DEPTH-DEFYING GRAPHICS

3-D PROGRAMS FOR THE AMIGA

By Sheldon Leemon

ONLY A YEAR ago, the possibility of creating three-dimensional graphics and animation with commercial software packages on small, inexpensive microcomputers would have seemed remote at the very least. About that time, however, two Amiga developers working independently of each other produced startlingly realistic 3-D graphics programs that tapped the powerful potential of the Amiga's graphics capabilities. Both of these individually conceived programs have now been picked up by commercial software companies and are available to the general user at fairly modest prices.

Part of the now famous "juggler" program of Eric Graham is the basis for a package marketed under the name Sculpt 3D by Byte by Byte. At this stage the commercial version is only an object-creation and drawing program, not a full-fledged animation package (although Byte by Byte was to have brought to market another Graham creation, Sculpt Animate 3D, by the end of 1987 to provide the necessary animation facilities for Sculpt). Meanwhile, the short animation sequences in realistic 3-D unveiled by Allen Hastings in late 1986 have evolved into the program VideoScape 3D now marketed by Aegis Development. It provides facilities for both the creation and animation of three-dimensional objects.

Although not strictly comparable because of the animation dimension missing in Sculpt 3D, both of these programs are revolutionary in what they are likely to set off in the future development of graphics on the Amiga. Our examination of the programs does make comparisons between them where relevant, but also accentuates the individually distinct characteristics of each.

VideoScape 3D

In November of 1986, at the awards banquet of the Second Amiga Developer's Conference, an Amiga user named Allen Hastings presented a pair of remarkable short films. Each frame of both had been created on the Amiga and then filmed individually with a 16mm movie camera. The realistic 3-D animation electrified the crowd, whose members had clearly never seen this kind of work done on such a small computer system. Aegis Development prevailed upon Mr. Hastings to share his movie-making techniques, and the result is a powerful 3-D animation package called VideoScape 3D.

The main focus of VideoScape 3D is the creation and playback of frames of video animation. These animated scenes may be played back in short segments at speeds of up to 30 frames per second and taped with a video recorder. They may also be taped a frame at a time, using more sophisticated and costly video gear or 16mm movie equipment. Although you may be inspired to make short films, as Mr. Hastings did, it is more likely that you will want to use VideoScape to create animated logos or title sequences for videotapes.

In order to create an animated scene with VideoScape 3D, you must first create the files that describe the shape of each object in the scene and the files that describe the motion of

each object. Then, you must create a file that describes the position and motion of the "camera" used to view the scene. Let's take a look at each of these preliminary steps.

