# reach for the stars

Surround sound meets science with spectacular results at the newly redesigned Hayden Planetarium

Photos: AMNH/D. Finnin

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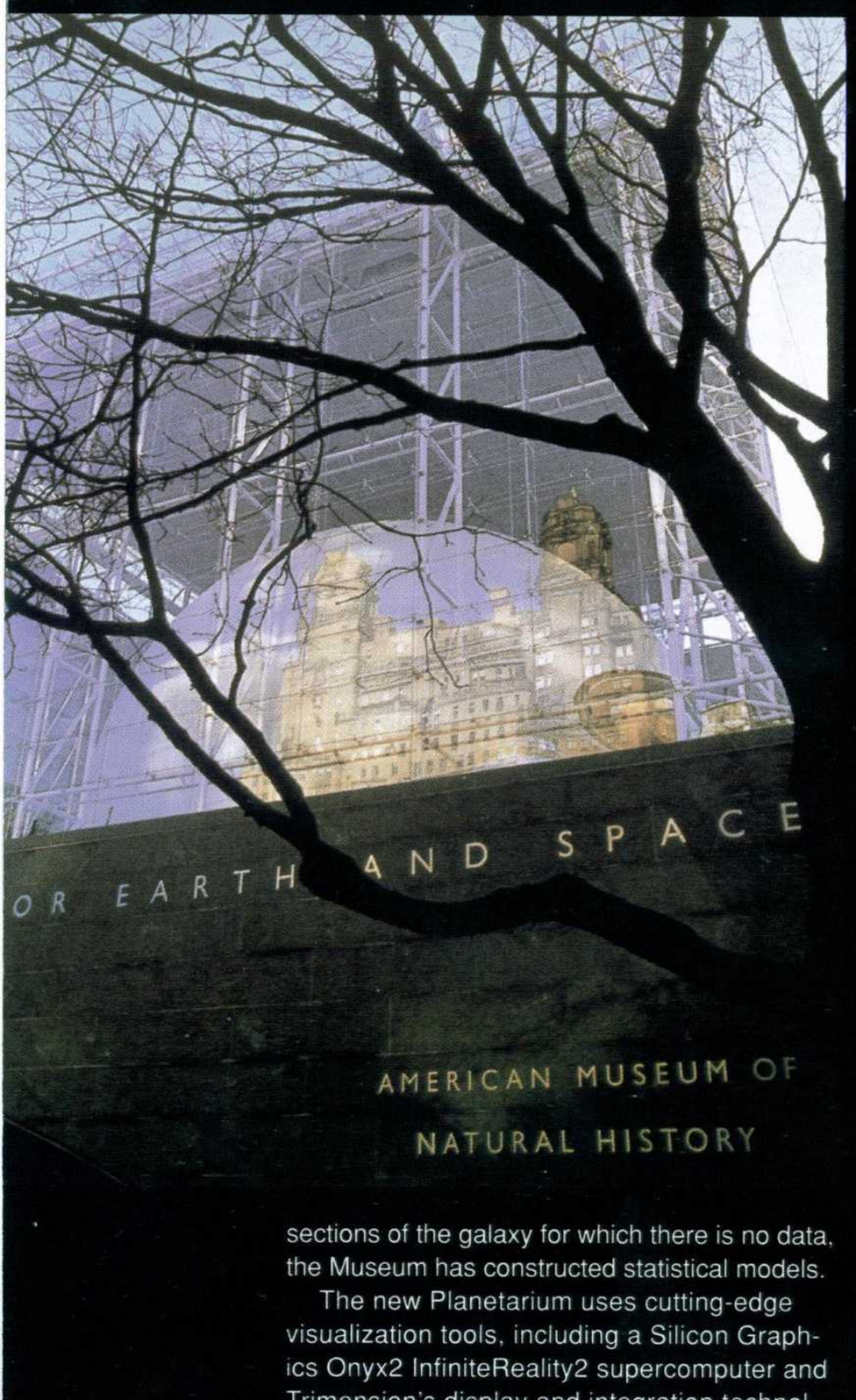
This winter, the American Museum of Natural History in New York City opened the most spectacular addition in its 130-year history — the Frederick Phineas and Sandra Priest Rose Center for Earth and Space.

