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INTRODUCTORY ESSAYS:

Gene Youngblood
A. Michael Noll
Cynthia Goodman

The Siggraph '82 Art Show celebrates the increasing access to electronic technology available to artists today and the growing aesthetic awareness in computer graphics.

Over one thousand entries for this juried exhibition arrived from all over the world. All the work was produced after January 1, 1980. The eighty-eight pieces in this show are diverse in style, medium and technique, holding as a common thread the pursuit of artistic excellence. The use of computers in these works shows that style is established by the artist and not identifiably derivative of the hardware, as was the case five years ago.

We invite artists to participate in Siggraph and encourage them to use it as a teaching and learning forum. Technological art is the future of communications and the source of new and powerful imagery.

Elaine L. Sonderegger
General Conference Chairman

front cover:
Mike Marshall
"Beam and Bubbles" 1982

back cover:
Harry Holland
"Santy Fold" 1982
TOWARDS AUTONOMOUS REALITY COMMUNITIES

A Future For Computer Graphics

Gene Youngblood

Gene Youngblood is an internationally known author and lecturer in electronic art and technology who currently teaches at both the California Institute of the Arts and the California Institute of Technology. Mr. Youngblood has organized international conferences on The Future of Television for The Annenberg School of Communications at U.S.C. for The Actors Guild of America. He is author of EXPANDED CINEMA (1970), the classic work of media theory and criticism, and is completing a new book, THE FUTURE OF DESIRE, and publishing articles on the revolutions in biology and electronic technology.

It may live in a vacuum tube (for a few more years at least), but to hear the Mercantile Masters talk you'd think computer graphics lives in a political vacuum as well. For electronics, however, the last quarter-century has been equivalent to pulling back the string on a bow — the storing of enormous technological potential. Now the string is about to be released in the universal application of that technology: the next 25 years will be the flight of the arrow, propelling us into the Electronic Age and precipitating an historic and unprecedented revolution in communications. And in the shadow of the Communications Revolution we begin to understand the awesome political and cultural implications of that proto-forever we refer to so feebly today as computer graphics.

Autonomy and Heteronomy

The practice of the moving-image arts can be divided into five technical categories: (1) production or acquisition of image and sound; (2) recording and information in some storage medium; (3) processing or post-production; (4) distribution of the material to its target address or marketplace; and (5) the display or presentation of it in one or more formats. Today autonomous individuals have access to tools for the recording, storage and display of audiovisual information but very few of us have processing technology and only the Mercantile Masters control the distribution. The result is cultural heteronomy ("other-law"), a hierarchical structure of authority and reality.

However, I suggest that within ten years the Communications Revolution will give every householder the capability to engage in all five fields of moving-image practice. That's because the computer is a universal machine that can contain and become all media, and because VLSI technology will increase computing power by a factor of a thousand in a decade. Thus the computer, on line to user-controlled networks, will become the tools we need to practice the construction of social reality. The result will be cultural autonomy ("self-law"), a nonhierarchical structure of authority and reality, characterized by the proliferation of "autonomous reality-communities." I shall speak more of this momentarily; meanwhile, consider the following:

The Moving-Image Arts

In ten years the video camera will be a tubeless 100-percent solid-state household computer with image resolution greater than 35mm film. It will contain no internal optics, will focus automatically by sonar or Fourier analysis, and microprocessors for image deconvolution or image enhancement will obviate the need for expensive lenses. Lensless zooming will be accomplished by computer operations on the signal rather than mechanical manipulation of the lens. Recording will be digital, on metal tape (later in semiconductor or bubble memory), and the entire camera/recorder unit, resembling a super-8 system, will sell for less than $1000.

That's the computer as camera; what about the computer as source of the image? We know all about that, don't we? Taking seriously the predictions about the future of computer memory and remembering that software trails hardware by about five years, we can safely assume that the personal computer of a decade hence will be a 32-bit "geometry engine" pipeline processor capable of addressing a gigabyte of memory with throughput rates adequate for real time shared 3-D graphics with a resolution of at least 1000 x 1000 pixels. It will also function as an image processor which, with add-on cards, will perform all the post-processing today requiring $200,000 industrial tools or custom user-built devices like Dan Sandin's Digital Image Processor or Woody Vasulka's Digital Image Articulator. And it'll control a read-write optical disc for video editing.

Of course the personal geometry engine with its flight-simulator capability will be on line to broadband cable and switched optical fibre networks, which distribution and access to "telegraphics" and "network reality synthesis." At the amateur level thousands of young warriors will live in labyrinthine networked adventure games and computer clubs will operate dedicated computer networks sharing their simulations and sharing their programs in video as the non-member cable audience looks on and learns. At the venture-capital level, commercial Image Utilities with pictorial data bases will sell real-time simulation: just punch up the right cable channel, turn on your Apple IX and shake hands with the animated outlay of Cray-5 or the latest Josephson-junction superbrain. The data bases, like visual hyper-maps, will be of biological, anatomical and physiological algorithms for the synthesis of environments, figures and behaviors specified and controlled by the subscribers who could, of course, download the results in their own local memory for future metaconstructions.

Amateurs and Professionals

One consequence of all this will be a loss of distinction between who's a professional and who's an amateur inssofar as that's determined by the tools to which we have access. No motivation is as pure, no achievement more dignified than the pursuit of one's own work for its own sake. Yet in our professionalized society this most noble aspiration has been reduced to a sneering joke — the amateur as some kind of bozo — as though doing it for love were synonymous with a transference of quality and value. As a matter of fact, by far the most interesting computer graphics I've seen have been produced by skilled amateurs in their living rooms using tools they designed and built. They aren't "hobbyists," they are artists; but please excuse them, they can't afford a Cray-1 — yet. But just give us quality tools and see what happens.

