SECTION FOUR

Planetarium Education and Training

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The Current Role of Planetariums in Astronomy Education

By William A.Gutsch, Jr.[1] & James. G. Manning[2]

[1]The American Museum-Hayden Planetarium, New York, USA
The Interntional Planetarium Society

[2]The Taylor Planetarium, Museum of the Rockies, Bozeman, Montana, USA

For decades, planetariums have been created to serve the cause of astronomical enlightenment – to offer people knowledge and understanding and a sense of place in a universe far bigger than themselves. It is an important role and one that we in planetariums continue to play – changing, we hope, as times, technology, educational philosophies, *and our view of the universe change.*

The first projection planetarium was demonstrated by the Zeiss Optical Company at the Deutsches Museum in Munich, Germany in 1923. By 1970, the height of the Apollo moon program, there were an estimated 700 to 800 planetariums in the world, half of them less than six years old. Today, 26 years later, that number has more than doubled to a little over 2,000.

The world organization of the planetarium profession is the International Planetarium Society with over 600 members in more than 30 countries. Based on figures compiled in the 1995 IPS Directory, we find that slightly more than half of the world's planetariums are located in North America, with large numbers also in Asia and Europe, but relatively few in other parts of the world. If we consider distribution by country, we find that half are in the United States, more than 300 are in Japan, and Germany ranks third with nearly 100. Nineteen countries have ten or more planetariums.

Some 33 percent of the worlds' planetariums are located in primary or secondary schools; 17 percent are at colleges and universities; 15 percent are part of museums and science centers; 7 percent are associated with observatories or other institutions. The settings of the remaining 27 percent are somewhat uncertain because of their location in parts of the world where communication is still conducted with some difficulty.

The heart of planetarium theaters is still the star projector. These devices range from the familiar dumbbell shape of the German made Zeiss, to inverse dumbbells like those fabricated by Tokyo-based Goto Optical Mafg., Co. to spherical or ellipsoidal models made by German, Japanese and American firms, to digital video projection systems known as Digistar and supplied by the Salt Lake City based firm Evans & Sutherland. Planetarium theaters vary from horizontal floored facilities to those with significant pitch. Some planetariums provide intimate settings while others have seating capacities of over 500. In addition, hundreds of portable planetariums such as Starlab operate around the world and provide astronomy education experiences in schools, auditoriums, shopping centers, and remote locations.

It is estimated that over 55 million people worldwide currently visit planetariums each year. Thus, planetariums represent one of the largest and most visible avenues for presenting astronomy and related subjects to the public. And this, in turn, gives planetariums an enormous potential and responsibility for supporting both formal and informal astronomy education.

Planetariums are well known for reproducing the naked eye sky as seen from any place on earth as well as demonstrating, in time-lapse fashion, many of the cycles of the heavens from simple diurnal rotation to the retrograde loops of the outer planets. But planetari-

ums also can create numerous other environments that encompass the audience, bringing them into the experience in a way that classrooms, books, television or the computer screen cannot. They can combine and effectively use audiovisual technology to help create these experiences. And they possess tremendous flexibility in how these audiovisual resources can be used. Indeed, many modern planetariums are utilizing exciting new equipment on the cutting edge of revolutions in multimedia storage, computer control and display to go well beyond the old lecture format of past planetarium experiences. Today, more than ever, the planetarium can truly reflect the exciting spectrum of astronomical discovery and take audiences on journey's from the turbulent atmospheres of *other planets to the event horizons of black holes.*

First and foremost, we strive to educate, in ways ranging from curriculum-based school lessons to popular-level programs. We also strive to enlighten for we want people not just to know but to understand and to incorporate this understanding in their lives. And yes, many of us also try to entertain–an endeavor based on the sound pedagogical principle that people simply learn and remember more when they are emotionally engaged in the subject matter. And not least, we strive to inspire. Our time with people is brief, and it is perhaps less important that someone remembers the diameter of Jupiter, than that he or she remembers Jupiter as an exciting and dynamic world that, in turn, can give us greater insight into our own. Such a person is also more likely to leave the planetarium to read more in a book, enroll in a class or come to an observatory open house.

