Gyorgy Kepes, Billy Klüver, and American Art of the 1960s: Defining Attitudes Toward Science and Technology

Anne Collins Goodyear

National Portrait Gallery, Smithsonian Institution

Argument

This essay aims to broaden our understanding of relationships between art, science, and technology during the 1960s by juxtaposing two of the most important, and under-examined, figures of this period, the artist Gyorgy Kepes and the engineer Billy Klüver. While these two are generally linked due to their similarities, a closer examination demonstrates significant differences in their outlook. Comparing the organizations they nurtured, Kepes, the Center for Advanced Visual Studies at the Massachusetts Institute of Technology, and Klüver, Experiments in Art and Technology, provides unique insight into the distinct origins of such organized collaborations between art, science, and technology. It reveals both how the cultural conditions of the 1960s contributed to the perceived need for such agencies and how interactions between art, science, and technology reflected, at once, the culmination of aspirations reaching back to the opening decades of the twentieth century, and a perceived break with the past.

In a 1968 interview with art critic and artist Douglas Davis, Gyorgy Kepes (fig. 1) pointed to evidence of what he identified as "a welcome change in our cultural climate," suggesting that the public had finally become interested in exploring interconnections between art, science, and technology. In order to illustrate the magnitude of the shift he perceived, Kepes related the following experience to Davis:

> In 1951, to break down what I considered unwarranted resistance, I organized at MIT's new art gallery a comprehensive exhibition of what I called "The New Landscape." It is a welcome change in our cultural climate that recently a leading museum could present, as an important and legitimate enterprise, an almost identical exhibition with almost identical material ["Once Invisible" at New York's Museum of Modern Art, summer 1967]. It was not so in 1951. When finally the book *The New Landscape in Art and Science* was published in 1956, the climate was still not very favorable. Some art magazines refused to review the book on the grounds that art and science are unmixable entities. (Davis 1968, 39)

While Kepes may have exaggerated for the sake of emphasis the negative reception his project received, his comment nevertheless testifies to the increasing prominence of science and technology in the art world in the mid-1960s, a development which

Fig. 1. Wendy Synder MacNeil, *Gyorgy Kepes*, 1983, platinum palladium print on vellum. National Portrait Gallery, Washington, DC. © 1983 Wendy Synder MacNeil. Photo: National Portrait Gallery.

may indeed have appeared "sudden" to contemporary observers.[1] Read superficially, Kepes' observation, particularly his remark about the "cultural climate," seems to imply

---

[1] Despite Kepes' recollection, several reviews of *The New Landscape in Art and Science* appeared, among them: Alford 1958; S. Moholy–Nagy 1959; Eckbo 1958; Hastorf 1958; Fry 1957; Kaufmann 1957; and Henrion 1959.

that a new consensus regarding the interaction of art with science and technology had recently been reached. However, despite a surge of interest in this area, there was no universal agreement on how to define the points of commonality between these diverse disciplines.[2]

This article contrasts the backgrounds and philosophies of two individuals who played critical roles in stimulating partnerships between art, science, and engineering during the 1960s in the United States: artist Gyorgy Kepes, who founded the Center for Advanced Visual Studies (CAVS) at the Massachusetts Institute of Technology (MIT) in 1967, and engineer Billy Klüver, the driving force behind the New York-based organization, Experiments in Art and Technology (E.A.T.), established in 1966.[3] The purpose of this comparison is two-fold: first, to draw attention to the critical, yet understudied impact of discourses of science and technology on American art of the 1960s, and, second, to explore the roots of divergent models of art's relationship to science and technology that co-existed at this time. Although few recent scholars have yet examined the widespread interest on the part of American artists in science and technology during this period, those who have taken up this phenomenon have tended to focus upon the dynamic of "art and technology" with little attention to how science figured into, or was figured against such interactions.[4] At the same time, these studies have focused almost exclusively upon the 1960s without examining how the legacy of early twentieth-century engagements with science and technology, such as that of the Bauhaus, carried over into this decade.[5] And despite their differences, Kepes and Klüver, where treated together, have tended to be linked due to the similarities of their enterprises, eliding the important distinctions between them.[6] While the historical circumstances of the 1960s were critical to the emergence of both CAVS and E.A.T., I will argue that the 1960s represented a cultural crossroads between philosophies of art-making developed in pre-World War II Europe – when scientific breakthroughs seemed to offer proof of the interrelatedness of all aspects of life and new modes of

[2] Edward Shanken has pointed out the different approaches to combining art and technology during this period in a recent study. However, while Klüver and E.A.T. figure in Shanken's essay, Kepes does not, and his study does not address the question of science and art (see Shanken 1998).

[3] I have maintained periods in E.A.T. due to the stated preference of Klüver and Martin (1997, 317).

[4] See for example, Shanken 1998 and Jones 1996.

[5] This, of course, is not to downplay the rich literature on the arts' connection to science and technology during the first part of the twentieth century (see, for example Henderson 1983, Henderson 1998, and Wilson 1986). Most recent scholars, however, have abided by the traditional World War II break in studying the 1960s, thus there is little discussion of how discourses from the first part of the twentieth century intersected with the 1960s (see, for example, Jones 1996, Lovejoy 1997, and Bijvoet 1997). A notable exception is Linda Dalrymple Henderson, whose forthcoming study of the artistic use of the fourth dimension during the second half of the twentieth century addresses how the notion of the fourth dimension as a spatial concept, supplanted by the popularization of Einsteinian physics, was resurrected during the 1960s (see Henderson forthcoming).

[6] See Burnham 1986 and Bijvoet 1997, 15–52. While Bijvoet acknowledges some distinctions between Klüver and Kepes, she does not problematize the model of the "Art and Technology" movement that she adopts. Given Bijvoet's larger project of treating art, science, and technology from 1960–1990, she stresses the similarities rather than the differences between E.A.T. and CAVS.

seeing, the understanding of which could avert future conflict – and those forged in the aftermath of World War II, when the exploitation of new technologies appeared the key to economic and political triumph.

As a point of departure, it is worth returning to the 1968 statement by Kepes quoted initially. In making his comment, Kepes was responding to several developments: the foundation of E.A.T. and CAVS, and the organization of a number of sympathetic exhibitions at leading American museums, such as the Museum of Modern Art in New York (MoMA). Within the next three years, several more such exhibitions would open in major museums in New York, Washington, D.C., and Los Angeles.[7]

Kepes was not alone in his perception that the 1960s, broadly conceived, represented a major turning point in attitudes toward science and technology. The British historian and theorist, Reyner Banham, for example, had recently rooted his ground-breaking study *Theory and Design in the First Machine Age*, published in 1960, in the cultural circumstances of his own era.[8] As Banham explained:

> This book was conceived and written in the late years of the Nineteen-fifties, an epoch that has variously been called the Jet Age, the Detergent Decade, the Second Industrial Revolution. Almost any label that identifies anything worth identifying in the period will draw attention to some aspect of the *transformation of science and technology*, for these transformations have powerfully affected human life, and opened up new paths of choice in the ordering of our collective destiny. (Banham [1960] 1975, 9–10; italics mine)[9]

Indeed, the very title of Banham's book was based on the observation that he and his contemporaries had entered what he identified as the "Second Machine Age" (Banham [1960] 1975, 10–12).[10] Marshall McLuhan's seminal *Understanding Media*, first published in 1964, was inspired by similar perceptions of fundamental technological and attendant cultural change. According to McLuhan:

> After three thousand years of explosion, by means of fragmentary and mechanical technologies, the Western world is imploding. During the mechanical ages we had

---

[7] These included *The Machine as Seen at the End of the Machine Age*, at MoMA in 1968, and held in conjunction with *Some More Beginnings* at the Brooklyn Museum of Art; *Cybernetic Serendipity*, at the Corcoran Gallery of Art in 1969; *Software Information Technology* at the Jewish Museum in 1970; *Explorations* at the Smithsonian's National Collection of the Fine Arts (now the Smithsonian American Art Museum) the same year; and *Art and Technology* at the Los Angles County Museum of Art in 1971. Shanken similarly sees a burst of museum exhibitions in the U.S. as an index for interest in these interdisciplinary collaborations (Shanken 1998, 1).

[8] Banham was a member of the British Independent Group (IG), a loose coalition of artists and intellectuals, who were linked by their common interest in contemporary culture. On Banham's links with the IG, see Whiteley 2002, 82-139.

[9] Interestingly, this introduction was rewritten for the edition published by MIT Press, significantly downplaying the excitement of the 1950s that helped inspire Banham to undertake his study originally (Banham [1980/1960] 1989).

[10] For a more extended discussion of how Banham's theory of the First Machine Age reflected his views toward the Second, see Whiteley 2002, esp. 142–85. Pierre Francastel's nearly contemporary study of the impact of technology on art and architecture of the nineteenth and twentieth century was similarly motivated by the context of his own era; see Francastel [1956] 2000.

extended our bodies in space. Today, after more than a century of electric technology, we have extended our central nervous system itself in a global embrace, abolishing both space and time as far as our planet is concerned. (McLuhan [1964] 1994, 7)

Significantly, while not related directly by their authors to the context of the present, the 1960s also witnessed the publication of two extremely important treaties on theories of historic change: George Kubler's *The Shape of Time: Remarks on the History of Things*, and Thomas Kuhn's *The Structure of Scientific Revolution*, both of which appeared in 1962.[11]

It is perhaps more than coincidence that these two influential works should have aimed to describe the fields of the arts and the sciences and that each author should have resorted to interdisciplinary research, with Kubler using the lessons of the new field of information theory and Kuhn turning to the work of the art historian E. H. Gombrich (who himself made ready use of Gestalt theory and psychology) to make his points.[12] The intellectual and cultural climate of the 1960s had been indelibly marked by the perceived need to bridge the gap between the "two cultures," as C. P. Snow famously termed it, of the arts and humanities on one side and the sciences on the other.[13] Remarking on the extraordinary "flood of literature" inspired by the publication of his 1959 Rede lecture at Cambridge, Snow concluded about his ideas: "contained in them or hidden beneath them, there is something which people, all over the world, suspect is relevant to present actions" (Snow [1963] 1993, 54–55). The political, intellectual, and social urgency of crossing the divide would be addressed through channels as diverse as popular culture, sociology, and legislation.

