Application Brief

SGI™ Technology Powers the Hayden Planetarium's Dazzling New Space Theater

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—Carter Emmart
Art Director for Science Visualization
Digital Galaxy Project

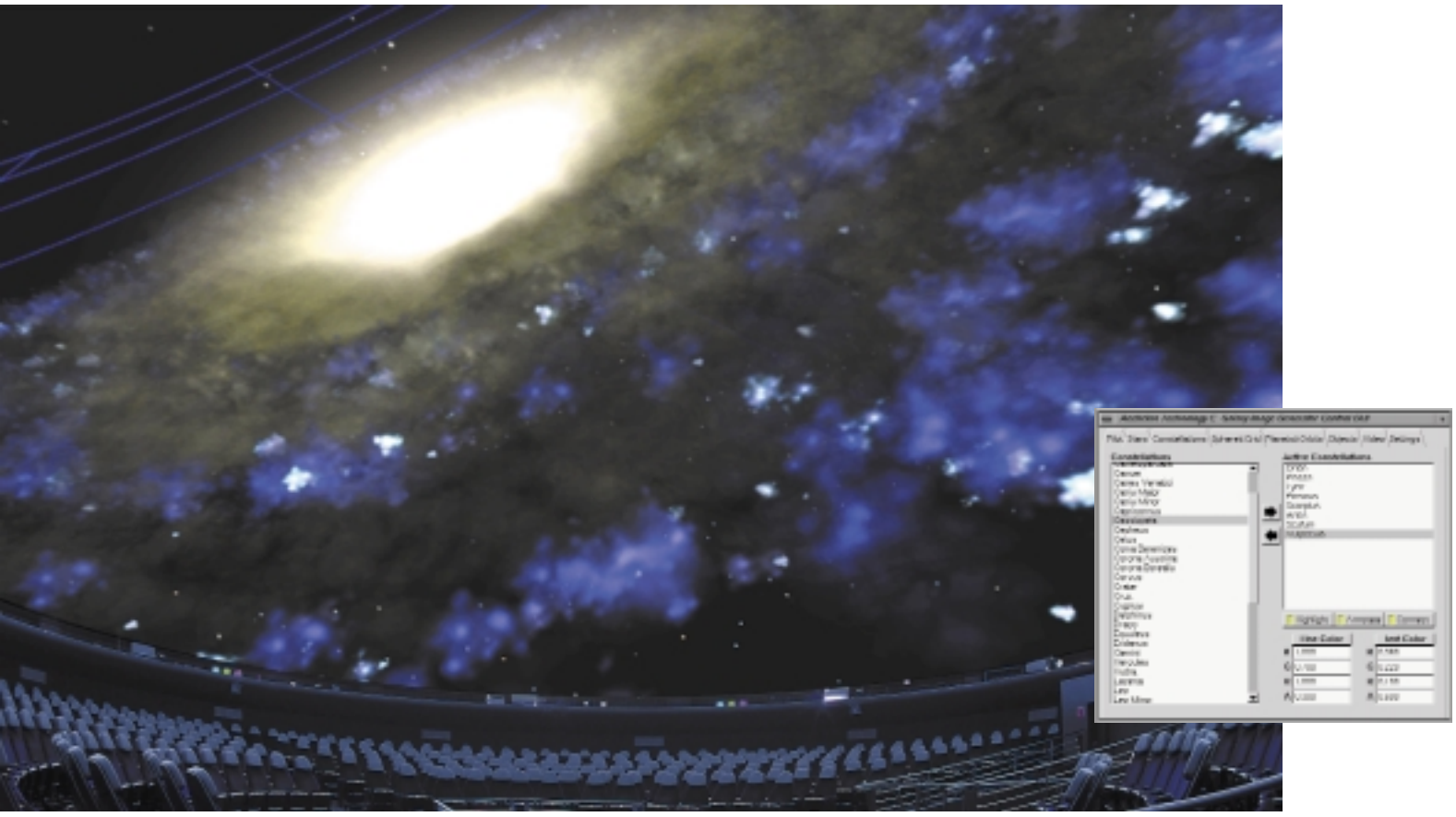
World's Largest Digital Theater Awes New York Audiences with Immersive Visualization

The new Hayden Planetarium, part of the Rose Center for Earth and Space at New York's American Museum of Natural History (AMNH), opened its spectacular Space Theater February 19, 2000, to unveil the world's largest digital immersive visualization system, powered by a Silicon Graphics® Onyx2® InfiniteReality2™ system. The first experience offered by the new Hayden, titled "Passport to the Universe," begins with a two-minute show from a state-of-the-art Zeiss projector that rises dramatically from the theater floor. The Zeiss presentation is followed by an immersive, three-dimensional, intergalactic space ride narrated by actor Tom Hanks.

The visual ride takes visitors from earth-orbit altitude past Mars, the moons of Jupiter, and Saturn to the edge of the solar system, then accelerates at breathtaking speed toward the Orion nebula, where it moves among unborn stars and cosmic clouds. The journey continues to the edge of the Milky Way through a cluster of galaxies, at which point the flight accelerates to galactic speed, flies through a supercluster, and pauses at a point that represents the limit of human knowledge of the universe. A dark spot on the dome grows quickly into a black hole. The flight enters the black hole, and the audience finds itself back at its earth-orbit starting point. The Digital Galaxy provides the infrastructure for this remarkable experience.