By the end of this decade millions of amateurs will be evolving new graphic arts routines, constructing private visual languages over conversational networks like some thousand-headed Hydra, dwarfing the "contribution" of military-industrial professionals and reducing them to a rather dull clip-book footnote. As a matter of fact, military-industrial domination of computer graphics signifies its immaturity as a medium. A tool is "mature" inssofar as it's easy to use, accessible to everyone, offering high quality at low cost, and characterized by a pluralistic rather than singular practice, serving a multitude of values. Professionalism is an archaic model that's fading in the twilight of the Industrial Age; the Simulators of the Apocalypse should be honored to share the SIGGRAPH spotlight with noble amateurs — heroic warriors of the Electronic Age — who shall inherit the world of simulation by living in the worlds they simulate.

Communication and Conversation

The migration to alternative reality communities will not be achieved through communication. Communication (the term Latvian, "a shared space") is interaction in a common context ("to weave together") which makes communication possible and determines the meaning of all that's said: the control of context is the control of language is the control of reality. To create new realities, therefore, we must create new contexts, new domains of consensus. That can't be done through communication. You can't step out of the context that defines communication by communicating; it will lead only to trivial permutations within the same consensus, repeatedly validating the same reality. Rather, we need a creative conversation (from the Latin, "to turn around together") that might lead to new consensus and hence new realities, but which is not itself a process of communication. "Do you mean this or this?" "No, I mean thus and such..." During this non-trivial process we gradually approximate the possibility of communication, which will follow as a trivial necessary consequence once we've constructed a new consensus and woven together in a new context. Communication, as a domain of stabilized non-creative relations, can occur only after the creative (but non-creative) conversation that makes it possible: communication is always non-creative and creativity is always non-communicative. Conversation, the prerequisite for all creativity, requires a two-way channel of interaction. That does not imply communication, but without it there'll be no conversation and no creativity at all. That's why the worst thing we can say about the mass media is that they communicate — at a time when creative conversations on a massive scale are essential for human dignity and perhaps even our survival.

Simulation and Desire

What's important to realize is that in our conversations we create the realities we will talk about by talking about them: we become an autonomous reality-community. To be conscious observers we need language (verbal or visual), and we need to use language we need each other: the individual observer, staring insomniac at an image box, is an imposibility; there is only the observer-community or reality-community that can talk about things (like religion, art, science) because it creates the thing the observer talks about.

The Electronics Revolution, bringing conversational machines and networks, will give rise to autonomous reality-communities of politically significant magnitude, defined not by geography but by consciousness, ideology, and desire. As constituents of these communities we shall hold continuously before ourselves alternative models of possible realities. We shall learn to desire the realities we simulate by simulating the realities we desire, specifying, through our control of context, what's real and what's not, what's right and wrong, good and bad, what's related to what, and how. This is the profound significance of simulation: it is not fiction, it is the future of political possibility. The purpose of fiction is to mirror the world and amuse the observer; the purpose of simulation is to create a world and transform the observer. Behold: armies of amateurs gathering even now, preparing for the Image Wars, and for all the ancient dichotomies between art and life, destiny and desire.
COMPUTERS AND THE VISUAL ARTS: A RETROSPECTIVE VIEW

A. Michael Noll

While working as a research scientist at Bell Telephone Laboratories, Murray Hill, NJ, A. Michael Noll helped to pioneer the creation of computer-assisted art work during the 1960s. He exhibited his work in the first international exhibition of computer graphics. He has published proposals for and critiques of the new aesthetic dimensions offered by computer graphics in many visual, art, computing, and technical journals. He is currently planning the development of videodex and other telecommunications services for AT&T.

"In the computer, man has created not just an inanimate tool but an intellectual and active creative partner that, when fully exploited, could be used to produce wholly new art forms and possibly new aesthetic experiences."

Fifteen years ago I wrote these words; they represented my view then of the potential for the use of the digital computer in the visual arts. However, these "new art forms" and "aesthetic experiences" existed in computer music, thereby possibly supporting the conclusion that the use of the new technologies in the arts has been a "panacea that failed." This estrangement between promise and reality could lead to a disillusionment with the new technologies in the arts, but in my judgment this would be a premature conclusion given the relatively infancy of this application of computer technology.

In the early 1960's, a number of computer researchers began investigations of the use of computers in the visual arts. My own work in this area at Bell Labs touched upon computer choreography, computer-generated stereoscopic movies (a "butterfly"), and "random" patterns, all produced by a computer-controlled microfilm plotter. Others in the same time frame, like Ken Knowlton and Ed Zajac at Bell Labs, were also investigating the use of digital computers in animation for artistic and educational purposes.

Computer art grew slowly but steadily during the 1960's, and a number of international exhibitions were held, most notably Cybernetic Serendipity in London in 1968. More and more computer specialists joined the ranks of the "computer artists."

After utilizing a four-dimensional perspective-projection technique to create the computer-animated film "Snow Flakes" for a network television special, I became somewhat disillusioned with computer art and "retired" from the field. My last written thoughts on the subject were that...the use of computers in the arts has yet to produce anything approaching entirely new aesthetic experiences. I also wrote that...little has actually been accomplished in computer art...in its first decade.

This disillusionment is not surprising. A similar thing happened in computer and electronic music where technologies whose major contributions were in the development and fostering of the technology. One particularly laudable pioneer was Max Mathews at Bell Labs who also created an environment in which musicians had access to the computer music technology. These pioneers and musicians were personally interested in classical music and hence naturally applied their investigations to that area. However, it was not the serious classical music field that ultimately exploited the new electronic technology but rather the mass-market pop and rock fields. Musicians appeared who were thoroughly familiar with using these new musical instruments. The artistic emphasis was on the effects and the quality of the sounds produced and not on the technology itself.

This view of computer music supports the conclusion that the pioneers of technology are often not the ultimate exploiters of their technological inventions. Furthermore, the utilization of the technology is frequently in areas not envisioned by the pioneers. And lastly, the ultimate exploitation usually takes much longer than envisioned at the invention of the technology.

