THE NeXT 3D GRAPHICS KIT:
3D Imaging Made Easy

Jeff Martin
Developer Support Engineer
Jim Inscore
Technical Publications Writer
NeXT Computer, Inc.

In a high-energy physics lab, particles emitted from an electron gun collide with an inert substance. Traditional tracking instruments generate reams of data—the success or failure of the experiment might take days to determine. But a NeXT™ computer generates a three-dimensional image of the phenomenon in real-time, making it clear that this experiment is a success.

In a business computing lab, a complex economic model tracks data in multiple variables. Ordinarily, pages of text and graphs would be required to describe the model and its effects. But plotted in three-dimensional graphics on a NeXT computer, the data is easier to comprehend, easier to interpret.

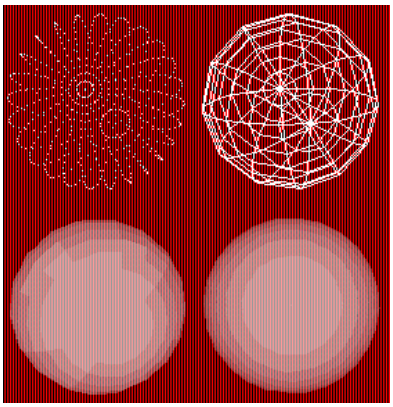
In an animation studio, a crackling creature of pure electric energy stalks the streets of a city. A 30-second sequence requires the most sophisticated three-dimensional rendering techniques—and could take a week of supercomputer time. Now, it's rendered in a few nights on a network of NeXT computers.

These are just a handful of the projects that can benefit from the NeXT 3D Graphics Kit—the NeXTSTEP™ 3 enhancement that provides interactive and photoreal three-dimensional rendering on NeXT computers.

3D in depth

Computer-generated three-dimensional images literally add another dimension to the normally-flat world of the computer screen. The extra information in a three-dimensional image "broadens the bandwidth" of the user interface. In fact, the NeXTSTEP interface already incorporates three-dimensional effects in windows, controls, and other interface features to make their actions seem more natural than other graphical environments.

A three-dimensional renderer is a program that takes data describing a three-dimensional image—shapes, color, lighting, surface textures, and so on—and generates a two-dimensional view of the image. Typically, renderers come in two types: photoreal and interactive. Photoreal renderers—such as the RenderMan™ renderer used for effects in *Terminator 2, The Abyss,* and other movies—can take hours of processing time per frame. The renderer has to do a lot of work to calculate each pixel in the scene precisely, based on surface color, surface type, orientation, light positions, and so on. Interactive renderers are used to let the user experience a three-dimensional space: for example, to "walk-through" a building design. This requires faster image generation—that in turn requires a lot of simplification of the scene.



Point cloud, wireframe, faceted, and smooth rendering styles

Because of the different applications for photoreal and interactive rendering, the two have evolved separately. For example, there has not been a standard way to generate a scene interactively, and then send it to a photoreal renderer for output.

Enter the NeXT 3D Graphics Kit™. The 3D Graphics Kit wraps Pixar's Photorealistic RenderMan™ and an Interactive RenderMan™ together in an easy-to-use object-oriented programming toolkit.

Integrated, interactive, and industry standard

Like the rest of NeXTSTEP, the 3D Graphics Kit offers an integrated, interactive, and industry-standard approach. Like PostScript® in two-dimensional graphics, RenderMan represents the standard in high-quality, three-dimensional scene description. In fact, the 3D Graphics Kit's Photoreal RenderMan renderer is the same as that used for *Terminator 2*. The RenderMan Interface Bytestream (RIB) format provides a standard way for modelling programs to send rendering to any renderer—photoreal or interactive.

Interactive RenderMan lets users create and manipulate three-dimensional scenes in real time. It supports four types of rendering styles: point cloud, wireframe, constant, and smooth. The 3D Graphics Kit also supports interactive selection, rotation, and other manipulation.

The 3D Graphics Kit is fully integrated with the Application Kit™ and other components of the NeXTSTEP development environment. For example, a single view can display two-dimensional drawing with PostScript and three-dimensional drawing with RenderMan. When printing, the 3D Graphics Kit automatically uses the photoreal renderer for three-dimensional images, then incorporates them into the document as it is printed. For fast rendering of complex images, the

3D Graphics Kit is integrated into the networked environment, offering "plug-and-play" support for rendering on multiple hosts.

