Planetarium

A Challenge for Educators

UNITED NATIONS

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Office for Outer Space Affairs

Planetarium
A Challenge for Educators

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FOREWORD

1992 has been designated as International Space Year by a wide variety of national and international space organizations, including the United Nations. The activities being undertaken for International Space Year focus on three major areas: (1) monitoring the global environment and the resources of the Earth; (2) education in space science, technology and applications; and (3) public information and education relating to space activities and their benefits. A goal of the international cooperative efforts of International Space Year, and the major emphasis of United Nations efforts, is to encourage all countries, and particularly developing countries, to participate in space-related activities and to broaden the appreciation of the importance of space activities for economic, social and cultural development.

While most space activities, including those of the United Nations, have focused on the applications of space technology for economic development, space science also makes an important contribution to social, cultural and intellectual development, which are inseparable from economic development in the long run. The study of the mysteries of the heavens has always played a central role in stimulating the human imagination, provoking questions about our relationship to the Universe around us, and inspiring people to improve and enrich their lives. Today, the space-age view of the Earth as one small fragile planet in the vast Universe of planets, stars and galaxies dramatizes our contemporary concerns with protecting our world from the destructive forces that now threaten it.

As educational institutions designed for a broad public of all ages, planetariums can make an important contribution to the study and appreciation of the Universe around us, particularly in urban society where we are increasingly cut off from a clear view of the night sky. To help generate interest and support for planetariums as centres for culture and education, the United Nations, as part of its International Space Year activities, is publishing this guidebook on the Planetarium: A Challenge for Educators. While many major cities already have planetariums, most people in the world do not have ready access to such institutions. In this publication, the experience of people in the establishment and development of existing planetariums has been assembled in order to encourage and guide the establishment of planetariums for those who do not yet have access to these important cultural and educational facilities.

Office for Outer Space Affairs
United Nations

PART ONE

INTRODUCTION

1

WHAT IS A PLANETARIUM AND WHY ARE PLANETARIUMS IMPORTANT?

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"In an era when the light-saturated skies of our cities have transformed the stars into an endangered species, the beauty and mystery of the night sky is preserved upon the domes of the world's planetaria. Because I have heard audiences spontaneously applaud those artificial stars again and again, I am certain that the planetarium is more important and more valuable now than ever. For thousands of years–probably tens of thousands of years–we have been inspired and beckoned by the stars. They give us the gift of perspective. Although there is no substitute for the real thing, the planetarium reminds us all-older generations and younger generations–how important it is for us to escape the desert our cities have made of the sky and how necessary it is to see with our own eyes the wonders of the night. The growth of our knowledge and the expansion of our spirit depend on it."

Edwin C. Krupp, Griffith Observatory, Los Angeles

We are citizens all of a single planet. We live on the shores of this tiny world, the third planet of nine, circling an average star, the Sun. This star is just one among billions in a great city of stars, the Milky Way, itself just one among a billion other stellar cities stretching on perhaps forever. This Universe, more vast than all our imagining, and filled with wonders more than we can dream, is a heritage for all mankind. A planetarium is a theatre that brings the awe and wonder of the Universe to its citizens.

And, perhaps, the greatest wonder is that we are thinking stardust. For the atoms of our bodies, our clothing, the places where we live, and all we own and share, and the atoms of our planet - all were made in the stars. A planetarium is a theatre that brings to men and women, to parents and children, the marvels of the Universe that gave them birth.

But the Universe is more than just a distant wonder; it gives to every human the gift of the starry nighttime sky. This gift is free to all, except when veiled by clouds or masked by human lights. It is an environmental treasure that can be shared by all peoples and hoarded by none. A planetarium is a theatre that shows and shares this common treasure.

Peoples in every land and continent have reached for the stars and sky in monument and myth. Rings of stone point sunward in many lands from Canada to Kenya. Ancient buildings of stone align with the sky worldwide from Mexico and Peru to Kampuchea and China. First peoples around the world, from the Andes to the Arctic, from the Pacific Islands to all of Asia, from Australia to Africa, embraced the sky in legend and myth. African Bushmen saw the Milky Way as the backbone of night and to the Inca it was a river of light and life. Planetariums are theatres that can preserve this cultural heritage unique to every nation and retell the ancient stories beside the modern science. Planetariums are centres of science education. They can teach the inspiring wonders of the Universe and the simple beauty of the sky we share. They can teach people the world over the cycles of their sky and introduce them to the sky they will see their whole lives. They can interpret the latest astronomical discoveries and bring to all people a fresh understanding of the Universe. They can inspire men and women to contemplate thier own place in the Universe and to consider how the Universe and mankind may be related. A planetarium is a place to learn and a place to think and question freely in the many realms of science. Many young people are drawn to a career in science or technology by an early interest in astronomy and space. The astronomical community has natural links with planetariums and science museums. Astronomically-trained, scientifically literate individuals populate the staff of most these institutions, and some are managed by professional astronomers. Many Planetariums are associated with science museums, a natural partnership, and a majority of planetariums are part of a college or university or a public school system.

Planetariums range in scale from large elaborate multimedia theatres seating several hundred people to small inflatable, portable domes with room for fewer than thirty individuals. Even though large metropolitan planetariums are the best known, the majority of planetariums even in the United States are small, modestly equipped facilities run by one person. The most important component of any planetarium is the educational vision of the director.

Planetarium personnel worldwide associate in the International Planetarium Society with members on every continent. Planetariums in North America and Western Europe are also associated into several regional affiliates of the International Planetarium Society. These organizations are described elsewhere in this book. Planetarians tend to be very sharing, helpful people who readily cooperate with each other.

In the major sections of this book, a modern planetarium and its programmes are described through the use of carefully selected reprints of articles from the literature. Though their coverage is by no means complete, they give a good sense of the physical facilities and especially the educational mission of a planetarium today. The concepts set forth here can be applied to planetariums both small and large or as the first step in shaping a new or proposed planetarium.

The majority of the world's planetariums are in the United States, Western Europe, and Japan. It is our hope that planetariums will be established in many other nations as well. This book has been produced to help inspire progress toward that goal. New planetariums can be large state-of-the-art space theatres, less elaborate teaching facilities, or small inflatable domes. Which of these is appropriate for a particular facility depends on the goals established for the facility and on the available finances.

We strongly emphasize that anyone considering planetarium work or development should join the International Planetarium Society and make contact with existing planetariums. These are essential steps in developing one's concept of the planetarium in a practical way and in preparing one to oversee the establishment of a planetarium.

A list of addresses is provided in this book for those who wish to make contact with the international planetarium community. The International Planetarium Society publishes a complete worldwide planetarium directory. Recommendations from planetarians and information in the International Planetarium Society's journal The Planetarian and elsewhere can then lead to contact with vendors of domes, star projectors, audio-visual systems, and other planetarium equipment.

A list of references for further reading is also included to provide the reader with entry points to the planetarium literature.

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ROLE AND VALUE OF THE PLANETARIUM

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Because every planetarium will serve a population with a particular nature, specific goals will vary among planetariums. Even before a planetarium building is designed and the instrument and other equipment are purchased, a directing person or group should clearly identify those specific goals.

A long-running dialogue exists in the planetarium profession about whether education or entertainment is the top priority of planetariums. This issue arises primarily for museum or science centre facilities, since education is acknowledged as the primary goal in pre-college and university planetariums.

It is my view that the staff of museum and science centre planetariums, as well as planetariums in schools, should also regard themselves as educators. I like the term "planetarium communicator" for anyone having a role in directing, planning, and presenting programs. In our profession we seek to communicate so much: the joy and spirit of astronomy, astronomical facts and concepts, and astronomy's connections with a wide range of disciplines: physics, chemistry, biology, psychology, mathematics, geography, history, literature, and art. While communicating these ideas, entertainment should not be ignored. The best visual, auditory, and audience participation effects available to a particular staff should be chosen to make the communication process a memorable and enjoyable experience. Lasting learning and desire for more learning occurs when experiences are enjoyed. However, high-technology special effects should not substitute for active experiences–pencil-paper activities, hypothesis-testing, and interaction between audiences and planetarium communicators.

As a second area of importance, I think that it is the responsibility of every planetarium to be accurate in its presentations. Giving a reversed presentation of day-and-night, westward sun or moon motion along the ecliptic, an eclipse in which either the full moon (lunar) or new moon (solar) move westward on the dome, or slides that are inverted and/or backwards–such things are inexcusable. They can initiate wrong ideas and perpetuate the wrong ideas held by many people.

I also think that a planetarium should assume the responsibility to oppose so-called "pseudoscience", including astrology, reports that aliens from space have visited the Earth and built large structures, mind-reading, and fortune-telling. The forms which this opposition can take may vary from outright position statements from the planetarium and the area scientific community to a presentation of the pseudoscience and a logical degradation of its position.

Cultural mythology is a different situation. In cultures emerging from strong beliefs in mythological explanations of natural phenomena, planetariums should proceed with care in showing how science explains these phenomena. A difficult process of accommodation must occur in those brought up to believe the mythological explanation. For optimum learning and understanding, the planetarium communicator must be sensitive to this mental process. I recommend that planetarium communicators working with audiences with strong culture-based mythological backgrounds show sincere respect for this heritage, noting that the stories will always form a beautiful and important part of that particular culture. Then the planetarium presentation can gently proceed to replace the mythological belief by revealing inconsistencies with what can be observed.

As my third main point, the most significant aspect of the planetarium communication process is the group of people who are planning and presenting the programs. The value of the planetarium's offerings, regardless of the size and technical level of the facility, is highly dependent upon these individuals. Therefore those hired as planetarium directors, planners, and presenters should have skills that make them effective planetarium communicators. I have done research that has identified the following individual characteristics as both important and trainable: knowledge of astronomy and related sciences; an ability to coordinate instrument operation with narration; an ability to plan programs; an understanding of the scientific method; and a respect for accuracy.

In the same study, I found these characteristics of planetarium communicators important but nontrainable: clear and pleasant speaking voice; ability to explain things clearly; ability to write well; scientific aptitude; mechanical aptitude; enthusiasm, dedication, and interest; creativity and imagination; flexibility; and humility. Further, a planetarium communicator should have some understanding of the psychology of how people learn, including developmental learning levels of children, if a planetarium will be serving young people. Former experience as a classroom teacher is particularly worthwhile in individuals giving school lessons.

Job descriptions of individual planetarium communicators can vary widely, as type of institution, population served, and staff size, direct. But a person with abilities and enthusiasm should be given freedom within appropriate guidelines to help develop the total planetarium's programme to its maximum potential. Each planetarium communicator should find his or her job interesting and challenging for, after all, what can be more rewarding than knowing that you help translate the truths and mysteries of the Universe?

PART TWO

THE CONCEPT OF A PLANETARIUM

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THE DEVELOPMENT TRIANGLE

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Over the past two years I have been involved in providing information for new planetariums under development, and I have been amazed at how much misinformation seems to be out there. There are, of course, the obvious misconceptions which can be easily corrected–the man who wanted to install the Spitz A3P in his car, the man who wanted to know how much the Cinema 360 laser system cost, and the lady who was inquiring which planetarium projector showed the IMAX movies. Of greater concern is that some misconceptions are carried forward into the actual developmental stages of a planetarium. These are the misconceptions that can create something I call "The Development Triangle". What is the development triangle? It is a breakdown in the communications between the administrators of a proposed facility, its consultants, and the vendors of the equipment that will ultimately complete the planetarium.

Some museum director, college president, or city official decides that he or she is going to build a planetarium. He gets an opinion from somewhere about how to proceed, and it's full speed ahead. He develops a prejudice from early on about what the planetarium is to be, how much it will cost, what it will look like, how it will be staffed (if at all) and, well, you can envision the rest. The basic difficulties seem to be the lack of knowledge of what a planetarium is, what the technological options for planetariums are, what realistic funding levels for constructions and operation are, and, probably most importantly, what its staff size, and the staff's relationship to the production efforts, should be.

So, you may say, tell us something we don't know. There are problems, but what do we do about them? I'll suggest there may well be something we can do about it–something that will create an improvement in what we see being developed as the facilities of the future.