In the United States, the perceived cultural conflict took on particular significance in the wake of the Soviet launch of Sputnik in October 1957. As many contemporaries reported, the Soviet achievement proved to be a major psychological victory, capitalizing on American fears of global Soviet domination. Americans quickly

[11] For an insightful analysis of Kubler's theories of time and historical change, see Lee 2001.
[12] On Kubler's use of information theory, see Lee 2001, 63; and Kubler 1962, 21 and 60. See also Kuhn [1962] 1970, 161, where he cites Gombrich's discussion of evolving mastery of mimesis in antiquity and during the Renaissance (Gombrich [1960] 1989, 11–12.) Significantly, Gombrich compares the ancient quest for pictorial imitation of nature to contemporary interest in technology: "it may be said that the progress of art toward that goal [mimesis] was to the ancient world what the progress of technics is to the modern: the model of progress as such" (Gombrich [1960] 1989, 11). Gombrich's emphasis on the concept of "invention" to describe new achievements in the development of painterly imitation fits well with Kuhn's own description of changing scientific "paradigms," which, like Gombrich's study of artistic representation, makes use of the example of gestalt psychology. Note that both use the classic gestalt problem of the rabbit/duck image to illustrate the phenomenon of changing perceptions (see Gombrich [1960] 1989, 5; and Kuhn [1962] 1970, 111). Gombrich's preface provides an excellent overview of his indebtedness to various scientific colleagues, including the X–ray physicist Gottfried Spiegler (Gombrich [1960] 1989, vii–xvi).
[13] Snow first introduced the concept in a 1956 publication, "The Two Cultures," *New Statesman*, 6 October 1956, but more famously developed it in his May 1959 Rede lecture at Cambridge. The paper he delivered was then published in two parts as "The Two Cultures and the Scientific Revolution," *Encounter* 12 (June 1959): 17–24 and 13 (July 1959): 22–27 (Collini 1993, xxv, xxvi, and xxx).

responded to the new threat, determined to reassert scientific, technological, and military superiority over their rivals. The national reordering of priorities had an immediate impact on popular culture as well as national policies. Coverage of scientific topics in the mass media increased substantially in the wake of Sputnik.[14] Even comic strips reflected the trend. A March 1958 episode of "Penny," for example, based on the adventures of a high school girl, depicts the heroine sacrificing a date with the captain of the football team to date a nerdy science student. When her gentle attempts at romance are repeatedly rebuffed, she concludes in the final frame: "Encouraging the scientific mind in our national emergency may be patriotic, but it sure is a strain on a girl!"[15]

Some six months after the strip's publication, in September 1958, President Eisenhower signed the National Defense Education Act into law, legislating increased training for American students in science and mathematics (as well as in foreign languages). Yet, despite an increased emphasis placed on scientific education, public perceptions of the scientist continued to indicate that exclusive pursuit of scientific research lacked a "human" dimension (Beardslee and O'Dowd 1962, 249). In a society bent upon supporting scientific study, art was seen as an antidote to the potentially inhumane tendencies of science. The very foundation of the National Endowment for the Arts and Humanities by Lyndon B. Johnson in 1965 was motivated by the belief that federal funding for the sciences demanded analogous support for the arts. Signing the NEA and NEH into existence Johnson remarked, "We have not always been kind, in America, to the artists and scholars who are the creators and keepers of our vision. Somehow, the scientists always seem to get the penthouse, while the arts and humanities are always down in the basement" (Johnson 1965; cited in McCombie 1992, 39).

This cultural background helps to explain a widespread and heightened commitment on the part of American artists to engage science and technology in their work.[16] It was precisely this climate that gave rise, within the period of a year, to the establishment of E.A.T. in 1966 and CAVS in 1967. Yet, while both organizations sought to foster interdisciplinary collaborations between the "two cultures," the methods, philosophies, and outcomes of the two proved to be radically different.

Although Kepes' Center for Advanced Visual Studies opened approximately a year after E.A.T., its roots, and those of its founder, stretched back into the early years of the twentieth-century. Based on the conviction that visual language represented a bridge between art and science, the Center put into practice the Bauhaus and constructivist

---

[14] According to one contemporary 1959 study of "Public Opinion about Science and Scientists," two-fifths of magazine and newspaper editors polled "reported double the coverage; another two-fifths reported increases around 50 per cent" (Withey 1962, 155).

[15] Harry Haenigsen, "Penny," 16 Mar. 1958, *New York Herald Tribune*, 1958; published in *The Austin-American Statesman*, 16 Mar. 1958.

[16] This phenomenon was obvious to contemporary observers, who sought to chronicle it (see Burnham 1968; Benthall 1972; and Davis 1973). Despite these publications, however, evidence of the widespread interest among artists in science and technology would soon fade from histories of the period.

ideals Kepes had embraced since the beginning of his career. Born in 1906 into a comfortable home outside Budapest, Kepes grew up amidst the social, political, and intellectual transformation that attended the collapse of the Austro-Hungarian Empire following the First World War (Kepes 1972–73, 2; Goodyear 2002, 85–86).[17] As a young man Kepes sought out the opportunity to work with fellow Hungarian artist László Moholy-Nagy. A pioneer of new media, including photography, film, and even the telephone, Moholy-Nagy had played an important role at the Bauhaus, which sought to unify the aesthetic and technological dimensions of training in the arts and architecture. There he led courses and established its well-known series of Bauhaus books. Moholy's devotion to teaching and to the dissemination of theories of seeing made a profound impression on Kepes. Kepes shared Moholy-Nagy's commitment to raise art to the level of scientific investigation, and eventually traveled to the United States with his friend, where he taught at the New Bauhaus in Chicago.[18] Although Kepes' views would begin to diverge from those of Moholy during his years in Chicago, he would retain his passion for teaching and his commitment to an interdisciplinary art informed by contemporary science and technology.

In the fall of 1967, Kepes succeeded in establishing CAVS, an entity that represented the fulfillment of ambitions he had harbored throughout his career. Founded at MIT, where Kepes had taught visual design in the School of Architecture since 1945, CAVS' successful foundation reflected the esteem of Kepes' colleagues as well as his own persistence.[19] At the same time, it also had the advantage of meeting cries for curricular change at the scientific institution. Inspired by C. P. Snow's argument that only education could remedy the gap between the "two cultures," several versions of a Ford Foundation Grant Proposal were composed at MIT during the summer of 1967, with the goal of establishing a new campus to house a new Center for Humanities and the Arts.[20] Although the proposed campus and Center for Arts and Humanities were not developed, program changes were made within the School of Architecture, which had been seen as a vital component of the new campus. The Center for Advanced Visual Studies, devoted to the study of visual culture at an elite science institution, further promised to address the concerns raised in these proposals.[21]

In this environment, Kepes' proposal for a Center intended to bring artists, engineers, and scientists together met with ready success. Yet if CAVS was an outgrowth

---

[17] Unless otherwise noted, the details of Kepes' upbringing and early career are taken from Robert Brown's interview of Kepes (1972–73).

[18] On the Bauhaus and the New Bauhaus, see Wingler [1962] 1969; Tupitsyn and Költzsch 2000; Boxer 1993; Allen 1983; and Margolin 1997, 215–50. Kepes' background is treated more fully in Goodyear 2002, 84–130.

[19] Henry Millon noted that the Center represented in part a tribute to Kepes by his colleagues as he neared retirement (Henry Millon, interviewed by the author, Washington, D.C., March 25, 1999).

[20] These anonymous drafts are now preserved in the files of the MIT Committee on Visual Arts, a presidentially appointed body established in 1966. See MIT, Committee on the Visual Arts, AC 48, Institute Libraries and Special Collections, MIT Libraries, Cambridge, MA.

[21] For more on these proposals, see Goodyear 2002, 143–44.

of the cultural climate of the 1960s, it also reflected long-standing interests developed by Kepes over the course of a forty-year career. It was to be the realization of Bauhaus ideals in the second half of the twentieth century, but an enterprise that expanded on the goals of its model. Asked to comment on the relationship of CAVS to the Bauhaus, Kepes responded:

> My own interest is in continuing that strain of the Bauhaus which attempted to find agreement across a wide spectrum of disciplines – science, engineering, art. . . . Our interest at the Center is not only in new materials or technical implements, but in new knowledge. Today the possibilities suggested by new materials are much broader than they were in the days of the Bauhaus. Neither electronics nor the computer existed then. (Davis 1968, 40)

In addition to making work facilities available for artists interested in new technologies, the Center was intended, above all, to provide a model for the interaction of the arts and sciences for society as a whole. As Kepes told Douglas Davis, "I sincerely hope that the Center will develop a work pattern – I can best suggest its nature through a physical simile, the dove-tail joint in which the complementary characteristics of interacting elements combine to achieve an optimum strength" (ibid., 39).