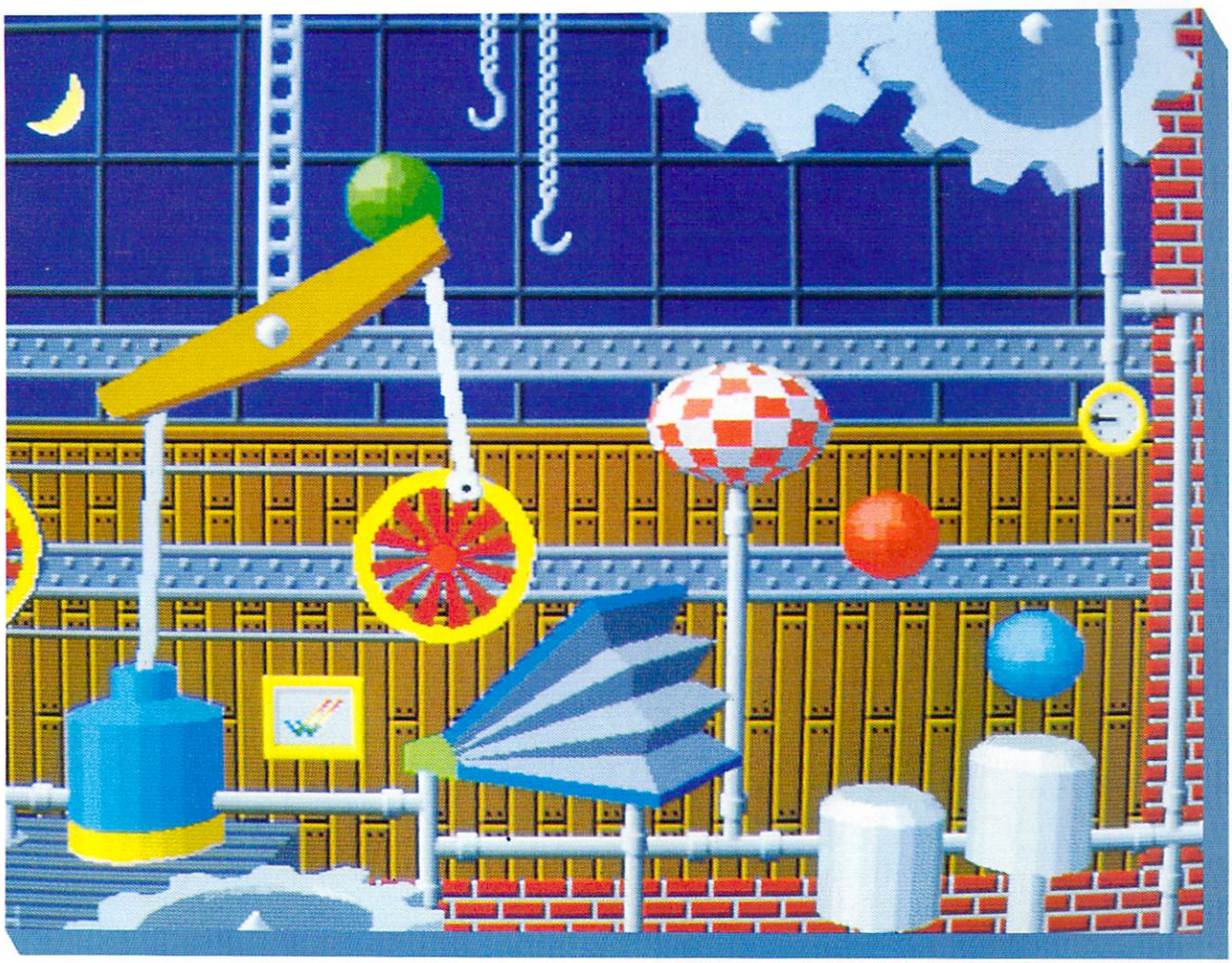
Getting Into Shape(s): Object Geometry Files

The files describing the shape of the 3-D objects are called Object Geometry files. VideoScape provides several methods for creating these files, but none are particularly easy to use or powerful. The first is called the Easy Geometry Generator program (EGG), which can be used to create regular objects, such as a box, faceted sphere, cone or cylinder. You can also use it to create very specialized shapes, such as a star field, a flat tiled surface or a ring of distant mountains. Unlike most Amiga programs, EGG is not at all interactive. When you run the program, it asks you a series of questions about the objects, which you must answer in sequence. It does not show you a picture of the object, nor does it give you a second chance to change your mind after you have answered. When you are finished, you can save the object file and end the program, or abort, but you cannot create another object without running the program again. In order to use this program successfully, you must plan your answers in advance and type them in carefully.

Another object-creation utility is the Object Composition Tool (OCT), which allows you to load one or more objects and then edit and/or combine them. You can use it to change an object's size, position, orientation or color. All objects loaded and edited in the same session are saved as a single object file. The user interface for the OCT program is exactly the same as that of EGG.

The third of these utility programs is Designer 3D. This is actually a special version of the shareware program ROT by Colin French. This program provides a much more interactive object creation environment, because it allows you to enter point coordinates and see the resulting polygons displayed in a three-window view. Its editor is quite simple, however, and limited to 98 points in 98 polygons. It makes no provision for building "standard" shapes, such as cubes, pyramids and spheres, and provides no fancy editing tools. Although it allows you to save a shape in ROT or VideoScape format, it only loads ROT shapes.

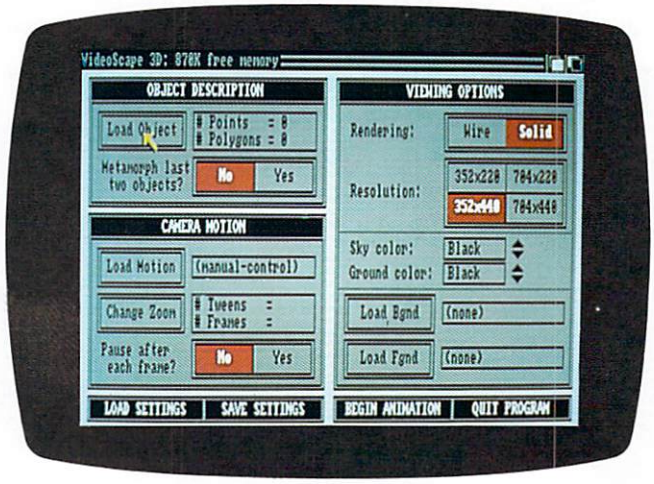
Because all of the files used by VideoScape are plain ASCII text files, you may also create an object geometry file with a text editor. Using this method entails multiple hardships. First, you must figure out every coordinate of every point, a task requiring a thorough knowledge of the mathematics of solid geometry. Next, you must enter each of these coordinates into a text file, along with the color code for each ►



