CAD/CAM approach to sculpture

BY MICHAEL O'ROURKE

For the last several years, Michael O'Rourke has been developing unique, state-of-the-art techniques for sculptural modeling with computers. As a Master of Fine Arts candidate at the University of Pennsylvania in Philadelphia, he had access to the university's computer science facility, where he experimented with computer graphics while he received training in traditional sculptural techniques. Now employed at the New York Institute of Technology's Computer Graphics Laboratory as senior staff artist, O'Rourke continues to explore the applications of computer graphics for sculpture. In what follows, he describes his working procedure, using a recent project to illustrate his creative application of computer technology.

Michael O'Rourke at work in his studio.

I USUALLY BEGIN the composition process with very quick, freehand pencil sketches. Once I have an idea where I want to go with the composition, I begin modeling its component pieces on the computer.

There are a number of modeling techniques available to me. I can select geometric shapes from a stock library of shapes and then scale and position them. I can draw freehand with an electronic stylus on a tablet to produce an outline, and then push or extrude that outline in space so that it appears on the screen as a three-dimensional object. I can make a composite of several shapes together, or subtract one from another (a cube minus a cylinder, for example, might yield a cube with a cylindrical hole through the center). I can also slice through a shape at any angle, chopping off a corner of a piece or perhaps beveling it.

All of these approaches are embodied in a set of computer programs that are effectively my "tools." I use these and other programs first to model the individual component pieces and then to combine these pieces into the whole composition. Since this model is not a physical entity but a purely digital one, I can make changes in both modeling and placement quickly and easily.

Generally what I'm working with at this stage is a wireframe image, or line drawing, of the object on the computer screen (Fig. 1). This is a fully three-dimensional representation of the object. I can turn it around and look at it from any point of view, simply by pushing a joystick. As the composition develops, the wireframe representation can become ambiguous, making it more difficult to read. If this happens, I make shaded surface representations of the composition (Fig 2). Although these are somewhat more time consuming (it takes about a minute for the computer to generate each image), the information they convey about the model is much more complete.

Fig. 1, preliminary image from O'Rourke's series "Images of Ourselves."

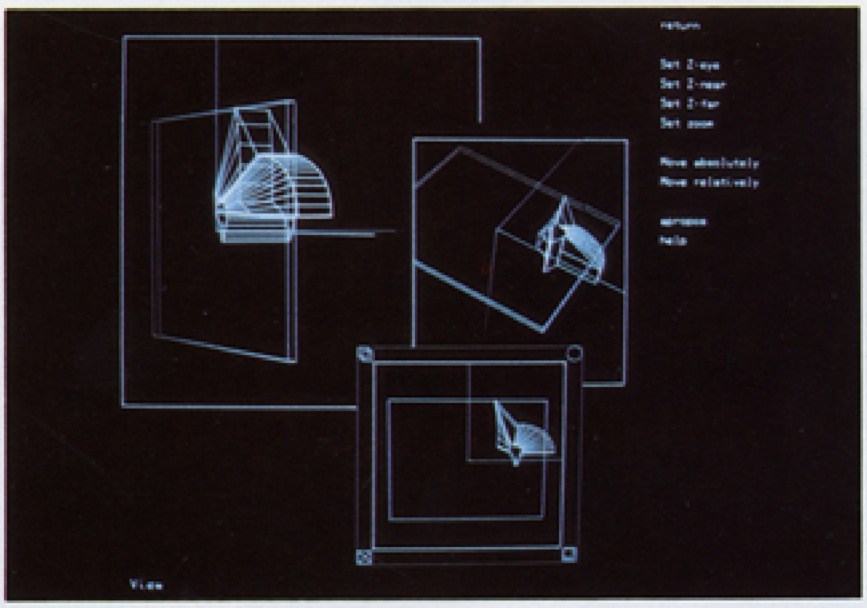
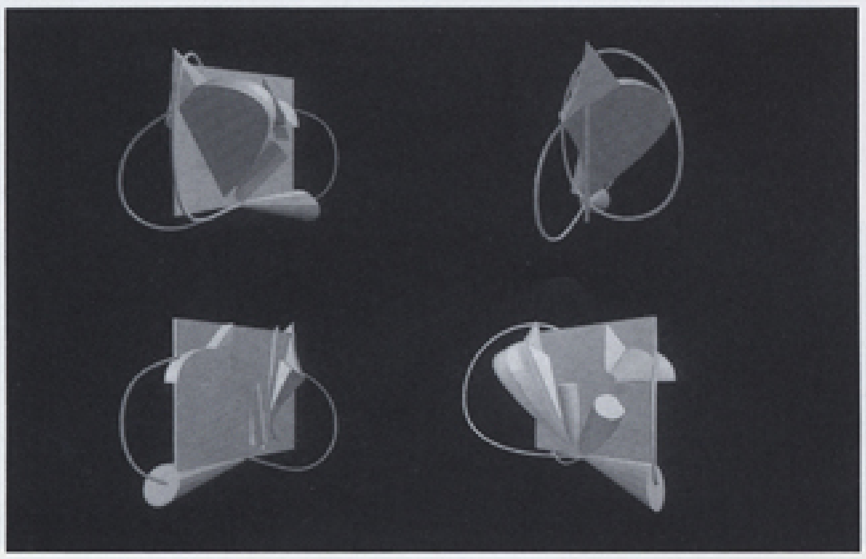