Collaboration was central to the Center's philosophy. Kepes envisioned that members of the Center, removed from the pressures of the art market, would work together on artistic "tasks" intended to benefit the community at large. Framing his proposal, Kepes explained that the group of artists should encompass many specialties, from painting and sculpture to film, light-work, and graphic design, and that the community should be "located in an academic institution with a strong scientific tradition" (Kepes 1965, 122). While Kepes' suggestion that the Center be established in "an academic institution with a strong scientific tradition" indicated his affinity for MIT, it also coincided with his belief that artists must be schooled in the scientific and technical idioms of their own century in order to produce authentic and socially responsible work.

The name chosen for the facility, the Center for Advanced Visual Studies, attested to Kepes' interest in the nature of vision – and in visual language – the cornerstone, in his view, of collaborative engagement between artists and scientists. In his published proposal, Kepes reiterated views he had expounded in print since the early 1940s, "Vision is a fundamental factor in human insight. It is our most important resource for shaping our physical, spatial environment and grasping the new aspect of nature revealed by modern science. It is at its height in the experience of artists, who elevate our perception." Echoing Moholy-Nagy, Kepes continued, "Artists are living seismographs, as it were, with a special and direct sensitivity to the human condition. Their immediate and direct response to the sensuous qualities of the world helps us to establish an entente with the living present" (Kepes 1965, 121; Moholy-Nagy [1947] 1965, 30).

Ironically, however, in light of the progressive nature of CAVS and his strong faith in artists, Kepes' determination to found CAVS was also fueled by his dissatisfaction with contemporary art, which he believed had abdicated its intellectual and social

responsibilities.[22] Kepes' frustrations with the new art of the late 1950s and early 1960s surfaced publicly for the first time in his anthology, *The Visual Arts Today*. In his brief introductory essay, Kepes' observations about vision and cognition, visual form and communication became moral demands. Rather than seeking to explicate current practice, as one might expect from the title of the collection, Kepes pointed to what he saw as solipsism on the part of contemporary artists (Kepes 1960, 10). Reporting that in the wake of World War II, "I was impelled . . . to search for values rather than tools," Kepes faulted others for failing to fulfill the social responsibility that he defined for them, "to make our perceptual grasp of the world functional, meaningful, satisfying, and communicable" (ibid., 6). He chided his peers: "Some of the discourse in these pages would have been obviated if the contemporary scene were not so vast, noisy, confused, and contradictory, and also if its values were accessible. . . . We need, therefore, more than the artist's capacity to respond strongly to aesthetic facts: we also need clear, comprehensive thinking" (ibid., 8).

Kepes was heavily criticized for the book's unusual emphasis on the point of view of older scholars with little evident effort to incorporate the work of young artists and thinkers.[23] Yet if Kepes did not grasp the motivations of the Abstract Expressionists and others active during the 1950s, ridiculing Jackson Pollock and Willem de Kooning, the issues which he would identify as being of interest to himself – symmetry, the relationship between body and mind, photography, film, proportion, and perception – would define a new generation of artistic practice by pop, minimal, and post-minimal artists, such as Roy Lichtenstein, Andy Warhol, Donald Judd, Sol LeWitt, Robert Morris, Robert Irwin, and James Turrell.[24] But Kepes' failure to include a single essay or statement by artists or critics actively engaged with avant-garde practice of the 1950s prevented such parallels from surfacing in this volume. In his review of the book, Richard Hamilton, an artist and intellectual deeply involved with Britain's Independent Group, lamented Kepes' failure to truly engage with contemporary art, but also concluded with the observation: "While being naïve in the extreme in his

---

[22] It was not until the late 1960s and early 1970s, with the rise of more environmentally-minded art, that Kepes' perceptions of vanguard art as a whole began to change. The final volume in Kepes' Vision and Value series (discussed below), *Arts of the Environment*, contained an essay by Robert Smithson on "The Spiral Jetty" as well as an essay by the Yale-based artists group, Pulsa (see Kepes 1972). A preliminary program for a symposium on "Art and the Environment" organized by Gyorgy Kepes for CAVS for February 14–15, 1972, included several highly regarded contemporary artists: Robert Smithson, Hans Haacke, Patrick Clancy, Robert Morris, Alan Sonfist, Yvonne Rainer, and Otto Piene (Robert Smithson and Nancy Holt Papers, Archives of American Art, Smithsonian Institution [hereafter AAA], Roll 3833). However, the final program indicates that of this group, only Piene participated (Gyorgy Kepes Papers, Exhibition Files, AAA).

[23] See Calas 1960, 7; Banham 1961, 299; and Galloway 1962, 282–84. Several years later, Fenton addressed flaws he perceived in Kepes' arguments (Fenton 1969, 24–27).

[24] Essays on these topics are provided by eminent scholars and artists who had built their reputations a generation – or more – earlier, including Andreas Speiser, Rudolph Wittkower, James J. Gibson, E. H. Gombrich, Edward Steichen; Maya Deren's essay on cinematography was a notable exception and was duly noted and praised by reviewers (Kepes 1960). For Kepes' remarks on Pollock and de Kooning, see Kepes 1960, 11.

understanding of contemporary art, his studies on the nature of vision abound with notions of great importance for the visual artist today" (Hamilton 1961, 91).[25]

The relationship that Richard Hamilton perceived between Kepes' engagement with principles of vision and design and the work of contemporary artists points again to the widespread interest among contemporary artists during this period in intersections between the arts and sciences. Michael Lobel's recent study of Roy Lichtenstein, for example, demonstrates how engaged the pop artist was with scientific theories of vision and cognition.[26]

Hamilton's critique of Kepes' inability to draw connections between his project and that of many emerging pop and minimal artists resurfaced in a review by art critics Lucy Lippard and John Chandler of Kepes' then six-part Vision and Value series, published between 1965 and 1966.[27] The collective name of the series drew upon Kepes' interest in the problem of bringing a new language of vision to bear on the technological scientific values that pervaded society. Modeled after the Bauhaus books, the volumes dealt with particular themes of interest to Kepes, including symmetry, kinetics, modules, symbols, and the environment. Rather than having each book devoted to the viewpoint of a single individual, as had been done at the Bauhaus, Kepes invited a broad range of contributions from noted scientists, cultural theorists, and artists for each volume. Most were introduced with a statement by Kepes. The contributors included literary historian and theorist Leo Marx; psychologists Rudolph Arnheim, Anton Ehrenzweig, and James J. Gibson; composer John Cage; artists Johannes Itten and Ad Reinhardt; sculptor George Rickey; engineer and designer Buckminster Fuller; media theorist Marshall McLuhan; architects Alison and Peter Smithson; historian Siegfried Giedion; mathematician Jacob Bronowski; and biologist C. H. Waddington.[28] While the series had influential admirers, several critics raised concerns about its content, organization, and omissions.[29] Chandler and Lippard noted the "nearly total disregard for the art of the last 15 years" despite the obvious interest of a number of

[25] On the British Independent Group, see Whiteley 2002, 82–139.

[26] See in particular chapter 3 of Lobel's study, "Technology Envisioned: Lichtenstein's Monocularity" (Lobel 2002, 75–103).

[27] I thank Linda Dalrymple Henderson for bringing this review to my attention. Although the bulk of the series appeared between 1965 and 1966, the Vision and Value series eventually grew to seven volumes in 1972. The Vision and Value series, published in its entirety by George Braziller, New York, consisted of: *The Education of Vision* (1965); *Structure in Art and Science* (1965); *The Nature of Art and Motion* (1965); *Module, Proportion, Symmetry, Rhythm* (1966); *The Man-Made Object* (1966); *Sign, Image, Symbol* (1966); and *Arts of the Environment* (1972).

[28] These are contributors to the first six volumes. It is worth noting that like Reyner Banham and Richard Hamilton, cited above, Alison and Peter Smithson were members of the British Independent Group; they were among those to whom Banham dedicated *Theory and Design in the First Machine Age* (Banham [1980/1960] 1989; for more on the Independent Group, see Whiteley 2002, 82–139). See Davis 1968, 39, for further information on the seventh Vision and Value volume, *Arts of the Environment*.

[29] Mumford was among those whose praise was quoted in advertisements for the book series; also notable is that of Herbert Read. See, for example, advertisement for the Vision and Value Series, *Arts Magazine* (May 1968) 42(7):1.

minimal and pop artists in such topics as "module, proportion, symmetry, and rhythm," the subject of one of Kepes' volumes (Chandler and Lippard 1967, 28).

Intriguingly, Chandler and Lippard began their joint review with an observation of direct concern to the present study: "While practicing artists and practical engineers were collaborating on their *Nine Evenings of Art and Engineering for the Armory*, the final volumes of Gyorgy Kepes' Vision and Value series were made available to the reading public" (ibid., 27). Just as Kepes was concluding the series of volumes that would directly advance the foundation of CAVS, the event that would inspire Klüver to co-found E.A.T. was underway.

Born of connections Billy Klüver fostered between avant-garde artists and engineers at Bell Labs, *Nine Evenings of Theater and Engineering*, performed in October 1966, grew out of the synergy produced by an unconventional career. Twenty years younger than Kepes, Klüver too had been raised in Europe, in Klüver's case, Sweden, and had developed an early interest in film. Indeed, it was largely this interest that encouraged Klüver to immigrate to the United States as a young man (Klüver 1999). However, unlike Kepes, Klüver did not perceive an inherent link between art and science, but instead pursued an alliance between art and technology.

After completing his Ph.D. in electrical engineering at Berkeley, Klüver accepted a job in 1958 with Bell Labs, located just outside New York City. With the encouragement of his childhood friend, the curator K. G. Pontus Hulten, Klüver spent his free time in New York, becoming acquainted with a group of emerging avant-garde artists. Unlike Kepes, Klüver found contemporary art extremely invigorating. His increasing involvement with the New York art scene encouraged him in his work as an engineer. In a recent interview, Klüver explained: "The reason I invented [the concept of] art and technology was because of that I could do something [with these artists.] There was a tremendous amount of energy in the art world. I watched them [and wondered], how would they react [to these new technologies]?" (ibid.).