Object-oriented scene description

The 3D Graphics Kit takes an object-oriented approach to the potentially complex world of three-dimensional scene description. The kit encapsulates scene description in a few intuitive objects—notably camera, shape, and light. (Note that classes in the 3D Graphics Kit all have the prefix N3D.)

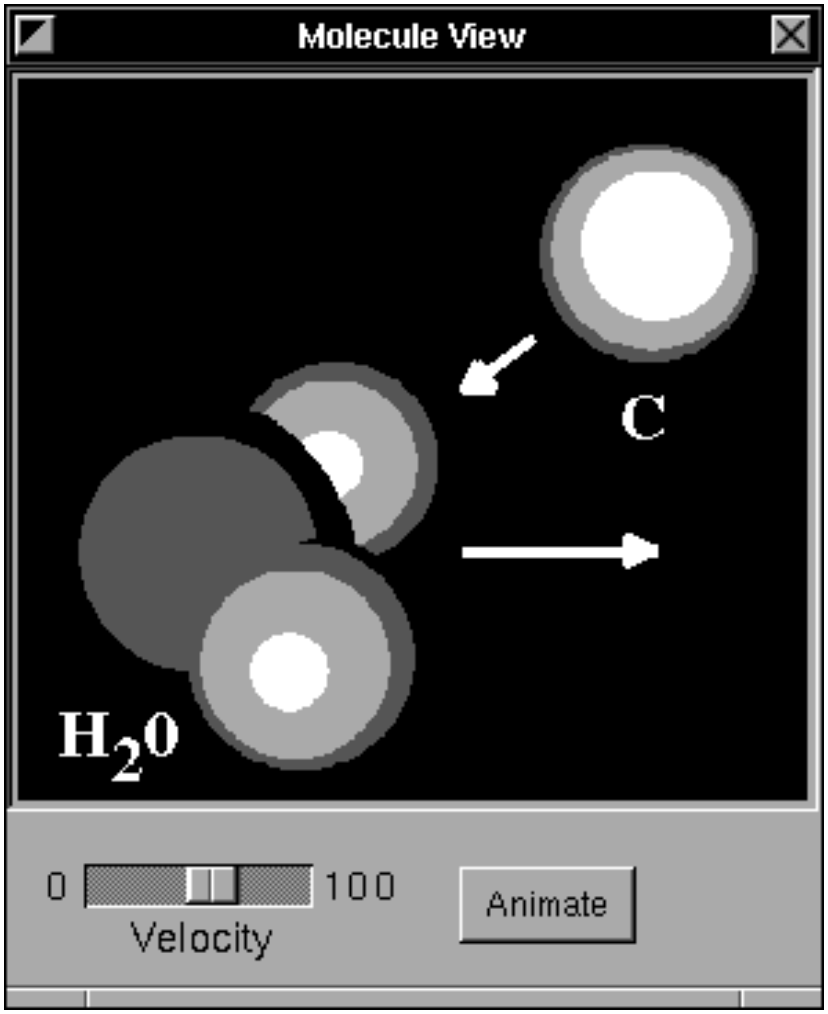
N3DCamera is the 3D Graphics Kit's view. Like other views, it goes in a window and displays drawing—including interactive three-dimensional rendering. N3DCamera's methods provide camera-like control over camera position, focal length, image size, and so on. A subclass of N3DCamera, N3DMovieCamera, provides a mechanism for counting frames and playing through an animated scene.

N3DShape is the basic shape in a 3D Graphics Kit scene. N3DShape has methods for positioning, rotating, scaling, and applying textures. You can create subclasses of shape to draw specific objects, simply by overriding the renderSelf: method and using RenderMan-specific geometry functions. An N3DShape that draws a sphere, for example, has a two-line renderSelf: method:

```
- renderSelf:camera

{ RiSphere(radius, -1, 1, 360.0,
RI_NULL);

return self;

}
```

N3DLight is a class that lets you position and adjust the lights in a scene. It provides several standard light types: spot, point, distant, and ambient. Lights can be placed anywhere in a scene.

Other classes in the kit include: N3DRIBImageRep, which works with NXImage to let you create and composite three-dimensional images anywhere; N3DShader, which applies different types of shading functions to N3DShapes; and the N3DRenderPanel.



