

Linux in Hollywood: A Star Is Born

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Although Linux has yet to achieve wide popularity in the computer game world (“Will Linux Be Computer Games’ Dark Horse OS?” *Computer*, Dec. 2001, pp. 161-162), it is making rapid progress toward becoming the dominant operating system in the other major entertainment arena: motion pictures. Name a motion picture from the past year or two that featured stunning animation or dazzling special effects, and chances are the film’s producers used Linux-based computers to splash those graphics on the big screen.

For most of the past 30 years, Hollywood has led the development of computer graphics by constantly pushing the state of the art to wow audiences with ever more spectacular visuals. Many of these achievements can be seen annually at SIGGRAPH conferences and exhibitions, where leading researchers and practitioners in the computer graphics field demonstrate work that companies such as Industrial Light and Magic or Pixar have done for the latest blockbuster films.

ARMS RACE

Showcases like SIGGRAPH underscore the competitive pressures that force studios to take risks and innovate to top their rivals’ latest special-effects extravaganzas. The use of Linux on PC’s is becoming pervasive in the movie business, supplanting traditional platforms such as Sun and SGI in much of the film production process. The Linux operating system initially found



Cheaper, faster, and more customizable than established players, Linux has become the film industry’s new favorite.

a niche for use in computer-generated image rendering for film.

The 3D rendering process takes computer-generated models and, placing them in a scene, provides them with hidden surface removal, shading, and illumination. Rendering computer-generated imagery can create amazing effects, such as the beautiful sunrise seen in *Shrek*, the May 2001 animated film from Dreamworks SKG. As Figure 1 shows, CGI rendering transformed *Shrek*’s 3D wireframe models into living characters breathtakingly illuminated by morning sunlight.

Although animated films such as *Shrek*, *Toy Story*, and *Monsters, Inc.* have been popular and successful, Hollywood has long derived most of its revenues from mainstream blockbusters. With recent advances in technology, rendering systems can now be applied to these moneymakers, producing results so realistic they can be blended seamlessly into live-action footage. CGI, when composited with live actors and constructed backdrops, can create scenes previously impossible to portray convincingly—such as those seen in the *The Fellowship of the Ring*, part one of Peter Jackson’s *The Lord of the Rings* trilogy.

Late in the film, the fellowship confronts a cave troll deep in the mines of Moria. Thanks to digital sleight of hand, several of the human actors who play the diminutive hobbits appear to be less than half their true size, while the troll—a mythical monster fabricated completely from CGI—moves with ground-shaking menace and attacks with a bone-crunching ferocity that makes it disturbingly believable.

The film’s early box office success and its two in-the-can sequels indicate that many more such efforts will soon be appearing at a theater near you.

PAYING TO PLAY

The algorithms and techniques needed to render these effects—such as ray tracing, radiosity, motion blur, and anti-aliasing—are so computationally expensive that early CGI efforts required a supercomputer’s processing power. In a major pioneering CGI effort, for example, the producers of 1985’s *The Last Starfighter* used a Cray X-MP computer to render the film’s animated effects. Developed by Digital Productions and designed by Ron Cobb, although advanced for their time, these animations took several minutes per frame to render. Pushing this early technology to the limit had its price: It took more than six months to render the film’s 36,000 animation frames, and just renting the Cray cost more than \$250,000 per month. Subsequently and unsurprisingly, Digital Productions went out of business (<http://www.cs.unc.edu/~zimmmons/tron.html>).

The technology proved too compelling to abandon, however. Lucasfilm,

the production company responsible for the special effects in *Star Wars* and many other films, tried using a specialized computer optimized for the task to address the demand for high-end rendering. This machine, the Pixar, proved so successful that it lent its name to the independent film studio spun off from Lucasfilm in 1986. Later bought by Apple founder Steve Jobs, Pixar became known for clever animated films such as *A Bug's Life* and *Monsters, Inc.*, and developed the Renderman software renderer, for which Ed Catmull, Rob Cook, and Loren Carpenter received an Oscar in 2001.

Continually advancing technology helped film CGI explode in the early 1990s, when the innovative combination of Sun Sparcstations and Renderman software made RenderFarm possible. Deployed by Sun and Pixar in 1994 for *Toy Story*, the first completely CGI film, RenderFarm consisted of 87 dual-processor and 30 quad-processor Sparcstation 20s. This impressive hardware collection ran the Solaris Unix operating system across a 100-Mpbs Ethernet network. Even so, it took more than three hours to render each frame of the film on a workstation, although RenderFarm's inherent parallelism let Pixar complete all 114,000 frames of the 77-minute film in just two years.