One of Klüver's first collaborative projects with an artist was to assist Jean Tinguely in the construction of *Homage to New York* (fig. 2). Klüver took his participation in the event seriously, involving his assistant at Bell Labs, Howard Hodges, to help devise an electronic system by which the sculpture, a self-destructive machine, could destroy itself. Yet although the mechanical sculpture served no functional purpose, not even prolonged aesthetic contemplation, Klüver found nothing offensive in it, complimenting the artist instead for his understanding of "the ideal of good machine behavior," which Klüver characterized precisely *as* "[t]he self-destruction or self-elimination of the machine"(Klüver 1968a, 171). Indeed, Klüver did not interpret Tinguely's sculpture as a critique of the machine itself, but rather as a playful endorsement of the "humor and poetry" that results when the machine becomes *more* than a transparent, functional object (ibid.).

Klüver's involvement in the development and performance of Tinguely's *Homage to New York* informed his understanding of the goals of contemporary art and their relationship to the world of engineering of which he was a part. Working
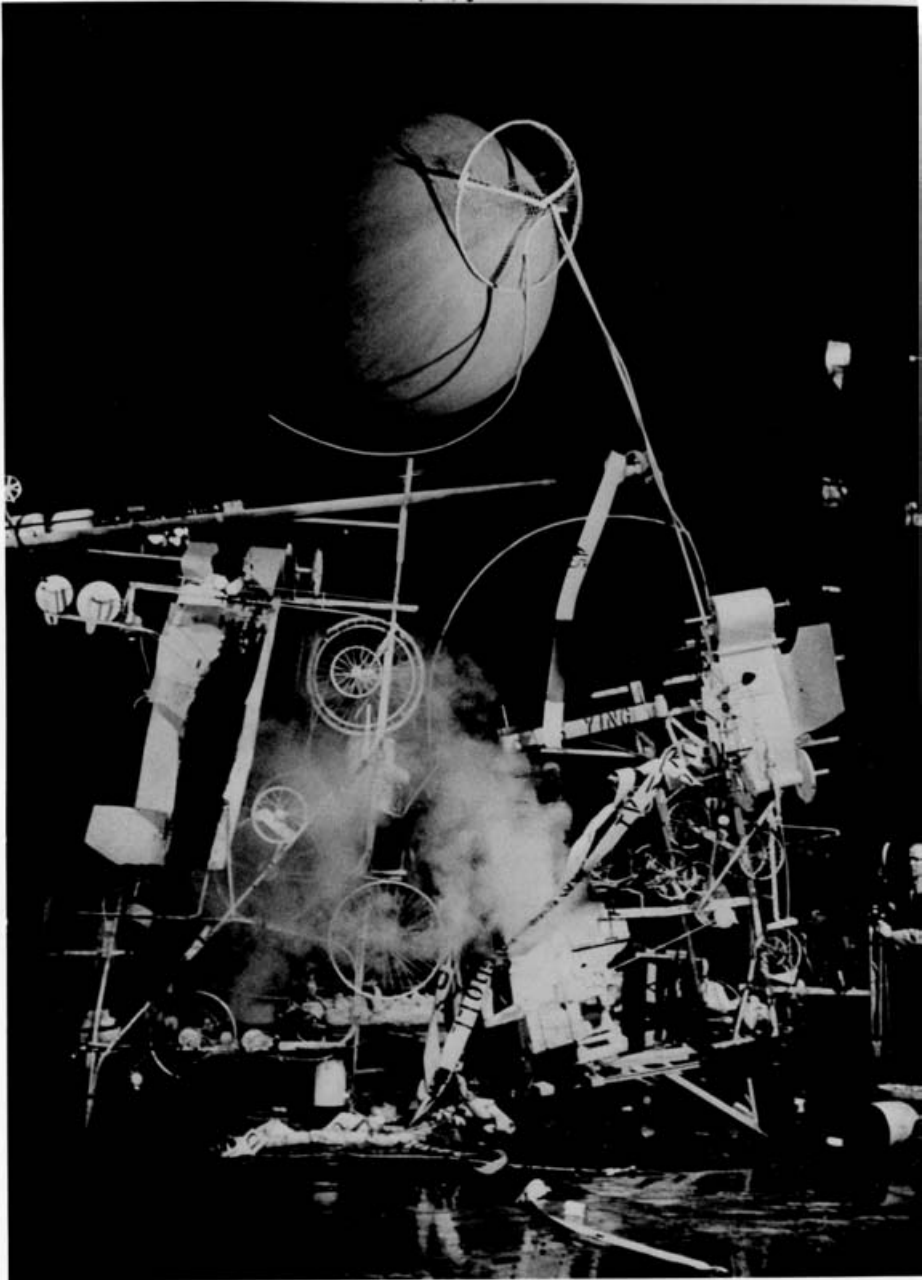
Fig. 2. David Gahr, *Homage to New York* by Jean Tinguely, 1960, gelatin silver print. © David Gahr. Photo: courtesy David Gahr.

with Tinguely, Klüver recognized an affinity between the artistic process and the engineer's experiment. "In the same way that a scientific experiment can never fail, this experiment in art could never fail," wrote Klüver. "The machine was not a functional object and was never treated like one. The spectacle can therefore not be judged in terms of whether this or that thing did not work" (ibid.). Aside from Tinguely's philosophic embrace of process – or experiment – Klüver was also intrigued by the artist's fascination with "the possibilities of engineering." He observed that, "[a]s an engineer, working with him, I was part of the machine. This new availability was largely responsible for the size and complexity of the machine" (ibid.). Witnessing the compatibility of viewpoints of artist and engineer proved an epiphany: "At that point, I realized I could do something technical for artists" (Klüver 1999).

From the first, Klüver indicated his discomfort with science as a partner for the artist. Unlike Kepes, Klüver felt strongly that art and science were not compatible elements. An early statement reveals how different Klüver's position was from that of Kepes. Including a representative quotation of his own in the publication accompanying the exhibition *Art 1963 – A New Vocabulary*, Klüver wrote, in a Duchampian vein:

> I am afraid of the consequences of a science which is built on concepts like symmetry, invariance, uniqueness, time and beauty. I would love it if the purpose of science was to create surprise, nonsense, humour, pleasure, and play. (Kaprow and Klüver 1962, 3)[30]

Klüver's discounting of science as something rigid and predictable and his espousal instead of "surprise, nonsense, humour, pleasure, and play" suggests his desire for a physical rather than purely theoretical involvement in art-making. For Klüver it was in the realm of real engagement with materials that new possibilities might be tested, defying expectations.

Klüver pursued his desire for a tangible connection with the creation of technically-informed artworks by collaborating with artists in his capacity as engineer. These projects included working with Robert Rauschenberg on the construction of the multi-sensory environment *Oracle* (fig. 3), Jasper Johns on the creation of artworks incorporating neon elements, Andy Warhol on the development of a floating sculpture, and Marcel Duchamp on the repair of a *Rotorelief*. In the course of these partnerships and others, Klüver invited scores of artists to tour Bell Labs. He later attested to the tremendous impact of this unusual access to cutting-edge technology, explaining: "the artists could see the hands-on process and one could actually *do* things" (Ramljak 1991, 32).

---

[30] Compare Duchamp's 1963 statement, "If I do propose to strain a little bit the laws of physics and chemistry and so forth, it is because I would like to think them unstable to a degree" (Roberts [1963] 1968, 63). Duchamp's remark clearly echoes the analysis Lebel (1959, 29) had offered earlier "If he [Duchamp] proposed to strain the laws of physics and chemistry just a little, it is because he wants us to think them unstable to a degree." On Duchamp's fascination with science and technology, see Henderson 1998.
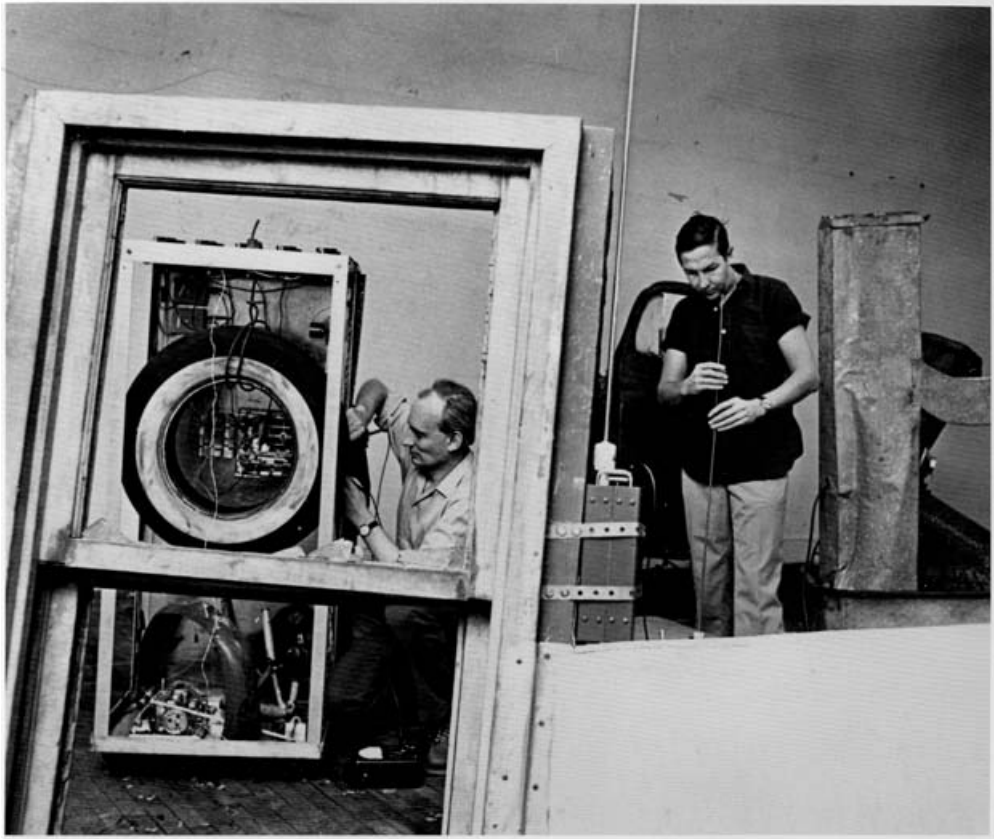
Fig. 3. Billy Klüver and Robert Rauschenberg working on *Oracle*, 1962–1965, gelatin silver print. Photo: courtesy Klüver/Martin Archives.

