Portable Planetariums Teach Science

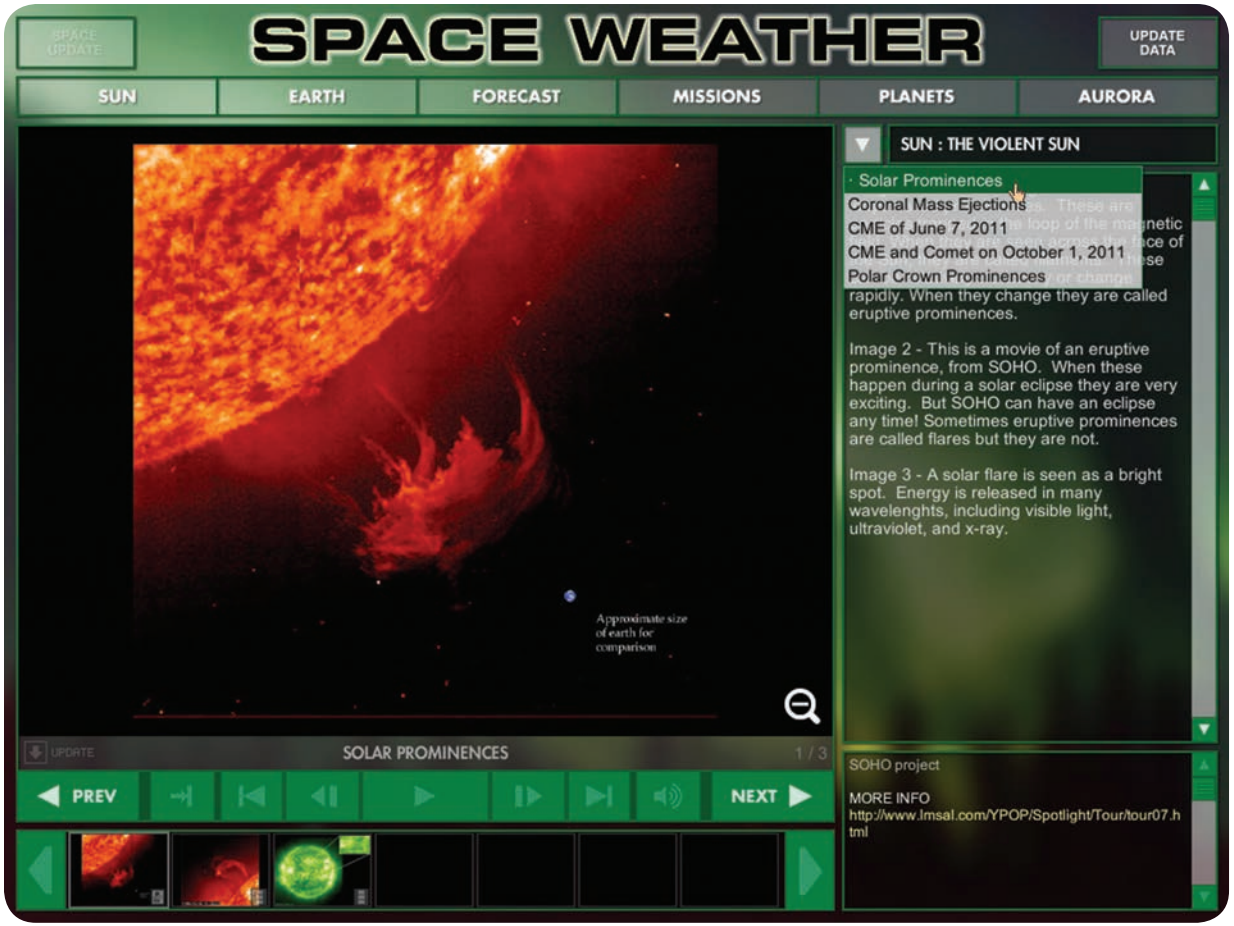
NASA Technology

By the mid-1990s, NASA was collecting an enormous amount of information about Earth and the universe. For example, the Earth Observing System, comprising a fleet of satellites, was gathering long-term data on the world's atmosphere, land surface, and oceans. Meanwhile, the Hubble Telescope and other spacecraft were focusing their lenses toward the cosmos, amassing a trove of images that were helping scientists answer intriguing questions regarding the life cycles of stars and the formation of galaxies, and even proving the existence of black holes.

Traditionally, such information had been largely inaccessible to the public, because there was no infrastructure in place capable of distributing computer-based data to the masses. But in recent years, the Internet—a technology that would connect the planet in ways never before imagined—had begun to take the country by storm. The agency recognized the forthcoming Information Age and put out a call for proposals on how best to use the Internet to share NASA data.

Technology Transfer

One successful proposal—the first of several—came from Rice University and the Houston Museum of Natural Science. Together they put forth an education outreach idea: to create the world's first Internet-accessible museum kiosk. In 1994 NASA entered into a joint cooperative agreement with the two institutions, which a year later resulted in an exhibit called *Earth Today*. In it, visitors could interact with three programs: *Welcome to Planet Earth* provided hourly global satellite weather photos, maps and forecasts; *Space Weather* described the plasma environment of Earth and showed how the planet's atmosphere and magnetic field protect it from the hazards of space; and *Houston Today* dispensed local weather information.



Rice University and the Houston Museum of Natural Science received NASA funding to develop the world's first Internet-accessible museum kiosk. One of its software programs is *Space Weather*, which describes how Earth's magnetic field and atmosphere protect it from the hazards of space.