polygon they create. To complicate matters further, the points must be listed in the correct order (clockwise from their visible side), and it is up to you to make sure that all polygons listed lie in the same plane.

As tedious as all this sounds, it appears that in order to make complex objects, you have to resort to this method at least some of the time. For example, although the OCT program can be used to combine two objects, VideoScape cannot draw intersecting objects. The only way to create such objects, therefore, is to manually edit the object text file so as to break the intersecting objects down into sub-objects. To assist in this task, the manual suggests first plotting out all objects on graph paper. Such a suggestion seems fairly suspect in itself. Isn't the whole point of having powerful personal computers like the Amiga to do away with crude tools like graph paper?

The next task is to define the movement of each object and of the camera that is used as the viewpoint for the scene. There are actually two types of movement to describe: positional movement, the physical movement of the object from one point to another in 3D space, and rotational motion, in which the object twists around while staying in the same



VideoScape 3D—main screen

spot. The manual explains this in aviation terms, although it uses such terminology incorrectly. In the manual, *Pitch* refers to rotation around the X axis (correct), while *Heading* is used to describe rotation around the Y axis (the correct term would have been "Yaw"). *Bank* refers to rotation around the Z axis ("Roll" would have been the correct choice). In any event, once you accept VideoScape's choice of terms, you can proceed without further confusion. Rotational movement is relative to a described "reference point," usually the center of the object, about which it rotates.

In a VideoScape motion file, you describe the object's position in the starting and ending frames, called the "key frames." You specify also the number of intermediate frames, called "tweens." The program then plots automatically the intermediate positions to provide smooth animation. The camera movement file format is identical to that of the object movement file. You place the camera at a starting and ending position, and VideoScape "moves" the camera smoothly. Note, however, you are responsible for making sure that the camera stays pointed at the scene. You cannot just ask the camera to "track" a particular object. Object motion and camera motion files must be created with a text editor. It is possible, however, to move manually the objects and camera using the Command Window.

Control Central: VideoScape's Command Window

The command window is the main part of the program, by which you put together all of the elements described above to form your animation. Its controls are divided into four panels. The Object Description panel allows you to load object geometry files and object motion files. It also allows you to enter manually the motion information for an object, as well as a position offset, so that you can have two copies of the same object in the scene at once. Finally, this panel lets you "metamorph" the last two objects loaded, so that during the scene, the second to last object loaded seems to change shape into the most recently loaded object.

The second panel is called Camera Motion, and it is used to load camera motion files. You may also choose to control the camera manually using the numeric keypad during display of the animation. Initial and final camera zoom factors may be entered, so that the camera zooms smoothly in or out during the animation.

The third panel provides Viewing Options. Full overscan is used to make the picture occupy the entire viewing area of the screen. Four resolutions are available, ranging from 352 × 220 to 704 × 440. The objects in a scene can be drawn either as wire-frame models or as solid polygons with hidden line removal. A fixed palette of 32 colors is used for 352-across pictures, while 16 colors are used for pictures with higher horizontal resolution. The objects themselves may be created only in one of 16 selectable colors (actually only 12 are currently used). Doing some color blending does allow you to simulate additional colors. These are used for shading to provide textures, such as matte or glossy finishes. Only one distant light source is used, the direction of which may be controlled, and the diffuse lighting casts no shadows. The Viewing panel also lets you load IFF foreground and background pictures; both are loaded every frame, the former before object rendering and the latter after object rendering.

The Screen panel allows you to load and save all of the settings for a scene, including object geometry, object motion, camera motion and viewing option. It also allows you to begin the animation. This is displayed on a separate screen, either a frame at a time or continuously. Because objects are constructed from solid polygons, without much shading, each frame takes only a few seconds at most to draw. Once a frame is drawn, you can save it to an IFF picture file with a single key stroke.

