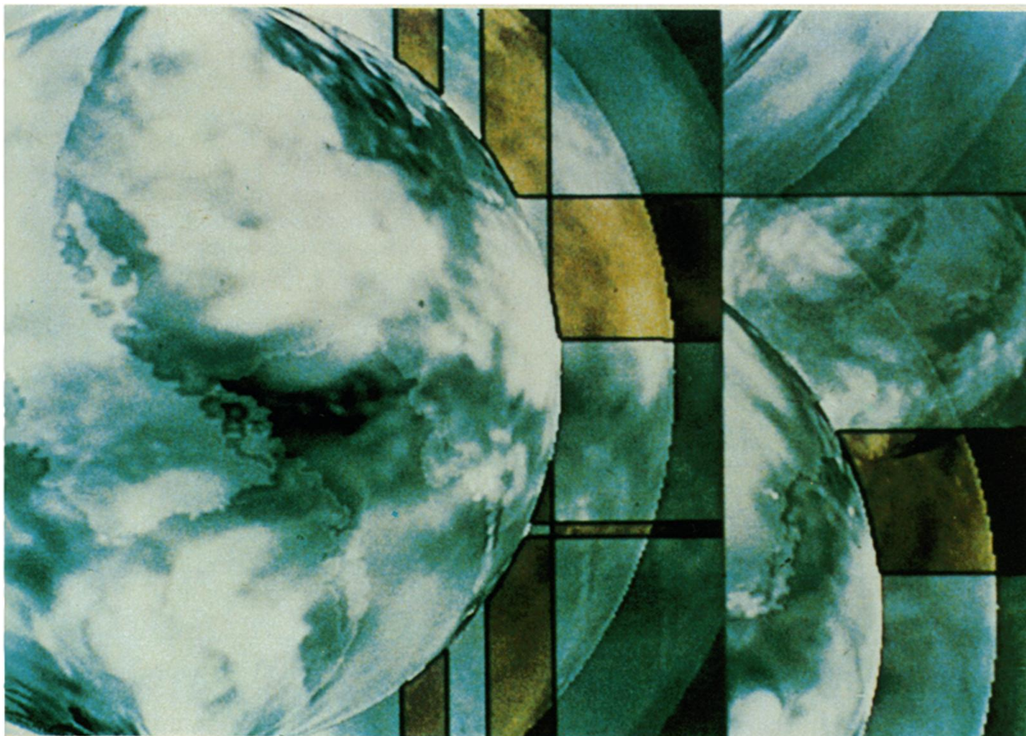
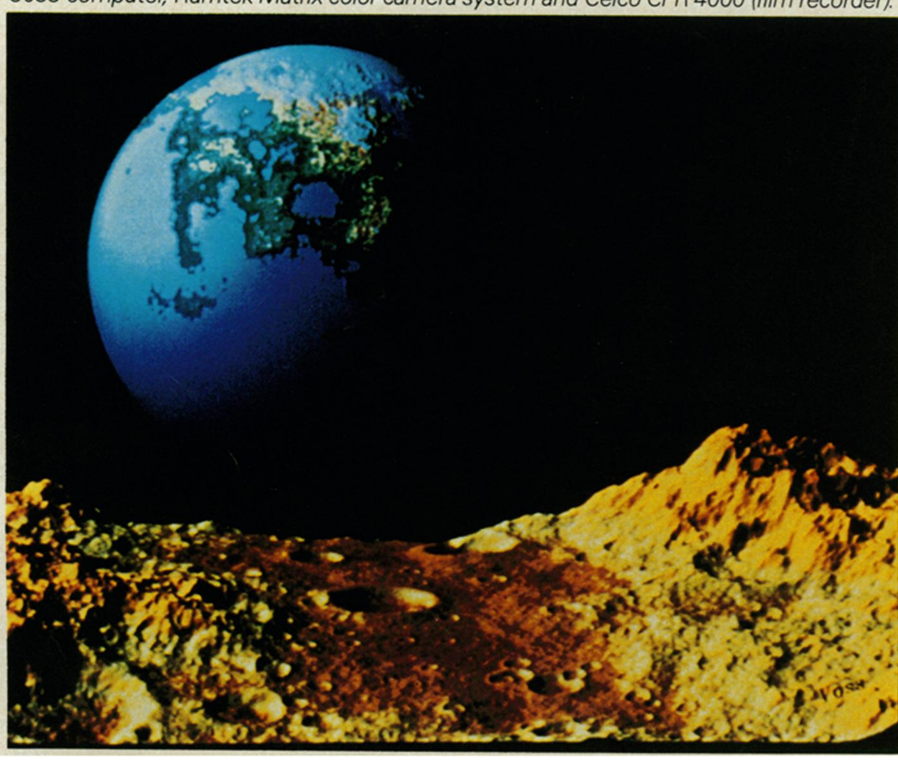
Computing for Art's Sake