The centerpiece of the facility is the new Hayden Planetarium, presenting the most technologically advanced Space Theater in the world, in which visitors can experience Space Shows of incredible realism. The Planetarium, as well as the "Big Bang Theater" — a dramatic recreation of the first minutes of the origins of the universe — is situated inside a sphere 87 feet in diameter, which appears to float in a glass-walled cube.

The new Hayden Planetarium is unlike any other such facility in the world. In the top half of the Great Sphere, the most technologically advanced Space Theater in existence uses advanced visual technology (including a customized, one-of-a-kind Zeiss Star Projector) to create shows of unparalleled sophistication, realism, and excitement. With this high-definition system, the Hayden Planetarium is the largest and most powerful virtual reality simulator in the world.

The Space Theater presents a spectacular real-time, virtual universe that re-creates the Galaxy based on actual astronomical data. It includes data on our solar system from the National Aeronautics and Space Administration (NASA), the European Space Agency's Hipparcos database of more than 100,000 nearby stars, and a statistical database of more than two billion stars, developed by the Museum, to complete the Milky Way Galaxy. For those

# reach for the stars




sections of the galaxy for which there is no data, the Museum has constructed statistical models.

The new Planetarium uses cutting-edge visualization tools, including a Silicon Graphics Onyx2 InfiniteReality2 supercomputer and Trimension's display and integration technology, to bring audiences three-dimensional astronomical imagery that is as breathtaking as it is scientifically accurate. The unique system also has the ability to combine real-time visual simulations with pre-rendered graphics, high-resolution video, and online news of current science events, making it a state-of-the-art educational tool.

To meet the enormously rigorous surround sound demands in the construction of this theatrical and virtual reality behemoth, director of engineering Aram Friedman brought in Benjy Bernhardt to design the system, choose the hardware, and develop the software. The two had worked on another monster multimedia experience at the Luxor project in Las Vegas, and were ready to tackle an even more demanding one.