The program includes support for single-frame video recorders, allowing them to record each frame unattended. Although prices for such equipment are expected to come down dramatically, it is still quite expensive. A much more affordable way to record the scene is to save it first as an Anim file. This is an IFF animation file containing the initial scene, plus information about the changes between frames. It can be used with the player program included in the package to display short scenes at full animation speed. Although Aegis has been trying to make Anim a standard ►

format for displaying compressed scenes of animation, it does not appear to be robust enough to meet everyone's needs, and it is thus unlikely to be adopted universally in its present form.

After Long Deliberation . . .

Many superb animations have been created already with VideoScape 3D, demonstrating clearly the power of this software. Nonetheless, as the package label indicates, this program is intended for the video professional or advanced hobbyist, not the casual user. The object editing facilities, or lack thereof, are a real weak point. Using a text editor to create object and motion script files requires a firm grasp of solid geometry and a lot of patience. Most users will quickly discover that entering lists of numbers is not their cup of tea. Fortunately, some alternative object editors are available already, and more should appear in the near future. VideoScape users who envy the object creation facilities of Sculpt 3D should be aware that a conversion utility available from Syndesis (20 West Street, Wilmington, MA 01887, 617/657-5585) allows you to convert objects from Sculpt 3D to VideoScape format. Syndesis also plans to produce software allowing conversions from other 3-D object file formats, which should make huge libraries of objects available to VideoScape users.

Even after your objects are created, you should be prepared to invest a lot of time in order to produce a few seconds of animation. Some extra memory and a hard disk would help, too. Although the program runs on a 512K machine, it cannot record an Anim file without at least a megabyte; because a few seconds of fairly complex animation can produce an Anim file much larger than the 880K that can fit on a floppy, you will need a hard disk to cut down on the number of Anim scenes required for your animation.

VideoScape 3D has its limitations. In order to draw the objects as quickly as possible (a must when generating many frames of animation), it restricts severely the color palette selection, and it does not use the 4,096-color HAM mode. Also, it does not allow for shading of curved surfaces to make them appear more rounded. As a result the images it produces tend to be a bit flat and lifeless. Nonetheless, despite these limitations, it presents the user who is willing to make the investment of time and effort with the first workable system for creating 3-D animation on the Amiga.

Sculpt 3D

In late 1986, an astonishing 3-D animation program began to circulate. In it, a ray-traced robot juggler stood on a checkerboard landscape, juggling three mirrored balls. The moving shadows and reflections and the subtle shading gave the scene an air of intense realism. The juggler quickly became a symbol of the Amiga's graphics capabilities. The program's author, Eric Graham, said that the Amiga had allowed him to create the 3-D graphics program that he had been wanting to write for 20 years. That program—under the name Sculpt 3D—is now available commercially from Byte by Byte.

Sculpt 3D is a sophisticated object creation and drawing system. It can be used to make models of three-dimensional objects, which can then be viewed from any angle. It's useful for graphic arts and for designing imaginary "prototypes" of new products. The Sculpt program does not provide animation facilities, although it can be used to create animated scenes using a set of programs that Byte by Byte has released to the public domain. These programs provide the means to compress a number of frames and play them back as a smooth animation. Byte by Byte had scheduled for release in late 1987 a separate animation package called Sculpt Animate 3D. The current Sculpt 3D program would then be used as the object creation facility for that program.

Simplified Editing: Seeing Triple

Editing 3-D objects plays a major role in the creation of 3-D graphics, so Sculpt places a great emphasis on simplifying this process whenever possible. The main program screen contains three windows known as the tri-view. One of these windows displays the current objects in the scene from the north or south view, a second from top or bottom, and the third from east or west. Objects in the tri-view windows are portrayed in wire-frame representation, which means that they are shown as a collection of points connected by lines. Each of the tri-view windows has the normal Amiga drag bar, sizing box and front/back gadgets. In addition, each contains a number of custom gadgets that control the display. Four move arrows can be used to scroll the objects in any direction within the window. A center gadget centers the current cursor position within the window. Zoom in and zoom out gadgets change the size of objects within the window. Shift keys can be used to vary the magnitude of zoom and movement.

The program offers a wide variety of ways in which new vertices and surfaces may be entered. The most direct method for entering a point is to draw it in with the mouse. Once three points have been entered, a special gadget may be used to connect selected points as a triangular face. In Sculpt 3D each object is composed entirely of triangular faces, because, by definition, any three points always lie in the same plane. When you require greater precision than freehand placement of points allows, Sculpt enables you to open a coordinate window that shows the exact cursor position at any given point. This window also includes a tape measure tool, which allows you to measure the distance between any two points. Because it takes many points to define a curved shape, ►

Sculpt provides a curve tool that lets you create a number of connected points. If you use the curve tool to form a closed loop, you may use the Fill command to divide automatically the interior of the loop into triangular segments.