A juried art show in Boston hints at a growing love affair between artists and their computers



Assante's 24" x 28" Cibachrome print, Nuworld 5 *(above), was generated on a PDP11/34 computer and Evans and Sutherland frame buffer. Software by E. Cohen and A. R. Smith. The 20⅜" x 21" Cibachrome print of fractal planetrise (below) was created using an IBM 3033 computer, Ramtek Matrix color-camera system and Celco CFR 4000 (film recorder).*



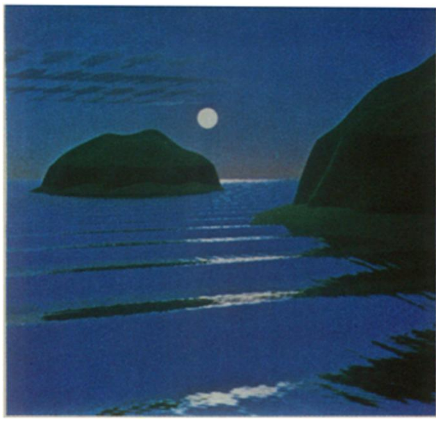
By JANET RALOFF

WARP IT OUT was a show stopper. And fun. Maybe even silly. But was it art? Several skeptics paused to ask that question, though most didn't seem profoundly concerned what the answer was, because Jane Veeder's interactive presentation (p. 330) was a crowd pleaser. It was also one of 88 "works" selected for exhibition at an art show in Boston this summer—held in conjunction with the annual meeting of the Association for Computing Machinery's Special Interest Group on Computer Graphics (Siggraph). And it exemplified as visibly as any the unusual ways artists are embracing computers to explore the dimensions of their craft.

To the untrained eye, some of the Siggraph art looked fairly conventional: there were colorful abstract photographs, classical sculpted forms, clever animated films, and a share of just plain witty or unusual "things." But in few works was the most basic qualification for entry in the exhibition—use of a computer—obvious.

However, explained Copper Giloth, organizer of the art show and herself a computer artist, none of the more than 1,300 entries and proposed installations made it into this year's show unless she felt that use of a computer "had been an integral part" of the artistic process that created it. And, she boasted, "I don't think I've seen a show that's dealt with this high a quality of art in the last five or 10 years. I was really amazed — both at the numbers and the quality."

For Frank Smullin, a Durham, N.C., sculptor, computers are a godsend. "In 1974 I built a 28-foot-high tubular sculpture on commission," he says, "and I did it without a computer." He had to. At the time he knew nothing about computers and lacked access to them anyway. He says, "I couldn't even afford a handheld calculator that could do trig, so I did all my computations with a slide rule and trig tables." Although it took him a month to assemble his creation, it had taken two months to do the computations that made assembly possible. "I simply wouldn't have gone on with this kind of work if I had to go through that agony again," he told SCIENCE NEWS. "What got me into computers was my great satisfaction with sculpture but my unwillingness to manually go through



Max 1982/Siggraph 82

Carla's Island, *a $35\frac{3}{4}$"x $36\frac{7}{8}$" Cibachrome print from Dicomed D-48 film recorder.*

Giloth 1981/Siggraph 82

Datamax UV-1 Zgrass computer was used for DESO7x3*—a 31" x 26" plotter drawing.*

the computations."

Throughout history, Smullin maintains, sculptors have adapted "the most recent technology—basically, manipulating anything they could get their hands on. And the computer is just another new tool."

As with any new tool, acquiring skill in its use requires work. "And I've had a lot of trouble," Smullin says, "because I've been teaching myself programming as I go. I didn't find existing software [the mathematical sequences that program a computer to perform specific tasks] that easily fit my needs," he says "so I had to write all of my own."