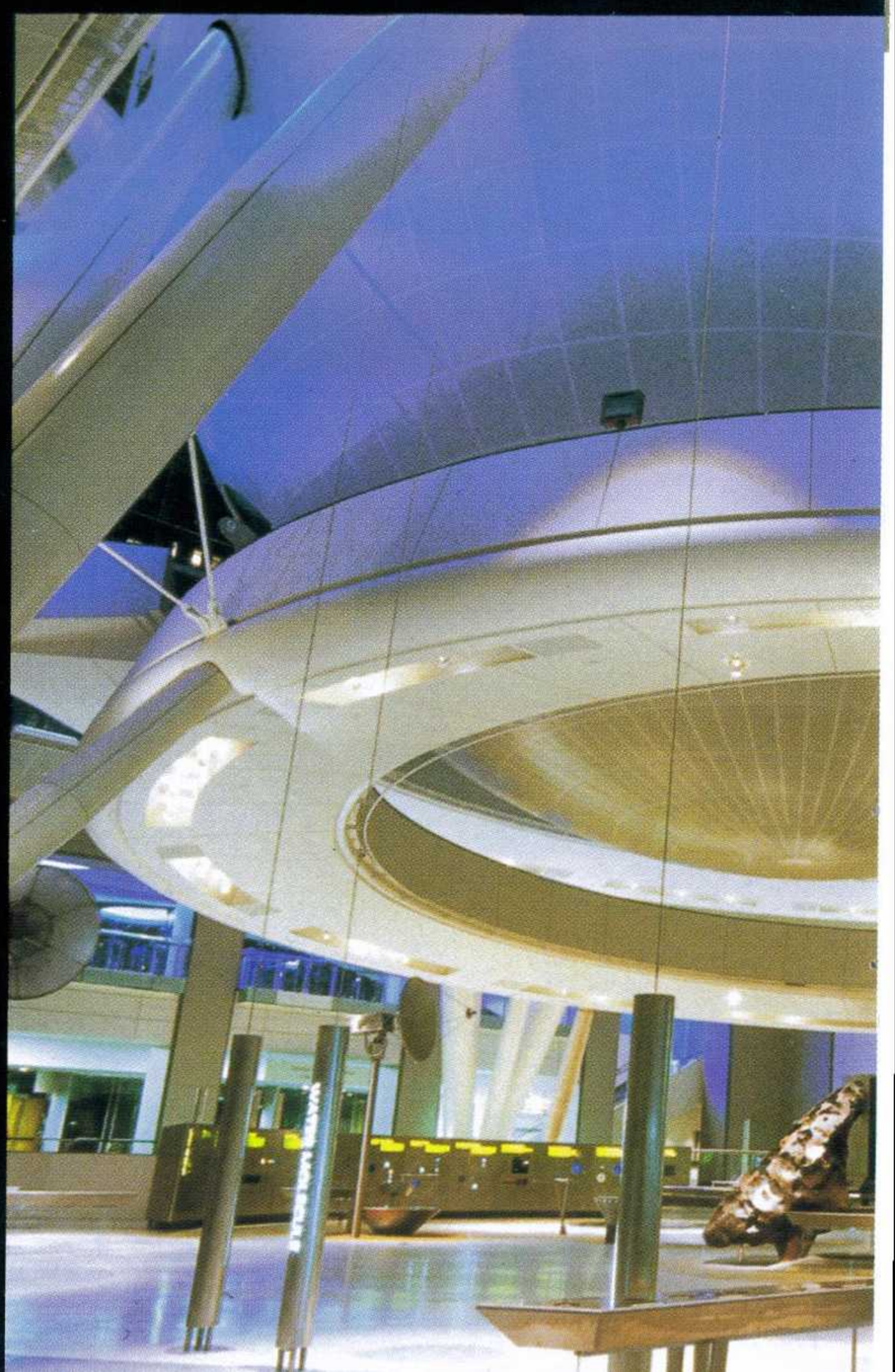
"I came in midway through the game," explains Bernhardt. "What they had was a theater design, sort of a classical planetarium. One of the reasons I was brought in is because the theater plays two roles — it's a planetarium and also a virtual reality theater, and the people who had done the original spec, who had done a good job, didn't really know it was going to become a virtual reality theater. So a lot of my task was to look into what could be tweaked in order to make it more versatile and allow future stuff to go on."

What design wound up suiting both purposes? "There are different camps making surround sound audio systems," says Bernhardt, "and they come from different backgrounds. There are the theater people, the film mix people, who are close, and there are the virtual reality people, who are really coming from a different place. So I had to do a lot of research and find out what product met as many needs as we could because we couldn't really afford to put in several separate systems at fifty grand a pop. The original spec was for Level Control Systems out of Sierra Madre. They're involved in a lot of Broadway and Vegas-type live production. They make a chassis that gives you eight in, eight out, and you can put a bunch of chassis together and make a really big matrix. It does routing and panning."

And where does the sound come out, with 360 degrees of space to fill? "Our configuration is three speakers at the top, then we have a ring of eight, then a ring of twelve," describes the designer. "If you want to position a sound pretty precisely either at a speaker or at an imaginary spot between speakers, you can do that with a system like the LCS. What the LCS does — but doesn't do as easily out of the box — is what the VR systems have traditionally done, which is a simulation where your camera position in xyz coordinates gets sent in real time to a spatialization box, which assigns various inputs to locations so your visual and audio databases match not only what the sound source is, but where it is. We tried to have our cake and eat it, too, and we decided that the LCS software was mature and that our first priority was to do the first show, which, of course, colored a lot of our purposing decisions.

"So we have a four-chassis LCS system on which the mix is done. The zenith (top) speakers are Meyer CQ-1's, the sky and horizon (middle and lower) are Meyer UPL-1's. Then we have sidefill speakers (11 EAW UB12's) that take care of an architectural overhang that blocks a little bit of the sound from the back rows — just little kicker speakers — and we have four speakers on the lift (EAW UB12's) that rise up through the floor with the Zeiss planetary projector. One of the things I've found from in-the-round situations is that sounds can get localized behind your head, and it's always nice to have sources in front of the audience if you can. Plus, we have three Bag End subwoofers (S18E-1's) and an Aura AST-1F-4 seat shaker under every seat."