Entering shapes point by point can be a tedious operation, so Sculpt provides a number of built-in primitive shapes that can be added to any scene. These include spheres, hemispheres, cubes, prisms, cylinders, tubes and cones. The program also allows you to duplicate any object that already exists in the scene, so that you can, for example, turn a single tree into a forest. A variation of the Duplicate command allows you to "reflect" the object, creating its mirror image.

Because each of the built-in objects is actually composed of many triangular faces, objects such as spheres and cones are only approximations of rounded shapes. Spheres, for example, are really pseudo-spheres made up of polygons, as

in a geodesic dome. When you add one of these objects, the program prompts you to enter the number of faces for the object, allowing you to make it look rounder or more angular, as you desire.

If you want the object to look more rounded, Sculpt has some powerful features to help achieve this goal. First, it allows you to subdivide each face and to then apply the Be Sphere command, which adjusts each vertex on the face of the object so that all are equidistant from the center. The result is a pretty good approximation of a sphere. Secondly, it allows you to apply to the object an attribute called smoothing, by which you can shade the object in such a way that the curved face, although angular in shape, appears to be smooth. This feature distinguishes Sculpt from other 3-D programs such as VideoScape, which cannot produce a smooth-looking sphere.

Editing Features: Some Real "Grabbers"

Once you have added an object to your scene, Sculpt lets you edit it in a number of ways. Most of these editing operations are designed to work on the objects defined by a set of selected vertices. Points can be selected with a mouse, by using window gadgets, or with menu items. The simplest form of editing allows you to erase all of the selected points or edges, or those closest to the cursor. Another simple, but effective, editing feature allows you to make the object larger or smaller in any or all dimensions. You can also rotate the object in any dimension, choosing your own axis of rotation with the cursor.

The powerful grabber tool can move any selected points in an object with the mouse. If all of the points of an object are selected, the grabber simply moves the entire object around in the scene. Unlike such programs as VideoScape 3D, Sculpt allows you to move objects together so that they intersect. If only part of the object is selected, however, the grabber pulls only those points and thus stretches the object into a new shape.

A more subtle version of this tool is the magnet. While the grabber moves all points the same distance, the magnet has a stronger "pull" on points that are closer to it. The strength of the magnetic attraction may be varied, and the magnet may be used to either attract or repel vertices. Another sophisticated editing feature is called unslice. If you have two or more selected planes stacked over one another, this feature treats them like "slices" from a three-dimensional solid and connects them to form that solid.

Among other editing features offered by Sculpt are a couple of "power tools" that can be used to turn two-dimensional outlines into three-dimensional objects. The spin tool, for example, sweeps the selected plane around an axis of symmetry in a specified number of steps. By spinning a circle around an axis, for instance, you come up with a torus (a donut-shaped object). Instead of spinning the cross-section around, the extrude simply pulls it straight out into a third dimension. The technique is similar to forcing molding clay through a stencil. One common use for such a tool is building 3-D letters. You simply draw the letter and then pull it outward to give it the dimension of depth.

The objects that you create with Sculpt 3D have inherent display characteristics. These include the color of each face and its texture. Faces inherit the face color in effect at the time of their creation. This color may be changed at any time, using a bank of sliders, or by using the fetch gadget, which takes the average color of selected faces. The user may also change the color of a face at any time after its creation.

The texture attribute of an object face is handled in a manner similar to that of its color. When an object face is created, it also takes on the current texture. Possible textures include dull, shiny, mirror, luminous and glass. Dull surfaces reflect light in all directions, like flat paint, while shiny surfaces reflect a small amount of the light back towards their points of origin. A mirrored surface reflects light like a colored mirror, while a luminous surface emits light of a given color, rather than reflecting it. A glass surface reflects part of the light and transmits the rest. The user may modify the texture of a selected face at any point.