In setting these goals, planetariums operate in all three realms of learning: in the thought-processing cognitive realm; increasingly in the psychomotor area, as we offer more interactive experiences involving physical action; and, as noted, we also operate in the affective domain, the realm of feelings, as we encourage greater appreciation and enjoyment of the universe around us and try to cultivate a sense of the adventure of science.

Public "Sky Shows"continues to be a major offering of many planetariums. They are offered in a variety of forms, from the traditional live-narrated current-sky program to automated, multimedia presentations on popular space-related topics. Most planetariums also present educational programs specifically designed for particular school grades to meet science curriculum objectives. Where possible and appropriate, we often create shows that relate to recent discoveries or current astronomy related news items. In this way, planetariums frequently serve as a respected and recognized source of scientific information in their areas and provide more in-depth coverage than can usually be given by the local or national news media. Most planetariums also present educational childrens programs specifically designed for different ages or grade levels. In places, cooperative efforts with popular television or motion picture companies have used character recognition to help make learning fun. Examples include works by one of the authors at New York's Hayden Planetarium in conjunction with the Children's Television Workshop and Lucasfilm Ltd.

Supporting our efforts are improving technologies. The new planetarium at the Forum Der Technik in Munich has a Zeiss Model VII projector, which uses fiber optics to create stars that look like true points of light. The Digistar computer graphics system allows the audience to travel through a variety of user generated and shared databases that can recreate the radio, infrared or X-ray sky as easily as the visible universe. Flights through the Yale Bright Star Catalog database, as well as galaxy data compiled by Geller, Huchra and others, are also easily accomplished.

Among the planetariums utilizing digital projection technology is the London facility which recently reopened after extensive renovations. Whenever possible, planetariums

are updating themselves with new technology to better meet their goals and serve their public.

Computer systems are increasingly in use in planetariums today, both to control the planetarium projector and to automate auxiliary effects in programs. Video projection, pioneered by such planetariums as the one in Armagh, Northern Ireland is becoming an audiovisual staple. Some planetariums now have access to Silicon Graphics and comparable workstations for creating sophisticated video animation sequences for their programs and for distribution to other facilities. Most significantly, several companies in the U.S. and Japan are now developing computer controlled, interactive video systems that cover the entire planetarium dome with integrated, full color raster scanned images – a development which will completely revolutionize both the capabilities of the planetarium and the "look" of its shows. The line between what motion picture companies and planetariums can create and present is rapidly beginning to grey.

Advances in laser projection systems now allow for the creation of dynamic special effects from displays of the aurora, to solar flares to planetary magnetospheres. Jack Dunn at the Mueller Planetarium in Lincoln, Nebraska, has developed a program for people with visual impairments such as retinitis pigmentosa. Using the intense light of lasers to create star fields, he has given them back the night sky they thought they had lost forever.

Planetariums such as the Hansen Planetarium in Salt Lake City, the Buhl in Pittsburgh, and the Munich Planetarium have installed responder devices attached to each seat which allow the audience to vote on a choice of space destinations or topics within a program, respond to questions and even "fly" the planetarium theater as a kind of "spaceship of the mind".

Hands-on experiences are manifesting themselves in more traditional ways as well, especially in school programming. The Holt Planetarium at the Lawrence Hall of Science in Berkeley, California, has been a pioneer in interactive programming; its activity guide series called PASS (Planetarium Activities for Student Success), created by Alan Friedman, Alan Gould and others is currently being translated into Japanese for use in that country's many planetariums. Among its myriad activities are lessons involving the identification of features on the moon and the use of models to demonstrate the moon's phases.

Sheldon Schafer at the Lakewood Museum Planetarium in Peoria, Illinois, creates mysteries in which the time of the crime and the culprit can be determined by knowing when and where certain constellations appear in the sky. At the Suginami Science Education Center in Tokyo, Shoichi Itoh engages students in discovery through lessons in which they photograph the planetarium star field, create planetariums of their own, and find the constellations on their own using star maps.