Something similar has occurred concerning the use of computers in the visual arts. It is in the field of graphics and graphic design — and not the more-classical visual arts — where the use of digital computers has achieved success. Computer graphics systems are widely and routinley used to produce slides for graphic presentations in the corporate world. The production of masks and designs for integrated circuits has been greatly facilitated by the use of computer-graphic systems. The world of commercial television has massively turned to computer graphics, and the design of textiles and wallpaper are already being facilitated by computer graphics.

The technology for doing digital computers to create visual images has been steadily evolving over the years. I can remember a time when the use of color was quite novel requiring complex color separations produced from black-and-white display tubes. Now, color display and high resolution are the rule, and costs continue to decline. Developments in software have solved the hidden-line problem and facilitated the use of shading for depicting surfaces.

It is in its use as visual medium in the visual arts where the digital computer has not yet achieved its anticipated potential. Digital computers are being used to create visual imagery, but many people feel that something is missing.

The images sometimes appear to be attempts of mimicking other media. Many are cold and sterile and are somewhat devoid of human expression. Randomness combines with geometric structure to create designs that are frequently interesting, but that are little more. One is frequently left with the impression that many patterns are simply experiments in learning the new medium.

On the other hand, as Jack Dallibon writes, there is some fundamental dissimilarity between art and technology as systems of "human sensitivities."

Or is there something inherent in the computer that makes it particularly well suited to producing geometric designs but poorly suited to expressing stimuli from reality and nature. Or is it, as I believe, far too soon to judge the true effect of the digital computer in the visual arts. At some point in the future, photography may pass the computer, and photography may pass the photography. Perhaps the future will evolve in ways that are difficult to envision and after the potentials have been totally exploited in new art forms evolve from the computer technology.

One thing that is clear is that the future will have truly arrived when the emphasis is on what has been produced as opposed to how it was produced. Far too much of the computer art was produced thus far too little an emphasis on the computer and far too little on the art. It is as if the medium has become the art! Also much computer art does not utilize the interactive and dynamic potential of the computer. Static images are programmed that do not relate to the individual viewer. The potential for the computer to sense the viewer's state of being and change the image accordingly has not been explored.

The man-machine communication problem is still challenging; the computer is a difficult medium for artists to control; and the technology remains mostly inaccessible.

Arlene Gottfried Alion Schoener's belief that a form of "citizen-artist" could emerge from the use of the new technologies.

The increasing growth in home computers with color graphics capabilities would seem to be bringing us closer to that day. However, I believe that the aesthetic sensitivities and training of the artist are and will continue to be unique in the use of the computer, or any artistic medium for that matter. What might happen from the growing popularity of home computers is the gradual growth of a body of people who are keenly literate in computer graphics and who later become artists bringing the computer medium along with them and contributing to its development.

Creative persons from the artistic community — not technologists — must continue to appear who are expert in the use of the computer medium. The computer as the medium must surrender to the artistic medium produced. Presently, the two continue to be too intertwined. In conventional art it is rare that one would criticize the medium in general, for example water colors, if one did not like a particular work utilizing that medium. Unfortunately this is not the case in computer art which remains tied to the computer community and has yet to find its home in the artistic world.

In final conclusion, I am indeed optimistic about the future of computer art and have come full circle to again believe in the great promises of the paragraph quoted at the beginning of this essay. I have no doubt that it will occur — the key question is when.

Footnotes


ART AND TECHNOLOGY: BRIDGING THE GAP IN THE COMPUTER AGE

Cynthia Goodman

Cynthia Goodman, art critic, historian, and curator, has published numerous publications including Arts Magazine, Portfolio, and Harper's Bazaar. Her numerous exhibitions and catalogue essays include "Hans Hofmann as Teacher: Drawings by His Students at M.I.T." from the collection of Governor Nelson A. Rockefeller (State Legislature Building, Albany), Frederick Kiesler's Endless Search (Andre Emmerich Gallery, N.Y.), and "Hans Hofmann in the 1930's" (Philadelphia Art Museum), Judith Godwin (Inger Gallery, N.Y.), and Hans Hofmann: A Centennial Appreciation (Andre Emmerich Gallery, N.Y.). She is currently writing a book on art for Porter Magazine as well as compiling a catalogue raisonne of the paintings of Hans Hofmann, and a catalogue of the Hofmann collection at the University Art Museum, Berkeley, for publication by Cornell University Press.

Much as the majority of the art public has tried to ignore the art and technology phenomenon, it is no longer either possible or fashionable to do so. The incessant retrospective of video artist Nam June Paik at the Whitney Museum in New York in the Spring of 1982 was just one of numerous recent examples of the acceptance of the new technology in a traditional art environment. A lack of critical thought process by which the works are made, has caused the word "computer" in connection with art to be met with particular distrust out of the ill-founded fear that this merely complex machine might soon replace the artist in the creation of art. Yet in spite of the electronic implementation, computer-aided art is still in many ways as much a handicraft product as conventional art forms but simply produced in a different manner. Furthermore, because most artists are as yet unacquainted with the mechanics and potential of computers, their accomplishments on computer systems, which may assume various forms including color xerography, photo enlargements, plotter drawings or video, to name only a few, are often the product of intense collaboration in a laboratory-like environment between the artist and someone technically proficient in the contemporary practice. This new practice is in keeping with the myth of the sculptor or painter struggling preferably in solitude in a studio to realize his artistic concepts in pencil, paint, metal, stone, or other common materials.

The study of art-technology have often been rejected outright. Lilian Schwartz's frustrating, yet enlightening encounter probably typifies countless others experienced by her colleagues. In 1969 a computer generated print which Schwartz submitted to a competition in New Jersey was rejected. The following year, she entered the same print, listing the medium as silkscreen. This time, not only was the print accepted but also bought by the Trenton Museum for future exhibitions.