One suggestion is create a document sanctioned by the International Planetarium Society–a process document, a "how- to" in planetarium development. A committee would be given the task of deciding what this document should contain. Then, if a prospective facility were proposed, at least some guidelines could be provided. What should the document contain? One way to decide what information to put into such a document would be to survey the planetariums that have been developed in the last two years to see what kinds of problems are related to the development question. Several difficulties are clear, however, and these seem to indicate these definite guidelines on what such a document should contain:

A. Instructions on developing a statement of purpose for the new facility. What is this new facility to be, what is it to accomplish for its parent organization, at what cost, and how is it to be staffed to get this accomplished?

B. Instructions on the selection of a consultant or consultants for the facility, someone who will represent the interests of the organization, not the interests of the consultant or a particular vendor, or at least will not under any circumstances consult on items they do represent. The consultant should study the statement of purpose and discuss budget and staff size, while creating a schedule of visitations that will clearly support the purpose and will most educate the proposer as to options and equipment. Any person, consultants included, brings to a project a personal prejudice, but he must divorce himself from this. The primary responsibility of a consultant is to provide a series of educational opportunities for the clients, allowing them to make their own choices while making sure that critical mistakes are not made. The consultant should provide specific output in the form of reports that indicate the progress and the conclusions that are being reached.

C. A director must be hired at the early stages of development. If a planetarium is to have a particular configuration, why shouldn't it at least have the configuration that most nearly reflects the personnel that will use it? Staff considerations are some of the most difficult considerations, and the director should be available to make those decision.

D. The architect must be chosen and a design plan started which incorporates secondary consultation, if necessary, that will bring expertise to the specific design that has been chosen. There are some excellent resource people in our industry for a diverse series of planetarium designs.

E. The primary system vendors should be chosen prior to a commitment to a design plan. The largest justified complaint I hear from vendors is that no clear plan is defined to incorporate systems into the actual architectural design of the facility. This is not entirely true when it comes to the instrument, but is largely true when talking about automation systems, audio equipment, special effects projectors, video, film systems, laser equipment and the like. The selection process for these major systems should be undertaken by the director of the facility with consultation advice at an early stage in the building planning.

F. The document could contain a list of resources in alphabetical order. The resources should include instrument companies, dome companies, other categories of vendors, consultants, architects, and other resource specialists. It may be difficult to create this list without showing prejudice, and it may be difficult to keep an updated, accurate file. However, such a list would serve as an invaluable tool to developing planetariums.

It may be equally important to ask what this document should not contain. It should not, if possible, contain information that would stifle creativity in the creation of new facilities in architecture, technology, or staffing. It should, on the contrary, promote the kind of diversity and excellence which has always been a hallmark of our facilities and our profession.

The best source of information for a developing planetarium should and could be the International Planetarium Society. We are a group that collectively represents the ultimate resource in planetarium information. If we can create a document which will set aside individual and geographic prejudice, then we can help to create facilities that the future will be proud to accept. Will this then bridge the gap and create a sense of cooperation between administration, consultants, and vendors? Can it turn the potential Bermuda Triangle into a cooperation triangle? I honestly don't know, but I challenge us to give it a try.

Author's note: A group designated the "Planetarium Development Group" was formed within the International Planetarium Society and is currently working on a comprehensive development document. The current chairman, Ken Wilson of Universe Planetarium, says the document is nearing completion. He can be contacted at Science Museum of Virginia, 2500 West Broad Street, Richmond, VA 23220, USA.

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ON THE TEACHING OF ASTRONOMY IN A PLANETARIUM

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INTRODUCTION

A modern planetarium is a circular room with a light gray ceiling, shaped as a hemispheric dome. This acts as a projection screen and is either horizontal, in which case the spectator chairs are set in concentric circles, or tilted up to 30 degrees with unidirectional seating in the theater.

Many, in the largest facilities sometimes hundreds of, projectors are used in a planetarium. The most important of these is the so called planetarium projector. This can project up to thousands of stars, sun, moon, planets, usually also constellations and celestial coordinate grids onto the dome.

There are well over a thousand planetariums in operation in the world today. These can be found in one of two categories. Firstly, the large public planetarium with a typical dome diameter of 15-25 meters and seating over 200 persons. Secondly, the school planetarium, usually belonging to a college or a high school, having a dome between 5 and 10 meters and seating one or two classes. There is also a third type which has gained popularity during the last few years: The small, portable planetarium with a simple projector and a collapsible 2-5 m dome.

THE PLANETARIUM PROJECTOR

There are three types of projectors available today. The Zeiss and Spitz type projectors use separate projectors for planets, sun, moon, etc. In the Zeiss type projector the stars are projected through some 20 objectives, each covering a small part of the firmament. The Spitz type projector instead uses a star ball with pinholes and individual lenses for each star. By means of mechanical motion around three or four axes, daily latitude, and precessional motion can be achieved.

Zeiss type projectors are manufactured by Zeiss in Germany, and by Minolta and Goto in Japan. They come in sizes suitable for domes in sizes 6 to 25 meters.

Spitz type projectors are manufactured by Spitz in USA in models for domes 5-25 meters in diameter. There are several makers of small portable planetarium projectors with Starlab in USA being the market leader; these are all of the pinhole type.

The above mentioned projectors produce beautiful starry skies but are "oldfashioned" in the same way as modern cars are: Their basic construction dates many decades back. On the other hand, the third projector type is instead so modern that is has been successfully operating less than ten years.

This is the Digistar by Evans & Sutherland in the USA, which utilizes a small high resolution high intensity computer monitor, projected onto the dome by means of a fisheye lens system. The concept permits all kinds of motions including extended simulated travels in space and time.

OTHER PLANETARIUM EQUIPMENT

Auxiliary projectors are much used in planetarium shows: Ordinary slide projectors are aimed at different parts of the dome and found also in the smallest planetariums. Larger planetariums usually have six or twelve projectors (or six or twelve dissolve pairs) which together can fill the dome or the lower part of the dome with beautiful panorama scenes.

Especially the larger planetariums use many different so called special effect projectors in their shows. Some, like planet orreries (the orrery projects a "top view" of the solar system onto the dome), are manufactured by planetarium projector makers. Sky-Skan in USA makes several dozens of different projectors animating everything from rainbows, meteor showers and aurora borealis to rotating planets, galaxies, and black holes. Most special effect projectors are however built in-house from own or other planetarians' construction ideas. Video projection is also increasingly used in planetariums today.

A good audio system–the larger the planetarium, the more channels–is usually found in a modern planetarium. The number of planetariums that are fully automated is quickly increasing. In those, pre-recorded shows are run by computer.

Many large planetariums are also equipped to give other kinds of shows, usually more entertaining type than other educational type shows. There are two kinds of dome-filling movie systems, the expensive and truly amazing Canadian Omnimax and the much more affordable and still quite thrilling Cinema-360 from USA. There are several different producers of equipment for the quite spectacular laser shows in which high-power lasers draw intense pictures in red, green, and blue on the dome–typically accompanied by high-volume rock music.

PLANETARIUM PROGRAMS

The traditional planetarium, with a marvellous mechano-optical planetarium projector and not much else, was equipped to project a beautiful starry sky with planetary motions, etc. It was thus a perfect instrument for teaching pre-Copernican astronomy. A well-equipped planetarium is however much less limited in choice of subjects; there are in fact no limits at all but the imagination of the starmakers.

The planetarium thus offers the possibility of an ideal setting for all kinds of cosmic education. To my opinion, the most important task is to give the scientific concept of the universe to the general public, and to elementary and high school students. This concept includes the size and content of the observed universe, its creations, history and possible future; stellar development and the origins of the elements; the forces and rules that govern the universe; the development of the solar system, the earth, and life on earth; the loneliness and beauty of spaceship earth. Other good tasks are to help people find their way around on the firmament, present modern space research, give facts and speculations about life in space, and present the slow historic growth of knowledge out of ancient beliefs.

Somewhat less, but still important is teaching of astronomy to special groups: Amateur astronomers. University astronomy students. Teachers (in-service education). Ship and aircraft personnel (astronomic navigation).

As in all science education there is one great mistake the planetarium educator can make: To present her subject too uncritically. To use one's facility for promoting huge governmental spending on space exploration and exploitation (with possible military use) is, in my opinion, an example of programming that should not be found in any planetarium.

MAKING PROGRAMS

Planetarium shows can be more or less educational, more or less entertaining. A successful show should, of course both be entertaining and give the audience new insight. This applies to programs shown to a general audience as well as such made for specific groups like children of a certain age.

A planetarium show can be basically "live" or basically "canned". A live show features a lecturer ("starmaker") who runs the show. This is the only way to do participatory programs and is therefore preferred especially by school planetarians. A canned show is built around a pre-recorded audio tape with the projectors run automatically or manually. Such shows can be more elaborate than live shows. Full use of a large planetarium's technical resources is really not possible in another way. In such a place, virtually all shows are canned.

While the largest planetariums have a big enough staff to produce their own shows, many medium size facilities could make good use of ready-made programs. Unfortunately, there doesn't exist much standardization in the planetarium field A show made for one planetarium cannnot be used unchanged by another planetarium. (See however Petersen's article on recent efforts.)

In spite of this, planetarium show packages can be purchased from several sources like Hansen Planetarium and Strasenburgh Planetarium, both in USA. Even if such a show is far from ready to use, a typical package includes an audio tape, all slides needed, and a great deal of useful information like how to build the required special effect projects.

An interesting kind of live planetarium show is given once a week at Griffith Observatory, Los Angeles. Following a short introduction, the program is completely governed by audience questions. The lecturer uses the planetarium projector, a random access video disc equipment and video projection system, and a random access slide projector loaded with the latest news in order to be able to answer most questions. This is obviously a very demanding type of show, and most shows at Griffith are canned.

A good compromise between canned and live presentations can be to first show a canned program and afterwards have some time set aside for audience questions. Especially when giving programs to school groups, some kind of interaction between the children and the starmaker is much preferred.

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PHILOSOPHY AND DIRECTIONS IN PLANETARIUM PROGRAMMING

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INTRODUCTION

Planetariums serve several roles in their communities:

1. They are popularizers of astronomy and space science.

2. They support and enhance the teaching of astronomy and related subjects within the formal education system.

3. They provide a community resource for astronomical information.

Not all planetariums incorporate all of these roles or do so to the same degree.

Planetariums, as facilities, come in a variety of forms. At one extreme might be a space theater with its wide-format films. A major public facility would have a strong emphasis on public shows and school programming. A college or school facility would emphasize programming for the education system at some or all levels with some or no public programmes. At the other extreme would be the small portable planetariums with 100 per cent use for school activities.

POPULARIZERS OF ASTRONOMY

Others will speak more directly to school or course issues. The balance of this paper is directed to public programming, which is the primary means by which planetariums act as "popularizers of astronomy."

In many major facilities that emphasize public programmes, the trend is one of greater sophistication in presentation. This sophistication involves greater use of projection technology but more importantly a better knowledge of the audience and its needs, more effective development of show concepts, a good writing style, and high production values.

Such planetarium programming responds to what we perceive the audience is looking for or expecting. Good communications (and, good education as well) starts with knowing your audience. Audiences in many cases want to hear about and see the results of new discoveries, new theories, and current speculations. They respond less favourably to historical programmes and sky lore. We should not be surprised at this trend for what we are seeing is part of the cultural dimension of astronomy. Astronomy is perceived as new, futuristic, high-tech, etc., to such an extent that commercial advertising readily uses astronomy to sell products. Likewise, film and television raise in our audiences high expectations in visual presentation.

In short, if you are big, visible, and invite an audience to your facility at a significant fee, you had better be good at what you offer. In terms of astronomy content, you should not expect a lot of hard in-depth science. A public show in a planetarium is not a classroom nor does it speak to a homogeneous audience.

To become more effective popularizers of astronomy, planetariums need some or all of the following:

1. to have access to good, up-to-date information and materials;
2. to have good communication skills to interpret that information;
3. to know the needs and expectations of their audience;
4. to exploit and to use the knowledge of learning processes and new technologies of presentation;
5. staff that combines a good knowledge of astronomy, including concepts and processes, and good communications skills.