How, and where, do you mix for that kind of space? "There's certainly no way to do the mix other than in the space itself, which has been a challenge in terms of the schedule," admits Bernhardt. "That's mostly the kind of background I have — on the Luxor project in Las Vegas, it was a similar kind of venue where you have 18 separate channels, and you can't simulate that sort of situation. Sound effects and dialog were coming off a 24-channel Pro Tools system and our music was mixed on a Sonic Solutions systems. The LCS, as well as being a matrix mixer, also has hard-drive playback through its own digital disc recorder, so we dumped the 32-channel Sonic Solutions content there and had 24 channels of Pro Tools being mixed live. It gave us the ability to live edit it as we went, because the other issue is the precise timing



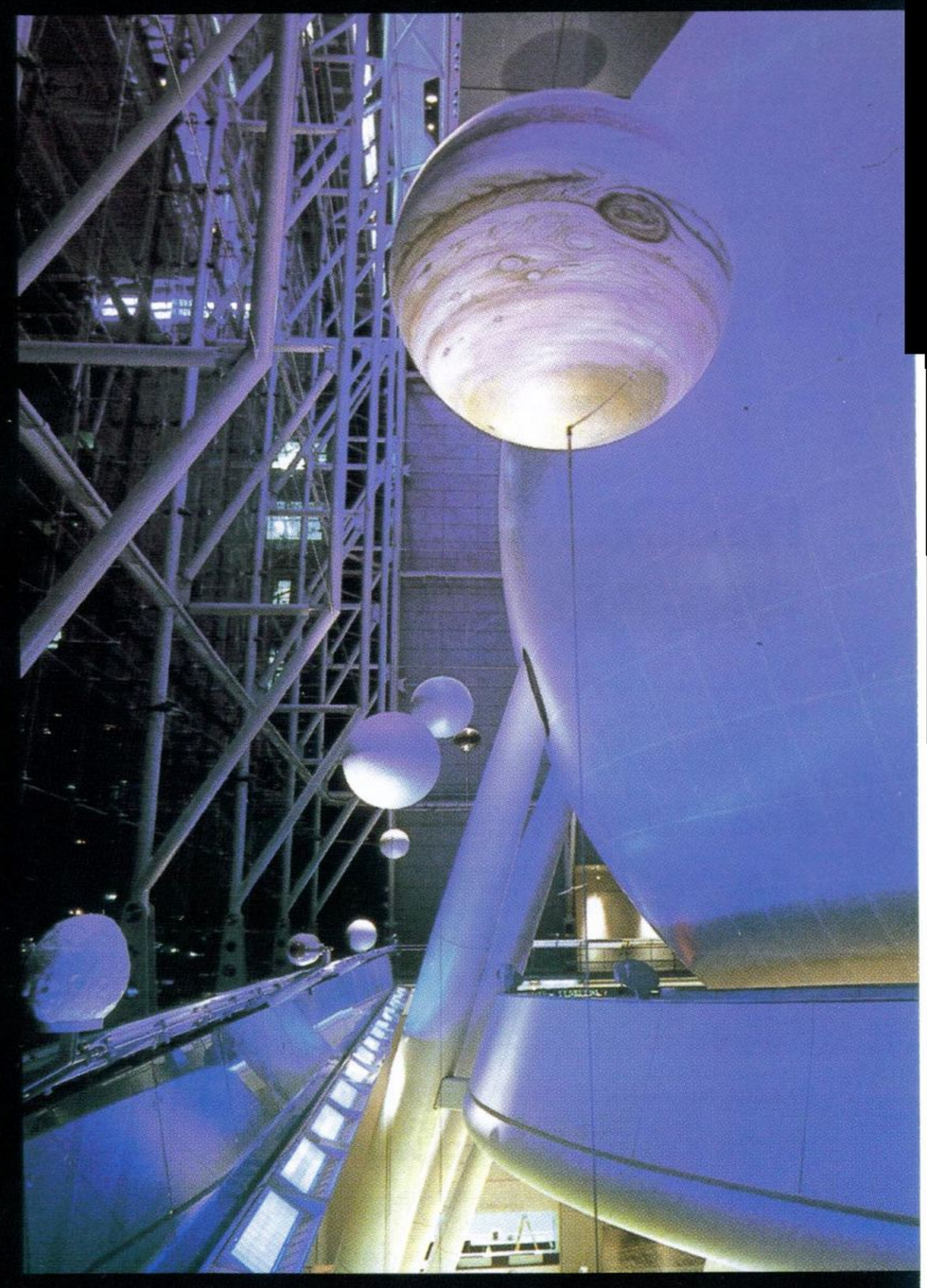
for the effects. It's very hard to get that when you have a little video dub of something that, on the dome, takes up 68 feet, so, to get precise timing cues, they really had to do that in-dome, especially since the content was never frozen, always changing. When all is said and done, the Pro Tools tracks are going to be recorded onto the LCS hard drives and then the final playback medium is entirely contained within the LCS."