The exhibit's achievement yielded further funding from NASA to transfer the kiosk programs into educational software that could be used in homes and schools. They developed a program called *Space Update* in 1996, followed by two others called *Space Weather* and *Earth Update*. In order to distribute the software, the institutions licensed the technology to Space Update, Inc., founded by Patricia Reiff, a space physicist at Rice University who, along with Carolyn Sumners, director of the museum's planetarium, were the co-principal investigators in the NASA-funded projects. A year earlier, the two partnering institutions, Reiff included, had also started working on another joint venture, this time through a cooperative agreement with the Earth System

Information Partners program, created by NASA's Office of Earth Science in order to promote such research. For this contract they put the agency's research literally under the bright lights by developing the country's first fully digital planetarium (and only the third in the world), which debuted at the Houston Museum of Natural Science in 1998. Another result of the contract was their production of an accompanying show called *Force Five*, the world's first Earth science planetarium show focused on hurricanes, tornadoes, and space storms. Soon afterward, Reiff founded Houston-based Museums Teaching Planet Earth Inc., or MTPE, in 1999, to distribute the Earth sciences show and software.

In 2002 came their third cooperative agreement with NASA, once again working with its Office of Earth Science. This time funding came from the Research, Education, and Applications Solutions Network, or REASoN program, which aimed to further educational outreach. The goal was to develop the world's first portable digital planetarium along with new educational shows. MTPE would be granted a license to promote and sell the technology to schools and other institutions.

Originally, the plan was to make use of the existing portable domes on the market, which were only running analog-based shows. After realizing that several improvements could be made to enhance user experience, it was decided that a new model would be developed. MTPE's needs and suggestions helped its supplier, Avela Corporation, to develop the groundbreaking double-door entrance, which acts like an airlock, preventing the dome from deflating. It also stops light pollution from seeping in and disrupting a show and is optimized for wheelchair access.

Another key improvement was the replacement of the standard shiny white finish, common with previous domes, with a dull gray microsurface. The new surface absorbed sound better and also minimized the reflections caused by the wrinkles in the fabric. "If all you're doing is projecting stars, it doesn't bother you that the reflection

With funding from NASA's Earth System Information Partners program, Rice University and the Houston Museum of Natural Science developed the country's first digital planetarium. Here, a fisheye lens photo shows students at the Houston museum watching *Lucy's Cradle*, a digital show about human origins in the East African Rift Valley.

NASA awarded grants under its Research, Education, and Applications Solutions Network, or REASoN program, to Rice University and the Houston Museum of Natural Science to develop the world's first portable digital planetarium, which would be called Discovery Dome, along with new educational shows. As a result, Museums Teaching Planet Earth, or MTPE, was created to sell and rent the domes to schools and other organizations.

surface is wrinkled," Reiff says. "All it does is make the stars seem to twinkle. But if you try to show a movie that has bright scenes, you can see every single wrinkle on the inside of the dome."

The movies Reiff is referring to are the new shows that were produced as part of the third agreement with NASA. Among the many titles are: *Earth's Wild Ride*, which imagines life in a lunar colony; *Dinosaur Prophecy*, which offers a glimpse at how dinosaurs throughout time lived and died; and *Impact Earth*, which explains the birth of the solar system, the origin of asteroids, and the surface features of Mars. *Force Five* was also rendered in high resolution. Also developed was a software package called *Media Show*, which plays not only the movies created through the NASA agreement but also traditional movies.

Benefits

In 2005 the efforts undertaken by Rice University and the Houston Museum of Natural Science were realized when MTPE put the portable planetarium, Discovery Dome, on the market both for purchase and as a rental service. The venture has been an unqualified success, doubling its sales revenue every year from 2005 to 2008 and maintaining solid numbers since then, having sold 200 installations in 33 states and 33 countries. "We've had $6 million worth of sales," Reiff says, "which is more than a dollar-for-dollar payoff of NASA's original investment. And it has not only fostered our company but also several of the vendor companies that we work with."

Sumners, who is also vice president for astronomy and the physical sciences at the Houston Museum of Natural Science, notes that the space agency's seed funding for the digital planetarium has also had a lasting impact on the educational institution. She says, "The spinoff for the museum is the creation of self-sustaining venues for exposing the public and students to astronomy and space flight."

For Reiff, seeing the number children who have benefited from the technology has also been gratifying. She

now estimates that 70,000 children every year in Houston alone experience their shows in portable domes, which are often set up in school gyms. Educational outreach of that magnitude, she says, is made possible by affordability. "The average cost per child is a dollar and a half," notes Reiff, "and children don't have to miss their other classes or free lunches or get permission slips, and they don't have to pay for big buses, which also reduces the school's carbon footprint. Those are all things that I love about what we've been able to accomplish."

MTPE continues to improve its product line in many ways, such as using technology that allows mirrors to reflect images for the dome instead of the more expensive fisheye lenses. The catalogue of shows also continues to expand. One of them is *We Choose Space!*, which is funded by another NASA education program and includes images taken on the International Space Station with the company's lens. The latest show produced under the program, *The Great Planet Adventures*, allows visitors to experience living in low gravity on the various bodies of the solar system. For those who can't make it to a dome viewing, all the shows may be watched free on the ePlanetarium YouTube channel. Scripts, posters and activities are also available for download at no charge from the website.

Part of what keeps Reiff inspired and on the cutting edge of innovation can be explained through a personal story. As a seven-year-old Brownie scout, Reiff went on a father-daughter trip to the Oklahoma City Planetarium, where she became hooked on the stars immediately. "I've always appreciated how that planetarium opened my eyes to the rest of the universe," she says, "and that's one of the reasons why I've always wanted to give back to planetariums things that they can use to help inspire future generations of scientists." ❖

The Great Planet Adventures is a new program available for use on Discovery Dome. The program shows viewers what it would be like to explore planets that have low gravities.