In these requirements planetariums share a common need with science museums and schools, and one wonders if the 80 per cent of astronomy majors who, it has been said, do not pursue a career in astronomy research or formal teaching, might be better served by an education that gives them the other skills with which to pursue these other careers.

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PLANETARIUM METHODS BASED ON THE RESEARCH OF JEAN PIAGET

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As planetarium interpreters we instruct elementary groups on such topics as why the sun shines, how to recognize constellations, and how to find directions, thinking that if we just explain it "right" the students cannot help but fully understand. After all, the planetarium provides visual supplement to our accurate explanations.

However, the in-depth research of the late psychologist Jean Piaget over half of a century indicates that understanding is a function of maturation level and that some topics basic to planetarium astronomy should not be introduced (if we teach for understanding) until these levels of potential comprehension are reached. If students are on the verge of changing level, certain things done in the planetarium could accelerate the transitions. The following ideas are based on Piaget's data and conclusions.

LEARNING LEVELS AND PLANETARIUM METHODS

What are some of the specific topics or techniques which should not be presented in the planetarium until appropriate levels have been reached? Piaget has learned that children up to about second grade practice transductive reasoning; i.e., for them one fact explains another. When a child, aged six, is asked, "Why does the sun stay up?" he replies: "Because it's bright" or, if slightly older, "Because it's daytime." If we try to explain to kindergarten-age children that the sun stays up for half of the time because the Earth rotates, most do not really understand. However, they may be able to repeat this as a "fact".

Until about age seven (second grade), most children are unable to organize their thoughts of time, motion, and space to correctly reconstruct a succession of perceived events. They are also unable to comprehend simultaneously moving objects which are advancing at different rates. Five and six-year-olds, shown the phases of the moon at half-week intervals during a synodic month, could not be expected to explain, identify, or draw a correct succession of moon phases. Nor can it be thought that children of this age will understand the simultaneous motions of the planets, even as they watch them in the planetarium sky. They will confuse distances moved with time intervals. If asked what happened after seeing this, they would reply that the planet which went farthest went for the longest time.

A definition, Piaget found, can first be comprehended as the child leaves the transductive (fused fact) stage at age seven or eight. The child is then more aware of relations between separate events. But definitions for children seven through twelve should be based on concrete experiences. Since Piaget found that students at this stage have the ability to define, order, and classify, planetarium programs and their follow-up activities should center about categorizing information and observations. Following a program about the organization of different types of bodies in space, for example, children could draw, write (including question worksheets as well as essays), or tell that the Earth is a planet, planets orbit the sun, the sun is a star, and many stars form a galaxy. Drawings of the sun at different times of day or moon phases at different times of the month during planetarium presentations or groupings constellations on the basis of a number of different characteristics, are other examples of appropriate activity. Children between second grade and junior high learn basic concepts mainly be inference, rather than by deductive logic. Planetarium methods which require deduction should be withheld until sixth or seventh grade. An example of what should not be done at second or third grade for average students: The class is shown the effect of rotation on the sky over an accelerated period of 24 hours and then asked which way the Earth turned. This experience would be valuable at about fifth or sixth grade to "ease" or promote students' transition to the deductive reasoning level.

Astronomical ideas are bound up with concepts of great distances and times. Piaget learned that until a student reaches about age eleven or twelve, his ideas of infinite space and time cannot develop. An average five-year-old (kindergarten age) can imagine to only a certain size and then no larger. The fourth grader accepts the concrete information of "93,000,000 miles," "100,000 light-years," and "a billion years," but to such a child an idea of "forever" or "going on without end" as indicated by the (improbable) steady-state theory of the origin of the universe would be nothing but words.

One of the first things most of us do at the beginning of an astronomy lesson in the planetarium is point out directions. But prior to about eighth grade, one is continuously developing a sense of direction. Elementary children may be confused easily. Even the more basic idea of horizontal and vertical based on the Earth's surface and gravity direction do not completely develop until about age nine. Not until about seventh grade do most students comprehend the correct relation of left or right, as dependent on the way one if facing. No wonder that students, even in sixth grade, have trouble understanding why east is on the left and west is on the right on activity sheets used for plotting the moons motion along the southern half of the dome! But since a number of these students are approaching the idea of relativity of right and left, this planetarium experience can precipitate the transition. Thus the planetarium has value for fundamental learning. One further extrapolation of Piaget's research to planetarium directions: Until age seven, a child who learns that a star is in a position to the right or left of another object will not recognize it when direction is changed relative to the way the child is facing. Thus if the child turns or the sky turns (diurnal motion or projector rotation to cause planetarium direction change), kindergarteners would not realize that the "Seven Sisters" constellation should still be to the right of Orion, as seen from the Northern Hemisphere.

RECOGNIZING CONSTELLATIONS

How about the ability to recognize constellations? Piaget finds that prior to age three, an age we usually do not admit to the planetarium, a child cannot distinguish closed shapes such as triangles, circles, and squares from one another. At age five the child can tell circles from rectangular shapes. He can distinguish among straight and curved lines, tell that angles are of different relative sizes, and explain relationships between sides of a figure. It is at this age that children generally begin using such words as "shorter" and "longer." At about age seven, the student further differentiates a six-pointed star from a hexagon and uses (although does not abstract) a fixed point of reference necessary for recognition and presentation of a geometrical figure. The implications of these findings for constellation study are: Prior to age five for most, it is meaningless to try to teach shapes of constellations. The child will not "see" it differently from other star groups. At about first grade, simple, different shapes can be investigated, which can be assisted by the use of projected line segments to indicate difference in side length and angle size. (The projected lines can be useful throughout the concrete stage of mental development–ages seven to twelve as well). At about third grade, the students can easily distinguish hexagons and crosses. The ability to recongize a complex pattern in a radically different orientation (e.g., invented) is evidently an advanced skill, since the author has noted that many adults (including planetarians!) have difficulty recognizing Scorpius at a latitude near the South Pole.

What are the implications of Piaget's research for drawing constellations while learning them? Until the ability to handle abstract ideas is reached in junior high, motor activity is extremely important for the understanding of spatial relations. Whenever possible, young children should physically re-create their perceptions. This includes drawing. Piaget found that at about age seven or eight, a child can copy a two-dimensional model (e.g., a group of stars in a limited area of the sky) but that he is unable to preserve correct distances between objects. At age nine to ten, the student can reproduce correct intervals between objects or points. Thus if third graders draw a constellation map, such as the Big and Little Dippers, the distances in most cases are greatly distorted. Therefore it would be wrong to use their maps as a basis for later outdoor recognition, but the motor learnings which occur during its construction are very helpful. A fifth-sixth grade student has developed a feeling of scale and proportion which permits the construction of a more accurate star map. A grid (two perpendicular line segments) on the paper and also projected against the planetarium sky, would be very helpful to student on this stage of development. Finally, between ages 11 and 13 (sixth and eighth grades), students become able to abstract a reference system (grid) to correctly position objects in a field. Constellation maps will gradually improve as children between grades two and eight gain experience through interaction with the real world.

VIEWPOINTS

Before age seven (second grade) most children do not have the idea of their having a particular space viewpoint, different from possible others. This is indicated by their inability to develop a sighting procedure with a string or table edge to determine straightness of a line. At about late third or early fourth grade for average-ability children, this ego-centrism is replaced by the ability to correct image things as seen from many different points in space. At this time the student becomes able to imagine looking down on himself on the rotating Earth from a position above. A second-grade program which requires or is supposed to result in a dual perspective of looking into the sky and looking back on Earth or solar system or Milky Way Galaxy is inappropriate.

Prior to the stage of abstract thinking at about thirteen (eighth) grade), students are incapable of combining different perspectives with another concept, such as motion. From about eighth grade onwards it should be possible to have students learn moon motion as perceived from Earth and other points in space. Also possible then is the dual understanding of Earth's revolution: a view of the sun moving along the ecliptic through the Zodiac related to a distant perspective of the Earth-sun system. High school and college students, as well as most adults attending public programs, are potentially ready for these dual perspectives involving motion.

The deductive method becomes desirable in science-oriented planetarium lessons beginning in about eighth grade. After gathering data on moon phase and motion, a student should be able to predict future positions of the moon. After gathering data on planet positions, students should be able to match Earth-based planetarium data with heliocentric aspects.

The study of astronomy contains many examples of projective geometry (the apparent shape and size of objects related to their orientation and distance). Between ages eight and eleven (third and sixth grades), students develop the ability to predict that the apparent shape of a tipped circle will be an ellipse. The reason for the elliptical appearance of the Andromeda Galaxy then can be comprehended. Also at about fourth grade, the perspective sense develops, so that these students can understand the reason for a radiant of a meteor shows. Not until about age twelve can students accurately coordinate shapes of shadows formed by different three-dimensional objects, place in different orientations between a light and a screen. Piaget's research indicates, therefore, that until about seventh grade, most students will not understand why the constant shape of the shadow of the Earth on the moon, as the full moon enters or leaves total eclipse, is a proof of the Earth's spherical shape. (I find it interesting that Carl Sagan, in The Cosmic Connection speaks of visiting a class in which a first-grader says, " saw an 'eclipse'. The shadow was round, it wasn't straight. So the Earth has to be round." As indicated by his other repeated comments from the class, the group had been coached or instructed. So perhaps the student was merely parroting.)

Piaget has pointed out that different children pass through the stages of the sequence of mental development at different times, which can be accelerated by physical or social experiences. This may indicate that individualized activities for each child, in some planetarium programs, are desirable. But since present demands of efficiency of planetarium utilization require that we give planetarium lessons to groups, usually the grade level, it is valuable to be aware that the average student at a particular level is potentially able to understand. School curricula should, of course, also reflect this awareness. Perhaps planetarium interpreters, aware of Piaget's findings, can be instrumental in guiding construction of the astronomy portions of the school science curriculum.

Planetariaum research projects hopefully will help to establish evidence that particular planetarium activities promote transition between levels of thinking.

LEARNING IN THE PLANETARIUM AT POTENTIAL COMPREHENSION LEVEL

Piaget identifies two equal-but-opposite stages of non-learning in which many students are found. In the first, the student is exposed to something he already knows in such a familiar way he is bored. In the second situation he confronted with something which may be fascinating to the teacher but which the student cannot relate to his experiences. The trick for motivation is a tension between the familiar and the strange. This calls for creative teaching, touching upon personal relevance whenever possible. Regardless of potential for understanding at any mental stage, a person is not apt to learn if this situation does not exist.

What are some methods which provide the needed tensional situations for learning? One technique recommended by Synectics Educational Systems is the method of presentation by analogy. Some examples often applied to astronomical content related in the planetarium are comparisons of (1) stages of star evolution to stages of human life; (2) constellation figures to connect- the-dot pictures; (3) a spiral galaxy to a pinwheel or a fried egg, depending on orientation; (4) the constellations that do not resemble their names to the U.S. State of Washington, which does not have boundaries producing the silhouette of the First American President George Washington; and, (5) the view of the sun moving along the ecliptic against the Zodiac constellations to the view of a campfire seen as you slowly walk counterclockwise around a group of friends sitting close to the fire.

Psychologists have found that a person cannnot consciously recall and verbalize an experience, even if beyond the stage at which introspection appears–age seven–unless it has some relevance to his outlook. This implies that methods which aim at involvement will more likely result in learning. Multidisciplinary use of the planetarium is therefore desirable. Topics of mathematics, English, social and life sciences, languages, and the arts can and have been coordinated by many with planetarium capability. Gestalt philosophy and psychology ("The whole is greater than the sum of its parts.") also predicts that a program of astronomical poetry coordinated with a views of the sky, or a presentation of circle-and-sphere applications of celestial navigation given to a geometry class which has just completed a unit on circles, will result in greater learning than a planetarium experience unrelated to topics studied elsewhere. (This, of course, implies that an effective planetarium programmer has a wide range of academic interests).

Mythology is very interesting to children and adults alike. Perhaps this is due to the great amount of self-reference found in all literature. One engages in reflection as characters and situations are described.

