Art-and-Technology: Recent Efforts in Materials and Media

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To avoid misinterpretation, the term "art-and-technology" should be hyphenated because we are looking at an integrated art form which developed, roughly, during the past 70 years (since Naum Gabo's virtual volume, *Kinetic Construction*, Berlin, 1920[1]). Art-and-technology results from "incorporated" contributions of art, science, and technology or, better, from artists, scientists, and engineers (plus industry, business, government, etc.). Although art-and-technology has frequently been bad-mouthed or even pronounced "dead" by advocates and practitioners of pure art as well as science *and* technology, it is alive and well and enjoying more vitality, variety, and expansion than ever before. It is currently the only expanding field in the arts; it feeds vitally into technology and industry—most visibly in entertainment but it also provides stimulus beyond fun to areas of science and engineering where "art applications" have abounded since the advent of photography and its vast consequent uses in science.

We can claim an eloquent tradition for art-and-technology in ancient historic, cultural manifestations such as the Egyptian pyramids and their "environmental" scale or the Greek theater with its elaborate stage machines.[2] We are aware of elements of that tradition when we observe contemporary art-and-technology such as sky and space art (Figures 1 and 2), computer-generated virtual reality, performance with medical inquiry and medical apparatus, and art concepts inspired by molecular biology (Figure 3).[3] Emphasis of search—whether artistic/expressive, conceptual/philosophical, or inquisitive/scientific—depends on taste and motivation. However, Leonardo is an undisputed idol to both artists and scientists.

This brief essay can render nothing more than some thoughts, ideas, and good examples in a field which already has grown complex and multifaceted:

Many components of material, industrial, and systems development have contributed to the dramatic emergence of nontraditional art forms in our century (the traditional ones being painting, sculpture, graphics, etc.). However, a simplifying but helpful division into generations may categorize, first, a mechanical generation (e.g., Marcel Duchamp, Alexander Calder), then an electric generation (exemplified by Laszlo Moholy-Nagy,[4] Thomas Wilfred,[5] and successors of "kinetic art"[6]) and, more recently, a multimedia generation, integrating electronic media and tools, for example, into "combines" (originally Robert Rauschenberg's term) by expressive artists like Stan VanDerBeek[7] (light projections, video, computer graphics) and Nam June Paik[8] (altered TV, video sculpture, broadcast art), plus "virtual reality multimedia." Currently, electronic media are popular, industry-supported, and have been introduced in many art schools and new art-and-technology institutes.[9]

Whereas art-and-technology had often been misunderstood to be united only in curatorial service in museums and in archeology up to the fifties, as of 1966 Billy Klüver[10] of Bell Laboratories and the multifaceted painter and performer Robert Rauschenberg,[11] formed a national network for methodical collaborations between engineers, scientists, industry, and artists called EAT (Experiments in Art and Technology). It has "chapters" in many U.S. cultural centers, such as New York City, Boston, and San Francisco. In 1967, Gyorgy Kepes,[12] painter/photographer, head of the light department at the New Bauhaus in Chicago (1938-44), and MIT professor since 1946 formed the MIT Center for Advanced Visual Studies.[13] CAVS is a research institute dedicated to collaboration and search not only toward art-science combinations, but also to asking the big question where and how artistic and intellectual/academic efforts are "interdependant" within a human, global, and a sociopolitical environment.

Kepes' foundation was enforced by artist fellows invited for collaboration at CAVS (Otto Piene, Vassilakis Takis,[14] Harold Tovish,[15] Jack Burnham, Stan VanDerBeek, Wen Ying Tsai et al.[16]), and also by the intellectual and collaborative support of such MIT scientists as Harold Edgerton,[17] Philip Morrison,[18] and Cyril Smith,[19] to name just a few. Takis' work with MIT mechanical engineering professor Ain Sonin led to the artist's "Homage à Marcel Duchamp," a project for a tidal *perpetuum mobile*. "Doc" Edgerton's work with stroboscopic phenomena directly influenced Tsai's "Tsaibernetic," vibrating, light-sound, viewer-responsive sculptures and later Chilean fellow Alejandro Sina's high-frequency-discharge, suspended, and rotating neon sculptures (Figure 4).