LINUX STEALS THE SPOTLIGHT

Until 1996, high-end graphics workstations running some flavor of Unix owned most of the CGI market. In that year, however, Linux won its first major film role. Digital Domain used 105 DEC Alphas running Red Hat Linux to simulate and render water for John Cameron's *Titanic*, a film destined to become the greatest financial success of all time (Daryll Strauss, "Linux Helps Bring Titanic to Life," *Linux J.*, Feb. 1998, <http://www.linuxjournal.com/article.php?sid=2494>).

Digital Domain's desire to use DEC Alphas proved the primary motivation for choosing Linux. At the time, Alphas were three times faster than their SGI



Figure 1. Shrek, released early in 2001, raised the bar for feature-length computer-generated animation with stunningly lit scenes like this one. Image courtesy of Dreamworks SKG.

counterparts. Even better, because they ran Linux, Digital Domain avoided paying the high cost of buying DEC's Unix OS for each machine. Moreover, access to the source code for Linux enabled Digital Domain's developers to easily port applications to their own Render Ranch software.

With the success of films such as *Toy Story* and *Titanic*, most major motion picture studios now employ CGI—and strive to reduce the costs of using this expensive technology. Hence, digital FX houses and animation studios are rapidly deploying less expensive Pentium-based computers that use Linux and a variety of rendering software packages.

Linux's latest coup involves its central role in the production of *The Lord of the Rings*, for which Weta Digital, a New Zealand company (<http://www.wetafx.co.nz/>), created the special effects. Weta's 160 digital artists generated roughly one terabyte of data per day with dual-processor SGI 1200 servers running Linux.

Weta used PRMan, the Linux version of Photorealistic Renderman, to

render the images for the trilogy's first installment. According to chief technology officer Jon Labrie, Weta reduced the cost of rendering to a tenth of that for SGI's Octane workstations (<http://www3.tolkienonline.com/docs/1132.html>). Weta bases its primary rendering resource on SGI 1100 and 1200 Linux-OS-based servers. Having started with 32 dedicated processors, the FX house currently runs 192 dual-processor Pentium SGI servers that render frames 24 hours a day, seven days a week.

Other computer companies, taking notice of Linux's CGI successes, have entered the market with their own offerings. Hewlett-Packard, for example, now markets Linux servers and desktops to the film industry, and, according to Simon Avery, the producers used HP servers to make *Shrek* ("Linux takes Hollywood by Storm," *The Wall Street Journal Online*, 17 May 2001, <http://www.zdnet.com/zdnn/stories/news/0,4586,2761566,00.html>). Likewise, Dreamworks found that systems running Linux produced a tenfold increase in rendering capability. Moreover, the

company did not need to pay the hefty fees associated with buying and maintaining Microsoft or other proprietary operating systems.

SPREADING INFLUENCE

The CGI research community has also embraced Linux for high-end graphics applications. Paul Debevec, executive producer at the Institute of Creative Technologies, notes that his organization uses “a cluster of 20 dual-processor Intel 1-GHz Linux RedHat 6.2 nodes as our render farm. We use this cluster to run our proprietary ‘Arnold’ global illumination-rendering software. This software allows us to create very realistic animations of complex virtual environments as they would appear illuminated by real-world illumination. We chose Linux for its reliability, performance, ease of setup, and cost” (<http://www.ict.usc.edu>).

Besides rendering applications, ven-

dors now offer several popular modeling packages for Linux—including the high-profile Maya from Alias/Wavefront, an SGI subsidiary. The company estimates that at least one-fourth of its major studio clients have begun switching to the Linux version of Maya, film production’s most popular 3D modeling software. For example, when The Moving Picture Company, based in London, chose Maya to create shots for *Harry Potter and The Sorcerer’s Stone*, it picked the Linux version. Softimage, a subsidiary of Avid, began shipping its flagship animation package SOFTIMAGE/XSI v.2.0 in December 2001 and expects at least 15 percent of its sales to derive from Linux platforms.

Given the many systems that run it and the numerous applications that support it, film makers can

now use Linux for an animated feature’s entire production process, including modeling, animation, and rendering. These developments alone, however, will not be enough for the open source OS to threaten Microsoft’s market dominance. The digital film, television, and commercial-production business remains a niche market. Nevertheless, this sector acts as a bellwether for high-performance technology trends. Thus, when we see the entire film industry adopting Linux to remain cost- and performance-competitive, how can we help but wonder what new realms Linux may conquer next? ■

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