3D Technology: Ready for the PC?

Neal Leavitt

3D technology was once the exclusive domain of skilled computer-graphics developers and gamers with high-end machines and software. Workstations needed considerable processing power and memory to create and render the complex mix of colors, textures, and virtual lighting and perspective necessary to make figures appear three-dimensional.

The first 3D technology for PCs appeared in 1987, but it was primitive by today's standards and was used almost exclusively for games.

"It took 45 minutes just to load a scene file from a disk, hours to render a single frame at video resolution," said F. Kenton Musgrave, CEO of Pandromeda, a computer-graphics-software company.

3D technology has come a long way since then, increasing in performance while decreasing in cost. PCs are more powerful and less expensive than in the past and can better handle 3D. In addition, the way people want to use 3D has begun to spread from games to such activities as Web and product design, corporate presentations, and even personal entertainment. Moreover, PC makers have put 3D acceleration and other types of 3D technology into most of their computers.

However, although useful for design and architectural applications, 3D has not found its killer app outside of video games. Therefore, consumers, as well as most small and large businesses, have not flocked to the technology.

In addition, developers have been hampered by the lack of a dominant media player or development environment for use with 3D graphics on the Web, said Roger Chandler, Intel Labs' strategic marketing manager.

Because of these and several other factors, 3D technology has not yet made a major impact on the marketplace outside of video games and several other specialized areas. However, industry observers note the technology and its potential are developing faster than perhaps any other desktop-computing area.

Jon Peddie of Jon Peddie Associates, a digital-media-market-research company, forecasts that sales of 3D-development software for both occasional, PC-based and professional, workstation-based users will continue to increase steadily during the next few years, as Figure 1 shows.

THE NEW 3D TECHNOLOGY

Early 3D technology was expensive and difficult to use. The technology was so computationally intensive that it was suitable only for graphics workstations costing hundreds of thousands of dollars.

As recently as 1991, many users worked with 3D technology on Silicon Graphics Indigo workstations with MIPS R4400 RISC processors running at 150 MHz, 96 Mbytes of RAM, and multiple 3D geometry engines with 24-bit graphics. PCs, on the other hand, had i486-based processors running at only 25 to 33 MHz, 8 Mbytes of RAM, and no 3D acceleration.

Because of technology restrictions, said Andy van Dam, a computer-science and technology professor at Brown University, "[Rendering] 100,000 polygons and triangles per second was hot stuff back then. Now, it's in the millions."

Better PC hardware and software

Technology advances have driven PC hardware capabilities up and prices down, thereby making 3D more accessible to consumers and furthering research on methods and algorithms.

"The most computer-intensive operations can be done in hardware or firmware, making for huge [performance] improvements," noted Peter Ryce, senior director of product management and marketing for Macromedia, a Web-development-software company.

"So many of the necessary algorithms are encoded in hardware or are available through graphics APIs," he said, "that 3D is much easier to create because it provides a level of abstraction for developers. They don't have to hand-code every little function."

Motherboard-bus improvements have enabled the efficient internal transfer of massive 3D datasets and large bitmap graphics. Also, Ryce said, "Improved software for creating 3D textures and animation have made 3D more desirable."

Graphics cards and the AGP slot

The competitive graphics-card market has led to the development of improved and less expensive technology that has helped the consumer 3D market.

According to Pandromeda's Musgrave, most of the technology improvements let graphics cards perform work, such as creating lighting effects or transforming images, formerly handled by the CPU. The graphics cards perform the work faster, while the CPU is free to handle other tasks.

"These accelerator cards are perhaps the biggest improvement factor," said Musgrave. "You can now get for a few hundred dollars the functional equivalent