Another method of creative teaching which results in introspection and a feeling of relevancy is simulation. Role- playing techniques can aid the development of problem-solving skills as well as promote concept-and-fact learning. William Chronister has simulated an observatory situations in the planetarium with a class playing roles as astronomers, chief physicist, photometry expert, librarians, and observatory caretaker. Additional simulation situations of the present which might be tried in the planetarium are (1) a solar eclipse expedition; (2) a meteor-shower counting party; (3) an imagined month at a seaside location, relating tides and moon position; and (4) a "lost at sea" (or desert) situation with the possibility of perishing unless celestial navigation is used.

Role-playing might also be applied to situations of the past, such as (1) the A.D. 1054 supernova observation by the Chinese or different civilizations, reflecting the differences in cultural outlook applied to astronomy; (2) appearance of Halley's Comet at various points in history; and (3) the view of the sky by the Egyptians circa 3000 B.C., with the problem of aligning the pyramids.

Planetarium projections into possible conditions of the future provide a unique application of science fiction. Even when the audience is passive, science fiction contains human relevancy. Probably this helps to explain why it has been so popular. A situation in which student visitors take roles (such as the characters in the Black Cloud by Fred Holye) may provide even greater interest.

In addition to greater conceptual learning, which is created by these tension-causing, relevancy techniques, there is opportunity present for greater affective learning. If groups enjoy the planetarium experience, they are more apt to return for additional programs. Role-playing situations can be the basis of discussion conducted in a class prior to, following, and perhaps even during the planetarium visit. Additionally, open-ended simulations in which students must solve problems, select and hold views, expand explain and defend decisions, provide learning which goes way beyond subject matter.

Although certain subject matter we judge as important today may become obsolete to the average citizen of tomorrow, the ability to solve problems, the ability to make decisions, and the acquisition of astronomy as an interest which may turn into a life-long leisure-time activity are possible outcomes of creative planetarium utilization for many of our visitors.

7

INNOVATIVE ASTRONOMY EDUCATION PROGRAMS FOR DEVELOPING COUNTRIES

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INTRODUCTION

It is desirable that planetariums in developing countries should make the maximum and most efficient use of the planetarium infrastructure and facilities to cover as much ground as possible in the popularization and dissemination of astronomy. After all, the number of planetariums in developing countries necessarily has to be small, and so specialization in specific fields becomes a luxury. In India, for example, there are about ten planetariums, and another five or six will come into operation in the next few years. But these planetariums have to cater to a large population. In the United States, which has a fraction of India's population, on the other hand, there are hundreds of planetariums. The following suggestions are based on successfully implemented projects at the B.M. Birla Planetarium, Hyderabad.

A golden rule for planetarium programmes anywhere, and certainly in developing countries, is to start a planetarium sky show or activity with a local flair. For example, the local names of stars and constellations, local myths, local astronomers or, more specifically, topics like the history of astronomy in the region should be highlighted.

PLANETARIUM SKY SHOWS

It is important for planetariums in developing countries in particular to choose the levels of their astronomical presentations (sky shows) carefully. These could be broadly classified as follows:

(a) Popular programmes for the lay public.
Such sky shows should have a minimum of subtle inputs.
The lay audiences in developing countries definitely prefer
a spectacle and a dramatic experience to a pedagogic presentation.

(b) Sky shows, preferably live and participatory in nature,
for school groups. It would be advisable to prepare them
in consultations with the relevant teachers. In any case a

dialogue with the teaching community is essential.

(c) More specialized, again preferably live, programmes for amateurs and astronomy students.

EDUCATIONAL AND AMATEUR ACTIVITIES

Educational activities should be spun around planetariums. It would be helpful if these planetariums also acquire mini/portable planetariums, and, of course, telescopes for such activities. At the B.M. Birla Planetarium, for example, a project entitled Astro School has caught the imagination of educators. In this programme, a set of school children is given a one-day exposure to all the excitement of astronomy through sky shows, exposure to a mini planetarium, illustrated lectures, computer graphics, astronomical games, science-fiction films, and whenever possible, sky observation sessions.

Planetariums in developing countries would also do well to organize informal astronomy courses for lay persons. At Hyderabad, the course is of a multi-media nature and lasts for three months, with two evening lectures per week. The course has generated so much enthusiasm that rejection of applicants is a major problem. The teaching community in schools, particularly in the rural areas, is in general scientifically impoverished and ill-equipped to teach astronomy or science itself while preserving the sense of excitement and discovery. So planetariums would render a service to the community by conducting two or three-day camps for science teachers from schools, particularly the rural schools. An important extension of this idea is camps of shorter duration, for example on selected Sundays, for the lay public. Such one-day camps using portable planetariums, for school students/teachers in the rural areas, would be a great boon for this less fortunate segment of society in the rural areas.

Regular lectures by interesting speakers, workshops–for example, on telescope making–and exhibition of astronomical and scientific films and videos should be a part of the culture of every planetarium. Such events are logically linked with the amateur astronomical activities that can build up around a planetarium.

It is interesting that at Hyderabad, where one of the only astronomy university departments in India has been functioning for nearly three decades, the first amateur astronomical association came into being shortly after the inauguration of the planetarium. The association was formed by a group of lay persons who attended a three-month multi-media astronomy course offered by the planetarium.

RESEARCH ACTIVITIES

Seminars on catchy topics organized by the planetariums not only give a boost to the interest in astronomy but also earn for the institution a lot of publicity. This has been the case in Hyderabad, where the B.M. Birla Planetarium has organized major seminars on Halley's Comet, Indian Astronomy and finally Ancient Astronomies. In fact, one of these seminars coincided with an equally important international seminar on a topic in theoretical physics. While the former got wide coverage in the press, the latter was almost totally ignored.

INFORMATION CENTRES

A planetarium would render its community a great service by organizing a research centre for the history of astronomy of the region. Even the planetarium-projector facility itself could be directly used, for example, in the dating of historical events by using relevant astronomical allusions.

Planetariums in developing countries should act as centres for dissemination of astronomy information. At Hyderabad, this is done through posters, press releases and educational films which are telecast over all the country. In this connection, an acute problem faced by planetariums in developing countries is the lack of immediate access to important astronomical-event information. People look to planetariums, and not university departments, for information. And it is of vital importance that there should be an agency on the lines of the IAU telegrams that can transmit–at a price, if necessary-such information preferably in layman's language, to planetariums.

The planetarium at Hyderabad for example receives even long- distance calls from people wanting to know whether and when a comet can be sighted and so on. So the importance of such an international information facility cannot be overemphasized.

Another sad problem faced by planetariums in developing countries is the lack of resources to meet the need for take-away literatures, audio tapes, video cassettes, planispheres, books, souvenirs, and so on. The problem is even more acute in a country like India with its import regulations.

LEADERSHIP

For developing countries, it is important that the established and successful planetariums should provide leadership for the new and also smaller planetariums. An acute problem in this context is the lack of trained personnel, for the simple reason that a planetarium culture is either non-existent or nearly so. With exactly this in mind, the B.M. Birla Planetarium, Hyderabad, has introduced a university-recognized post-graduate diploma in Planetarium Techniques and Management. This will, we hope, built up a cadre of planetarium directors and educators.

CONCLUSION

Lastly, it should be pointed out that the success of a planetarium depends to a great extent on its showmanship and marketing ability. In fact, this task is easier in the developing countries, where media coverage is much more accessible than in the advanced countries. An author once advised novices that they should break their necks to get into print. A good dictum for a planetarium would be that it should break its neck or whatever to remain in public view.

PART THREE

OUTLINE OF THE HISTORY OF PLANETARIA

8

"PLANETARIUMS, ± 25 YEARS"[1]

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The planetarium profession has been constantly evolving, ever since the production of the first projection planetarium instrument by the Carl Zeiss company nearly 70 years ago. On the occasion of the 25th anniversary of the Middle Atlantic Planetarium Society, I was invited to describe the major changes I saw in the planetarium field over the past 25 years, and to suggest the direction of changes over the next 25 years. I began by reviewing back issues of Sky & Telescope, and I dug out my copies of "Bauersfeld's Folly" – Tom Hamilton's blue ink, single spaced sheet with its great gossip of the planetarium profession.

In this essay I'll first try to describe what we thought the big issues were 25 years ago; then report on what actually happened. Then I will turn to the other side of my crystal ball and try to prognosticate. Please note it will not be fair to criticize these predictions until another 25 years have gone by.

The Planetarium Environment, circa 1965

Twenty-five years ago we were nearing the end of the "post- Sputnik" era. In October 1957 the Soviet Union had surprised everybody by launching Sputnik, the first artificial earth satellite, and science education in the United States became, overnight, vitally urgent for the survival of the West. We needed umpteen million more scientists, engineers, and mathematicians in order to survive the cold war.

There was a great push to produce more scientists, by expanding science education. Building more planetariums was a part of that push. The push lasted about a decade. Because by the 1970's, scientists were driving taxi cabs and griping that they were going to have to teach in junior colleges, and God forbid, even in high school. Somehow the need for scientists had been satisfied. (It was at that moment, by the way, that I finished graduate school.)

So our talk was turning, 25 years ago, to education for non-scientists. Even if we were, after all, going to have sufficient physicists and astronomers, perhaps everybody needed a little

[1]This essay was adapted from the Margaret Noble Address for the Middle Atlantic Planetarium Society's 25th Anniversary Meeting, May 4, 1990, at the Benedum Natural Science Theater, Olgebay, West Virginia. It was originally published in a slightly different version as a special insert in the Constellation, Vol. 24, No. 4 (1990), and in the Planetarian, Vol. 20, No. 1 (1991), 8-13.

astronomy in their lives. New courses were entitled "Physics for Poets." We were preaching interdisciplinary science. It wasn't just astronomy or physics, it was "earth science," and that could involve chemistry, biology, astronomy and everything else.

There was a new agency called NASA that had just started sending people up into space, and it was clear that planetariums were going to have to start dealing with pictures of men in funny looking deep sea diving outfits, only they were diving in space, not the ocean.

In schools and universities the big talk in education was making anything relevant. Remember when every course had to be relevant, had to have social utility?

How did planetarians address these cultural issues?

Big Planetariums: Special Effects, Music, and Drama

For the big planetariums the obvious answer to meet all the nation's needs was for every dome to have more slide projectors, more special effects, and more loud speakers, preferably distributed all over the dome. Projectors and loud speakers multiplied exponentially.

There were some more subtle answers as well. Planetarium shows did not have to be structured exactly like lectures any longer. Drama, multiple voices, and music could create emotional experiences to go along with the intellectual ones. These enrichments spread, and continue to flourish today.

An example. One of the most beautiful planetariums in the world is in Bombay, India. By 1980 the Nehru Planetarium had gone far beyond the programming style of its models, such as the planetarium in London. In London in 1980 you would still hear a lecture, naming every single constellation in tonight's sky, with a few slides from one projector on the side. At the Nehru Planetarium, a staff member came out dressed as Galileo, describing his amazement at what he saw when he first looked through his telescope at the planet Jupiter on a night in 1610.

Small Planetariums: Teacher-Proofing and POPS

How were small planetariums to respond to these changing needs of their constituents? Were they going to compete with the drama and special effects of the big domes? Indeed about the first thing everyone tried to do was to get more projectors and more special effects for their small planetariums. But there were other moves afoot.

One thing you heard about if you listened to talk about where small planetariums should go was automation. "Teacher-proof" automated small planetariums were being sold to New York City. You just wheel the device into the center of your room and hang this big umbrella over it. Invite your students in, turn on the tape, and come back in an hour when the lesson is done. You have finished your astronomy lesson for the day. These machines were not big hits with either teachers or students.

Some electronic devices seemed awfully intriguing. Consider a system available with the Spitz A4 projector. The A4 was a beautiful machine then and it still is a very beautiful machine today. But what was being talked about was a "student response system." Each student had several buttons on his chair. By asking the students to select one of those buttons to press, you could give an instant multiple choice test. An IBM Selectric typewriter would clack out for you a list of which button each child had pressed.

This system was a wonderful solution–the only problem was that nobody was sure what problem it solved. The system did not develop further. But new, reliable, small planetariums of high quality, like the Spitz A4, inspired more lasting experiments as well.