In spite of popular misconceptions, developments in technology have gone hand in hand with evolution in the field of the arts throughout much of history, and the accomplishments of numerous artists with the arts have been intertwined with and enhanced by their knowledge of science. Leonardo da Vinci most frequently comes to mind as the artist whose profound curiosity about the mechanical sciences coupled with his practical ability as an inventor, produced a great number of drawings of interest to the scientist as well as for the lover of art. Representing only one of his many engineering concerns, among his sketches are over five hundred dealing with the phenomenon of flight including drawings of helicopters, parachutes, gliders, and flying machines propelled by man.

Nevertheless, Leonardo's aeronautical studies had no direct application on aviation. However, according to Dr. Jon B. Eklund of the National Museum of History and Technology in Washington D.C., who organized with Dr. Cyril Stanley Smith of the Massachusetts Institute of Technology the exhibition "Aspects of Art and Science" for the Smithsonian in 1978, their researches have led them to conclude that in numerous since, the illusion of flight from those artists has had a direct application to science as well as science contributing to the arts.

The use of acids and other corrosive materials in the etching process is a prime example of his theme and one which he conducted with a motor from Brazilian beaches from Chandahar, India, that show how as early as 3000 B.C. craftsmen were using an alkali substance to etch decorative patterns into such ornaments. Acids were also used by the Pre-Columbian cultures of Central and South America in order to create a gold surface in a process that has become known as "depletion gilding." In Europe the potential of the etching medium was later developed as a means of reproducing prints.

Finally, this technique culminated artistically in the production of works of the high caliber of Rembrandt's prints. As Eklund has noted, some of the first mentions of the use of acids for etching were attacked with etching, and it is likely the eventual developments upon the artisans' knowledge of acids based on an intimate familiarity with their medium, their preparations remained in the literature of the 1st half of the 19th century.

A link between the worlds of art and science has intrigued and challenged many artists of the twentieth century. In this respect, the Futurists were particularly explicit about their goals, proclaiming that "the Technical Manifesto" of April 11, 1910, that art should portray the world as created by "victorious science." Although not as consistent as the Futurists in their allegiance to modern technology, recent discoveries also exemplified a force that conformed to the sixties, with its flair for popular entertainment and its concern with the development of new media and techniques to break the mold of traditional art. Allen Gelber, for example, incorporated a video camera in an installation in his exhibition "Great American Nude "39 of 1969. Other artists employed the advances of modern technology as a means of expanding their techniques. In "Polaroid" of 1959, Robert Whitman's contemporary paintings of the stain paintings of Helen Frankenthaler and Morris Louis, created by soaking paint into unprimed canvases beginning in the fifties, may be attributed to a great extent to the properties of the newly invented Polaroid-based instant cameras. The sixties, by then, were defined not only by the innovations in the field of sculpture, but also by the development of the artist's home studio and workshop. Larry Bell sensibly colored glass boxes, using a technique initiated by the U.S. Air Force to cover the glass surfaces in the pits of their fighter planes.

In the late 1960's art world attention began to be focused on the use of computers in art. The "Technological" exhibition at the Whitney Museum of Art in New York in 1967 was based on a goal they expressed jointly in one of the first publications of "E.A.T. News," that is, to "catalyze the possibility available within the fields of industry, technology, and the arts." In order to do so, "E.A.T. has assumed the responsibility of developing an effective collaborative relationship between artists and engineers." This organization was stimulated by the conviction that such an interdisciplinary interaction would prove beneficial not only to the participants but also to society as a whole.

The major accomplishment of E.A.T.'s joint effort was the "Polaroid" of 1967 designed for the World's Fair in Osaka, Japan in 1970. This pavilion contained the first light-sound system built for a spherical structure, the largest spherical minor ever constructed - a mirror that reflected the viewers on the 90-foot high ceiling, and a man-made cloud containing water which floated above the dome.

The first opportunity to explore the art and technology phenomenon on an international level occurred at the Venice Biennale Biennale of 1974 in Venice, where the "Science and Technology" exhibition opened in 1966 and its name was changed to "The "Art and Technology" program. Two years later the program expanded to place approximately twenty major artists and technologists on view for as long as a twelve week period within major technological and industrial corporations based in California.
Tuchman's proposal was motivated by a belief similar to Klüver's and Rauschenberg's, that giving the sculptor's hands back to technology would greatly increase their artistic capabilities and be advantageous to industry as well. Among the 76 artists and their corporate sponsors who participated in his large scale project were Andy Warhol (artist in residence: Cowles Communications, Inc.); Jean Dupuy (artist in residence: Cummins Engine Company, Inc.); Tony Smith (artist in residence: Container Corporation of America); and Robert Rauschenberg (artist in residence: Teledyne). The objects created by the artists in this program were exhibited at the Los Angeles County Museum of Art as "The Machine as Seen at the End of the Machine Age," an exhibition curated by Pontus Hulten at the Museum of Modern Art in New York in 1968. Documented artists' attitudes toward technology beginning with Leonardo and continuing through the machinist paintings of Francis Picabia to the "meta-matic" machines of Swiss-born artist Jean Tinguely. Pointing toward the direction of future collaborations, included in this exhibition was a new work by Paul em Schimmel, "Grey Computer." This construction was seated comfortably in a rocking chair, because as the artist compassionately explained in his operating instructions, "computers sometimes get fatigued and have headaches... therefore...the chair for the rest...remember if you treat your computer well, it will treat you well." Also in 1968, Jasia Reichardt curated an exhibition titled "Aspidipity: The Computer and the Arts" at the London Institute of Contemporary Art. Her exhibition, the first international survey of computer inspired art, included poetry, painting, sculpture, choreography, music, drama, and architecture, demonstrating how pervasive the use of advanced technology in the creation of art had already become.