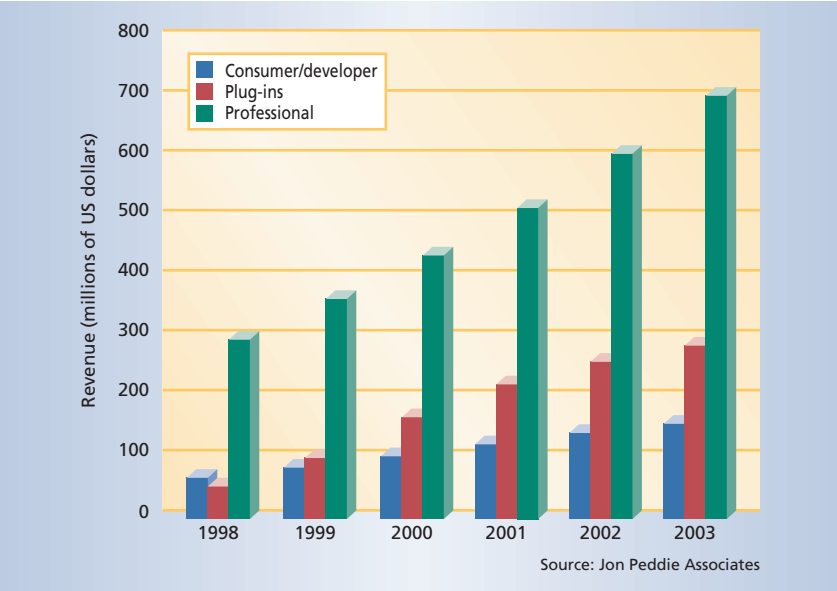

Figure 1. Sales of 3D-development software for occasional users (consumer/developer and plug-ins categories) and professionals have grown steadily and will continue to do so during the next few years, according to a study by Jon Peddie Associates, a market research firm.

of what was once an SGI (Silicon Graphics) workstation costing hundreds of thousands of dollars. The key to 3D graphics is real-time interaction—not waiting for the computer to calculate images to see the result of a change. As you move or change 3D scenes, the effect of the change is instantly visible. These cards make that possible."

The accelerated graphics port on personal computers, which permits faster data transmission, has also helped make 3D technology more suitable for PC users, said Conan D. Hunter, a program manager for Corel. Corel makes the Bryce 5 3D-development tool.

AGP uses a PC's RAM to refresh the monitor image and support the texture mapping and other functionality required for 3D image display.

"Objects look smoother and more realistic and can scale depending on available bandwidth and processing capability," explained Intel Labs' Chandler.

Overcoming network-bandwidth limitations

Macromedia recently rolled out Director 8.5 Shockwave Studio, a development environment that incorporates Intel's 3D graphics software. The software provides an adaptive geometry and rendering engine, which uses algorithms to adapt its performance to the user's processing power.

Macromedia's product lets developers create scalable 3D Web content that anyone with a Shockwave 3D player can view. With the technology, Chandler said, a Web server transmits compressed content via the Internet to the user. The user's CPU then renders the full-resolution geometry by adding details and polygons based on instructions the Web server sends to the Shockwave player.

In the past, the network transmitted the full-resolution geometry, which slowed online 3D viewing. According to Ryce, network bandwidth is the biggest bottleneck for delivering 3D via the Web. Two new features of Macromedia's technology help overcome this bottleneck.

The *multiresolution mesh* (MRM) feature, which Figure 2a shows, lets a user download a low-resolution version of a model and start interacting with it. The server then streams additional geometry information that progressively improves the resolution, based on the client's processing power.

The *subdivision surfaces* (SDS) approach, which Figure 2b illustrates, lets a user download a low-resolution model, as well as an algorithm that tells the client computer how to increase the resolution.

Another Director feature, which Figure 2c shows, enables transmission of an animated 3D model's key data points, called *bones*. Also transmitted are the movements associated with the bones and instructions for how the client computer should reconstruct the full model.

"This makes it possible to transmit animation content with a fraction of the bandwidth previously needed," Chandler said.

NEW USES FOR 3D TECHNOLOGY

Although gamers are still the primary PC-based 3D users, Macromedia's Ryce said anyone who uses a computer to design physical objects would benefit from the technology's improvements.

Architects, landscape artists, industrial designers, and engineers benefit from seeing their concepts in 3D before manufacture or construction, he explained. In addition, 3D is used by meteorologists to visualize weather formations, by doctors to examine tumors detected by CAT (computerized axial tomography) scans, and by scientists to see objects ranging from galaxies to atoms.

"While 3D graphics look nice and are a part of nearly every consumer PC now," said Carl Howe, principal analyst for Forrester Research, a market research firm, "there are few business applications that drive their adoption, and those business apps that exist are very specialized."