The experiments that I was most excited by were called "participatory oriented planetarium shows" (POPS for short). I don't know who first tried audience participation, but I happened to be in the Middle Atlantic Planetarium Society (MAPS) region when I was learning about the technique. One of the planetariums I visited was Charles Foell's in Warminister, Pennsylvania. There were no seats! There were a lot of colored lamps in the middle of the floor, and there were kids studying the effects of color mixing by mixing their shadows on the dome. Later they were trying to guess what colors a child was wearing, while looking at him bathed in entirely red light.

Middle Atlantic Planetarium Society members were certainly in the vanguard of the development of the POPS technique. The MAPS book Under Roof, Dome and Sky inspired a lot of us to begin using participatory programs. Here was something the big planetariums couldn't do as well as we could in our small domes. At the Lawrence Hall of Science in 1972 we started building a planetarium for the express purpose of doing participatory shows. So audience participation was one major way that small planetariums 25 years ago could begin to respond to the challenges of the post-Sputnik era.

The notion of having the audience do something, of stopping your show and waiting for them to do it, seemed to be diametrically opposed to the tape recordings, automation, loudspeakers and the special effects that were all the rage at the time. Many of us starting out then thought we were on a crusade to save small planetariums from the dangers of too many slide projectors and special effects. We have since learned that these techniques can be used together. I expect we have mellowed a bit and realized that the POPS technique is one of a variety of powerful techniques in a planetarian's repertory.

POPS techniques have survived and thrived, as have automation and slide projectors. One of my all-time favorite hands-on activities for both big domes and small has been giving all the visitors diffraction gratings and letting them identify the elements in an artificial star. I saw this participatory activity being done last year in a new planetarium in La Coruna, Spain. POPS has indeed become a standard feature of planetariums worldwide.

What We All Missed

So the talk of automation, drama, music, special effects, and POPS proved to forecast correctly the past 25 years. But what did we miss?

–Portable Planetariums

I cannot find any record in discussions 25 years ago of the serious potential for a portable planetarium. Yet today the portable planetarium has been a major revolution in the field. It has basically demystified the planetarium for thousands of teachers and hundreds of thousands of students. Many believe that nearly all good science teachers, given portable planetariums and a few days training, can become planetarium directors. The surprising thing is, they can.

Portable planetariums have literally spread around the world. Working under license, the Indians have now built 50 copies of a STARLAB Phil Sadler and I took over in 1982. At the New York Hall of Science we have 9 STARLABs we use for teacher training and rental.

Portable planetariums are one major direction we missed. We didn't imagine the powerful impact of making good equipment much cheaper and more portable, and especially of putting it in the hands of teachers, instead of just planetarium specialists.

–Show Packages

The idea of sharing programs was around in 1965, but I was surprised by the speed with which planetariums would gear up to use shows others developed. In 1965 it was mostly "Oh, send me your script and maybe later you'll loan me some slides to have copied." But now it is common to get an entire show package, with music, lots of slides, teacher guides, and even special effects. I don't think we appreciated how important these shared packages would become. The Hansen Planetarium, the Strasenburgh, and later companies like Loch Ness Productions now make excellent quality programs. The planetarium with a staff of one, part-time, can now run a state-of-the-art dramatic program, along with a POPS program and a traditional sky show.

–LASERIUM, OMNIMAX, and especially DIGISTAR

We also missed three big technologies: LASERIUM, OMNIMAX and DIGISTAR. The one that I believe is most important for the future of the planetarium is the DIGISTAR. The first one went in the Science Museum of Virginia. The quality of its stars were similar to balls of cotton fluff on a dimly-lit dome. But astronomy was no longer linked to the Earth-centered view. The conventional planetarium takes a Ptolemaic view of the universe. The DIGISTAR gave us a main projector with the ability to work with what astronomers have been doing for the past 200 years, which is astrophysics. The DIGISTAR sky has improved noticeably, and we're just starting to realize its potential, as the DIGISTAR and the family of instruments that I'm sure will be following it are developed.

Light shows like LASERIUM and all-sky film projectors like OMNIMAX are also major new technologies which came to fruition in the past 25 years. They were less concerned with astronomy than STARLAB or DIGISTAR, but they certainly found homes in our domed theaters. Both have had a significant impact that lasted a lot longer than many of us thought they would. And part of that impact has been to displace some astronomy programming in most of the domes they inhabit. More on this in a moment.

You now have my list of what happened to the planetarium field over the past 25 years, predicted and not predicted. Most of these developments, particularly well-produced shared shows, POPS, STARLAB, and DIGISTAR, are major achievements I believe we will continue to develop for the next 25 years.

OMNIMAX vs. Astronomy?

I have concerns, however, about other new technologies, particularly OMNIMAX. OMNIMAX is certainly an impressive projection system, with sensational images. But where it has been used in planetariums, one effect has been to displace some of the science programming in those theaters. Most of the OMNIMAX programs available to date are primarily travelogues. The only science I think much about when I see a typical OMNIMAX film is human biology. That's because when the inevitable airplane flies over the inevitable cliff, my stomach reminds me of the biological power of the visual image.

In an attempt to mitigate the displacement of astronomy and science education, many installations, like those at the Boston Museum of Science and the Cité des Sciences et de l'Industrie, have two domes: one devoted to OMNIMAX, and the other to a planetarium and science education. But the OMNIMAX is always the better advertised, better funded, and the better attended. One reason is that it usually makes money; planetariums usually lose money. Making money isn't the goal of museums, but it is a seductive pastime. Most visitors choose to pay for only one domed theater presentation, so they miss the planetarium experience entirely.

OMNIMAX is a medium that may well have enormous potential for science education, but today, even in the most "educational" of its films, OMNIMAX remains an activity with a temperature and a pace vastly different from that of the contemplative learner, or of the planetarium projector. If science education and not only entertainment are our goals, then we have two challenges: how to make the OMNIMAX work for science education, and how to restore astronomy to the dome, with an importance commensurate with its importance in the human endeavor.

Opportunities for the next 25 years

We are entering an age much different from the one in which planetariums were born. Many people in media believe that five seconds is the maximum attention span, and that hot, fast-cut images and sounds are necessary to engage an audience. We are a counter example, an activity in which people enjoy a slightly longer contemplation in, and of, time and space. We have the challenge of holding on to our special high ground in public and school presentations over the next 25 years. We can continue to develop the kinds of presentations that require and reward more visitor thought than is expected for a music video or a vicarious flight over a cliff.

I am especially optimistic about our potential for claiming (or reclaiming) a major education role. Once again this nation has discovered the schools are important; that we need scientists and engineers; that everybody needs to understand some science; and that our failure in meeting these needs is a national crisis.

There are important differences from the post-Sputnik era to keep in mind. In New York City, we are facing the retirement of 50% of the current teaching force by the year 2000. That means the loss of tens of thousands of our most experienced teachers, including almost all of the science teachers who were stimulated to excel by the post-Sputnik era. So we have a problem in science teaching which is even worse than it was then. Going for us, however, is a clearer recognition of the problem than we had in the 1950's. We understand that beating the Russians in missile building is not the only reason to teach science.

Also in our favor is that the cold war is no longer around to sap the funds we need to solve problems. There's no Vietnam war building up, we all hope. There are other needs – fighting AIDS, building housing, bailing out savings and loan incompetence. Yet there are still lots of resources in this rich country for education.

We have fewer delusions than we had 25 years ago. Twenty five years ago many believed that the computer, automation, and programmed learning were going to solve most problems in education. We now know that those are nice tools but they are insufficient. We also understand now that training in pedagogy and group dynamics is not enough to turn out a science teacher; we need plenty of preparation in real physics, astronomy, biology, chemistry, and math, as well.

In the 1960's we were asking questions like "what is ideally the best way to teach constellations? Is it tape? Is it live? Is it participatory?" Now we know that we were not asking precisely the question we needed to answer. The crucial question is "what works?" There is probably no universal "best." What we need are a variety of techniques which simply work, in real situations.

I predict we have coming up the strongest opportunities for accomplishment in the history of the planetarium medium. In the next decade we can become very major players in the world of the 21st-century science education.

The Special Qualifications of Planetarium Educators

Those of us in planetariums can reclaim our special science teaching role. There is a desperation in our country for examples of consistent competence in science teaching. And planetarium educators are prime examples of consistent competence over 25 years or more.

Planetarium educators know the fundamentals of astronomy solidly and keep up with it through Sky and Telescope and Mercury. We have work benches and are not terrified of technology. We present things in our planetariums in a way students and teachers want to experience. And we want to keep doing what we do so well. These are characteristics which are perceived to be, and to a sad extent are, lacking in many of the people who are trying to teach science today, especially at the elementary level.

We can make planetariums a locus for science teaching in the schools. We can readily adopt teaching concepts like project STAR and the curriculum guidelines being produced by Project 2061. Then we can announce: we are ready to present the best contemporary curricula, and we are ready to help other teachers use this material. We are ready to accept part of the responsibility for creating that 50% of teacher force that must be renewed in the next ten years.

We're locally based – we're in schools, museums, and colleges, in every state. We have a wonderful network of organizations – like MAPS – which knows how to share materials. So give us the necessary funding, responsibility, and accountability, and we'll start quality programs going in the majority of school districts in the United States. No other group of educators is as well positioned as we are to make that offer.

Are we ready? We'll need to screw our courage to the sticking point; but the opportunity is here, now.

Technologies Coming on Line

We are going to be the first educational institutions with a new generation of computer assisted technologies. We'll have CCD programmable telescopes, small DIGISTAR projectors, videos made on DIGISTAR and on supercomputers. We can quickly use these aids in planetariums, including portable planetariums. The planetarium can become a distribution and training center in the use of this equipment and software. We learned in the 60's that packaging and continuing training and service were just as important as a curriculum itself in determining whether or not new material would be used beyond the first years of excitement. Planetariums and planetarians are ready to do that packaging, training, and service.

We will be able offer our visitors experiences in a new kind of exhibit, a "cosmology simulator. You walk into a room that looks like the cockpit of a spaceship. There are computer display windows showing stars, planets, and other spaceships all around you. You have controls for speeding up, for slowing down, and for steering. But before you can start traveling, you must choose your cosmology! Do you want to fly around a universe that goes by Aristotle's rules, or Newton's, or Einstein's? The resulting voyages will be astonishingly different.

I also think a new computer technology called "virtual reality" will let us make a "personal planetarium." You put on a special helmet and gloves. Each of your eyes is looking into a small video screen. All of a sudden you are no longer at a planetarium; you are in orbit around the planet Earth, with stars all around. Everything is in 3-dimensions and color. Move your head left, and you see the constellations in that direction. Look down, and you see the Earth turning slowly, far beneath your feet.

Now try the gloves. You can reach down and touch the Earth, push it further away, or pull it closer. Or reach out and grab a star. It's hot, but the temperature has been scaled down so you don't burn yourself. Try squeezing the star–here's the way to learn about the evolution of stars. Squeeze hard enough, and perhaps you can create a neutron star, or a black hole (we have to be careful not to make that one too realistic).

All of the technology for making a "cosmology simulator" or a "personal planetarium" exists today, but is still too expensive for planetariums. But the cost of computer technology is continuing to fall. I predict we'll have both kinds of exhibits in several planetariums and science centers in time for the next century.

An Exclusive Capability

Everyone I have met remembers that stunning first-visit planetarium experience, when a room of furniture, equipment and people disappeared, to be replaced by a hemisphere of stars. Here was a view of a very different universe, instantly juxtaposed with our daily environment. That awesome, mostly empty space of stars is much more representative of what the preponderance of the universe is really like. This is the universe we've been learning about in this century, and that new instruments like the Hubble space telescope will be telling more about over the next decade. The creation of this universe is a story we, of all the generations of humanity, are first putting together.

Planetariums have the challenge to get across the newly imagined sweep of space and time. Remember when you first saw a wide- angle rotating galaxy effect? I remember in the 1960's being deeply moved by watching that effect, and by an opaque projector effect of a small tumbling asteroid moving slowly through an immense star field. I'll never forget my new sense of proportion about what's in the universe. This sense has never been achieved on television, or by hemispheric film, with its jumpy, washed out stars. It has been produced in prose by our most gifted writers, but not very often. Astronomy and astrophysics have created new perceptions of our place in the universe, and it is the large planetarium's unique capability to transmit this perspective.