What's more, up until last year Smullin says he was "very limited" by the cost of buying access time on someone else's computer. "I initially started working with mainframe computers, interactively," he says, "which was very expensive." The $3,000 he spent during the first two years, mainly for computer time as he developed his software, "was substantial to a poor artist." But "with new high-power microcomputers, I can now do the same programming for free," he says, using a low-cost machine at home.

Today Smullin uses the computer to create perspective renderings—drawings that depict how a proposed sculpture should look from any designated viewpoint. He did not yet have that capability, however, at the time he designed the sculpture depicted in the Siggraph show (p. 331). "The only way I had of inspecting the model then," he says, "was through a numerical analysis which looked for interferences" — places where the sculpture's components would inadvertently attempt to share the same space. And that function remains one of the single most essential aspects of the computer in his work.

The initial model for the sculpture depicted at Siggraph was a freehand welded structure 3 inches high. "I digitized the model in terms of coordinates and projections," Smullin says, indicating that all endpoints and intersections of the design —as would be seen from a specified view —were projected onto graph paper. These coordinates were then fed into the computer together with a list of the sculpture's connecting points and dimensions for the diameter of pipe to be used. With computer programs he developed, Smullin then inspected the model for interferences. The sculpture pictured at Siggraph "was manipulated to bring all crossing pieces to zero clearance," Smullin points out, "so that everything is just touching."

Once the design phase is complete, the computer spits out all construction specifications along with an actual pattern and instructions for cutting out the pipe. The latter has become a feature of growing importance as the number of angles that Smullin designs into his works has grown. "Trying to eyeball these complex cuts would be next to impossible and lead to wasting expensive materials," he says; "I'd run my costs up several thousand fold." As a result, he says confidently, "I can vouch for the absolute necessity of the computer in what I'm doing—I dare anybody else to do this without a computer."

Joel Slayton, the artist whose work appears on this week's SCIENCE NEWS cover, is also a convert to computers. "I started out as a photographer," he says, and then went to the Massachusetts Institute of Technology about five years ago to pursue an interest in graphics. "I sort of weasled my way into being the coordinator of this place called the Visible Language Workshop," he says, "and was primarily responsible for teaching computer graphics as a visual tool—an artists' tool."

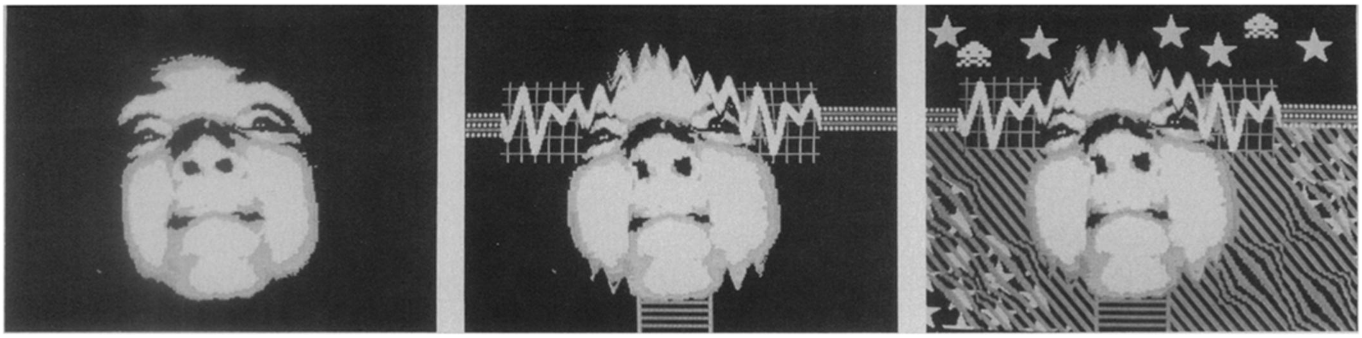
"From the outset, I was convinced programming wasn't a very important issue," he said in a phone interview from his new Oakland, Calif., studio. "I was much more concerned with what computer systems were capable of doing." In particular, he felt challenged to explore a range of alternative effects that might be achieved using software designed for specific purposes—such as moving a chunk of text around a video-display screen.

For the untitled work he exhibited at Siggraph, Slayton used a video camera to "grab" images from real life. Those visual data were in turn fed into "a computer called a frame buffer, which," he said, "has the capability of instantly digitizing a video frame [turning a video image into a string of numerical data]." It is the computer equivalent of "taking a snapshot," he explained: "I would bring people in, have them sit in front of the camera and pose."