It was from within the field of computers that developments with the most radical implications for the art field were to evolve. The exhibition "Software, Information Technology: Its New meaning for art," curated by Jack Burnham and sponsored by the American Motors Corporation at the Jewish Museum in New York, in 1970, had as its goal to use computers in a museum environment. Planned as a sequel to Pontus Hulten's exhibition "The Machine," Burnham hoped that it would "demonstrate the effects of contemporary control and communication techniques in the hands of artists," encouraging them "to use the medium of electronic technology in challenging and unconventional ways." Of prime importance, this show was to enable the public to interact with the artists' programs. In the group of artists who took part in "Software" were Les Levine, Doug Huebler, Robert Barry, John Baldessari, Agnes Denes, Lawrence Weiner, and Hans Haacke. The most astonishing aspect of this exhibition in consideration of the art museum surroundings in which it was shown, was that it contained machines but no traditional works of art.

As much as the previously discussed exhibitions and projects represented major attempts to bridge the art and technology gap, their widely publicized failures and problems contributed significantly to the fact that proponents of the use of technology were met with a great deal of resistance in their struggle to gain acceptance from a majority of the art community. Because of their disagreements, E.A.T. was eventually dissolved. It was Paul em Schimmel as administrator of their pavilion at the 1970 World's Fair. In the Art and Technology program there were also a number of misunderstandings and disappointments arising both from personality conflicts and unrealized expectations on the part of the artists as well as the companies involved. The "Software" exhibition was plagued by malfunctioning machinery which further alienated skeptical visitors. The exhibition was a great success, however, E.A.T. had taken the first step in a direction that would eventually change many of the rules about what was considered "a good" piece of sculpture. Hess, described as looking like "shipwrecked victims after thirty days in an open boat" the four, poor, terrified gerbils in Seek, the collaborative installation of Nicholas Negroponte and the Architecture Machine Group from M.I.T., the malfunctioning arm of which was covered by the animals' excrement. He continued with a warning typical of the antagonism provoked by this exhibition, that "artists who become seriously engaged in technology might remember...what happened to four charming gerbils." With a lack of sympathy also characteristic of the movement's adversaries, Hess concluded: "It is represented by the poor performances of the equipment in the show to simply accept that, "the big point in Art and Technology manifestations over the past ten years has been that none of the technology worked." In spite of such negative criticism, the promise of rich interchanges between art and science that aroused international notice at the World's Fair in 1970, has since evolved into an increasing interest in computer art and computers. Whereas some artists, especially those involved in the field of 2-D animation, have turned to the use of computers to facilitate or expedite an existing means of expression, others, including Callas, Titze and Lillian Schwartz, are increasingly involved in exploring the potential of computer systems to extend their imagery and painting capabilities. Recent computer innovations have allowed other artists, such as Turner Whitted, Lorren Carpenter, Nelson Max, Lance Williams, Ephraim Cohen, and John Whitney, Jr., to name only a few, to explore the challenging interaction between computer and human creativity.

Not only is the potential of the computer vast for creating two-dimensional works of art but also for the truly three-dimensional. The computer can assist in the actual fabrication of a sculpture through its participation in the milling process as well as in the conception and design. Ron Resch and Robert McDermott's approximately 40 foot high Hungarian Easter Egg now installed in Edmonton, Canada, was both fabricated and designed by the computer. The scale-translation difficulties encountered when rendering a piece of sculpture from a line drawing into a three-dimensional solid have always plagued the sculptor. As sculpture has grown in size, however, this problem has become even more acute and the issue of sitting more crucial and frequently troublesome. Whereas it is extremely arduous to move tons of steel on location, it is relatively simple to move a model of even the largest sculpture on the computer screen. Furthermore, not only can the computer aid the sculptor in translating his designs from two dimensions into three, but once a model is constructed, it also allows him to rotate the piece 360 degrees to view it from any side or from ten stories above. This ability is particularly helpful for the growing number of large sculptures commissioned for public spaces. The potential for using the computer to preview a sculpture on site also increases as the fabrication of pieces without the sculptor present but merely from his designs becomes commonplace.

In the same way that the computer has proved to be a great aid in solving engineering problems for architecture, computer capabilities have similarly been applied to determine the sizes in large scale pieces of sculpture. The 36 foot high bronze, concrete, and ceramic sculpture Serendipity by Joan Miró, for example, now situated on the plaza west of the Brunswick building in Chicago, Illinois, designed by Skidmore, Owings, and Merrill, was first analyzed in this architecture firm's computer center to determine its structural design before being assembled. Although in this instance the artist was not involved in the process, the computer, one cannot dismiss the possibility that in the future the computer might become as commonplace in the sculptor's studio as plaster and welding tools are today. Jacob Agam was one of the first internationally recognized artists to take advantage of computers to achieve his desired effects. While Visiting Lecturer at the Carpenter Center for the Visual Arts at Harvard University, one of Agam's initial computer projects in collaboration with David Cohen was the execution of studies for his sculpture Star of Life, based on the form of the Star of David. By his appreciation of how useful a computer technology was to him to expand his artistic possibilities, Agam is representative of the rising generation of computer artists who are incorporating this tool into their aesthetic vocabulary.

The exhibition created by the advent of the computer in the fine arts field is manifest not only in the objects themselves but also in the manner of their presentation to the public. Submitting slides of existing works of art to a jury for possible inclusion in an exhibition is not a unusual procedure. The slides submitted for consideration by the jury of the SIGGRAPH '82 exhibition, however, marked a departure from this practice in that they served as records of works of art for the museum for which the majority still existed only in the memories of computer systems around the world. In many cases, both the scale and the method of printing the finished pieces were not yet determined. The slides were submitted because of the depen- dence upon technical assistance required by many artists in order to execute their plans, there are numerous products of collaborative efforts in the SIGGRAPH '82 exhibition. In addition, the exhibitors - including computer scientists and mathematicians as well as painters, sculptors, video and filmmakers - represent a much broader based group of artists than in a traditional exhibition situation.