A Cultural and Social Purpose

Our new view of the universe is not just interesting – it is important. We are still completing the cultural revolution of Copernicus. The universe, as we now understand it, has created no privileged location for us, no sheltering circumstances that guarantee our survival. And that is an understanding which, I believe, can affect how we treat our planet and each other. People get an intimation of that understanding when the domed room disappears and is replaced by the stars. We get nervous twitters, not just oohs's and ah's, when we bring up our night skies. We need to make this cosmological circumstance explicit. We can define a new role for the planetarium, as the place where people assemble to confront together the meanings, practical as well as metaphysical, of this universe.

I've forecast "personal planetariums" that will offer each of us a private infinite universe. No personal planetarium will replace what we do in our planetariums, however, because we offer what no solitary experience can. We offer the opportunity to share and discuss our sense of amazement, wonder, and anxiety over the universe. The planetarium is a social phenomenon, not just a technological one.

9

PLANETARIUM OPENINGS - A STATISTICAL ANALYSIS

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Planetaria are unique places for making the acquisition of scientific knowledge an emotional experience. In all industrial countries, but also in many third-world states, these educational facilities are much frequented. As large planetaria having dome diameters above 20 m involve considerable investment and operating costs, their world-wide popularity may well be regarded as an indicator of the acceptance of popularized science dissemination by society. Most authors of publications about the planetarium as a cultural and educational institution so far have examined individual aspects of the subject and show little differentiation with regard to the planetarium as an institution on an international scale. To obtain reliable data on which valid judgements can be based, however, a detailed study of the statistics of the establishments of planetaria, differentiated by physical dimensions, regional factors and manufacturers, is indispensable. Reliable source material for such a study has long been lacking; but the latest edition of the "IPS Directory of Planetaria and Planetarians" 1/ provides a useful basis for a statistical analysis. The directory contains comprehensive information about the present situation of planetaria all over the world, stating the manufacturers, dome diameters and - where known - the year of opening. As the data nevertheless are less than complete in various respects, experts of various manufacturers kindly provided me with lists of information - some of them quite extensive - which I was able to use for the present study. Although even with this additional information the available figures must be assumed to differ somewhat from reality, the resulting account of the quantitative development of planetaria should nevertheless have a high degree of reliability.

The number of planetaria worldwide, derived from all available information and not counting planetaria below 5 m dome diameter, totalled about 1,600 in 1987. (In 491 cases, the time of opening was not identified.) This report summarizes the results of the analysis of the data.

OVERALL DEVELOPMENT INTERNATIONALLY

A cumulative representation of the overall rise in the number of planetaria on an international scale as a function of time, counting all sizes alike, is particularly revealing (Figure 1). The graph shows that the number of planetaria founded during the first 25 years after the invention grew slowly and - on average - steadily by about one planetarium per year. Most of these were large planetaria, and the majority of them were supplied by the Jena works. During World War II, no public planetaria were commissioned. After 1951, there was a phase of increased activity, with an average of eight establishments per year. From 1959, the number of planetaria worldwide increased enormously. By 1987, the end of the period studied, an average of 42 planetaria were founded per year. An analysis of this time span, during which planetarium consciousness spread most rapidly, revealed an exponential rise (organic growth) between 1961 and 1979, with an average growth coefficient of $x = 0.16 \pm 0.02$; i.e. $N_t = N_o e^{xt}$. Small and medium-sized planetaria have a large share in this development (Figure 6). The further rise after 1970 is moderate with a considerable share of large planetaria in recent years averaging three openings per year.

The overall curve of international planetarium statistics with its various stages constitutes a typical growth process as it can be observed in many developments in nature, but also in society: a prolonged phase of low propagation is followed by an acceleration phase, which eventually changes into exponential growth. But this cannot last forever and yields to a phase of decelerated growth. Such trends were found in 1973 by the author of this article for the spreading of observatories as places where astronomical knowledge is "produced" 2/. As regards planetarium openings, especially the exponential phase indicates a favorable situation for the spreading of planetaria. Such a situation is determined by the economic strength of the various countries on the one hand and by the enforcement of educational policies on the other, the latter being manifest in many variations depending, inter alia, on the country's social conditions.

Concerning the subjects of the work of planetaria during the recent phase (since about 1961), the characteristic trend is the development of a planetarium-internal "user philosophy". A dramaturgy for planetarium shows can be seen to have evolved, which is - especially in case of the large planetarium - increasingly subject to the requirement of combining educational and instructive elements organically with emotional and entertaining ones. Artistic presentation (language, music, graphics, special effects) are gaining in importance. The quantitatively most active phase of planetarium propagation in general, then, is evidently connected with a qualitative change in program production, a change that has begun to effect medium- sized and small planetaria as well. Quite plausibly, this goes hand in hand with the demand for a greater diversity of planetarium equipment, compared with the first decades after the planetarium was invented (sound system, multivision, video projection, laser equipment).

DEVELOPMENT BY DOME DIAMETERS

The development of planetarium founding shows a considerable differentiation by countries, dome size and manufacturers. There are several reasons for the differences:

The countries differ enormously by their economic situation and the level of their educational system.

The various manufacturers approach the market with their offers at different times.

Relative to the classical, large-size Jena planetarium, the development of small and medium-sized models started much later. The development and manufacture of medium-sized and small planetaria by a number of manufacturers is certainly a response to the different funds-raising capabilities of potential purchasers. Correspondingly, the total numbers of large, medium and small planetaria established relate inversely proportional to the costs involved in their investment and operation. Let K1 designate planetaria with dome diameters between 5.0 and 9.1 m, K2 such between 9.2 and 18.3 m, and K3 such between 18.3 and 25 m, the approximate, average ratio of K1 : K2 : K3 = 6 : 3 : 1 (Figure 2).

For individual planetarium (dome) sizes, by the way, no exponential growth phases can be identified (Figure 7). The number of large planetaria (K3) slowly increases, but the increase is steady throughout the period studied (with the exception of World War II). Higher growth rates for K3 planetaria are observed for the 1962 to 1968 period (3 planetaria per year) and for the recent years from 1982 until now (3 per year again).

SOME COUNTRY-SPECIFIC ASPECTS

Figures 3, 4a and 4b illustrate the evolution of planetaria in selected countries of Europe (France, Germany, Russian Federation and the United Kingdom), in the United States and Japan. By comparison to these, most other countries have only few planetaria; openings are sporadic and of little statistical relevance.

Europe has an important part in the propagation of planetaria, and the development here reflects significant phenomena of the development in general. This applies in particular to the slow, almost continuous rise beginning as early as 1923, and the rapid increase after 1959. However, the total of planetaria in Europe today is out-numbered by those in the United States as well as in Japan.

In the United States there is a striking rise in planetarium foundations after 1968; before that year there is hardly any appreciable quantitative development. Evidently, the change is connected with the United States Apollo project (the first Apollo spacecraft started for the Moon on 21 December 1968; the last manned Apollo mission started in December 1972). The importance of the Apollo project for the United States must be seen against the background of the successes of Soviet space-travel since 1957 and the international political situation at that time. This is a case in point illustrating the connection between a country's cultural and educational policies and the promotion of planetaria as a means to implement these policies. An externally similar though quantitatively and causally different development can be noted for the foundation of small and medium-sized planetaria in Germany; the marked increase after 1957, which ushered in the space age.

Development in Japan starts relatively late after the invention of the planetarium, but then advances continuously with high growth rates.

MANUFACTURER-SPECIFIC ASPECTS

By far the most planetaria operating in the world today are products of the Jena works, the United States Spitz company and the Japanese manufacturers Goto and Minolta (Figure 5). Spitz planetaria are found mainly in the United States and Japan, and most of the Goto and Minolta products stay in Japan, whereas planetaria made in Jena have the largest worldwide distribution; also, they have been turned out with greater continuity than other makes. Planetaria supplied by Jena most typically represent the overall process of planetarium development, from the first installation in 1923 to the modern, computer-controlled projection machines (Figure 8). The appearance of new manufacturers on the planetarium market (production starts: Spitz 1947, Opton GmbH Oberkochen/Germany 1949, Minolta 1958, Goto 1959) obviously had an effect on the number of planetarium establishments after 1951. The development of the medium-sized SPACEMASTER and the small SKYMASTER models at Jenoptik Jena GmbH was accompanied by a substantial upswing in international planetarium activities since the end of 1975.

In the majority of industrial countries today the demand for planetaria is largely met by the existing installations; nevertheless, the prospective market is still considerable. New planetarium foundations can be forecasted especially for those countries whose economic strength today is still far below that of industrial countries and whose further economic development is accompanied by educational measures of government and private institutions. Specific political motivations may also play a part. The activities of the planetaria existing worldwide, discussed and presented at international and regional conferences, doubtless have a stimulating influence on the motivation of others to implement new ideas in a planetarium of their own.

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1

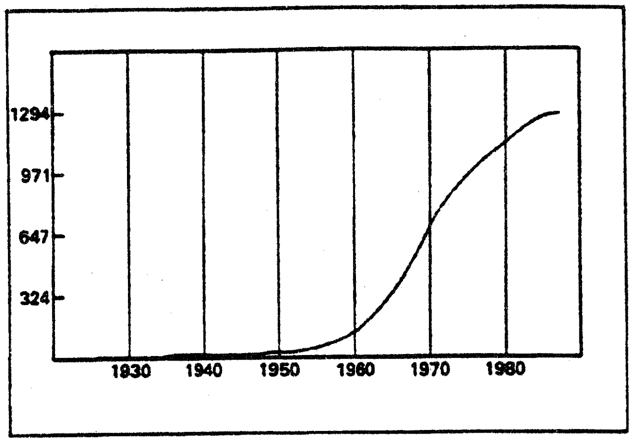

Fig.1 Number of planetaria worldwide

2

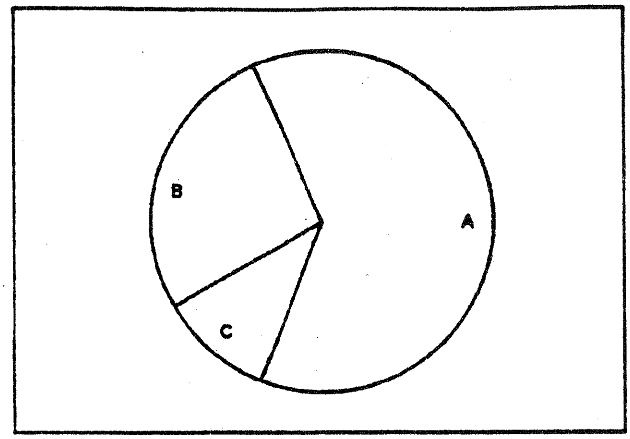

Fig.2 Distribution of planetaria by dome diameter
A: 5-9.1m; B: 9.2-18.3m; C: 18.3-25m

3

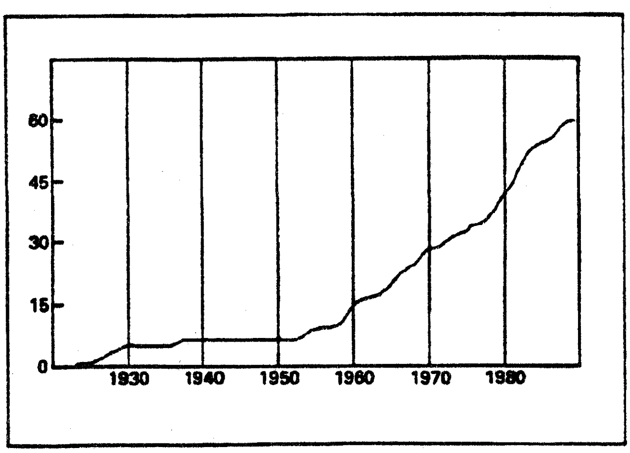

Fig.3 Number of planetaria in France, Germany, Russian Federation and United Kingdom)

