Numerous outstanding artists have been interested in science. Leonardo da Vinci most frequently entertained engineering concerns, among his sketches are drawings of flight including drawings of helicopters, para-sails, and flying machines. Leonardo's love of art and science is well known. Representing only one of his many loves of art, the artist whose profound mathematical inclinations how integral he felt art and science were. Perhaps his youthful achievements as an inventor, produced a great number of drawings of flying machines and a model helicopter. The references to non-Newtonian fluids that were part of his theory of the fluid behavior of water was stimulated by his observations in the High Speed Tunnel. The model was constructed in 1919 when his theories on space came to public notice. Eulalio J. is no longer either possible or fashionable to do so. The large 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 the art environment. A lack of familiarity with the actual process by which the works are made, has caused the word "computer" in connection with art to be met with a mixture of curiosity and distrust out of the ill-founded fear that this mystifyingly 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 handcrafted product as conventional art forms but simply processed in a different manner. Furthermore, both artists and critics of yet unabated with the mechanics and potential of computers, their accomplishments on computer systems, which may assume various forms including color xerography, photo enlargements, poster 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 computer field. This practice is in antithesis to the myth of the solitary artist, striving preferably in solitude in a studio to realize his artistic concepts in pencil, paint, metal, stone, or other common materials.

The products of art and technology have often been rejected outright as 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 its permanent collection.

In spite of popular misconceptions, development in the field of the arts throughout much of history, and the accomplishments of numerous outstanding artists 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 fertile imagination and ingenuity as an inventor, produced a great number of drawings of flight including drawings of helicopters, para-sails, and flying machines. 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 was a student of Dr. George F. Smith of the Massachusetts Institute of Technology the exhibition "Aspects of Art and Science" for the Smithsonian in 1978, their researches 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 it is the Technical Manuscript of his techniques in 1920 and one which he illustrated with a group of carpe­lian beads from Chanhadaro, India, that show how as early as 3000 B.C. craftsmen were using an alkali substance to etch decorative patterns into a metal surface. The references to non-Newtonian fluids that were part of his theory of the fluid behavior of water was stimulated by his observations in the High Speed Tunnel. The model was constructed in 1919 when his theories on space came to public notice. Eulalio J. is no longer either possible or fashionable to do so. The large 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 the art environment. A lack of familiarity with the actual process by which the works are made, has caused the word "computer" in connection with art to be met with a mixture of curiosity and distrust out of the ill-founded fear that this mystifyingly 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 handcrafted product as conventional art forms but simply processed in a different manner. Furthermore, both artists and critics of yet unabated with the mechanics and potential of computers, their accomplishments on computer systems, which may assume various forms including color xerography, photo enlargements, poster 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 computer field. This practice is in antithesis to the myth of the solitary artist, striving preferably in solitude in a studio to realize his artistic concepts in pencil, paint, metal, stone, or other common materials.

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Tuchman’s proposal was motivated by a belief similar to Klöver’s and Rauschenberg’s, that giving the visiting artists access to modern technology would greatly increase their artistic capabilities and be advantageous to industry as well. Among the 76 artists and their corporate sponsors who eventually participated in this large scale project were Andy Warhol (artist in residence: Cowles Communications, Inc.); Jean Dubuffet (artist in residence: Polaroid Corporation, Inc.); Tony Smith (artist in residence: Container Corporation of America); Claes Oldenburg (artist in residence: Gemini G.E.L.); and Robert Rauschenberg (artist in residence: Teledyne). This project, created by the artists in this program were exhibited at the Los Angeles County Museum in 1970.

The Machine as Seen at the End of the Mechanical Age, curated by curator 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-magical” riches of Swiss-born artist Jean Tinguely. Pointing toward the direction of future collaborations, included in this exhibition was Edward Kienholz’s Friendly Grey Computer. This construction was seated comfortably in a museum environment, because the artist compassionately explained in his operating instructions, “computers sometimes get fatigued and have nervous breakdowns . . . hence the chair for it to rest in . . . remember if you treat your computer well, it will work well for you.”