The nature of the various works on display depended to a great extent on the capabilities of the systems available to the artists. These systems may vary from high resolution (where the technology is suitable for the execution of collaborative efforts) to low resolution (where the artists are more likely to develop their own software). As so far, relatively few painters and sculptors are familiar with computer programs and the technology, the most likely solution seems to be one of closing the distance between artists and programmers. It is anticipated that not only will a greater variety of programs and systems soon be available to artists but also that more artists will learn how to do their own programming.

The enormous range of the potential means of expression offered to the artist by the computer is evident in the diversity of the works in the SIGGRAPH '82 Art Show. Some of the captivating new alternatives are represented by Rob Naught's computer-milled brass relief, the plotter drawings of Colette and Charles Banger, the planar exhibition in France. Of the time of the young ballerina for which the photograph was first scanned into a computer and then the colors were manipulated, and Margot Lovejoy's multiple image etchings based on geometric distortions done in their form. In both cases, the computer's use of repetitive imagery (in spite of the discrepancy in the scale of their work). Also of interest are the text manipulation both in Ed Post's frustratingly undecipherable multi-colored as- sage composed of different kinds of letters and numbers some upside down and others in reverse and that in the composition of Joel Slayton, reminiscent of some early twentieth century attempts by the Cubists and the Russian Constructivists to incorporate typography into
their pictorial compositions, the colorful, abstract 3-D Scanamural of Joan Truckenbrod, and the font design for the letter "c" of Kris Holmes and Charles Bigelow. Noteworthy as "state of the art" technology are the photographs of digitally synthesized 3-D images by Dick Lundin whose fiddluous instrument lies in its case on a wood-grained stage achieved by exploiting the computer's ability to create texture, Robert Conley's study of reflections and refractions, Richard Balabuck's fantasy of glistening architectural columns both stationed upright and fallen on a brightly patterned tile floor, and Benoit Mandelbrot and Richard Voss's imaginary landscape synthesized using fractals. Nelson Max's enchanting moonlit seascape is an example of a still from computer animation. The illusory vision of a planet by Tom Dewitt, Vibeke Sorensen, and Dean Winkler, is a still frame from digitally processed video. For his portraits of famous people, Ken Knowlton programs the computer to arrange dominoes according to a specific set of constraints resulting in halftone likenesses. The sculptures of Ron Resch, Rob Fisher, Frank Smullin (represented by a series of preliminary drawings for it), and David Morris, were designed with the assistance of computer technology.

Hopefully, computer-aided art such as that on exhibition at the SIGGRAPH '82 Art Show will soon be commonly accepted in art museum settings making it available to a wider audience, and increasing numbers of artists will be attracted to the field. Some of the intriguing recent options which may lure an artist to the computer are 3-D modeling, palettes of up to 16 million colors, innumerable brushes, animation inbetweening, and software programs which allow the scale, color, and format manipulation of visual images in ways for the most part impossible in physical mediums. The extraordinary new methods for aesthetic exploration now available to the artist "with the aid of the computer" have made it possible as Ruth Leavitt has expressed with a widely shared awe, to "explore areas which artists in the past only thought possible to dream about." 