Edgerton also worked with me on my strobed-at-nighttime "Light Satellite" (1972), a suspended optical glass sculpture in the Munich Olympic area. Astrophysicist Philip Morrison ("1D, 2D, 3D -Four") impressed one-time CAVS fellow Tom Van Sant[20] enough to inspire his concept of the powers of ten as a guide in his very large "Eyes on Earth" and very small "Ryan's Eye" works (Figures 5 and 6). Van Sant used reflected sunlight and the Landsat satellite on the one hand and an image etched on a salt crystal under an electron microscope on the other.

Examples of "sung" and unsung collaborations abound in a creative world in which one artist, one scientist, one engineer cannot "go it alone." Too much knowledge is required; too much lab work has to be done; too much apparatus is needed to master the changing (macro or micro) scale of art, image-making, electronic transport, or storage of "ephemeral material." Expressive, revealing, often poetic phenomena result from open-minded curious searching of artists and scientists in dialogue.

An unassuming little book, *International Directory of Electronic Arts-Art and Technology*[21] lists artists, institutes, departments, and programs dedicated to art-and-technology synthesis throughout the world. Hundreds of people and places are listed, predominantly in countries such as the United States, Germany, France, Japan, and England, but also in smaller countries such as the Netherlands and Belgium. A case in point: a new design college for "art and

communication" recently opened in Tampere, Finland, with resolute municipal and government support. A UNESCO institute of exchange, research, and education/training in matters of art-and-technology as an international "trading post" is being contemplated by authorities concerned. It is suggested to be associated with the Cologne *Kunsthochschule für Medien* and to be located in the Cologne Media Park. This new center for distribution, research, and teaching of electronic media is under construction in the 2,000-year-old German city. Excellent "media architecture" is provided by internationally known architects such as Herzberger, Nouvel, and Zeidler Roberts.

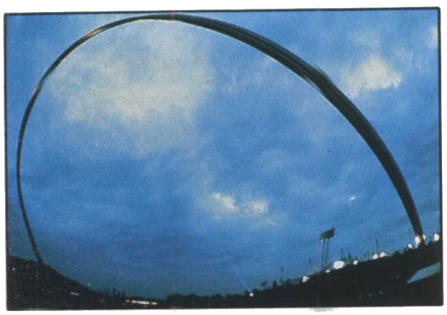


Figure 1. "Olympic Rainbow" by Otto Piene; a 2,400-foot-long, helium-filled inflatable sculpture; for closing ceremony of the 20th Olympic Games, Munich, 1972.

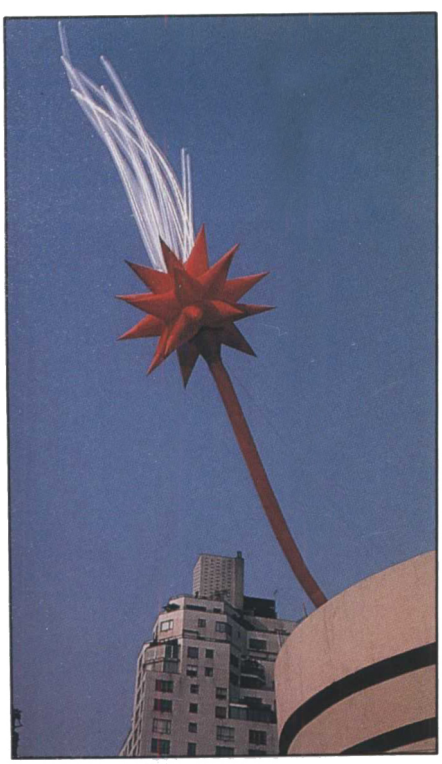


Figure 2. "Brussels Flower," by Otto Piene; inflatable sculpture; sky event in context with "Sky Dance" (Moore-Piene-Summers) at the Solomon R. Guggenheim Museum, New York, NY, 1984. (Photo: Elizabeth Goldring.)