Once the computer has digital data describing an image, Slayton says it's relatively easy to add text and move or alter pictures (turn, enlarge or reduce them). Equally important, he stresses, is the computer's image-processing capability. It can color images, manipulate their tonal values, distort pictures, or vary their apparent texture.

Best of all, there was no need "to enter any keystrokes into the system," he notes, eliminating the disruptive need to translate intended actions into typed commands. Using a puck and "tablet," Slayton entered commands in the computer just by "hitting four buttons with the puck. I could make decisions about what I wanted to do and have them occur almost simultaneously," he says.

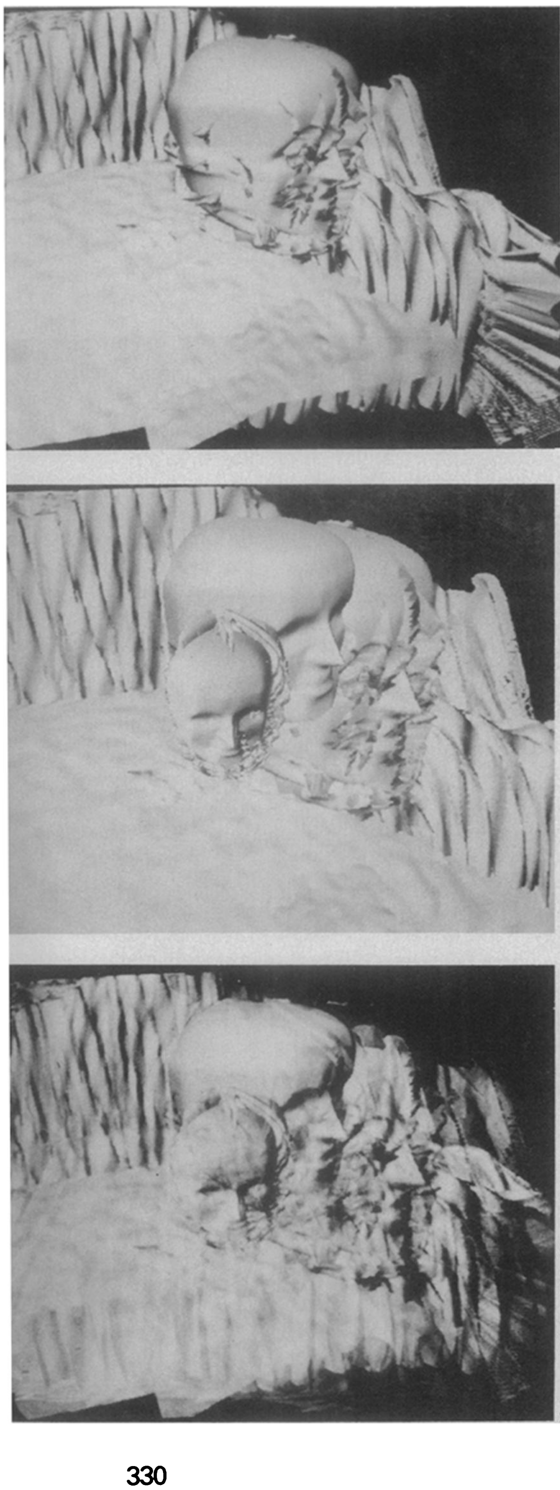
The computer-driven "Images" system on which Michael Assante created *Nuworld 5* (p. 328) is actually known generically as a "paint system." Developed at the New York Institute of Technology on Long Island, where Assante works, this system, too, is triggered by movements of a cursor across a tablet. Assante explains: "Our tablet is a drawing surface." As a pen is moved across the tablet, an antenna inside the pen relays position readings to the computer so that it will perform instructed actions at a corresponding position on a nearby display screen. "It's as though someone were holding a palette," Assante says. "You move down to the bottom of the tablet to get your color, then up to paint in the designated areas." And depending on the size of a frame buffer's memory, paint-system palettes can offer more than 500 different colors. Artists even design their own "brushes" simply by drawing a shape and instructing the computer to use that design as a brush. The next time the pen hits down, it will leave



© Veeder 1982/Siggraph 82

Frames 1, 5 and 9 from WARP IT OUT *sequence. In 1, video camera digitizes Veeder's face and displays it. Then she chooses green and purple color scheme. In stages 2-4 (not shown) ripples are applied to forehead and jowls, nose and cheeks are "magnified" and business chart is placed behind head. User selects and applies graphic effects from menu of offerings. Polaroid camera records final image.*

Series illustrating construction of La famille Camembert. *Final 16" x 20.5" Ektachrome print taken from Lexidata 3400 display. System also used VAX 11/780 computer.*



Nahas and Huitric 1982/Siggraph 82

paint strokes indicative of that shape.