This situation may be starting to change as the number of applications increases. For example, tools such as Alias/Wavefront's Maya, NewTek's LightWave, and Softimage's XSI help create 3D characters and effects for TV and movies. 3D tools such as Robert McNeel & Associates' Rhino help designers work on products ranging from furniture to car interiors and exteriors.

Meanwhile, companies are beginning to use 3D technology to increase business. Some companies are licensing a virtual-shopping application that My Virtual Model developed. Shoppers visiting an e-commerce site could use the application to personalize a 3D model

with their body dimensions and virtually try on clothes. Ford Motor Co. is using My Virtual Model's 3D technology to let shoppers explore a new sports utility vehicle.

THE FUTURE IN THREE DIMENSIONS

As 3D becomes more pervasive, developers will have more opportunities to bring 3D graphics to their Web sites, and users will expect such capabilities.

"We're going to see increased interactivity, realism, ease of use, and display quality over the next three or four years," predicted Pandromeda's Musgrave. "But we need more [computer] speed and memory, and improved input and display devices."

Keys to success

Several key factors may determine whether 3D technology succeeds outside a few niche markets.

Cost. Low-end 3D technology is now relatively affordable. Software for creating simple 3D images and acceleration cards for older PCs each costs about $100. In addition, libraries and exchange sites (such as http://www.turbosquid.com) sell hundreds of 3D models fairly inexpensively.

Ease of use. Creating 3D images can be daunting with high-end 3D tools. However, low-end tools are no more complex than other graphics applications on the market. Nonetheless, users need time to become familiar with the tools' terminologies and workflows.

Demand. "It will take time for people to find all the uses for 3D, but many topics are better understood by the addition of other media," said Ryce. "For example, the weather report is more appealing if you see a map of your area with cloud movement animated over it."

However, said Kenneth Smiley, a senior analyst with Giga Information Group, a market research firm, there probably won't be much business demand for 3D technology. "Daily business practices just don't require an additional dimension," he explained.

Cross-platform functionality. As is the case with many maturing technologies, 3D cross-platform functionality is increasing. For example, Shockwave content can run on Microsoft or Netscape browsers, on Macintosh and Windows platforms, with or without 3D-acceleration video cards.