Footnotes
Sonia Sheridan
My New Black Book 1982
(frame 4)
Paul Jablonka
Mural 1981
Jane Veeder
Bubblespiral 1981
Nelson Max
Carla's Island  1982
(still frame)
Walter Wright
untitled 1981
Ken Knowlton
Domino Portraits:
Groucho 1982
Herve Huitric
Monique Nahas
La Famille Camembert 1982
EXHIBITORS:
Assante, Michael
“Nuworld 5” 1982
Cibachrome print 23 x 28 1/4 in.
NYIT
Hardware: PDP 11/34, E&S frame buffer
Software: E. Cohen, A.R. Smith
Balabuck, Richard
“Columns & Arches” 1981
Ektachrome print 27 x 32 in.
“Home Again” 1982
Photo silkscreen 22 1/2 x 26 1/2 in.
Cranston-Csuri Productions
Hardware: VAX 11/780, custom display device
Bangert, Colette & Charles
“Grass Series V” 1982
Plotter drawing 11 x 13 1/2 in.
Hardware: Intertec Superbrain,
Watanabe WX 4671 plotter
Bergeron, Philippe, Magnenat-Thalman, Nadia & Thalman, Daniel
“Dream Flight” 1982
Film 16 mm, color/sound, 14 mn.
University of Montreal - National Research Council of Canada - National Film Board of Canada, Hautes Etudes Commerciales, Ministere de L'Eduction du Quebec
Hardware: CDC Cyber, Tektronix 4027, Gradicon digitizer
Coleman, Connie & Powell, Alan
“Video Still Lives” 1982
Kodacolor prints (4) 8 x 10 in. each
Experimental TV Center, Owego, NY
Hardware: Breaster synthesizer, Jones colorizer/keyer
Collier, Michael
“Building” 1982
Ektachrome print 28 1/4 x 32 in.
Cranston-Csuri Productions
Hardware: VAX 11/780, custom display device
Conley, Robert
“Refractions” 1982
Ektachrome print 28 1/4 x 32 in.
Ohio State Computer Graphics Group
Hardware: VAX 11/780, custom display device
Cook, David
“Untitled” 1982
Ektachrome print 20 3/8 x 28 in.
Digital Image Corporation
Hardware: Cromemco Z-2D, SDI Graphics, Matrix instrument camera
Software: Cook, D. & Wright, W.
Culver, Joanne
“Frozen Sun Cones” 1982
Ektachrome prints 18 x 20 in.
Hardware: PDP 11/45, Vector General display, Sandin Image Processor
Defanti, Tom, Sandin, Dan and Shovitz, Mimi
“Spiral PTL” 1981
Video color/sound, 5 mn.
University of Illinois, Chicago
Hardware: Vector General, PDP 11/45, Sandin Image Processor, Arp synthesizer
Dietrich, Frank & Molnar, Zsusza
“Circle Twist” 3:30 mn. 1982
“Snake, Rattle, Roll” 3 mn. 1982
Video color/sound
Sound: Joe Pinzarrone, Eugene Rator
Hardware: Datamax UV-1 Zgrass computer
Eatherton, Tom
“Point” 1981
Installation 9 x 9 ft.
Hardware: Z80 with custom interface to LEDs
Software: Terrill Moore
Emshwiller, Ed
“AFI/SONY Video Festival Poster” 1982
Ektachrome print 24 x 30 in.
NYIT
Poster Art Direction: Carol Gerson
Technical Support: Lance Williams
Ettl, Eric
“Reflections #3” 1982
B&W photograph 20 x 24 in.
Facility: Via Video
Hardware: Via Video System 1
Faught, Rob
“Fragment” 1982
Styrofoam 40 x 48 x 5 in.
Visible Language Workshop, MIT
Hardware: Perkins-Elmer 3220 CPU, ANG Grinnell frame buffer
Feders, Eudice
“Pillar of Smoke” 1982
“Pillar of Smoke and Fire” 1982
Plotter drawings (2) 12 1/2 x 22 in.
CSUN
Fisher, Rob
“Galaxy” 1982
Sculpture (plotter drawing) 9 x 13 x 78 ft.
Penn State University
Hardware: E&S Graphics System, Versatec plotter
Software: Ray Masters
Frankel, Richard
“RST 0.03” 1981
Video color/sound: 3:50 mn.
Hardware: Datamax UV-1 Zgrass computer
Gelberg, Larry
“Untitled” 1982
Ektachrome print 20 x 30 1/2 in.
Hardware: Terak 8600 computer
Gerberg, Darcy
“DVI Series 1 #8” 1980
Cibachrome print 28 1/4 x 36 in.
NYIT
Hardware: PDP 11/34, Genisco frame buffer, Dicomed D-48
Software: A.R. Smith 3-Paint
Gershwin, David
“Selected Images from Nova” 1981
Ektachrome print 14 1/2 x 38 in.
Digital Video Systems, Inc., NYIT
Hardware: VAX 11/780, Genisco frame buffer, Dicomed film plotter
Graphic Designer: Paul Sousa/WGBH
Gillerman, JoAnne
“Pentagon” 1 mn. 1982
“Five Responses to the Political Condition Now” 13 mn. 1982
Video color/sound
Sound: James Gillerman
Glosh, Copper
“DESO7x3” 1981
Plotter drawing 31 x 26 in.
Real Time Design, Inc.
Hardware: Datamax UV-1 Zgrass computer, Houston plotter
Greene, Ned
“Night Castles” 1982
Cibachrome print 24 1/4 x 25 1/4 in.
NYIT
Hardware: VAX 11/780, Genisco frame buffer, Dicomed D-48
Technical support: Paul Xander, Jr. and Lance Williams
Gutstadt, Howard
“Mixed Up” 1982
Ektacolor print 22 1/2 x 24 1/4 in.
Digital Image/GESI
Hardware: Harris frame store, 3M digital wipe generator
Subject: Susan Bradley
Hedelman, Harold
“Untitled” 1982
Ektachrome print 21 1/2 x 27 1/4 in.
Hardware: Grinnell frame buffer, VAX 11/780
Software: Harold Hedelman, Rikk Carey, Dan Ambrosi, Tom Mazzotta, Roy Hall, Wayne Robert
Hill, Gary
“Videograms” 1980-81
Hardware: Rutt/Etra synthesizer
Hockenhull, James
“Bellybuttons” 1980
Ektachrome print 26 x 32 in.
Hardware: Apple II, Amdek RGB monitor
Holland, Harry
“Sandy Fold” 1982
“Strata Variables” 1982
Cibachrome prints (2) 15 1/2 x 17 1/4 in. each
Carnegie-Mellon University
Hardware: PDP 11/03, AED 512 display device
Software: Warren K. Wake
Holmes, Kris & Bigelow, Charles
“Isadora Type Family” 1981
B&W photograph 24 x 20 in.
Prod. Facility: Hell Digiset, GmbH
Hardware: Siemens R-30 computer, Arlto digitizer, Digiset 400T photo typesetter
Software: ikanus by Dr. Kacow
Huitle, Herve & Nahas, Monique
“Ca Roule” 1981
“Impression” 1981
Ektachrome prints (2) 16 1/2 x 23, 14 1/2 x 15 1/2 in.
Hardware: LSI 11 frame buffer
“La Famille Camembert”
Ektachrome print 16 x 20 1/2 in.
Hardware: VAX 11/780, Lexidata 3400 display