Drawing: Many Ways to Make the Scene

The balance of Sculpt's controls have to do with the way in which the scene is drawn. In order to draw the scene, the user must set the "observer" and the "target." The observer ►

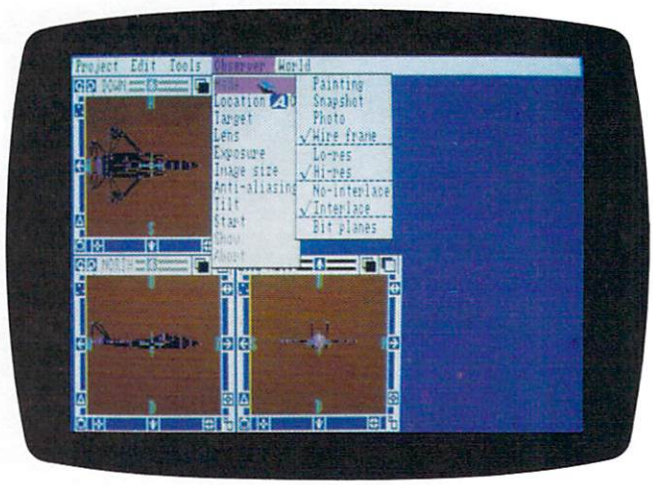
marks the position and angle from which the scene is viewed (the camera), and the target marks the position being observed. The width of view of the observer may be varied using a variety of lens settings. In order for the observer to "see" anything, a lighting source(s) must be added. These include one or more lamps, the position and intensity of which the user may vary as desired. Numerous lighting sources may be used, although each additional one increases the time required to draw the picture. The user may also select the brightness of the background (ambient) lighting. Light exposure is normally automatic, but may be controlled manually. As pictures often require the depiction of the sky or ground, Sculpt can generate automatically such a background.

The user may specify that the program draw a scene in low-resolution, high-resolution, interlaced or non-interlaced modes. The program can display a scene using anywhere from two bit planes of color (four colors) to six bit planes (the 4,096-color HAM mode). The HAM mode allows the most lifelike lighting effects, but takes the longest to draw. Sculpt can also create an image with more than six bit planes that can be written to a file for use with a hardware frame buffer device capable of a higher resolution than the normal Amiga screen.

Sculpt features a number of different drawing modes, which vary in the amount of detail produced and the amount of time taken to complete the drawing. The simplest mode is wire-frame drawing, which takes only a few seconds to complete. The next level up is called painting mode, in which the objects are displayed as colored polygons, with color and shading determined by the light sources. Color does not vary, however, within a single triangular face. This simple type of rendering is roughly comparable to the method used in VideoScape 3D.

The final two modes use a technique called ray-tracing, which computes the color of each pixel on the screen on the basis of the reflection of light rays. The simpler ray-tracing mode, snapshot, varies color and shading across flat surfaces, but does not take into account the effect of shadows. The more complex photo mode portrays shadows realistically. Both ray-tracing modes require a long time to draw an entire picture—up to several hours for a complex set of objects. For this reason, Sculpt allows you to set the size of the image in five increments, from tiny (⅛ screen size) to jumbo (overscan mode).

Because it may take up to several hours to draw a complex scene in the most detailed drawing mode, Sculpt provides a special batch mode that allows the user to designate a number of scenes to be drawn, one after another. Each image is saved to a file on disk as it is completed. In addition to reading files saved in its own internal format, Sculpt will also read text files that use its script language. This language allows the user to access virtually every feature of Sculpt from a text file, which allows for precise control and debugging of a scene. Although the program can read these script files, it cannot, however, save an existing scene as a text file.



Sculpt 3D—main screen

With All Precincts Reporting . . .

Overall, Sculpt's object-editing facilities are outstanding. Although somewhat complex, the editing tools provided are quite powerful. After you have used them for a while, you will find yourself becoming adept at creating even complex objects. Sculpt's drawing capabilities are also quite good. The ray-tracing modes produce extremely realistic results, even though they exact their toll in the time required to draw scenes. Complex scenes, particularly those with mirrored or glass surfaces, take hours to draw using the ray-tracing modes. An updated version of Sculpt (release 1.1) is available, however, that cuts the time it takes to ray-trace a scene by up to 65 percent. Registered owners of the 1.0 version can receive this update from Byte by Byte for the cost of postage and handling. Be aware, however, that even with this time-saving improvement, ray-tracing is a slow process. It also takes a fair amount of memory. Although it is possible to use the program with only 512K of memory, at least a megabyte is required for some of the more complex objects. Despite these limitations, however, the realism of the scenes that you can create, and the ease (if not the speed) with which you can create them, make Sculpt 3D well worth considering.■

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Product Information

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