4

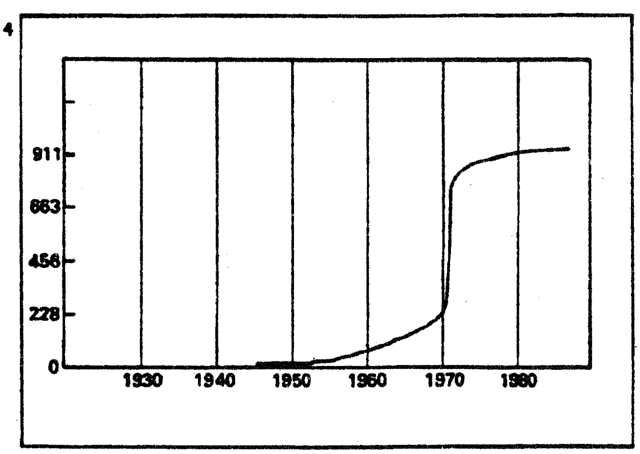

Fig.4 Number of planetaria in the United States

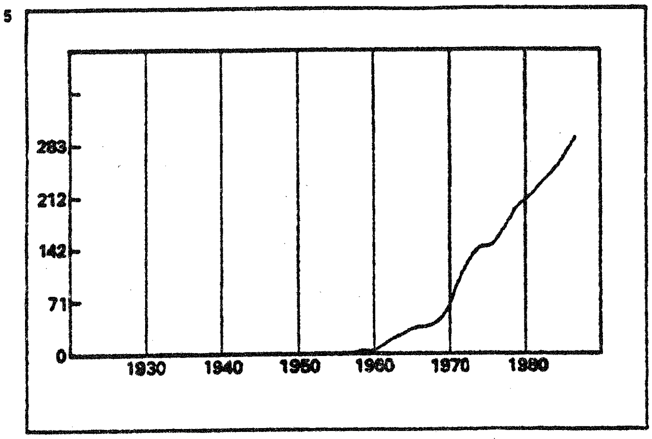

Fig.5 Number of planetaria in Japan

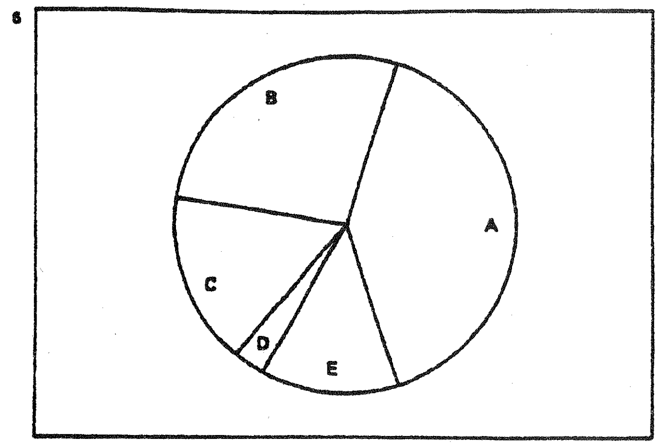

Fig.6 Share of major manufacturers in planetaria equipment. A: Spitz; B: Jena; C: Minolta/Goto; D: Opton; E: Others

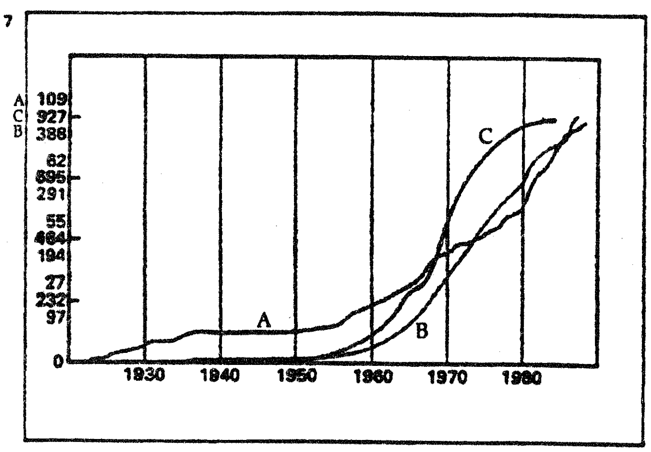

Fig.7 Number of planetaria by dome diameter A: 18.3-25m; B: 9.2-18.3m; C: 5-9.1m

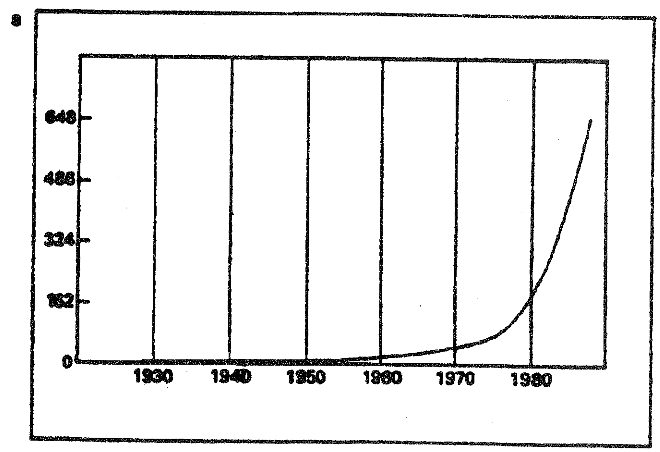

Fig.8 Number of planetaria equipped by Jena

PART FOUR

PLANETARIUM :

CENTRE OF CULTURE

AND EDUCATION

10

TIPS ON PLANNING FOR A PLANETARIUM EDUCATION PROGRAM

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PREFACE

In 1973, while teaching a course in descriptive astronomy at Butler University, I learned the value of a planetarium to an educational program. With encouragement of Warren Township Schools, I began to develop a plan for a planetarium facility and educational program in our school district. After becoming a member of the Great Lakes Planetarium Association (GLPA), I found that no one had published guidelines to use in planning planetarium facilities. Members of the GLPA encouraged me to write Tips on Planning for a Planetarium Education Program. Distributed to members in October, 1979, it was sixth in a series of TIPS booklets published by GLPA.

In 1992, I find that the basic planning strategies are valid. However, since 1979, developments in technology have made possible a variety of devices for information storage, retrieval, and presentation. The planning committee will find it useful to consider the need for newer devices as videotape players, CD players, laser disc players, video cameras, ZAP cameras, scanning reproducers, and hypercards. Personal computers with graphics capabilities may be useful, too. If the institutional site currently has access to cable TV or to satellite dish TV transmission, the planning committee may find it valuable to design the planetarium facility to incorporate the connections needed to join the TV network. The committee will wish to evaluate the devices which project electronically-generated star fields, as well as the conventional star field projectors.

PLANNING THE PLANETARIUM FACILITY

Philosophy and Objectives

With the preliminary dreaming finished, the statement of philosophy of planetarium education must be written. Then, the objectives of the program must be clearly defined. Completion of these two phases form the foundation of the planning phase. It is imperative that the present and future be kept in sharp focus. Design and construction of a physical plant before objectives are developed may seriously curtail the list of desirable objectives. With a dome precisely fixed in size and position, the physical plant is very difficult to change. The completed facility is unforgiving concerning poor planning.

Site Selection

Within the community to be served, careful consideration should be given to the best possible location for the planetarium. One of the first considerations will be the movement of students who will be using the facility. If all students who will be using the facility can walk to the building, several problems will be minimized. If transportation is needed, established traffic patterns and the availability of parking space for the visitors will influence the location of the physical plant. The actual location of the chamber needs to be near the parking area so that student traffic will not disrupt other activities.

Within a school district, it may be desirable to locate the facility near a secondary school. Students of secondary school age can serve as assistants in the planetarium during the school day. It may be helpful to have students and staff from art, music drama, mathematics, science and industrial education to help develop and produce programs to be given in the planetarium. Older students generally have the maturity and technical skills needed to produce scripts, slides, tapes and props needed in a planetarium production. Also, certain devices and staff from the school's audiovisual, art, printing, photography, wood-working, electronic, radio and TV departments can offer technical support. If a radio or TV station is part of a school program, some consideration should be given to setting for the necessary conduits in the planetarium space to run cables into the chamber for possible broadcasts.

In some communities, the site topography may indicate that the construction of a dry basement is feasible. Planners will want to consider the economy found in utilization of basement space for mechanical equipment, storage or workshops.

Certain auxiliary equipment associated with a planetarium education program may affect the location of the facility. If the objectives indicate the need for a telescope, an uncluttered horizon will be needed. A site to minimize light pollution will be desirable. Consideration of the use of portable telescopes versus fixed telescopes will be detailed. Fixed telescope mountings on a rooftop bring special considerations in location and design of the actual building to ensure extra strength for the anticipated weight and absolute stability for the telescope's mounting. Using a heliostat as part of a science education program will mean that the sun can be tracked for several hours each day.

As energy for the planetarium facility is considered, the planners should try to provide the space with its separate heating and cooling systems. Independence from another building's utilities will permit energy efficiency during the planetarium use in nonschool hours. For both practical and educational values, some communities may wish to consider the use of solar energy in the heating, cooling, and energy generation for the facility. The planners will need to seek help from local specialists as well as current literature concerning solar energy technology. In this present era, a solar energy plant can serve as a demonstration to the community.

The Planetarium Projector and Auxiliary Projectors

One of the most important decisions to be made is the choice of the planetarium projector. The planning group will need to study various systems to prepare to meet sales representatives. The planners will find it a good investment of time to visit several existing planetarium installations.

Planetarium projectors are of two basic designs. One design uses a system of lenses to project images on star plates upon the dome. Another system is designed to permit light from a very bright source to shine through holes drilled in a sphere and project on the dome. Some bright star images are projected by individual lenses. The techniques of the day-by-day use of each type should be studied. Since the projector is the heart of the planetarium facility, the day-by-day maintenance of each type should be considered.

If the planetarium education program includes some objectives related to laboratory use of the artificial sky for experiments concerning luminosity and position of the stars, the planners should evaluate the precision of the projector in these two areas.

Once again, the group will need to turn to the philosophy and objectives for the program to help in the decision concerning installation of a projector which is controlled by an operator, partially automated or fully automated. Among the possibilities for daily use, the system may be involved in an atmosphere of audience participation, classroom experimentation or as a means to present lesson segments to be discussed later. An important determination to be made involves the possibility that some shows will be repeated several times in a given day.

Some planetarium projectors include an option which permits its azimuthal rotation. This option is often elected for facilities which are designed with unidirectional seating because it will permit any region of the sky to be projected in front of the audience. As planning continues, this option will be carefully evaluated.

The planning committee will need to obtain exact information concerning the projectors included in a planetarium projector "package". A "package" commonly includes projectors for a pointer, sun, moon, planet, celestial equator, ecliptic, meridian, coordinate grids, precision circle, north celestial pole, zenith, twilight, sunrise and sunset projectors. Outlines of some constellation figures are sometimes included.

Consider the acquisition of a variety of auxiliary projectors to further create exciting illusions and help to visually reinforce learning. The wide variety of sensory stimulations by the entertainment media encourages their use in the provision of absorbing educational experiences.

The planning group should obtain lists of special effects projectors from planetarium projector suppliers and other companies which specialize in audiovisual materials. Projectors which are often used include panorama, solar system orrery, cardinal points, geocentric earth, meteor shower, comet, aurora, eclipse, binary star, cepheid variable star, constellation outlines, star clusters, a variety of galaxies and an astronomical triangle. Many experienced directors consider the projectors listed above as essential. Be aware that it is possible to build some of these projectors locally. In many instances, the homemade projectors will look different from the commercial models; but the effect can be made realistic in appearance.

Several slide projectors used to portray a variety of images will be needed. Commonly used is the 2 x 2 slide carousel projector. Depending upon the variety of visual images to be displayed in a given program, the planetarium staff will need to have several of these projectors available. Each installation should have at least one overhead projector to use. If a sufficient number of projectors needed for the creation of a skyline or panorama is not included in the "package", several projectors may be needed for this purpose. All of the projectors listed above need to be remotely controlled and include a device to control the brightness of the projector lamps. Projectors for 16 mm films, 8 mm films and film loops must be available.

Some exciting scenes can be created by use of a zoom lens in a suitable projector. Also, certain motions can be simulated by use of rotating image projectors.

The planning group should not consider the foregoing list as being complete. Many other special effect projectors are available.