The current wave of "pro-tech" art (Lawrence Alloway[22]), "TechnoCulture" (Theofilakis[23]), or "Nouvelles Technologies—un art sans modèle"[24] including "Chipppp Art" (Jürgen Claus[25]) and ARTTRANSITION '90 (a relevant synoptic conference organized by CAVS/MIT) is a concern of well-funded, relatively new institutions such as the spirited, pace-setting MIT Media Lab[26] (since 1985; director, Nicolas Negroponte) and the Karlsruhe, Germany-based ZKM (Zentrum für Kunst und Medientechnologie, under Heinrich Klotz). The latter probably is the most broadly oriented and most generously public-funds-supported new institution. Its program includes a new form of 20th century ("media") museum, a media design college, and several multimedia and music research operations.

Within academic, research, and display/performance activities of the past decade, most attention in art-and-technology has been paid to the industry-supported, predominantly electronic, "new media," which I call "classical" or merely "standard" media. Four in all, these are video (including video sculpture, video projection/performance, video disk, telecommunication, "tv art"); computer (graphics, music, e-mail art, virtual reality, "new" multimedia, telecommunication); laser (in performance, in environments, long-distance light art, light-music interaction); holography (still images, 3D video, architecture). The work ranges from the traditional, quasi-private scale of "art video" and "holography museums" to the largest distribution (Paik's '84 broadcast "Good Morning, Mr. Orwell"[27] and similar Paik broadcasts) and the longest distance (Lowry Burgess' "Quiet Axis"[28] involving a Discovery shuttle payload, 1989) and the vastest proliferation, (Joe Davis' "MicroVenus"[29] concept for "publishing via bacteria".)

The "immaterial image" is an old artists' dream. Therefore holography has had artists fascinated since its advent by employing lasers for reconstruction and subsequently, and increasingly so, as white-light holography. Image-makers like Harriet Casdin Silver[30] and Dieter Jung,[31] scientists like Steve Benton[32] and Mark Holzbach, and holographers of architectural space

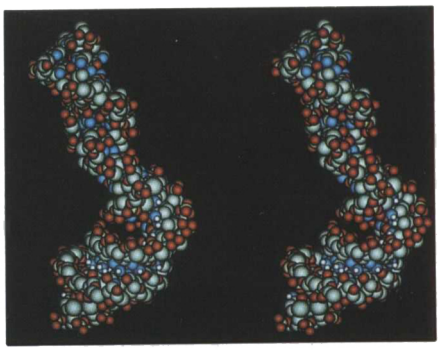


Figure 3. Stereo computer model of image-coded "MicroVenus" molecule containing the three principal conformations of DNA by Joe Davis, Cambridge, MA, 1991.

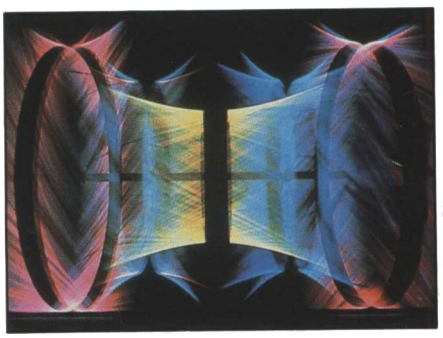
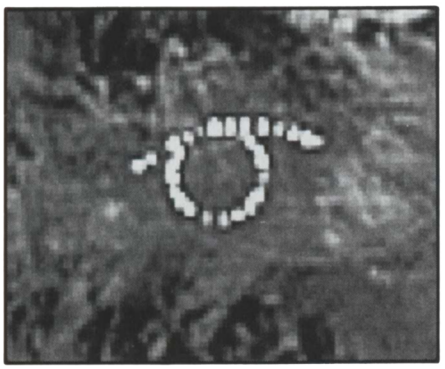
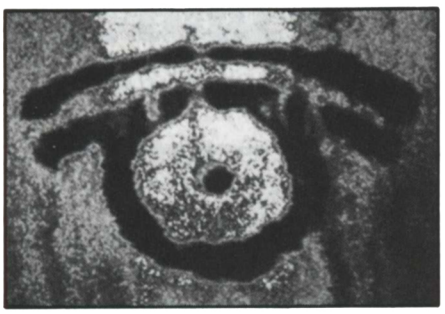


Figure 4. "Spinning Shaft," by Alejandro Sina; neon sculpture, 1978. The cylindrical image or virtual volume is created by rotating an array of straight lines of light, using special neon tubes modulated to generate a changing visual illusion when rotated.