Fig. 2



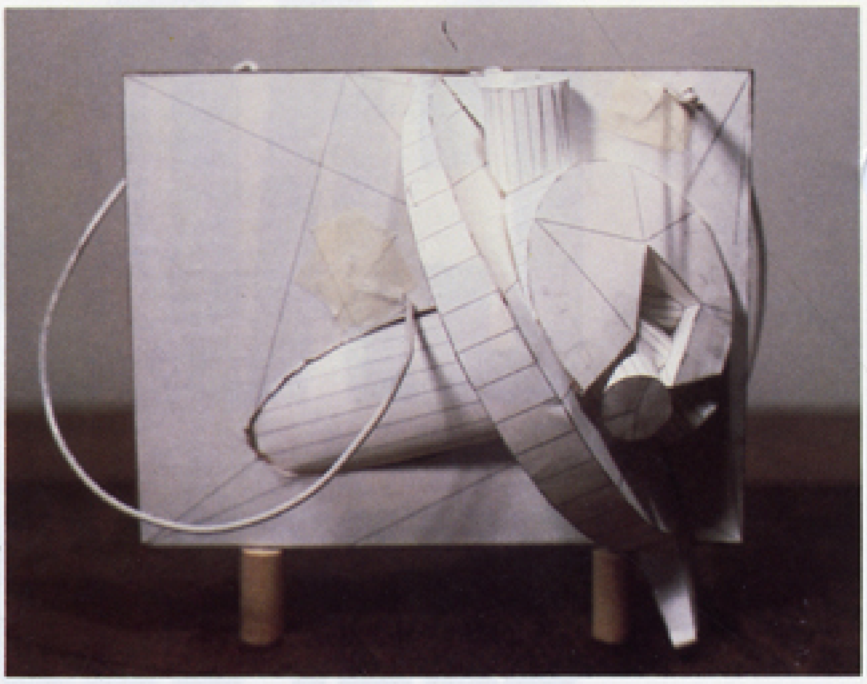


Fig. 3

Another representation that is extremely useful throughout this process is a plotter drawing. These are line drawings that are printed on a sheet of paper that I can carry away from the machine. I make these throughout the design stages and treat them as I would any other sketch. Having made the basic plotter drawing, I draw on top of it by hand, further developing the composition and making notations to myself.

