of the art world with its succession of aesthetic trends, celebrity artists, and increased commercialization. Well before *Software*, modern art was seen as a good financial investment, a development that artists Les Levine and Dennis Oppenheim critiqued in their work.[92] Burnham and the *Software* artists attempted to distance themselves from the glitzy and expensive superficiality he saw in many art-and-technology efforts, including those at MIT's Center for Advanced Visual Studies. Systems thinking had helped engineers grapple with technological complexity. Perhaps *Software* was a way to deal with the increasing complexity of an art world which, according to critic Lawrence Alloway, was behaving more and more like an intricate, decentralized system.[93]

Looking at the subjective nature of failure through the lens of an art exhibition points us to a larger historiographical point. Even as critics wondered "is it art?" at shows like *Software* or *Cybernetic Serendipity*, these exhibitions forced viewers then (and encourage historians now) to remember that art and technology are dynamic and contingent categories. Looking at where art and technology intersect puts both in greater relief and helps us see their historical context and evolution.

At the time, many critics branded *Software*, with its malfunctions and controversies, as literally art out of order. We might also see it as a reordering of both art and technology. For art, it suggested a future where artists used computers to make innovative, concept-based works beyond traditional imitative forms. *Software* foreshadowed a time when computers would no longer be depersonalized, monolithic mainframes, but personal information devices prized for their real-time interactivity. The show's persistent technical problems encouraged museum visitors to consider the messy complexity of modern technologies which, *when* they worked, suggested the possibilities inherent in an information-rich environment. Likewise, many of the show's contributing artists (and some technologists) recognized an opportunity to critique the sometimes-haphazard workings of modern information technologies.

Software opened in 1970, just as that era's art-and-technology boom was waning. A few years earlier, when the economy was flush, some company managers saw artist-engineer collaborations as a way of keeping employees happy while diversifying their skills and interests. By the early

91. Burnham, "Art and Technology." Judging art-and-technology projects as "failures" points to rich literature including Kunkle, "Technology in the Seamless Web"; Gooday, "Re-writing the 'Book of Blots'"; McCray, "What Makes a Failure," and more recently, Jones-Imhotep, *The Unreliable Nation*.

92. Cras, "Art as an Investment and Artistic Shareholding Experiments in the 1960s."

93. Alloway, "Network."

1970s, public disapproval of the Vietnam War, the environmental crisis, and, most importantly, the economic recession created by Nixon-era policies and international oil shocks made American corporations reluctant to support initiatives like *Software*.[94] Consequently, the impetus for art-and-technology collaborations was squeezed both by reduced support at the corporate level and diminished enthusiasm on the part of individual engineers concerned about keeping their jobs. New trends, such as ecologically informed art and a greater concern for identity politics, emerged. By the mid-1970s, lavishly funded art-and-technology initiatives looked as out of fashion as moon landings.

As a manifestation of conceptual art, *Software* certainly offered a panacea to the idea that only "inert objects"—hardware—could convey cultural information. As so many conceptual artists' work was tied to interactivity and real-time communication, *Software* offered an alternative vision of what art could convey. Ronald Kline, Geoffrey Bowker, and others have noted that cybernetics and information all had considerable interpretative flexibility. The ways artists could use computers to make art for *Software* were likewise flexible. Burnham imagined art and technology shared a common purpose. Both gave people "systemic relationships between social units and the environment" while communicating the "proscriptions and interdictions found in any language system."[95] Burnham's vision of both art and technology was, in essence, deeply rooted in the communication practices associated with information technologies.

Information flows were, of course, central features in sociologists and other experts' predictions for the future of work as the twentieth century drew to a close. Consider how Marshall McLuhan imagined artists—a community he called the "antennae of the race"—as especially skilled in anticipating technological change: "The artist is the historian of the future because he uses unnoticed possibilities of the present."[96] Experts predicted that processing information would take precedence over traditional manufacturing.[97] Indeed, economists and sociologists alike pointed to the 1960s as an inflection point in reordering work based around knowledge and information. While *Software* was an opportunity to reflect on an information-saturated, postindustrial society, it also conformed to Burnham's view of both art and technologies as systems of thought. Paralleling predictions by Daniel Bell and other analysts, Burnham's ultimate vision was one where technological change went hand in hand with profound social, economic, and aesthetic transformations.

Whether Burnham and the *Software* artists were exceptionally percep-

94. McCray, *Making Art Work*, ch 9.

95. Burnham, "Corporate Art," 71.

96. This analogy appears in many of McLuhan's works including *Understanding Media*, 64, while the phrases are from McLuhan and McLuhan, *Laws of Media*, 6, and McLuhan, "Third Program in the Human Race," 17.

97. Cortada, *Rise of the Knowledge Worker*.

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tive in the manner McLuhan imagined is debatable. From today's perspective, *Software* certainly appears to anticipate the increased centrality of information and data flows as well as the importance of computer software to the soon-burgeoning personal computer market. Burnham's emphasis on real-time computing and interactivity also offers a sense of prescience. But many artists circa 1970 produced works that did nothing of the sort. So, *pace* McLuhan, not *all* artists were the "antennae of the race" when it came to anticipating technological change.

In 1970, Burnham was asked if he saw "art dissolving into nothingness." No, Burnham replied, "it's dissolving into comprehension."[98] With *Software*, Burnham attempted something similar for technology—showcasing computing technologies when they were poised to become both personal and ubiquitous. Although realized in a decidedly unruly sense, *Software* projected a future when the instruments for managing information would be pervasive and interactive and would appear ever more detached from materiality. The medium was the message, one might say.

However, there is a larger historiographical point to consider. Burnham and his artists were clearly historical actors directly engaging with and critiquing technology. Their commentary, expressed via art works, went beyond simplistic reproach, as witnessed via their willingness to learn about, use, and even advocate an array of complex information technologies. Art-and-technology initiatives like *Software* may have been about reordering art, despite critics branding them as art out of order. But they also pose an opportunity for us to reorder our histories of technology by giving artists and art institutions a more prominent place in the picture.

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98. "Willoughby Sharp Interviews Jack Burnham," *Arts Magazine*, November 1970, 23.

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