(Sally Weber[33] and John Powell) expand the language of light art. "Holographic glass"[34] is likely to give architecture a new light/space and, possibly, poetic dimension.

New collaborations have added new media and new expectations to humanistic and expressive aspects of technology: Composer and laser artist Paul Earls[35] (Figure 7) has computerized his image palette and image/sound connection, sometimes working with the MIT Spectroscopy Laboratory (Prof. Michael Feld) and Digilab, a spectrometer manufacturer (MIT graduate Walter Zengerle). Artist Joe Davis has worked with the MIT High Voltage Laboratory (Chathan Cooke) in experiments and artistic projects toward light/sound transmission and GAS[36] payloads and





Figures 5 and 6. Contrasting very large (2.5 km) and very small (250 nm) drawings of a human eye.

Figure 5, called "Reflections from Earth," a collaboration (June 11, 1980) between T. Van Sant and many scientists and engineers in the Landsat program, shows satellite-imaged solar reflections of mirrors forming a composite shape of an eye in the Mojave Desert.

Figure 6, called "Ryan's Eye," a collaboration between artist T. Van Sant and M.S. Isaacson, A. Muray, and E.J. Kirkland, is an electron micrograph of an eye etched into the surface of a salt crystal with an electron beam. The etching was performed in 1982 at Cornell University's National Research and Resource Facility for Submicron Structures (now called the National Nanofabrication Facility). The larger image is 10 billion times the size of the smaller, with the size of the human eye (2.5 cm) in the center of the scale. The measurements and calculations were certified by R.P. Feynman of Caltech. A color version appears on this month's cover.

with the MIT Visible Language Workshop in remote laser carving events during which he also involved elementary school classes. Young students directed from Cambridge, Massachusetts, via slow-scanned, drawn images, the carving of steel and stones at the Church Metal Spinning and Fabricating Works in Milwaukee, Wisconsin (1984).

Biological materials, (i.e., tissues, organs, and organisms) are medium and addressee in a new world of artist/scientist/inventor teamwork into which Elizabeth Goldring[37] drew Robert Webb, the creator of the SLC (scanning laser ophthalmoscope) to develop a "visual language for the blind" (Figure 9). Here the world of medical diagnostic and information technology is engaged in an "eyedrama" to project letters and images into "unseeing eyes" where portions of the retina are still receptive (although lens and vitrius are often obscured.) We are observing an encouraging, rare example of melding artistic vision, literally and figuratively, with the scientist/inventor's precision expertise in a world of medical, humanistic values.

Looking at artists' use of materials, traditionally and "avant-garde, one can categorize them into solids, liquids, and gaseous materials. Traditionally, most "media" were solid, as in marble and bronze sculptures. Beyond, there are "Les Immateriaux" (Jean Francois Lyotard[38]), mostly seen as "electronic materials" and their conductors and "containers." The "ARTTRANSITION situation" is deftly visualized in the French/Egyptian sculptor, Roland Baladi's[39] marble tv and other marble electronic vehicle sculptures: material meets immaterial, past meets present and paraphrases "future."

Contemporary artists do not so much create new materials but invent new combinations of materials and "media." A case in point is Eric Begleiter's[40] development of food holography, ("candy holography") (Figure 10), where bright holographic images or mere interference patterns are embossed onto "improbable stuff" such as white chocolate, sugar crystals, pills, and

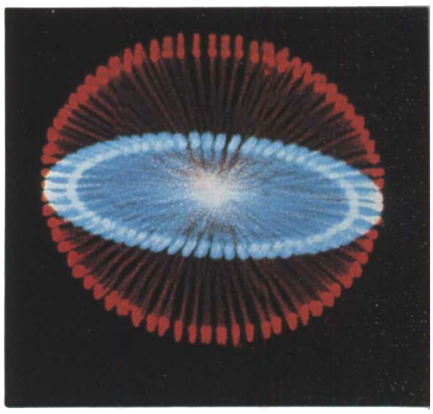


Figure 7. "Double Spiro" by Paul Earls; laser projection. A blue argon and red krypton laser are superimposed on a surface displaying computer-generated images from a program which varies projection angle. This picture captures one moment in an evolving image. (Photo: John Kruse)