ONCE I HAVE a satisfactory three-dimensional composition, I begin the process of making the first physical model. I first concentrate on those areas where several components intersect each other—where a cylinder goes through a backplane, for example. In the purely digital model, this intersection presents no problem, since the components are completely nonphysical. In the physical world, of course, two objects can't pass ghostlike through each other, and these areas of intersection must be dealt with. To do this, I run a program which subtracts from each part whatever intersects it. The result is that each part has just the right area scooped out of it to allow it to fit snugly up to its neighbors. For the whole composition, the result is like a three-dimensional jigsaw puzzle.

My next step is to calculate what each block-like component would look like if it were flattened into a two-dimensional plane. The effect is similar to what would happen if you removed the staples from a cardboard box and unfolded it. You end up with a flat pattern which, when folded back up, will give you the original three-dimensional shape. The flat pattern of each component is then plotted onto a piece of paper, cut out, folded up, and taped together to yield a paper version of the original shape.

I handle the tube-like curves differently. It would be extremely tedious to flatten these curves into a two-dimensional pattern. Instead, I calculate the location of key points on each curve from the digital model, scale them up appropriately, and use them as guides to produce the desired shape out of heavy electrical wire.

The result is a paper and wire preliminary model—a first physical maquette of what had been created digitally (Fig. 3). If the model reveals weaknesses in the composition or suggests better approaches, I rework the composition. I move back and forth between digital modeling and physical modeling, depending on which technique is more appropriate to the task.

When the three-dimensional composition has stabilized, I repeat the maquette-making process with sheet aluminum and quarter-inch aluminum wire. This produces a more detailed and larger maquette in a material closer to what I will use for the final piece.

AS THE BUILDING of these maquettes progresses, I work with the computer on another aspect of the piece—the color composition. Again, the computer lets me work out a lot of ideas quickly before beginning to work in the physical medium.

I first make digital images of the desired color patterns. Onto these images I digitally overlay a drawing of each component's flat pattern (Fig. 4). When the flat pattern is digitally wrapped up into a three-dimensional shape, the colors which were underlying are wrapped, or mapped, simultaneously onto the surface of the three-dimensional object. It is as if you were wrapping a colored sheet of latex around an object (Fig. 5).

When I feel comfortable with the color composition I've developed on the computer, I spray paint the aluminum maquette, using my

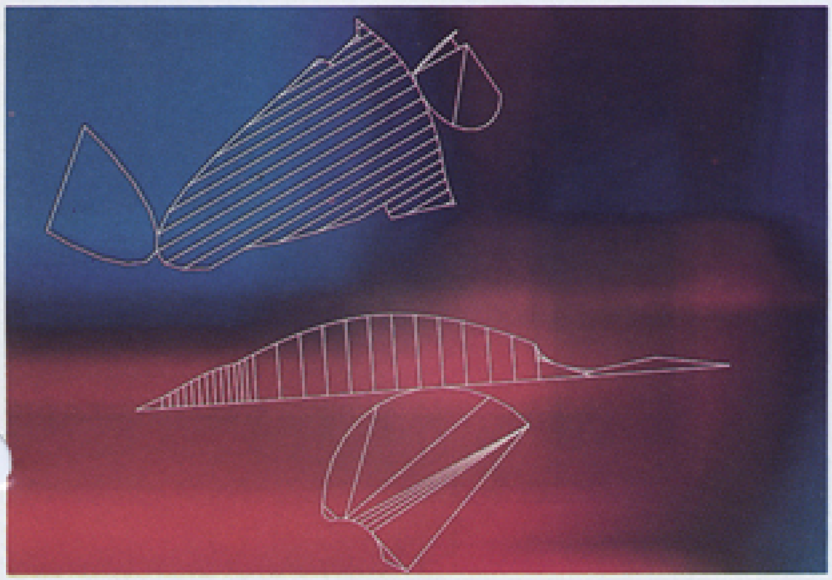


Fig. 4

digital color composition as a guide (Fig. 6). I make no attempt to maintain a one-to-one correspondence between the digital color composition and my spray-painted version. The former serves as a helpful, but not final working sketch.