Jeanne Bishop at the Westlake Schools Planetarium in Westlake, Ohio, reports that several Cleveland area planetariums are outfitting a Mobile Observatory with telescopes and computers for use by students; Jeanne plans to have some of her astronomy students prepare and conduct interactive lessons for elementary students using this equipment. And the staff at the U.S. Air Force Academy Planetarium uses its facility extensively for hands-on lessons of a special kind: Air Force cadet training in topics ranging from aeronautics to survival skills using a compass and the planetarium sky.

While our primary focus in most planetarium programs remains the physical aspects of modern astronomy, our fascination with the heavens in other ways can also be celebrated in the unique space that is the planetarium theater. Musical concerts, poetry under the stars, and live theatrical performance are periodic additions to many planetarium's schedules. At the Taylor Planetarium in Bozeman, Montana, one of the authors

has hosted storyteller Lynn Moroney in a performance of Native American sky legends under the stars. And at New York's Hayden Planetarium, the other has produced live performances of African songs, dances, and sky stories.

But the efforts of planetariums extend to more than just the star theater. Astronomy classes, seminars, and workshops regularly combine classroom, planetarium, and outdoor learning at many of our facilities. Teacher workshops offer in-service training and resource materials to teachers of all grades.

Many planetariums have telescopes associated with their facilities even in the heart of major cities and offer regular observing programs. During the day, they show people the sun and/or project white light and hydrogen alpha images or the solar spectrum. At night, the planets or deep sky objects are introduced and special events such as eclipses or the occasional bright comet receive special attention.

At the Buhl Planetarium at the Carnegie Science Center in Pittsburgh, Martin Ratcliffe uses the Internet to link students with the Mount Wilson Observatory in California, letting them control one of the telescopes there and engage in research projects.

This past winter, planetariums in the U.S., Europe and Japan teamed with research scientists via television and the Internet to give students a real sense of the adventure of doing science. An American teacher and a high school student flew aboard the Kuiper Airbourne Observatory while students in schools and planetariums were linked to them and scientists during two observing runs. Students at Chicago's Adler Planetarium even got to control the KAO's infrared telescope via computer from the ground. In the late winter and spring, students in several countries were awarded three orbits on the Hubble Space Telescope. They got to choose their targets (in this case, Neptune and Pluto) and, assisted by Heidi Hammel of MIT and Marc Buie of the Lowell Observatory, got to see their images come down on live TV. They also got to process these images on the Internet and confer with Marc and Heidi on the results. A similar project, in conjunction with the Pathfinder and Global Surveyor missions to Mars, is now getting underway.

Planetarium efforts also extend to exhibits. For example, in the summer of 1994, The Museum of the Rockies curated an exhibit called "Pioneering Space", built around NASA scale models and chronicling the history of the U.S. manned space program. A few steps away, people could see a complementary program called "The Final Frontier"in the planetarium. Many planetariums have extensive exhibitions to solidify the astronomy experience–including those in London, Madrid, Los Angeles, Chicago and Hong Kong.

The Lakeview Museum Planetarium in Peoria has developed a scale model of the solar system that won it a place in the Guinness Book of World Records. The planetarium dome represents the sun, and scale models of the planets are placed at locations throughout the city and beyond–with Pluto 40 miles away! Each July, the museum sponsors a bicycle ride from the sun to the planets. Where else can you visit all of the planets in a single day and, in relative terms, even peddle faster than the speed of light!

In this paper, we have attempted to give a brief overview of some of the exciting and valuable contributions planetariums are making to astronomy education. Being limited by time, we have been able to chose only a few examples from the multitude of activities going on in planetariums around the world. In the future, our on-the-job limitations, as always, will be time and money. But we will continue to strive to maintain the bridge between the research community and the general public and use the tools available to tell the exciting saga of our efforts to understand this amazing universe in which we live.