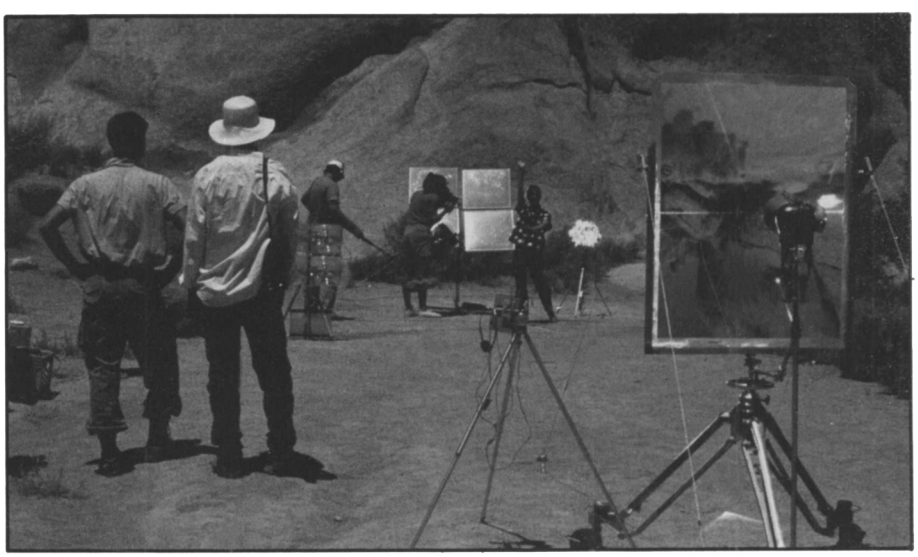


Figure 8. "Photon Voice" by Shawn Brixey and Laura Knott; outdoor event for CAVS/MIT "Desert Sun/Desert Moon" series of environmental art events documented by Smithsonian Magazine, Lone Pine, CA 1986. This event varies the conversion of light waves into sound waves and back into light waves through the interference of dancer/choreographer Laura Knott. Her action becomes evident in a terminal in which the movement of graphite particles parallels the dance movements.

Figure 9a. "Retinal Poetry Via the Scanning Laser Ophthalmoscope" by Elizabeth Goldring with Robert Webb; performance for ARTTRANSITION '90, Kresge Auditorium, MIT. (Photo: V. Grabill).

Figure 9b. "Eye/Sight II" by Elizabeth Goldring, Vin Grabill; interactive video installation, Lights/OROT, Yeshiva University, New York, NY, 1988/89. (Photo: V. Grabill).

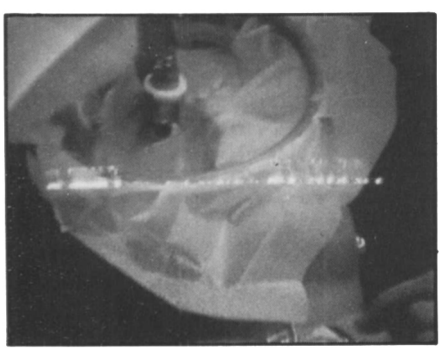


Figure 9c. "The Inner Eye: From the Inside Out" (21 min. color videotape), by Elizabeth Goldring, Vin Grabill; video still of ultrasound procedure (Photo: V. Grabill).

wafers. As with David Larkin, a young artist who uses liquid-crystal-covered surfaces as well as food fragrances to create temporary "images," consumption/ingestion of ephemeral "pictures" becomes an experience; distribution becomes a form of "broadcasting" in media addressing taste, touch, and smell along with addressing our visual sense and aesthetic judgement. Here art work is produced in great numbers (in contrast to traditional monumental monolithic and unique forms) and the "mega-editions" aesthetic adds another perspective to art, along with the new world of "nano aesthetics."