The intersection that Klüver created between Bell Labs and interested New York artists became the basis for *Nine Evenings: Theater and Engineering*, performed at the 69th Regiment Armory in October 1966. Working in conjunction with approximately thirty research engineers from Bell Labs, each of ten artists active at the Judson Church created a unique performance taking advantage of various experimental technologies.[31] They included dancers and choreographers Lucinda Childs, Deborah Hay, Steve Paxton, and Yvonne Rainer, composers John Cage and David Tudor, and visual artists Öyvind Fahlström, Alex Hay, Robert Rauschenberg, and Robert Whitman. Robert Rauschenberg's *Open Score* featured the first documented use of infrared photography by an artist, while Robert Whitman incorporated the new technology of video in

---

[31] For discussions of this series of performances, see Goodyear 2002, 182–203, passim; Bijvoet 1997, 31–36; and Loewen 1975, 46–89.

Two Holes of Water – 3. Alex Hay's *Grass Field*, employed electrodes and amplifiers to broadcast normally inaudible sounds of muscle movements, such as those of the heart and eyelids. Taking their lead from Klüver, the artists drew parallels between their creativity and that of the research scientist – or engineer. The emphasis on process on the part of artists seemed to have an analogous relationship to the role of the experiment for the engineer. Taking criticisms of the show's technical difficulties and late starts in stride, the artists involved in *Nine Evenings* compared themselves to engineers on the verge of a breakthrough: As Alex Hay told Simone Whitman, "Billy once mentioned that at Bell Labs any scientist who didn't have a ninety percent failure record on his experiments was not considered a good scientist. I understood this to mean that a good scientist is working on the outer limits of his understanding. That if a scientist who experiments consistently turns out to be successful, it means that the scientist is wasting time [proving] matters which he already knows to be true."[32] A willingness to take risks and explore new ideas linked artists with their engineer partners.

Due to an outpouring of interest in the intersection between art and engineering, Klüver joined forces with engineer Fred Waldhauer and the artists Rauschenberg and Whitman to found Experiments in Art and Technology the following month, in November 1966 (Klüver 1983, 54). Among the individuals to support this initiative was Gyorgy Kepes, who served both as a member of the Board of Directors and the Council of Agents for the new organization (E.A.T. 1967b, 7).[33]

Yet despite friendly contact between E.A.T. and CAVS, it was evident from the first that the projects and motivations of the two organizations were substantially different. Unlike Kepes, Klüver did not see his interaction with artists as part of a chain of historical continuity, but instead as a revolution in art, introducing a new strain of artistic practice. In the midst of *Nine Evenings*, Klüver claimed, "This would not have happened 50 years ago. The Futurist painters talked about science, they painted science, but they would never call for scientists. They dreamed about airplanes, but would never go close to one. It was all abstract to them."[34] E.A.T. was not about homage to the past, but instead about the connection of young artists with present-day concerns. As Klüver asserted in 1967, "The new interface between artists and engineers . . . has not developed only out of the historical relationship between art and technology. It has rather been born out of the direction and the nature of contemporary art itself" (Klüver 1967, 3). Indeed, the search for new media, for new means to recast the traditional

---

[32] Alex Hay, quoted in Whitman 1966, 5.

[33] Despite theoretical differences between Kepes and Klüver and the organizations they spawned, the two maintained a collegial relationship. Reciprocating Kepes' service on the E.A.T. Board of Directors and Advisory Council (Loewen, 119–120), Klüver (1999) took an interest in CAVS, participating in the Center's inaugural symposium in March 1968. A report on the event is provided by Spruch 1969. Correspondence between Klüver, Kepes, and Rauschenberg indicates cordial, if limited, communication (Billy Klüver to Gyorgy Kepes, 27 February 1968, Experiments in Art and Technology Records, GRI; and telegrammed invitation from Robert Rauschenberg to Kepes, 14 Jan. 1969, with a notation that Kepes "refused politely," Gyorgy Kepes Papers, reel 1211, AAA).

[34] Klüver, quoted in Gruen 1966.

categories of art-making by recourse to new materials and methods, was characteristic of the New York avant-garde art scene in the 1960s. In the words of Chuck Close:

> Things very much came out of the idea that the way to liberate yourself from the conventions and traditions of the past was to find a material that didn't have historic usage and see what it would do. What does rubber do? What does lead do? You wouldn't have wanted to use bronze, you wouldn't have wanted to use any traditional art material when the idea was to find a process and go with it. (Storr 1998, 88)

Although Close's comments pertain to his decision to create painted portraits based upon photographs, his insight also helps to illuminate some of the artistic goals that animated E.A.T.

In keeping with Klüver's views, E.A.T. focused on promoting interconnections between art and engineering. In a recent interview, Klüver explained that "there were a couple of things when E.A.T. began that we avoided immediately. One was to call it art and science. . . . 'Art and science' has a feeling of fakery to me. . . . Art cannot contribute anything to science as I see it" (Klüver 1999). Klüver continued to believe that the theoretical nature of science made it incompatible with the physical nature of art (Davis 1968, 42). Engineering, on the other hand, which engaged with manipulating technological materials, appeared to have a natural connection with artistic activity. Klüver reiterated his viewpoint in a 1968 interview with Douglas Davis, "The engineer and the artist deal with the physical world and work for direct solutions of problems. The scientist is not trained to deal with and handle the physical world" (ibid.).

The conceptual differences between the CAVS and E.A.T. were reflected in the forms the two organizations took. While the Center was formed as part of an organized academic institution, functioning as an artistic "think-tank," Klüver and Rauschenberg resisted pressure to institutionalize E.A.T. Unlike the Center for Advanced Visual Studies at MIT, Klüver, Rauschenberg, and others felt strongly that E.A.T. should not become a destination in itself. Instead, they believed it could function more effectively as a matching agency, bringing interested parties together. The fluid structure espoused by the organizers of E.A.T. went hand-in-hand with another radical notion that differentiated it from Kepes' Center. Almost from the moment of its appearance, E.A.T.'s organizers predicted its eventual demise. As one of E.A.T.'s first newsletter's stated: "Once it has achieved the change in the cultural and industrial climate so that industry can assume a more direct responsibility for the sponsorship of the artist-engineer collaboration, the function of E.A.T. as a mediator may well disappear" (E.A.T. 1967a, 4). Robert Rauschenberg later put it more succinctly, "If E.A.T. were successful, it would be unnecessary" (Davis [1973] 1975, 145).[35] CAVS, by contrast, was built to last, enduring to the present moment, while E.A.T., perhaps appropriately, has disappeared from the scene.

---

[35] See also Klüver's reiteration of this claim (Miller 1998, 29).

E.A.T. modeled itself in large part after the corporate sponsors it sought to attract, complete with a president and a Board of Directors. The organization's first newsletter, dated January 15, 1967, concludes with a flowchart describing the "proposed organization of E.A.T." Although the chart was roundly rejected by E.A.T. members and subsequently redesigned in a humorous fashion by Klüver in a letter to members, the underlying philosophy of the organization did not change significantly (Loewen 1975, 96).

But if E.A.T. emulated the organization of industry, the agency did so with utopian ideals in mind. Soliciting the support of industry for the collaborations between artists and engineers promised nothing short of a social revolution.[36] Just as Kepes felt that science and art could positively inform one another, so Klüver argued that art could redefine the goals of engineering, while technology could expand the possibilities of art. An early E.A.T. *Newsletter* declared:

> The collaboration between artists and engineers should produce far more than merely adding technology to art. The possibility of a work being created that was the preconception of neither the artist nor the engineer is the raison d'être of the organization. The engineer must come out of the rigid world that makes his work the antithesis of his life and the artist must be given the alternative of leaving the peculiar historic bubble known as the art world. The social implications of E.A.T. have less to do with bringing art and technology closer together than with exploring the possibilities of human interaction. (E.A.T 1967a, 4)

Almost immediately after its foundation, E.A.T. devised an "Artists in Residence Program," which moved artists into industrial partnerships. In the fall of 1968, the Singer Company announced that it would take on Mel Bochner as part of this program (E.A.T. 1968, unpaginated). This gesture was soon imitated by CBS, which agreed to set up two residencies for artists – one for a painter and one for a sculptor – for the year 1968 (Stanton 1968, 13). Shortly thereafter, Klüver announced that "Local One of the Amalgamated Lithographers of America ha[d] set up an experimental lithographic workshop for artists to use their advanced equipment" (Klüver 1968b, 5). In addition to facilitating residencies for artists, the organization developed extensive files which permitted it to match the needs of a given artist with the expertise of particular engineers.[37] In order to create the interactive sculptural installation *Soundings*, for example, which featured images of a chair on Plexiglas illuminated by sound-triggered lights, Rauschenberg worked, through E.A.T., with a group of Bell Labs engineers and scientists capable of devising circuitry to respond differently to the various voice pitches of audience members (Klüver with Martin 1997, 318–19).