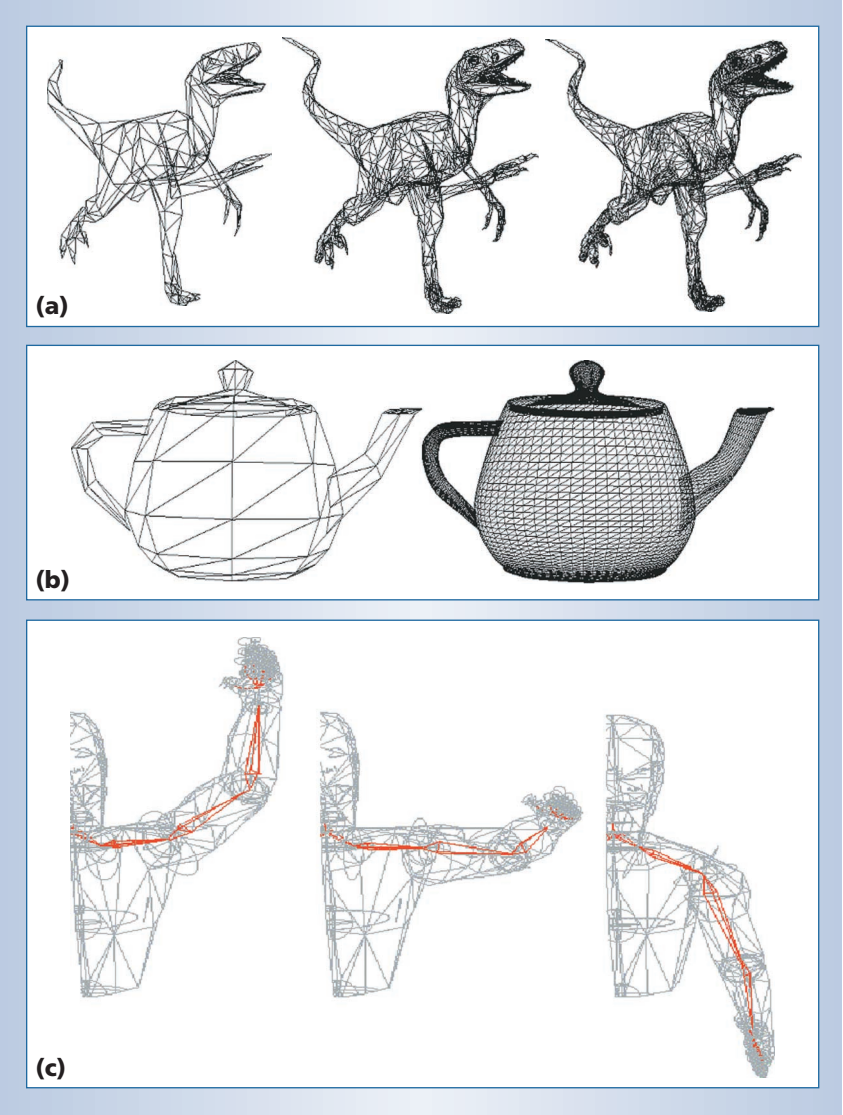

Figure 2. Macromedia's Director 8.5 Shockwave Studio development environment incorporates Intel's 3D graphics software. (a) The software's multiresolution mesh feature uploads a low-resolution version of a model and then streams additional geometry information that progressively improves the resolution, based on the client computer's processing power. (b) The subdivision surfaces approach transmits a low-resolution model and instructions for how to increase the resolution to a client computer. (c) The bones functionality sends an animated 3D model's key data points, called bones, as well as information on the way the client computer should reconstruct the model.

In addition, numerous vendors of 3D-development environments—including Discreet (which makes 3ds max), Caligari (trueSpace5), and Alias/Wavefront—have agreed to create modules that will let developers export work from these tools to Macromedia's Director 8.5.

Standards

The adoption of robust standards could be important to 3D technology's widespread use. For example, 3D ani-

mation companies want a uniform standard so they don't have to write multiple translators, in some cases for use with unproven formats.

Formats. Two early 3D formats never caught on: the Virtual Reality Modeling Language (VRML), an open file-format standard; and Microsoft's Chrome, a Windows add-on. They failed because content was difficult to create; there was no widely used playback mechanism; and bandwidth and hardware were less robust than they are today, explained Macromedia project manager Miriam Geller.

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According to Brown University's van Dam, there currently are three principal 3D standards, which are not compatible with one another.

The Web 3D Consortium (http://www.web3d.org) has developed the X3D (extensible 3D) standard, which uses XML to extend VRML.

OpenGL (http://www.opengl.org), an effort initiated by Silicon Graphics and maintained by the OpenGL Architectural Review Board, is a cross-platform API for 3D rendering and hardware acceleration.

Microsoft has developed DirectX (http://www.microsoft.com/directx/default.asp), a suite of multimedia APIs built into Windows OSs that let designers access hardware such as 3D graphics acceleration chips and sound cards.

Currently, van Dam said, no uniform 3D standardization effort is under way. "We have competing standards which means 3D [developers] are having to choose camps," he explained. "And that slows things down."

Players. Content developers have been waiting for a widely deployed player for which they can distribute material. The wide range of client systems, said Intel Labs' Chandler, has forced developers to either write to the common elements of multiple systems, thereby limiting the quality of the content they produce, or spend time and money writing different versions of their code.

"Developers have lacked a clear path to a broad audience and have had to choose among niche solutions, modifying and customizing applications for each player they want to support," he explained.

Ian Grey, who heads Poser Forum Online—a community for 3D artists, animators, model creators, and technical developers—doesn't put a lot of stock in online 3D for the next few years.

"High-speed connections are still not common enough to make them viable, and the number of people actually creating 3D content will have to increase significantly before there is enough hand-me-down knowledge of 3D for the general public to embrace it," he said.

3D isn't quite ready for the masses yet, Macromedia's Ryce agreed. However, he said, the day is coming when we'll see the technology make complex things easier to understand, products more desirable, and online entertainment experiences more exciting. ✷

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