Referring to small images in history ("a portrait on a pinhead"), Joe Davis also pays hommage to Tom Van Sant and leads us toward his "genetic studio":[41] "In 1982 California artist Tom Van Sant, with partners M.S. Isaacson, A. Muray, and E.J. Kirkland of Cornell University[42] used a Scanning Electron Microscope (SEM) to carve an icon into a single crystal of salt ("Ryan's Eye," named for his young son). Executed at a scale of 2.5 μm, this icon was orders of magnitude smaller than any previous work of art. A 'wizard of scale,' Van Sant created his ultra-small 'Ryan's Eye' (Figure 6) to complement a 2.5 km 'Desert Eye' (Figure 5) consisting of satellite-imaged solar reflections of mirrors forming a composite shape of an eye in the Mojave Desert.

"In the years since, complex images have been routinely scanned into crystalline substrates for the semiconductor industry (and others), including a facsimile of an M.C. Escher print seen in the *MRS Bulletin* several months ago.[43]

"Activities in genetics and molecular biology have already had obvious impact on fields such as medicine and agriculture. There are indications that recent advances in bio-technology may have significant applications in many other fields, including electronics, computer science, telecommunications, and the arts. CAVS artists Davis and Jose Wagner Garcia, working in such diverse areas as bioluminescence and the search for extraterrestrial intelligence, have undertaken several molecular-scale projects."

From a Davis writeup in *Omni*[44] magazine (and from the artist's direct representation), we learn that his "MicroVenus" project is a message in the form of bacterial DNA. "An algorithm, originally used to encode messages for extraterrestrial life, was used to encode a graphic 'Venus' (Germanic "life" rune) into a molecule of synthetic DNA. This has been spliced into the living bacteria *E.coli*" as a model for spore-bearing bacteria. They "could duplicate and spread throughout the galaxy." With collaborator Dana Boyd, a geneticist from Harvard University and the University of California at Berkely, he has generated about 1×10^{28} of this message. However, to spread messages through bacteria in the cosmos is currently a *"Denkmodell,"* like the one to install the human genome itself within the bacteria as, maybe, "the only practical way for humans to explore the cosmos."

Van Sant's current collaborative commitment reverses the direction: it condenses and combines satellite images of the Earth's surface to form a composite "real image" of the Earth as seen from space—the Geosphere Project. The full-resolution Geosphere Image is 8,640 pixels wide and 4,320 pixels high for a total of 37.3 million true-color pixels. Displaying the image at its full spatial resolution would require 338 standard broadcast television sets arranged in 26 stacks each 13 sets high. The Geosphere itself is "the first visually accu-

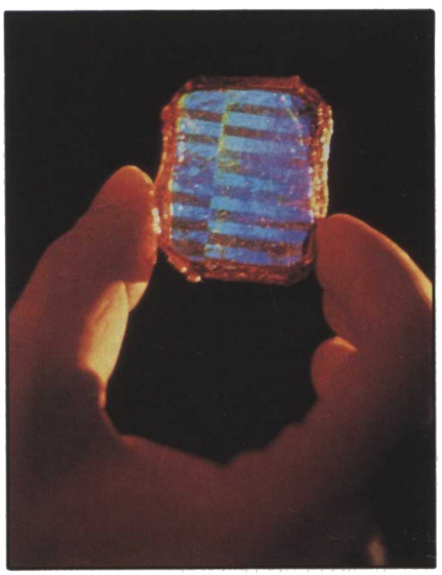


Figure 10. "Chocolate Hologram," by Eric Begleiter, 1990. Begleiter's patented Edible Holographic process allows a wide variety of transparent and opaque foods and confections to receive dramatic holographic effects and images through a safe, inexpensive process. The quality and flavor of foods are unaffected by the thin microscopic layer of diffraction ridges used in producing its amazing illusions. The structural part of the food mass allows it to produce illusions of space, projecting images both above and below the food's surface. Edible holograms use a physical, not chemical, basis to produce colors and images; no artificial ingredients or additives of any kind are used. (Photo: E. Begleiter).