The theoretical distinction drawn by Klüver between the relationship of art to engineering and science had an important bearing on the nature of E.A.T. and its

---

[36] Edward Shanken similarly recognizes the social agenda implicit in E.A.T.'s goals (Shanken 1998, 1–4).
[37] Billy Klüver and Julie Martin developed a system of hole-punching file cards so that matching records could be speared by the insertion of knitting needles (Klüver 1999).

goals. More so than CAVS, E.A.T. committed itself to art projects with definable ends, no matter how unconventional those might be from an aesthetic or technological viewpoint. As a result, many of the art projects undertaken by E.A.T. produced engineering breakthroughs and new inventions, though the commercial applications of such innovations were not always obvious.[38] Rauschenberg expressed his pride in the practical ramifications of E.A.T.'s collaborations in an interview conducted twenty years after the establishment of E.A.T.: "Something like nineteen brand–new patents that were direct results of Nine Evenings of Theater and Engineering went to the credit of the engineers of the respective companies. . . . The technology that went into *Soundings* contributed to a cure for deafness that is almost perfect now" (Rose 1987, 70).

By contrast, CAVS could not measure its success by virtue of its tangible results during the period that Kepes led it, which is not to diminish the importance of Kepes' legacy.[39] Despite a friendly atmosphere at the Center, few of the original fellows were committed to the prospect of working together on large scale communal art projects, such as a floating light sculpture for Boston Harbor (fig. 4), favored by Kepes. Many of these were envisioned as artistic undertakings that would ameliorate the urban environment, such as improving water supplies or cleaning up decayed neighborhoods. Despite Kepes' laudable aspirations, the ambitious nature of these undertakings meant that few came to fruition, leading one disillusioned former fellow, Jack Burnham, to criticize what he perceived as the impractical nature of the Center's projects (Burnham 1986, 240–41).[40]

Despite Burnham's disappointment, the affinity of these proposals with conceptual and environmental art, which permitted the creation of "thought projects" with no expectation of physical realization, cannot be overlooked, as Otto Piene has observed (Piene 1978). Kepes himself seems to have recognized that the dissemination of ideas was one of the most important contributions he could make to art during this period.

---

[38] One exception was a system for the production of water mist created to simulate clouds for E.A.T.'s Pepsi Pavilion, created for Expo '70 in Osaka. Physicist Tom Mee, who developed the technology in collaboration with Japanese artist Fujiko Nakaya, was able to adapt it for agricultural applications (Lindgren 1972, 48). Further testament to Mee's long-term success is provided by his letter to art historian and critic Barbara Rose, who was closely involved with E.A.T.'s Pavilion (Thomas R. Mee, Letter to Barbara Rose, 2 July 1991, Barbara Rose Papers, Box 2, Folder 12, Getty Research Institute for the History of Arts and the Humanities, hereafter GRI); in his letter to Rose, Mee included a number of newpaper articles on his invention: Marshall Ingwerson, "Tom Mee Sells Fog," *Christian Science Monitor*, 1 Mar. 1985; E. Shapiro, "Need a Little Fantasy?" *New York Times*, 10 Mar. 1991; Bruce Keppel, "Tom Mee's Fog Machine . . . ", *Los Angeles Times*, Business Section, 2 May 1985; and J. E. Ferrell, "Fog for Sale," *The Plain Dealer* (Cleveland), 10 July 1990. On technological innovations produced by E.A.T. see Ramljak 1991, 34; Davis 1968, 35; Miller 1998, 25–27.

[39] Bijvoet makes a similar observation (Bijvoet 1997, 44, 46, 51).

[40] The Boston Harbor sculpture was to have consisted of "floating mirroring buoys in the harbor and a mile-long programmed luminous wall." Although it was never completed, one segment of the piece, an artificial rainbow, designed by CAVS fellow Otto Piene (later Director of CAVS) was eventually realized at the Munich Olympics in 1972 (Wechsler 1978, 14). For more on CAVS projects during this period, see Bijvoet 1997, 45–50, and Wechsler 1978, 14–16.

Fig. 4. Gyorgy Kepes, *Simulated effects of a proposed mile-long programmed luminous wall, suggested for the Boston Harbor Bicentennial*, 1964–1965. Photo: courtesy Kepes family.

In the late 1960s and early 1970s, the artist devoted himself to a host of intellectual undertakings, which included the publication of *Arts of the Environment*, the seventh and final installation of the Vision and Values series, and the organization of symposia and exhibitions.[41]

The most significant of the shows Kepes put together was "Explorations," originally planned as the 1969 American contribution to the tenth São Paulo Biennale. After pressure from artists compelled Kepes to cancel American participation abroad, due to political concerns, a modified version of the show appeared at the Smithsonian Institution's National Collection of Fine Arts in the spring of 1970.[42] The exhibition coincided with a new receptivity on Kepes' part to vanguard contemporary art. In "Toward Civic Art," written for the accompanying catalogue, Kepes praised the new approach to scale and to "the social framework of the creative process" that it represented (Kepes 1970, [1]). Among the artists whose work he admired was earthworks artist Robert Smithson, with whom he initiated a correspondence. Smithson obliged Kepes by contributing an essay on his seminal work, *Spiral Jetty*, created on the Great Salt Lake in Utah, to *Arts of the Environment* (Smithson 1972).[43] Kepes in turn discussed the possibility of a fellowship for Smithson at CAVS and invited him to speak at numerous symposia.[44] Although Smithson ultimately did not travel to CAVS for these programs, he did express his interest in these opportunities and in Kepes' work.[45] By contrast, Smithson distanced himself from the technologically-oriented art associated with E.A.T.[46]

---

[41] See note 22 on the symposium "Art and the Environment," held February 14–15, 1972.

[42] One of the artists to voice particularly strong opposition to the São Paulo Biennale was Robert Smithson (Smithson [1969] 1996, 369). Critic Lucy Lippard similarly urged Kepes not to participate (Lucy Lippard, Letter to Gyorgy Kepes, 4 July 1969, Papers of Lucy Lippard, AAA.) "Explorations" appeared at the National Collection of Fine Arts from 4 April to 10 May 1970.

[43] On this contribution, see George Braziller to Smithson, Oct. 22, 1969; and Kepes to Smithson, Oct. 6, 1970. Assorted correspondence with editors at George Braziller indicates that Smithson met his deadlines and provided illustrations for the essay (James T. Burns to Smithson, June 17, 1970; and Victoria de Ramel's letters to Smithson of Jan. 20, 1972; Jan. 31, 1972; and Nov. 9, 1972). His participation earned him $500.00 (James T. Burns to Robert Smithson, Nov. 26, 1969). All correspondence in the Robert Smithson and Nancy Holt papers, AAA, reel 3833.

[44] Smithson appears to have turned down the multiple invitations he received to participate in symposia, despite expressions of interest in participating. See Kepes to Smithson on April 1, 1970; April 16, 1970; April 29, 1970; May 19, 1971; May 25, 1971; July 16, 1971; Aug. 24, 1971; Nov. 3, 1971; Nov. 16, 1971; and Dec. 9, 1971; see also tentative program for symposium on "Art and the Environment," February 14–15, 1972, all in Robert Smithson and Nancy Holt Papers, AAA, reel 3833. See also note 22.

[45] In late 1970, Smithson wrote to Kepes to explore a fellowship at CAVS (Smithson to Kepes, undated). However, despite Kepes' immediate telegrammed response (Kepes to Smithson, undated), Smithson's interest appears to have faded when Kepes informed him that CAVS could not provide funding to him for a large-scale project (Kepes to Smithson, May 25, 1971). For this correspondence, see Robert Smithson and Nancy Hold Papers, AAA, reel 3833.

[46] Critiquing E.A.T.'s *Nine Evenings: Theater and Engineering* in a 1966 essay entitled "An Esthetics of Disappointment," Smithson ([1966] 1979) declared "art's latest derangement at the 25th Armory seemed like The Funeral of Technology," commenting that the show's technical shortcomings and the frustration of the

As Smithson's complex response to CAVS and E.A.T. suggests, a comparison of the alternative visions of CAVS and E.A.T. is instructive for many reasons. Although Kepes and Klüver received significant recognition in the 1960s, in a climate of heightened awareness of the social impact of science and technology, their divergent outlooks reflect a coming of age at different moments, Kepes, in the 1920s, when popular interest in Einstein's Theory of Relativity was at its height, and Klüver, in the wake of the Second World War, as many new materials and electronic technologies were under development.[47] The differences in their perspectives suggest the need for a careful distinction between the enterprises of science and technology as well as between the conceptual versus material implications of partnerships between art, science, and technology.

For the art historian, it is less important to define "technology" and "science" ontologically, for such philosophical investigation is itself historically based, than to examine how particular artists responded to these disciplines at the time.[48] It is not surprising that several artists connected with the broadest manifestations of the "Pop" movement, named for its engagement with popular culture, such as Jasper Johns, Robert Rauschenberg, and Andy Warhol, should have approached Klüver for technical assistance engaging contemporary technologies, nor that Kepes' connection with the art of the sixties should have been with those artists, like Robert Smithson, who were more conceptually and environmentally minded. But perhaps most importantly, the alternative visions and perspectives of these two organizations complicate the well-established historical model of the "art and technology" movement of the 1960s both by the intrusion of the enterprise of science into the area and by the direct confluence of early twentieth-century ideals into the later period. The "second machine age" of the 1960s represented both a moment of culmination for visions dating back to the first part of the twentieth century, as well as the origin of new perspectives on the relationship of art to science and technology. At the same time, despite underlying differences in their goals, methods, and motivations, the organizers of these initiatives shared the conviction that art could help shape the development of science and technology, a belief capable of forging alliances between those who advocated revolution in contemporary art, and those who relished a sense of historic continuity.