Also in 1968, Jasia Reichardt curated the exhibition “Cybernetic Serendipity: the Computer and the Arts” at the London Institute of Contemporary Art. Her exhibition, the first international survey of computer art, included poetry, painting, sculpture, choreography, music, drawings, films, 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” shaped the 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. Perhaps the most famous of Curatorial curator’s exhibition “The Machine.” Burnham hoped that “Software” would demonstrate “the effects of contemporary control and communication techniques in the hands of artists,” encouraging them to explore the environment of the computer, the machine without traditional machines but with 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 in the service of art have faced much resistance in their struggle to win acceptance from a majority of the art community. Because of their disagreements, E.A.T. was eventually disbanded by Pepsi 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 disappointment arising both from personal 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 members of the art world. Critic Thomas B. 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 aroma of burnt meal, with a warning of the antagonism provoked by this exhibition, that “artists who become seriously engaged in technological processes might remember . . . what happened to four children getting wet.” This was also characteristic of the movement’s adversaries. Hess concluded by advising those who were disconcerted by the poor performances of the equipment in the show to simply accept it as “the present point of technological and aesthetic stagnation over the past ten years has been that none of the technology works.”

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 increasingly symbiotic relationship between artists and computers. Whereas some artists, especially those working in the machine environment, have turned to the use of computers to facilitate or expedite an existing means of expression, others, including David Em, Darcy Gerberg, and Lilian Schwartz, are increasingly involved in extending the capabilities of the computer to extend their imagery and painting capabilities. Recent computer innovations have allowed others in the field including Jim Blinn, Turner Whitfield, Loren Carpenter, Nelson Max, Lance Williams, and John Whitney, Jr., to name only a few, to explore the challenging domain of 3-D animation.

Not only is the potential of the computer vast for creating two-dimensional works of art but also three-dimensional works. 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 using a computer.

The scale-translation difficulties encountered when rendering a picture of sculpture in a line drawing into the three-dimensional solid have always plagued the sculptor. As sculpture has grown to monumental proportions, this problem has become more acute and the issue of size has become more and more pronounced. When it is extremely and only 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 in visualizing large scale sculptures commissioned for public spaces. The importance of the opportunity to preview a sculpture on site also increases as the fabrication of pieces without the sculptor present becomes more common.

In much 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 stresses in large scale pieces of engineering. 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 at all in the computations of his sculpture, one could certainly envision that in the future the computer might become as commonplace in the sculptor’s studio as plaster and welding tools are today.

Jaeck Agam was one of the first internationally recognized artists to make use of computers to achieve his desired effects. While Visiting Lecturer at the Carpenter Center for the Visual Arts at Harvard University in 1968, one of Agam’s initial computer projects in collaboration with the Computer Science, which was intended for his sculpture Star of Life, based on the form of the Star of David. By his appreciation of how using computer technology has enabled him to expand his artistic possibilities, Agam is representative of the many sculptors who are incorporating this tool into their aesthetic vocabulary.

The revolution 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 working art to a jury for possible inclusion in an art show is an accepted procedure. The slides submitted for consideration are reviewed by the jurors. In Agam’s presentation, however, marked a departure from this practice in that they served as records of works of art which for the most part at the time of entry still existed only in the memories of computer scientists and computer engineers. Both the scale and the method of printing the finished pieces were not yet determined when the slides were submitted. Also because of the dependence upon technical assistance required by many artists in order to execute their plans, there are numerous products of collaborative efforts in the SIGGRAPH ’82 Art Show. In addition, the exhibitors - including computer scientists and mathematicians as well as paint- ers, sculptors, and photographers - 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 tendency is for the works to be more collaborative efforts) to low resolution (where the works are more independent of the software). As so far, relatively few painters and sculptors are familiar with computer programs and technology, the direction for the future seems to be one of closing the distance between them. This is recognized as 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 Bob Fouch’s computer generated drawings of Colette and Charles Banger, the picture processing in Francis Olschafsky’s young ballerina for which the photograph was first scanned into a computer and then the computer manipulated it. Margot Lovejoy’s multiple image etchings based on geodetic data which in their formal recall Andy Warhol’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 message composed of different kinds of letters and numbers some upside down and others in reverse and that in the composition of Joel Staylor, 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-M Scanamural of Joan Truckenbrod, and the font design for the letter "o" 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 fictitious 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 Balsibuck'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 half-tone 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 museums 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 in-betweening, 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