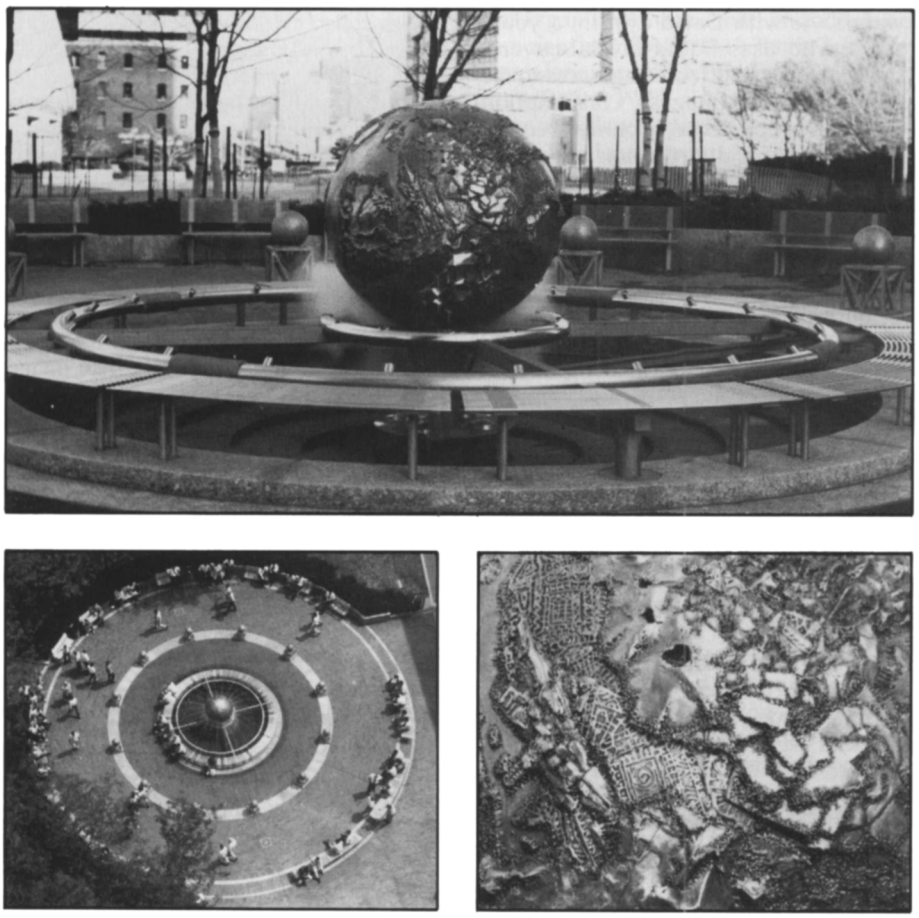


Figure 11. "Galaxy" by Otto Piene with Joan Brigham and Joe Davis, plus Halvorsen Architects; environmental light and water sculpture with mini-park on Kendall Square, Cambridge, MA, 1988/90, sponsored by Cambridge Redevelopment Authority, welded stainless steel and perforated, galvanized mild steel globes. (Photos: Thad Tercyak, CRA and Walter Dent, CAVS).

rate, three-dimensional model of Earth" (Tom Van Sant), consisting of 36 transparent photo-printed image gores adhered to a translucent fiberglass sphere illuminated by internal and external lighting and surrounded by a protective transparent shell.

In an ever-shifting world of human interests and curiosities, materials remain while the Earth is intact and new materials appear with expanding human reach. Meanings and the value of effects change: radiant cadmium red which enabled paintings to be "intense" is now "seen" as toxic. Throwaway "plastics" have to be recyclable. However, for my sky art inflatables, I yearn for nothing less than affordable, nondeteriorating, reusable, recyclable, ultralightweight, bright-colored, mirroring cloths, tough as steel and flexible as rubber to become inflatable/collapsable, orbiting image architecture in space.

References

Note: The literature listed represents a combination of general as well as specific reading; the combination should provide fair acquaintance with the subject, art-and-technology.

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Douglas Davis, *Art and the Future: A History/Prophecy of the Collaboration Between Science, Technology and Art* (Praeger Publishers, New York, NY, 1973).

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Margarete Bieber, *The History of Greek and Roman Theatre* (Princeton University Press) Princeton, NJ, 1961).

3. Illustrations accompanying this essay may serve to give an impression of the variety in current art-and-technology; some images, with captions, may not directly refer to the text.