---

audience constituted "a victory for art." Nearly three years later, withdrawing from the São Paulo Biennale, he wrote Kepes: "If technology is to have any chance at all, it must become more self-critical. . . . A panel called 'What's wrong with Technological Art' might help" (Smithson [1969] 1996).

[47] On the strong popular interest in Einstein's general theory of relativity during the 1920s, see Caton 1984, 37; and Henderson 1983, 358–59.

[48] It is noteworthy, for example, that Heidegger's famous essay "The Question Concerning Technology," which concerns art's relationship to technology, was published in 1954, during the period in which the question of the relationship between the humanities and the sciences was taking on a new importance (William Lovitt 1977, ix; and Heidegger [1954]1977).

References

Alford, John. 1958. Review of *The New Landscape in Art and Science* by Gyorgy Kepes and *The Anatomy of Nature* by Andreas Feininger. *Journal of Aesthetics and Art Criticism* 17:126–28.

Allen, James Sloan. 1983. *The Romance of Commerce and Culture: Capitalism, Modernism, and the Chicago-Aspen Crusade for Cultural Reform*. Chicago: University of Chicago Press.

Banham, Reyner. 1961. "Essays on Art." *Architectural Review* (May) 129(771):299.

Banham, Reyner. [1960] 1975. "Introduction – The Machine Age." In *Theory and Design in the First Machine Age*. 2d ed. New York: Praeger Publishers.

Banham, Reyner. [1980/1960] 1989. *Theory and Design in the First Machine Age*. 2d ed. Cambridge: MIT Press.

Beardslee, David C. and Donald D. O'Dowd. 1962. "The College-Student Image of the Scientist." In *The Sociology of Science*, edited by Bernard Barber and Walter Hirsch, 247–258. New York: Free Press.

Benthall, Jonathan. 1974. "Kepes's Center at MIT." *Art International* (January 20) 29(1):28–31, 49.

Bijvoet, Marga. 1997. *Art as Inquiry: Towards New Collaborations between Art, Science, and Technology*. New York: Peter Lang.

Boxer, Adam. 1993. *The New Bauhaus: School of Design in Chicago, Photographs 1937–1944: László Moholy-Nagy, György Kepes, Arthur Siegel, Nathan Lerner, James Hamilton Brown*. Exh. cat. New York: Banning and Associates.

Burnham, Jack. 1986. "Art and Technology: The Panacea That Failed." In *Video Culture: A Critical Investigation*, edited by John G. Hanhardt, 232–248. Rochester, Visual Studies Workshop Press.

Calas, Nicolas. 1960. "Art in Academe," *Art News* (September) 59(5):37, 57–58.

Caton, Joseph Harris. 1984. *The Utopian Vision of Moholy-Nagy*. Ann Arbor: UMI Research Press.

Chandler, John and Lucy R. Lippard. 1967. "Visual Art and the Invisible World." Review of *Vision and Value* Series, edited by Gyorgy Kepes. *Art International* (May 20) 9(5):27–30.

Collini, Stefan. [1959] 1993. "Introduction." In *The Two Cultures*, by C. P. Snow. Cambridge: Cambridge University Press.

Crowther, J. G. 1931. *An Outline of the Universe*. London: Kegan Paul, Trench, Trubner.

Davis, Douglas. 1968. "Art and Technology – Conversations [Interviews with Gyorgy Kepes, Billy Klüver, and James Seawright]." *Art in America* 56:28–47.

Davis, Douglas. [1973] 1975. *Art and the Future: A History/Prophecy of the Collaborations Between Science, Technology, and Art*. New York: Praeger Publishers.

E.A.T. 1967a. *E.A.T. News* 1(2) (1 June). Experiments in Art and Technology Records, Archives of American Art, Smithsonian Institution (AAA).

E.A.T. 1967b. *E.A.T. News* 1(3) (1 November). Experiments in Art and Technology Records, Archives of American Art, Smithsonian Institution (AAA).

E.A.T. 1968. "Press Package," 18 September, n.p., Experiments in Art and Technology Records, Archives of American Art, Smithsonian Institution (AAA).

Eckbo, Garrett. 1958. Review of *The New Landscape in Art and Science* by Gyorgy Kepes. *Landscape Architecture* 48:197.

Fenton, Terry. 1969. "Two Contributions to the Art and Science Muddle: 1. Constructivism and Its Confusions." *Artforum* (January) 7(5):22–27.

Fry, E. Maxwell. 1957. Review of *The New Landscape in Art and Science* by Gyorgy Kepes. *Journal of the Royal Institute of British Architects* 64:506.

Gabo, Naum. 1951. Letter to Gyorgy Kepes, 31 December. Gyorgy Kepes Papers, Archives of American Art, Smithsonian Institution (AAA).

Galloway, John C. 1962. Review of *The Visual Arts Today*, edited by Gyorgy Kepes. *Art Journal* 21:282–84.

Giedion, Siegfried. [1941] 1976. *Space, Time, and Architecture*. Cambridge: Harvard University Press.

Gombrich, E. H. [1960] 1989. *Art and Illusion: A Study in the Psychology of Pictorial Representation*. Princeton: Princeton University Press.

Goodyear, Anne Collins. 2002. "The Relationship of Art to Science and Technology in the United States, 1957–1971: Five Case Studies." Ph.D. diss., University of Texas at Austin.

Gruen, John. 1966. "Theater with the Avant-Garde: Art, Art and Phone Co. on Party Line," *World Journal Tribune*, 18 September. Experiments in Art and Technology Records, Archives of American Art, Smithsonian Institution (AAA).

Hamilton, Richard. 1961. Review of *The Visual Arts Today* by Gyorgy Kepes. *Design* 154 (October): 91.

Harrison, Newton. 1970. "Path." In *Explorations*, part 3, no. 10, n.p. Exh. cat., Washington, D.C., National Collection of Fine Arts, Smithsonian Institution, 4 April–10 May.

Hastorf, Albert H. 1958. Review of *The New Landscape in Art and Science* by Gyorgy Kepes. *Progressive Architecture* 39:218, 224, 228.

Hayakawa, S. I. [1944] 1995. "The Revision of Vision." In *Language of Vision*, by Gyorgy Kepes, 9–10. New York: Dover Publications.

Heidegger, Martin. [1954] 1977. "The Question Concerning Technology." In *The Question Concerning Technology and Other Essays*, translated by William Lovitt. New York: Harper and Row.

Henderson, Linda Dalrymple. 1983. *The Fourth Dimension and Non-Euclidean Geometry in Modern Art*. Princeton: Princeton University Press.

Henderson, Linda Dalrymple. 1998. *Duchamp in Context: Science and Technology in the Large Glass and Related Works*. Princeton: Princeton University Press.

Henderson, Linda Dalrymple. Forthcoming. "The Fourth Dimension 1950–2000." In *The Fourth Dimension and Non-Euclidean Geometry in Modern Art*. Cambridge, MA: MIT Press.

Henrion, F. H. K. 1959. Review of *The New Landscape in Art and Science* by Gyorgy Kepes. *Architectural Review* 126:300.

Johnson, Lyndon Baines. 1965. "Remarks for Signing of the National Foundation for the Art and the Humanities Act of 1965," 1; Enactment and Signing; Legislative Background: Arts and Humanities Foundation, Box 1, LBJ Library.

Jones, Caroline A. 1996. *Machine in the Studio: Constructing the Postwar American Artist*. Chicago and London: University of Chicago Press.

Kaprow, Alan, and Billy Klüver. 1962. *Art 1963: A New Vocabulary*. Exh. cat. Philadelphia: YM/YWHA, 25 October–7 November.

Kaufmann, Jr., Edgar. 1957. Review of *The New Landscape in Art and Science* by Gyorgy Kepes. *Architectural Record* 121:62, 67.

Kepes, Gyorgy. [1944] 1995. *Language of Vision*. New York: Dover Publications.

Kepes, Gyorgy. 1960. "The Visual Arts Today." Special issue edited by Gyorgy Kepes. *Daedalus* 89.

Kepes, Gyorgy. 1965. "The Visual Arts and the Sciences: A Proposal for Collaboration." *Daedalus* 94:117–33. Reprinted in *Architectural Record* 137:145–56.

Kepes, Gyorgy. 1968. Interviewed by Dorothy Seckler, 18 August, Wellfleet, Mass., sound recording on cassette, Archives of American Art, Smithsonian Institution (AAA).

Kepes, Gyorgy. 1970. "Toward Civic Art." In *Explorations*, part 2, n.p. Exh. cat., Washington, D.C., National Collection of Fine Arts, Smithsonian Institution, 4 April–10 May.

Kepes, Gyorgy, ed. 1972. *Arts of the Environment*. New York: George Braziller.

Kepes, Gyorgy. 1972–73. Transcript of interview by Robert Brown, 7 March and 30 August 1972 and 11 January 1973. Archives of American Art, Smithsonian Institution (AAA).

Klüver, Billy. 1967. "Interface: Artist/Engineer," *E.A.T. Proceedings* no. 1 (April 21). Talk delivered at MIT on that date. Experiments in Art and Technology Records, Archives of American Art, Smithsonian Institution (AAA).