The last way in which I use the computer is to help scale the sculpture. I begin by digitizing a photograph of the painted aluminum maquette. I then make a digital composite of this picture along with a similarly digitized image of something of known scale—a person, for example. This not only conveys to others what I would like the final scale of the piece to be, but also helps me refine my own ideas about scale.

In short, I begin to use the computer as soon as I have completed the preliminary, freehand sketches of my proposed sculpture and I continue to use it until the piece is ready to be fabricated. The computer system I use allows me to achieve regular, geometric forms and irregular, freehand ones as well. It facilitates the creative processes of making a sculpture, from experimenting with ideas and colors to constructing and scaling the final sculpture. But I feel one additional observation should be made. In working with complex and developing technologies, we move out of the private realm where an individual artist can work self-sufficiently in his or her studio. This work was done in an advanced technical facility, the New York Institute of Technology's Computer Graphics Laboratory, and with a great deal of help from a number of people. Of course technology available in a facility like this one is more comprehensive than that of personal computer systems. At some point, when the computer equipment

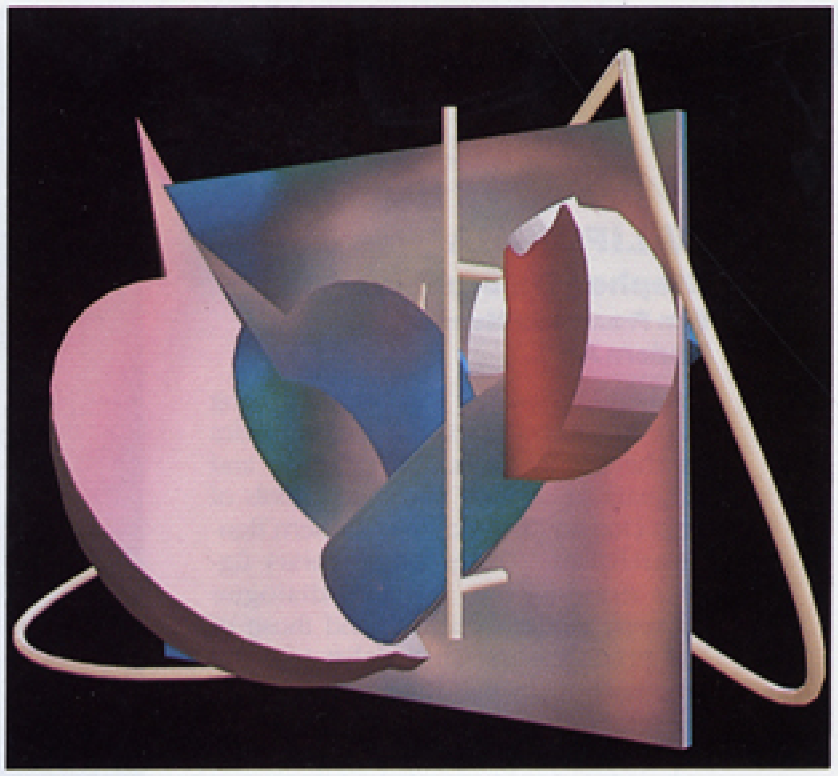


Fig. 5

which is now state-of-the-art can be bought off the shelf, we will be able to outfit our studios with it. But for now, doing this sort of work implies a very different working environment. □

For terminal graphics display, O'Rourke uses an Evans & Sutherland Multi-Picture System (MPS), a "real-time, three-dimensional transformation vector machine." The MPS is connected to a network of VAX 11/780 mainframe computers. A Hewlett-Packard 7500 series plotter is used for hard copy output. O'Rourke's work will be on view in a group show of computer-related art at the Tibor de Nagy Gallery in New York City this September.

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Fig. 6