Why not use a real brush and paints? "When you take a long time to sculpt something or put paint on canvas," Assante says, you're not going to play around with what might be the finished product because you'd risk "destroying what you had up to that point." Not so with the computer. Once a pleasing image has been rendered, it can be stored in the computer's memory for subsequent recall. Then the artist is free to continue playing with that image—changing its colors, the texture of its components (from simulated metal, for example, to plastic or oil-based paint). And at any time one can erase what isn't wanted. "It's just a super editor," Assante asserts.

It's also "a spoiler," he notes. "Evidence of that was given me many times by friends," he says, "especially printmakers. They'd become extremely jealous, saying 'It's just not fair what you can do. It would take me months to fill in an area that large with that rich a texture.'"

What's more, the process is "so clean," he notes. Not only is there no oil or acrylic paint to clean off one's hands, brushes and clothes, but also there's nothing to spill a cup of coffee onto, he says, because your image "is in a disc memory."

"There is one limitation," he warns. "There's never enough resolution." And the problem can become dicey, artists complain, when their images contain a lot of curves. The computer-graphics screen must approximate curves from discrete, ordered rows of pixels (dot-sized regions capable of emitting light). Though there are ways to disguise the problem, a careful eye can usually see through it.

Systems described so far have been designed by and for artists. But some who exhibited at Siggraph don't consider themselves artists so much as computer scientists and mathematicians who design equations capable of producing interesting pictures.

Take Benoit Mandelbrot. In his essay "manifesto," *The Fractal Geometry of Nature* (W. H. Freeman, San Francisco, 1982), he writes: "I conceived and developed a new geometry of nature ... It describes many of the irregular and fragmented patterns around us, and leads to full-fledged theories, by identifying a family of shapes I call *fractals*" (SN: 8/20/77, p. 122). And these fractals reveal, the IBM Research Fellow says, "a totally new world of plastic beauty."

Together with Richard Voss, he designed *Fractal Planetrise According to Benoit Mandelbrot* (p.328). Acknowledging that the image may look realistic, Mandelbrot emphasizes the work is not a photograph of anything real, nor was it "*intended* to be artistic." Everything about it is "artificial," he explains — and as comparably synthetic as would be "the complete synthesis of hemoglobin from the component atoms and (a great deal of) time and energy."

Voss, who like Mandelbrot works at IBM's Thomas J. Watson Research Center in Yorktown Heights, N.Y., says they use computers "to illustrate certain mathematical constructions. The input to those [computer] programs is something known as 'a fractal dimension'—a way of characterizing the irregularity of a surface. It simply takes random numbers generated on computers, massages them in a certain way to generate correlations among the random numbers, and then displays them."

Voss describes *Planetrise* as "a minimal specification of a landscape. You specify very few things—fractal dimension of the surface and information about how you want it colored. The computer does all the hard work; it puts in all the details of the rock—also the irregularities that a painter would have to spend months doing. These things come automatically by computer." And the fact that the image exhibited at Siggraph "looks like a planetrise is indicative of how well the description works," Voss says.

One reason all Mandelbrot's fractal pictures "look extremely interesting, extremely art-like," Voss claims, is that "they mimic natural shapes. In a sense, part of what [Mandelbrot] is doing could be called the mathematics of art — though that's a bit farfetched."

Monique Nahas and Hervé Huitric of Nogent-sur-Marne, France, also take a mathematical approach to their art. Literally the marriage of a theoretical physicist (Nahas) to an artist with a graduate degree in computer science (Huitric), the pair have come to "use state-of-the-art techniques very creatively," according to Aristides Requicha, associate director of the University of Rochester's Production Automation Project, where the French team worked last year.

Their images are totally synthetic. In *La famille Camembert* (p. 330), coordinates were fed into a computer denoting a number of points that would have resided on the surface of one of the faces if it had been a real, physical object. Then, using a technique called the bicubic B-spline surfaces computation, a "surface" was computed that ran near each of the specified three-dimensional coordinates (but not actually through them).