What kind of material is being recorded, and where do they get it from? "There's two kinds of shows," continues Bernhardt. "The first kind is canned, non-real-time with no user interaction, and that's being scored very much like a film would be. We had composer Stephen Endelman compose original music and record it in a studio. Sound effects were designed by Paul Soucek. Sound effects are an interesting issue, because, as any astronomer will tell you, there's no sound in space. That's been an interesting kind of fuel for the sound on this project because, on the one hand, you've got people who come from Hollywood and the *Star Trek* universe where things that go by you go 'whoosh' and then you've got astronomers who say you don't want to give anyone the impression that what they would see or hear out there is what it would really be like — we only want the experience of what it would really be like so we're not propagating false science. So we walk this line — certain kind of objects, like galaxies, that fly by you make a big 'whhffvv' sound as they would in any science fiction film, and I think everyone understands the dramatic element is key there.

"Then you have the science visualization, which is the second kind of show. That's essentially a simulation of the galaxy that you can fly through using a joystick — and also create modular automated sequences as a part of it. Then the issue is how do you have a sound corollary. What we want to do is, just as we have a database of objects in space — planets, stars, etc. — we want to have a database of sound objects. We have the preliminary software for that, which was done in C++ code by an intern last year, which essentially takes the camera position, which analyzes its field of view, and figures out what should be audible from that position. Our first project probably will be pulsars, because that's something that everyone can agree has a scientific and artistic point of view. What those sounds will be and what will produce them is still up for discovery. I'm interested in a system for sound sources that goes beyond sample playback and gives us acoustic modeling and other kinds of real-time synthesis."

The project has probably more computer power than any other theater in the world. What do they do with it all, soundwise? "We speak in a future tense, because it's not all there yet," admits the designer. "Essentially, there's an application that lives on the Onyx. There's a piece of memory called shared memory, and in there are all the attributes of where the viewer angle is. Any application can pull that information. There's another application that's running the sound corollary, which is looking at the camera position and calculating what in the sound objects database is in the range of hearing off-screen that requires cueing up that sound. That sends a signal over the network to a dedicated computer that's managing loading and playback of sounds.

"And that's the missing piece — a sampler. The message is going to be sent to the computer running Macs or other MIDI software, which translates coarse messages into MIDI messages and handles fadeup and fadeout. But I'd like it to go eventually to a computer that's going to its own sound engine, which would be either something from the game field, which has interesting simulation engines, or it would be something like the SCOPE system, which is just a generalized DSP architecture that lets you do playback, virtual synthesis, and so on."



So they've done the Universe. How do you follow that? "We'd certainly like to do inner space," predicts Bernhardt. "The brain, the human heart — things that could be explored and moved around in where you really see stuff. There are a lot of space phenomena that are great because they see things from the Hubble, flat images, but because of time they can figure out the model and create volumetric renderings. Or underground — oil exploration uses a lot of VR to turn sound into spatializations to determining where oil might be, though we probably wouldn't do that because of commercial consideration."

Ultimately, what was Bernhardt's role in the project as a whole? "When I came on, my concern was to make sure that the people who created the shows knew what they had to work with," he opines with pleasure, "and they definitely do." ■