Jablonska, Paul
“Mural” 1981
Cibachrome print 20 x 24 in.
Hardware: Data General Eclipse, Ramtek display, Dunn camera
Johnson, Tony
“Bubble Girl” 1982
Cibachrome print 25 1/4 x 29 3/4 in.
Digital Equipment Corporation
Hardware: Genigraphics 100B console, Software: TGX Program
Kawaguchi, Yolchiro
“Crystal Space” 1982
“Crystal City” 1982
Cibachrome prints (2) 20 x 24 in. each
Nippon University, Tokyo, Japan
Knowlton, Ken
“Domino Portraits: Groucho” 1982
Medium: 4 complete sets of uncut Brazilian double-9 dominoes 26 x 24 in.
Hardware: Cromemco
Lieberman, Henry
“Munching Squares” 1981
Ektachrome print 18% x 24 in.
Artificial Intelligence Laboratory, MIT
Hardware: MIT Lisp computer, frame buffer
Software: MIT Lisp
Lovejoy, Margot
“See the Beautiful Sea” #65, #60, book 1981
Intaglio prints (3) 25 x 19 3/4, 23 x 32½ in., book 4 ½ x 6 in.
McGill University
Hardware: Amdahl computer, line printer output
Lundin, Dick & Williams, Lance
“Saxophone” 1982
Ektachrome print 24 x 30 in.
NYIT
Hardware: VAX 11/780, Genisco frame buffer, Dicom film plotter
Software: Paul Heckbert
MacDonald, Bonnie
“Tama” 1982
Serigraph on rice paper, 24 x 37 in.
Digital Effects
Hardware: VP3 Video Palette System
Mallory, Robert
“Ribbon Series” 1981
Plotter drawings (3) 12 x 15 in. each
Hardware: CDC Cyber 175, DEC
UT-100, Calcomp 4 color drum plotter
Marshall, Mike
“Beam and Bubbles” 1982
Cibachrome print 20 x 24 in.
Hardware: Calma Design System, Data General Eclipse, Lexidata frame buffer
Max, Nelson
“Carla’s Island” (stil frame) 1982
Cibachrome print 35½ x 36½ in.
Lawrence Livermore Laboratories
Hardware: Cray 1, Dicom D-48 color film recorder
Morris, David
“Spiral Wind Form” 1982
Stainless steel sculpture 19½ ft. (maquette & installation photographs)
“Little One” 1982
Aluminum 7 ft.
Skidmore, Owings and Merrill (Chicago)
Hardware: Tektronix 4014, Xynetics plotter
Morton, Philip
“Aluminum” 1982
Video printer installation 12 x 8 ft.
Hardware: Datamax UV-1 Zgrass computer, Axiom video printer
Nakamae, E., Nishita, T. and Okamura, I.
“Islet Belt Given by Linear Light Source” 1982
“Lighting Simulation of a Linear Light Source” 1982
Cibachrome prints (2) 29½ x 31½, 29½ x 29 in.
Hardware: Okitac System 50/40, Graphica M-508R display
Olschafskie, Francis
“Newworth” 1981
Polaroid print 22 x 28 in.
Visable Language Workshop, MIT
Hardware: Perkin-Elmer 3220, Grinnell frame buffer
Made possible by Polaroid (Cambridge)
Porett, Tom
“Softland” 1981
Dot matrix prints (3) 9½ x 13%, 12½ x 13½, 12½ x 12½ in.
Hardware: Apple II+, Epson MX-80
Post, Ed
“Self 3” 1982
Plotter drawings (3) 13½ x 16½ in. each
Hardware: Tektronix 4662 plotter, Software: Tektronix I.G.L. graphics package
Pruitt, Melvin
“The Landscape” 1982
“Untitled” 1981
Ektachrome prints (2) 26 x 30 in. each
Los Alamos Nat. Lab, New Mexico
Hardware: Cray 1, III FR-80 graphics
Resch, Ron
“Van Leer Model” 1980
PVC sheeting 15 x 15 x 15 in.
Boston University
Hardware: Gerber flatbed plotter, IBM 370
Sandin, Dan
“Wandawega Waters” 1980
Video color/sound, 15 mn.
UICC
Hardware: Sandin Image Processor, Sandin digital colorizer
Shatran, Joan
“White Knight in Armour as Usual. ..” 1981
Color Xerox plotter drawing 5 x 7 ft.
Visible Language Workshop, MIT
Hardware: Perkin-Elmer 3220 CPU, Xerox 6500 Versetec plotter
Sheridan, Sonia
“My New Black Book” 1982
Ektachrome prints 18½ x 47½ in.
Hardware: Chromemco Z-2D computer system
Software: John Dunn, Easel
Siayton, Joel
“Mogul” 2” 1981
“Untitled” 1981
Polaroid prints (2) 22 x 36½, 10½ x 12½ in.
Visible Language Workshop, MIT
Hardware: Perkin-Elmer 3220 CPU
Made possible by Polaroid (Cambridge)
Smullin, Frank
“Labarynth of Data List” 1981
Sculpture (working drawings) 111 x 135 x 120 in.
Corten steel cylinder
Center for Advanced Visual Studies, MIT
Hardware: Calcomp 1051 plotter, Amdahl 470-V8, Tektronix 4052
Software: Frank Smullin, Perspect
Sykes, Barbara
“Video Haiku” Video
- “Waking” B&W/sound, 2 mn. 1980
Audio: Rick Panzer
- “Witness” color/sound, 3:15 mn. 1982
- “I Dream of Dreaming” B&W/sound, 4 mn. 1981
Audio: Stuart Pettigrew
Hardware: Sandin Image Processor
Truckenbrod, Joan
“Phase Transitions” 1982
3M Scanamural 5 x 7 ft.
Northern Illinois University
Hardware: Tektronix 4027 & 4051
Van Der Beek, Stan
“Steam Installation” 1982
Installation
University of Maryland
Vasulkia, Steina & Woody
“In Search of the Castle” 1982
Video color/sound, 3:05 mn.
“Bustergrid” 1982
“Bubblempiral” 1981
Cibachrome prints (2) 21½ x 28 in. each
“Warpout” 1982
Installation
Hardware: Datamax UV-1 Zgrass computer
Hardware Support: Real Time Design, Inc. & Dave Nutting Associates
Voss, Richard & Mandelbrot, Benoit
“Fractal Planetsrise According To Benoit Mandelbrot” 1981
Cibachrome print 20½ x 21 in.
Hardware: IBM 3033, Ramtek Matrix, Celco CFR 4000
Winkler, Dean, DeWitt, Tom & Sorensen, Vibeke
“Voyage” 1982
Video color/sound, 8 mn.
Hardware: D. Winkler custom computer, Grass Valley GVG 300 switcher, Digital framestore
Wright, Walter
“Untitled” 1981
Ektachrome print 20½ x 28 in.
Digital Image Corporation
Hardware: Cromemco 22, SDI Graphics, Matrix Instrument Camera
“Frame Buffer Show” 1982
Video frame buffer 10 mn.
West Coast University
Hardware: DeAnza 6400 frame buffer, DEC PDP 11/23, Conrac 7211
RGB monitors
Organized by: Robert Holzman, James Blinn, David Em