The Digital Galaxy: Science-Based Visualization of the Milky Way

The NASA-sponsored Digital Galaxy Project (DGP) is an initiative of the AMNH Rose Center. Scientists, imagery analysts, programmers, graphic designers, and educators are all contributing to this breakthrough project. Their primary task is to build a visual database of the 200,000 known observable stars that have been charted in all major astronomical catalogs, including the 100,000-star Hipparchos data set from the European Space Agency. To these catalogs they have added all charted pulsars, nebulae, and globular clusters. Coordinates for all these charted bodies have been transformed into a single data set of galactic coordinates.



The rest of the Milky Way's 100 or 200 billion stellar bodies remain uncharted, but DGP scientists have developed a science-based way to portray them to planetarium audiences. Each region of the galaxy, from its halo and its spiral arms to its central disk, contains stars of various kinds in numbers and ratios that can be estimated. DGP programmers use the Onyx2 system to synthesize up to a billion statistically correct stars to make every space flight experience realistic and scientifically sound.

The Digital Galaxy database runs in real time on the Onyx2 system. Show producers use Aechelon Technology's C-Galaxy real-time image-generation software to navigate through the database in real time, creating a galactic journey that is recorded digitally, frame by frame, for playback to planetarium audiences. C-Galaxy includes three travel speeds—planetary, for flight within the solar system; stellar, for flight within the galaxy; and galactic, for flight beyond the Milky Way. Alias|Wavefront™ Flight Path Editor points producers to the most appealing and effective flight path angles and sequences. New space flights can be easily plotted and recorded in a few hours. Presenters can use Flight Path Editor to select routes spontaneously before live audiences.

Prerendered, Ultrarealistic, Science-Based Sequences

The Hayden Planetarium has achieved its goal of three-dimensional scientific realism and cinematic quality. For "Passport to the Universe," C-Galaxy provides detailed, textured visuals of Earth, Saturn, and Jupiter and its moons. The Hayden uses C-Galaxy to merge prerendered visualization sequences into the presentation. The sequences, prepared by the San Diego Supercomputing Center (SDSC), include nebulae, newborn stars, and cosmic clouds.

"These are not artists' renderings. We are visualizing real science data," says Carter Emmart, art director for science visualization for the DGP. "We have maintained the accuracy we wanted. SDSC supplied us with 200,000 lines of code to render the Orion nebula for the show. They also supplied generic code that we used to sculpt nebulae and other elements.

"We worked closely with a researcher who has spent his entire career in studies of nebulae and has observed them through the Hubble telescope," continued Emmart. "Not a single detail of the Orion nebula was overlooked. We take the audience on a tour through this very alien environment—the edge of a dark cloud where stars are born. It looks like a flower opening up. Newborn stars are still swaddled in gases, which are blown back into teardrop shapes from the solar wind of the most dominant star. We spiral through this environment for two minutes. It covers the dome. The audience is fully immersed."

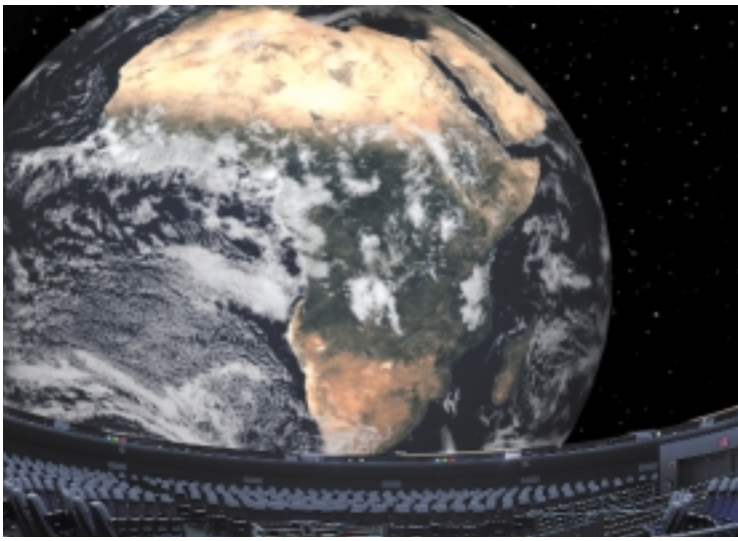
Other prerendered sequences in "Passport to the Universe" include a very large-scale view of the universe from beyond the Milky Way, using a background based on a 40,000-galaxy model developed by the National Center for Supercomputing Applications. This sequence includes renderings of Magellanic clouds, the Virgo cluster, and galactic superclusters.

The Enabling Technology: Silicon Graphics Onyx2 InfiniteReality2

Trimension Systems Limited served as integrator for the installation of the Space Theater visualization system, which includes industry-leading sound and projection technology. The heart of the system is a 28-processor Silicon Graphics Onyx2 InfiniteReality2 system with seven graphics pipes. "The Onyx2 system is essential," said Emmart. "Without it, we could not run real-time graphics at the resolution that's needed to make this simulation look real. We just couldn't do it with any other platform." The Onyx2 system drives seven Trimension projection displays that create a seamless, real-time visualization on the dome. Each display projects a 1280x1024 image at 30 frames per second, edge-blended with adjacent images.

"Passport to the Universe" is a recorded playback presentation. Its entire content, including prerendered sequences and real-time Digital Galaxy scenes, is stored digitally on 2TB Ciprico disk arrays and streamed to the projection systems by the Onyx2 system at very high bandwidth and resolution. The result is the highest quality e-cinema experience on the planet.

The Hayden's digital presentation system can do much more than present recorded digital space flights. It is capable of displaying everything from live external high-definition video feeds to a space ride guided by a presenter in real time. The system gives the Hayden tremendous flexibility in the choice and timing of its presentations.



Digital Galaxy Project
New Hayden Planetarium
Rose Center for Earth and Space
American Museum of Natural History

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