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5. Donna M. Stein, *Thomas Wilfred: Lumia - A Retrospective Exhibition* (Corcoran Gallery of Art, Washington, DC, 1971).

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10. Suzanne Ramljak, Billy Klüver interview, in *Sculpture*, special issue on art and technology, May-June 1991, Washington, DC.

11. Basic information on Robert Rauschenberg and the context of 20th century art, in H.H. Arnason, *History of Modern Art* (Harry N. Abrams, New York, NY, n.d.).

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14. William Burroughs et al., *Takis-Magnetic Sculpture* (Howard Wise, New York, NY, 1967).

15. Christopher C. Cook et al., *Harold Tovish: A Retrospective Exhibition 1948-1988* (Andover, MA, 1988).

16. *Tsaibernetic Art of Tsai, Wen-Ying* (National Museum of History and Taiwan Museum of Art, Taiwan, n.d.).

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18. Philip Morrison, *Ring of Truth: An Inquiry into how we know what we know* (Random House, New York, NY, 1987).

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20. Otto Piene, Lowry Burgess, Elizabeth Goldring, and Bernd Kracke, *SKY ART Conference '81* (CAVS/MIT, Cambridge, MA, 1981).

21. Annick Bureaud, see Reference 9.

22. An example of Lawrence Alloway's writing: *American Pop Art* (Collier Books and Whitney Museum of American Art, New York, NY, 1974).

23. See *Les Immatériaux*, edited by Elie Théofilakis (Centre Pompidou, Paris, 1985).

24. "Nouvelles Technologies—Un art sans modèle?," edited by Norbert Hillaire, *art-press spécial*, Paris (1991).

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30. LEONARDO, "Holography as an Art Medium," **22** (3 and 4) 1989.

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39. References in: Jean-Paul Fargier, Otto Piene, le degré zéro du nu, *art press spécial*, Paris, No. 12 (1991).

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41. References in: Steve Nadis, "Antimatter," *Omni* (Jan. 1991, New York, NY). Artists' statements provided to the author for this essay.

42. National Nanofabrication Facility, Cornell University, Ithaca, NY.

43. *MRS Bulletin* **XVI** (4) (1991) p. 78, Figure 2.

44. See Reference 41. □

AMPI Metallography Competition

The American Powder Metallurgy Institute (APMI) will hold its first annual powder metallurgy (P/M) metallography contest during the 1992 Powder Metallurgy World Congress, June 21-26, in San Francisco, California. Submissions of P/M and particulate material photomicrographs will be shown in a special exhibit at the congress.

Contest categories include black-and-white light optical, color light optical, electron microscopy, student, and artistic or aesthetic value. Manufacturers, users, and suppliers of powder and powder-related equipment are invited to participate.

The grand prize of $1,500 is sponsored by Buehler Ltd., LECO Corp., and Struers, Inc. Judging criteria will include technical content, quality and uniqueness of entry preparation, photographic quality of photomicrograph, and uniqueness of the preparation (aesthetically and technically).

Entries must be received by **May 22, 1992.** For additional information about the contest, contact Joan Rayca-Fassano, APMI, 105 College Road East, Princeton, NJ 08540-6692, phone (609) 452-7700.

Hennessy-Vuitton 1992 Science for Art Prize

Flavors, Fragrances, and Colors

LVMH Moët Hennessy-Louis Vuitton, Inc. is offering awards for single investigators whose work focuses on improving of physical or chemical characteristics of materials to obtain sensory effects (whether gustatory, olfactory, or visual) or the understanding of sensory effects.

Two prizes will be awarded: a Science Prize supporting basis research and an Innovation Prize dedicated to applied research. Each prize includes a 100,000 Fr (~$17,500) award, a commissioned work of art, and an all-expense paid trip to Paris for the ceremony in June 1992.

Submissions are due no later than **February 14, 1992.** Industrial as well as academic scientists are encouraged to apply. Nominations are acceptable as well.

For further information and application forms, please contact Olivier Goniak, LVMH Moët Hennessy-Louis Vuitton Inc., Two Park Avenue, Suite 1830, New York, NY; phone (212) 340-7489; Fax (212) 340-7620.