Once this representation of the face had been described mathematically, Nahas and Huitric applied "tricks" via their software, "le systême Rodin," to determine how light would reflect off it, where shadows would occur — even a sense of perspective (based upon an assumption of where the light source and viewers' eyes would be). The software also allowed them to create surface modulations or deformations in their images for added texture. (In experiments along this line last year, they modeled a dinosaur based on surface points measured from a balsawood skeletal-model kit they assembled. Afterward they deformed its surface to simulate a furry coat. The furry dinosaur "wasn't beautiful," recalls Requicha, "but it was cute.") Final works contain a composite of images that the Rodin program has melded mathematically.

Nelson Max, at Lawrence Livermore National Laboratory, got involved with graphics as a means to visually demonstrate mathematical concepts. However, he says, "People would look at a film, appreciate its beauty and give me all kinds of compliments. Eventually I just started thinking of myself as an artist."

"You see, I can't paint," Max says. "But I can do the mathematics and the programming" necessary to make an imagined scene appear on a computer display. "So the computer allows me to create fictional worlds I would not otherwise be able to," he explains.

Carla's Island (p. 329) is a high-resolution enhancement of a single frame from a four-and-a-half-minute movie by the same name. "Everything in the picture was done with polynomials and trigonometric functions," Max points out. For example, his islands were initially modeled as a couple of paraboloids "I just stuck into the ocean," he says. When viewers told him they looked "like breasts popping up out of the water," however, he decided to superimpose waves atop them to form rolling hills, added a "California"-style beach, and then stuck a cliff above it.

Color, lighting and reflections were determined by "ray tracing," a technique that follows the path of hypothetical light rays — emanating from the viewers' eyes — as they would bounce off and between objects in the field of view. Unlike the other artists described here, Max works with a Cray 1 "supercomputer" — one of the world's fastest. But to use the machine efficiently, Max had to "vectorize" his ray-tracing algorithms (mathematical procedures). "And that's not the way people normally think about ray tracing," he says. Normally they would analyze the path of one ray to completion before tackling the next. Max had to tackle 100 or more and sequentially compute the first step of each ray's path, before returning to sequentially calculate the second step. And so on.

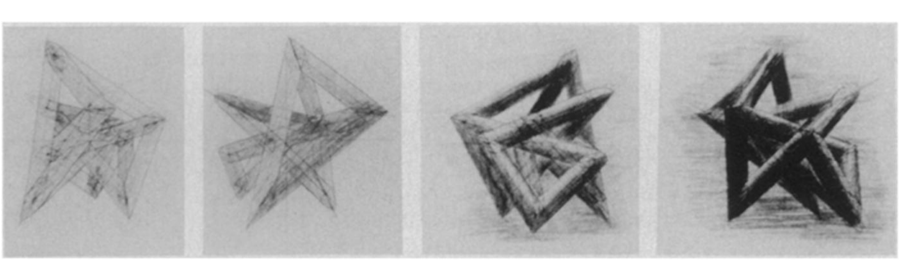
"The conventional art world doesn't really think of art as being technological," says Veeder, a rather nonconventional artist from Chicago, "but it really is." The introduction of spatial perspective in drawings and the development of paint in tubes — those were technological innovations that brought revolutions in art, she says.

"I don't have a very good mathematical background," admits Veeder, "but the main thing about computers is not mathematics, it's logic. Things like sine waves," for example, "are very powerful organizing forces in nature. And for artists to be able to interact with things in terms of logic is something that appeals to a lot of us," she says. "It's very intellectual."

But the computer's appeal has not yet become universal. When artists from other disciplines look at computer art, Slayton says, they often complain that "all you did was expedite what you could have done with your hands or mind. And to a certain extent, that's been true," he concedes, adding that that is changing.

Nonetheless, an antipathy toward computers has limited the ability of some artists to gain exposure. "Galleries don't particularly like [computer art]," Slayton contends, probably because they don't know what to do with it, how to display it or how to evaluate "sensibilities of the technology and its relation to the message." But "there's a whole new esthetic from which this discipline is just now emerging," he says. And art exhibited at Siggraph this year offered a glimpse into how that is being expressed. □

Perspective drawings of sculpture, rendered by Calcomp 1051 plotter, were hand-colored. Tektronix-4052 and Amdahl 470-V8 computers were used to compute coordinates.



Smullin 1981/Siggraph 82

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