Klüver, Billy. 1968a. "The Garden Party." In *The Machine as Seen at the End of the Machine Age*, by K. G. Pontus Hulten, 169–71. Exh. cat., New York, Museum of Modern Art. Greenwich: New York Graphic Society, Ltd. (Reprinted in Hulten, K. G. Pontus. [1972] 1975. *Jean Tinguely. 'Méta,'*130–43. London: Thames and Hudson.)

Klüver, Billy. 1968b. "The Artist and Industry," Talk given at the Museum of Modern Art, New York, 16 December, published as *E.A.T. Proceedings*, no. 4 (16 December). Experiments in Art and Technology Records, Archives of American Art, Smithsonian Institution (AAA).

Klüver, Billy. 1983. *What Are You Working On Now?: A Pictorial Memoir of the '60s*. Exh. cat., New York: P.S. 1, 16 January–13 March. New York: Experiments in Art and Technology.

Klüver, Billy. 1999. Interview with author (with input by Julie Martin) (13 January). Berkeley Heights, New Jersey.

Klüver, Billy, with Julie Martin. 1997. "Working with Rauschenberg." In *Robert Rauschenberg: A Retrospective*, organized by Walter Hopps and Susan Davidson, 310–327. Exh. cat. New York, Guggenheim Museum, 19 September 1997–7 January 1998. New York: Solomon R. Guggenheim Foundation.

Kubler, George. 1962. *The Shape of Time: Remarks on the History of Things*. New Haven: Yale University Press.

Kuhn, Thomas S. [1962] 1970. *The Structure of Scientific Revolutions*, 2d ed. Chicago: University of Chicago Press.

"Lab for Light." 1969. *The Architectural Forum* 130, no. 4 (May):62.

Lebel, Robert. 1959. *Marcel Duchamp*, translated by George Heard Hamilton. New York: Paragraphic Books.

Lee, Pamela M. 2001. "'Ultramoderne': Or, How George Kubler Stole the Time in Sixties Art." *Grey Room* (Winter) 2:46–97.

Lindgren, Nilo. 1972. "Into the Collaboration." In *Pavilion by Experiments in Art and Technology*, edited by Billy Klüver, Julie Martin, and Barbara Rose. New York: E. P. Dutton.

Lobel, Michael. 2002. *Image Duplicator: Roy Lichtenstein and the Emergence of Pop Art*. New Haven and London: Yale University Press.

Loewen, Norma. 1975. "Experiments in Art and Technology: A Descriptive History of the Organization." Ph.D. diss., New York University.

Lovitt, William. 1977. "Preface." In *The Question Concerning Technology and Other Essays*, by Martin Heidegger, translated by William Lovitt. New York: Harper and Row, 1977.

Margolin, Victor. 1997. *The Struggle for Utopia: Rodchenko, Lissitsky, Moholy-Nagy, 1917–1946*. Chicago: University of Chicago Press.

McCombie, Mary Eleanor. 1992. "Arts and Policy: The National Endowment for the Art's Art in Public Places Program, 1967–1980," Ph.D. diss., University of Texas at Austin.

McLuhan, Marshall. [1964] 1994. *Understanding Media: The Extensions of Man*. Cambridge: MIT Press.

Miller, Paul. 1998. "The Engineer as Catalyst: Billy Klüver on Working with Artists." IEEE Spectrum (July) 35(7):20–29.

Moffat, Isabelle. 2000. "'A Horror of Abstract Thought': Postwar Britain and Hamilton's 1951 *Growth and Form* Exhibition" *October*. (Fall) 94:89–112.

Moholy-Nagy, László. [1925] [1927] 1987. *Painting, Photography, Film*, translated by Janet Seligman. Cambridge: MIT Press.

Moholy-Nagy, László. 1938. *The New Vision: Fundamentals of Design, Painting, Sculpture, Architecture*, translated by Daphne M. Hoffmann. New York: W. W. Norton.

Moholy-Nagy, László. [1947] 1965. *Vision in Motion*. Chicago: Paul Theobald.

Moholy-Nagy, Sibyl. [1950] 1969. *Moholy-Nagy: Experiment in Totality*. Cambridge: MIT Press.

Moholy-Nagy, Sibyl. 1959. Review of *The New Landscape in Art and Science* by Gyorgy Kepes. *College Art Journal* 18:192–4.

Morgan, Robert. 1983. "Sermon for Tranquility: An Interview with Gyorgy Kepes." *Afterimage* 10:6–8.

Morris, Charles. [1956] 1967. "Man–Cosmos Symbol." In *The New Landscape in Art and Science*, edited by Gyorgy Kepes, 98–99. Chicago: Paul Theobald.

Piene, Otto. 1973. "For Gyorgy Kepes." In *Gyorgy Kepes: Works in Review*, 19–25. Exh. cat. Boston, Museum of Science, 15 May–12 September 1973.

Piene, Otto. 1978. Interview with Virginia Gunter, Spring, sound recording, Cassette 11, MIT, Committee on the Visual Arts, AC 48, Box 1, Institute Libraries and Special Collections, MIT Libraries, Cambridge, MA.

Ramljak, Suzanne. 1991. "Interview: Billy Klüver." *Sculpture* (May/June) 10(3):32–35.

Roberts, Francis. [1963] 1968. "Interview with Marcel Duchamp: 'I Propose to Strain the Laws of Physics." *Art News* (December) 67(8):46–47, 62–64. NB: Although published following Duchamp's death in 1968, this interview was conducted in 1963 on the occasion of Duchamp's retrospective at the Pasadena Art Museum.

Rose, Barbara. 1987. *Rauschenberg*. New York: Vintage Books.

Shanken, Edward A. [1998] 1999. "Gemini Rising, Moon in Apollo: Attitudes on the Relationship Between Art and Technology in the U.S., 1966–1971," *ISEA97: Proceedings of the Eighth International Symposium on Electronic Art* (Chicago: ISEA97, 1998. Reprinted in *Leonardo Electronic Almanac* (January 1999) 6:12.

Smithson, Robert. [1966] 1979. "An Esthetics of Disappointment: On the Occasion of the Art and Technology Show at the Armory." In *The Writings of Robert Smithson*, edited by Nancy Holt, 212. New York: New York University Press.

Smithson, Robert. [1969] 1996. Letter to Gyorgy Kepes, 3 July 1969. In *Robert Smithson: The Collected Writings*, edited by Jack Flam, 369. Berkeley: University of California Press.

Smithson, Robert. 1972. "The Spiral Jetty." In *Arts of the Environment*, edited by Gyory Kepes, 222–32. New York: George Braziller.

Snow, C. P. [1959] 1993. "The Rede Lecture, 1959." In *The Two Cultures*, with an introduction by Stefan Collini, 53–107. Cambridge: Cambridge University Press.

Snow, C. P. [1963] 1993. "The Two Cultures: A Second Look." In *The Two Cultures*, with an introduction by Stefan Collini, 53–107. Cambridge: Cambridge University Press.

Spruch, Grace Marmor. 1969. "Two Contributions to the Art and Science Muddle: 1. Constructivism and Its Confusions." *Artforum* (January) 7(5):28–32.

Stanton, Frank. 1968. President, Columbia Broadcasting System, Inc., Script for "Remarks for the North Carolina State Art Society," 29 November; Experiments in Art and Technology Records, Archives of American Art, Smithsonian Institution (AAA).

Storr, Robert. 1998. "Interview with Chuck Close," *Chuck Close*. Exh. cat. New York, Museum of Modern Art, 26 February–26 May. New York: Harry N. Abrams.

Takis. 1970. "Anti-Gravity." In *Explorations*, part 3, no. 23, n.p. Exh. cat., Washington, D.C., National Collection of Fine Arts, Smithsonian Institution, 4 April–10 May.

Thompson, D'Arcy Wentworth. [1917] [1942] 1952. *On Growth and Form*, 2 vols., 2d. ed. Cambridge: Cambridge University Press.

Tupitsyn, Margarita and Georg-W. Költzsch, eds. 2000. *Bauhaus: Dessau, Chicago, New York*. Exh. cat. Essen, Museum Folkwang, 12 Aug.–12 Nov. 2000. Cologne: Dumont.

Wechsler, Judith. 1978. "Gyorgy Kepes." In *Gyorgy Kepes: The MIT Years*, 7–19. Exh. cat. Cambridge, Hayden Gallery, Massachusetts Institute of Technology, 28 April–9 June.

Whiteley, Nigel. 2002. *Reyner Banham: Historian of the Immediate Future*. Cambridge: MIT Press.

Whitman, Simone. 1966. "A View of Nine Evenings: Theater and Engineering." E.A.T. Papers, Getty Research Institute.

Wiener, Norbert. [1956] 1967. "Pure Patterns in a Natural World." In *The New Landscape in Art and Science*, edited by Gyorgy Kepes, 274–76. Chicago: Paul Theobald.

Wilson, Richard Guy, et al. 1986. *The Machine Age in America*, *1918–1941.* Exh. cat. The Brooklyn Museum. New York: Harry N. Abrams.

Wingler, Hans M. [1962] 1969. *The Bauhaus: Weimar, Dessau, Berlin, Chicago*. Cambridge: MIT Press.

Withey, Stephen B. 1962. "Public Opinion about Science and Scientists." In *The Sociology of Science*, edited by Bernard Barber and Walter Hirsch, 153–159. New York: Free Press.

Yalkut, Jud. 1970. "Sao Paulo, No! Smithsonian, Yes!, Conversations with Gyorgy Kepes." *Arts Magazine* (May) 44(7):16–18.