With the NeXT 3D Graphics Kit and NeXTSTEP, three-dimensional research models can be created

PostScript and RenderMan: sharing a paradigm

In many ways, the implementation of Interactive RenderMan in NeXTSTEP is similar to the implementation of Display PostScript®. Here are some examples:

Device independence

Both PostScript and RenderMan are device independent. Just as the same PostScript code can be rendered on a 92 dpi color screen or a 400 dpi black and white printer, RenderMan can render its description at any dpi in wireframe, flat shading, smooth shading, or photoreal (in color or in black and white).

Server model

Both PostScript and RenderMan use the server model. Commands sent to the renderer are simply ASCII text. That means that the description can be used to render to a window, saved to disk, copied to the pasteboard, or sent directly to another application.

Unified imaging model

Both PostScript and RenderMan use a unified imaging model. That means that once you have done the programming to get the image on the screen, no extra work is required to get a motion picture quality photoreal rendering of your image.

What is the 3D Graphics Kit for?

A variety of projects will benefit from an easy-to-program environment for three-dimensional modelling, including the following:

Business Applications

Spreadsheets, presentation tools, report generators, and other business applications can easily incorporate three-dimensional graphics. By increasing the information available in a single chart or diagram, three-dimensional graphics make it easier to comprehend complex data.

Mathematics and Science

In *Mathematica*®, users can now create three-dimensional flat shaded graphs that can be viewed from any angle. The 3D Graphics Kit will make it possible to rotate that same graph from within a word processor or page layout program.

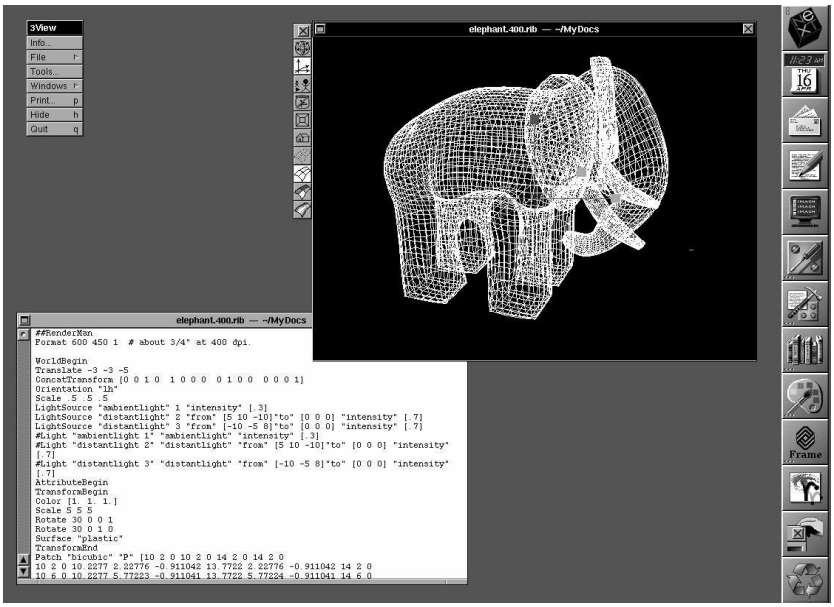
For scientists with experience in three-dimensional graphics but not programming, NeXTSTEP and the 3D Graphics Kit allow creation of research models quicker than ever. Hard-wired constants can be replaced with sliders and switches that are simply dragged and dropped into an application. This allows for flexibility and experimentation never before available.

Engineering and CAD

Half of the work of writing a CAD application is simply getting the geometry to the screen for the user to work with. Now the simplest applications can create models in wireframe, flat, or smooth shading rendering styles—and can add shaders to generate a photoreal image of the finished product.

Graphic Design

The 3D Graphics Kit provides the basis for a new generation of artistic tools, similar to Adobe Illustrator® but with the ability to manipulate images in three dimensions. Designers will be able to view or print their work interactively—from packaging to products, from any angle—rather than by building expensive, time-consuming, cumbersome models.



The 3View Interactive RIB Previewer—included as part of NeXTSTEP Release 3 Extended—lets users look at any RenderMan file. The user can rotate, translate, shade, and even print an image using photoreal rendering.

Animation

Whether for artistic or scientific visualization purposes, the 3D Graphics Kit delivers feature-film quality animation capabilities to anyone who needs them. With built-in support for multiple host rendering, the 3D Graphics Kit simplifies and speeds the process of frame generation.

The NeXT 3D Graphics Kit and 3View, an interactive preview application, are available in NeXTSTEP Release 3 Extended.