The Planetarium Chamber

After the projector has been selected to meet the objectives set by the planning group, the room in which it will be used can be considered. Certain room size parameters will be created by the selection of the projector. As the committee considers several items which can be included in this portion of the physical plant, the volume of space needed for complete installation will continue to evolve. The planners will need to keep uppermost in their mind that this is the space in which education will take place. Give extra consideration to make the word keeping the space free of all undesirable sensory distractions. Persistent, recurrent noises, unusual lights, offensive colors of undesirable odors can be totally distracting. Money needed to provide control of sensory distractions is a wise investment.

The entrance to the planetarium chamber must be designed to eliminate all distracting light from the exterior. Further, provision must be made to keep the darkened chamber from being suddenly illuminated by someone entering the room after a program has started. This problem is often solved by the use of two sets of doors arranged with space for a person to stand while the first set of doors close before the second set is opened. This arrangement is an example of a light trap. (The light trap will also help to minimize external noise.) One problem encountered in using a light trap is that the second set of doors may be sucked open when the first set of doors is opened. Including an air bypass in the design of the light trap will eliminate this problem.

One of the reasons that the design of a planetarium facility is different from the usual school room is the need for a hemispherical screen on which various sky images are projected.

This screen is commonly called a dome. The size of the dome is influenced by the selection of the star projector, the realism desired in the apparent sky, the anticipated size of an audience, the set size, the arrangement of the seating and the anticipated use of the space under the dome. A dome size of thirty feet should be considered to be the minimum size.

Domes are generally constructed from perforated aluminum or plaster. As the planning committee visit existing planetariums, it will compare each type of equal-sized domes. Generally, the perforated aluminum dome is favored by experience planetarium directors. They point out several advantages not offered by the plaster dome.

(1) Auxiliary projectors can be set behind the dome and images can be projected through the screen.

(2) Spotlights can be mounted behind the screen and used to highlight any important aspect of a program.

(3) Speakers can be mounted behind the screen.

(4) Special effects (including a person with a speaking or singing role) can be placed behind the screen and brought into the scene by use of spotlights.

(5) A small light bulb used to create an effect such as a nova can be placed in any point of the visible sky.

(6) The room's acoustical quality is enhanced.

(7) The heating and cooling system can use the holes in the screen to provide excellent circulation of air in the chamber.

The dome is usually mounted about seven feet above the floor level. To increase the possibilities for special effect utilization, a system has been developed to extend the dome material to near the floor level. This arrangement is often called a tilted dome. It is especially good for extensive slide and film presentations. Generally, there is less need for uncomfortable "neck craning". Unidirectional seating and a tilted or tiered floor will be used with a tilted dome. The planners will need to study their philosophy and objectives to see that the special programming implied in the construction of a tilted dome will be desirable in the future. A visit to a facility with a tilted dome will be valuable.

As space for the dome is considered, it is essential that adequate space be provided to permit free access to the back of the dome. The planetarium staff will frequently need to change the placement of equipment and check the sound system. Equipment needed for installation or repair will need to be taken into this space. Work lights need to be provided in this space. Several systems of catwalks and ladders have been developed to provide safe access to the uppermost regions of the entire dome. Proper measures will need to be taken to ensure that unwanted visitors are kept from behind the dome.

Control Console Placement

The control console can be installed in almost any area of the chamber. Generally, the best placement is near the edge of the chamber. Most planetarium directors favor a placement that will permit the teacher/lecturer to see the main portion of the sky that the audience sees. The console needs to be placed under the dome so that the operator can see all of the sky. If the seating is unidirectional, the console will probably be placed in the area of the North coordinate. Some installations have an auxiliary remote control unit to permit the teacher/lecturer also to be in the audience or in front of it.

The committee must fully understand the permanence of the installation projector and the control console. For the variety of programs to be prepared in the future, wiring will be needed to connect the control console to the main electric circuit breaker, the planetarium projector space, all auxiliary projector areas, the various sectors of the cover and the sound system units. Provision for several one-inch, two-inch and three-inch spare conduits should be made to connect these devices mentioned above. These empty conduits are relatively inexpensive to install at construction time and almost impossible to construct after concrete sets.

Lighting in the Chamber

For lighting to be used during a program, damnable daylight projectors mounted at the planetarium projector or damnable lights supplied in a cove near the base of the dome are recommended. Install continuous cove lighting around the complete perimeter of the dome.

If their objectives anticipate activities involving map study, note taking, or written responses when the sky is darkened, the committee will study means to provide low-level illumination near the seats of the participants. Some planetarium directors have solved this problem by providing dim reddened flashlights to use in the work periods. (The committee can easily visualize the generation of the problems associated with the distribution, use, and collection of flashlights.)

For several reasons the planetarium program lighting system should not be used during periods when a program is not in progress. Lighting needed at non-program times will be of a much higher level. Auxiliary lighting is less expensive to maintain than the lights of the planetarium system. If the auxiliary lighting is placed on a circuit other than that of the main control console, then the sensitive controls can be locked to ensure use by only properly trained staff. The auxiliary circuit will provide a source of electrical power for tools needed to work on various planetarium components and cleaning appliances. It is also possible that the room will be used during a time when the planetarium staff is not present.

Local and state codes may require emergency lighting systems. If this is the case, the committee will plan for these systems to be available to the planetarium at all times. If the chamber is located in a separate building, the problem will probably be solved in the overall design; but if it is located in an existing building, some special planning may be needed.

Electrical Circuits

The following statements in this paragraph are developed from personal observation. In my visits with fifteen planetarium directors, I found that the largest number of problems mentioned by these experienced people centered on inadequate and improper wiring in the planetarium. Many spoke of programs which had no special effects or poor effects because the solution of the problems related to the temporary installation of these effects were too time-consuming or impossible. Others discussed the undesirable noises associated with poorly placed special effects and slide projectors because the circuits were not properly placed. Some mentioned the physical discomforts which they have as they try to install circuits after the facility was completed. I feel that most of the electrical problems can be inexpensively solved at the time of planning for construction. (Editor)

The Planetarium Projector Elevator

It is possible to install an elevator to lower the projector into a pit about ten feet deep. With the projector lowered, an audience has an unobstructed view of the front of the chamber. Planetarium directors generally place a low priority on the need for an elevator. However, if the philosophy indicates that the room will double as a classroom or a small theater, then the installation of an elevator should be carefully considered.

Auxiliary Projector Installation in the Chamber

Several parameters must be balanced to find the optimal position for an auxiliary projector. Among the primary factors to be considered are the seating plan in the chamber, the loading ease of the projector, the noise level of the projector operation, proper ventilation of the projector and the screen to be used for image formation.

Solution of one of these problems often compounds another. For example, an attempt to cover or enclose a projector to control the operational noise may cause the ventilation to be inadequate. Moving a projector farther away from the audience increases its inaccessibility.

Some facilities have enclosed projection booths which solves the problems of noise, ventilation and accessibility very well. Projection from a fixed booth may prohibit complete coverage of desirable screen area for image formation.

Another solution to the three problems involves the installation of a translucent screen in the front of a unidirectional arrangement of the seats in the chamber. The carousel projector and movie projectors are set behind this screen. This installation is often called a rear screen projection system. The planning group will need to provide the space needed if this equipment is to be installed.

If the dome is to be used as the screen, projectors are often installed in a space near the lower edge of the dome. This permits a wide variety of regions for images to be projected. Without some enclosure, the noise level of the carousel operation is rather high. But, the cove area is a particularly good place for skyline projectors.

Sometimes, projectors are mounted behind the perforated dome. If the back of the dome is readily accessible, this can be a satisfactory arrangement. Operational noise is a problem, but ventilation is better.

In every instance of installation, adjustable mounts for the auxiliary projectors should be provided. These mounts provide a stable base for the projector as it is adjusted to aim the image to an exact location on the dome or screen.

The committee may wish to obtain a copy of Kodak's AV Memo S-80-6 entitled "Ventilation, Noise Control and Heavy-Duty use of the Carousel Projector" for study.

Heating and Cooling the Planetarium Chamber

The planning group will give careful consideration to their objectives and philosophy of utilization as they think about the control of a comfortable environment within the chamber. Again, this is a space for active learning.

If the planetarium is to be used during all seasons of the year and during hours when an associated building may be closed for another use, then the planetarium facility will need to have an independent means for heating and cooling the chamber area. Proper training should be given to the planetarium staff so that it can completely and efficiently control the heating and cooling systems.

Since the planetarium is a specialized classroom, acoustically treat the ducts which carry the air into the chamber will permit the proper volume of air to flow without rushing, whistling, or other distracting noises.

Not only must the temperature be carefully controlled, but also the humidity and dust in the air need to be at proper levels. Uncontrolled, these three factors will adversely affect the functioning and life of the electronic equipment in the room. A proper monetary investment in this area will pay future dividends of a better learning environment and longer life for the equipment.

As mentioned in the SITE SELECTION section of this pamphlet the planning committee may wish to study the possible use of solar energy for heating and cooling of the planetarium chamber. Visits to local installations of solar energy equipment may help the group to decide about the feasibility of its use in their area.

Sound in the Chamber

Several undesirable sounds can intrude into the quiet atmosphere of the planetarium classroom. By proper planning, many of the noises can be eliminated. Noise from the heating and air conditioning units has been discussed in this pamphlet. The masking of noise created by auxiliary projectors has been explored. Squeaking chairs may present another problem and quiet seating should be selected.

If the planetarium is located in a separate building, some noises will not occur. But if the planetarium is in a building with classrooms or other facilities, it may be subjected to noise from people passing in the halls, from class bells or from the telephone bell. Good planning will eliminate these problems. Bells can be switched off in the planetarium area and the chamber can be located in a traffic-free area. As final plans are reviewed, the placement of all equipment must be checked to ensure that undesirable noise is not permitted to enter the chamber.

The committee will need to consider the sound system design carefully to create a desirable learning environment in the chamber. In many programs it will be desirable to have music as an integral part of the presentation. Exciting sound effects enhance the learning experience. Recordings of historic events provide valuable information. Many dramatic effects can be created by voices which are heard from different portions of the chamber. Shows which will be performed many times in a short period of time should be taped to relieve the strain on the voice of the staff member. (For example: A Christmas show may be given sixty times in two weeks.) Perhaps these examples will give the planning group some ideas concerning the need for an outstanding sound system. The system components are usually offered by companies which supply planetarium projectors. It will be necessary for the planning group to draw up specifications of a desirable sound system before evaluating any system offered in a "package."

Have a microphone available for use as needed. If a stage or demonstration area is anticipated, microphone jacks may be needed in the area planned for that purpose. Look at the provision for an anti-feedback microphone.

The system will need a stereophonic amplifier with mixing facilities and a set of excellent speakers. The number of speakers will depend upon the anticipated use; but careful consideration should be given to the potential dramatic effects by using multiple speakers. Most planetarium directors feel that four speakers must be considered a minimum number. The system will need at least one stereophonic tape deck and a turntable, and a second tape deck is a highly desirable option.

Flexibility for a sound system is highly desirable. Capable of mixing sounds from a variety of input sources, the system must reproduce the mixture faithfully. For planetarium facilities which are to be automated, the sound system must be able to provide the needed synchronous signals.

As mentioned earlier, it is possible to find equipment free of mechanical clicks, pops, thuds and other annoying noises created by some components starting or stopping.

A wide variety and quality of sound system components can be evaluated. The committee may wish to engage the time of an experienced planetarium staff member to help in the design and selection of the components of a sound system. Few people know the problems related to sound in the planetarium better than an experienced staff member.

> In my visits with planetarium directors, the third greatest source of concern for the daily operating of the planetarium was centered on an inadequate or poor quality sound system.

The Walls of the Chamber

Two matters need attention as the walls are considered. First, during a planetarium program, stray light from various projectors may reflect from the wall surface and be distracting to the audience. Some walls have been painted flat black to control reflections; but the result is a depressing experience for a group which uses the chamber as a classroom. The second problem relates to the texture of the wall surface. The wall can be highly reflective of sound and create an echoic environment. Two considerations may be helpful: (1) Remember that after construction is complete, it is easier to "deaden" sounds in the chamber than to "enliven" the room again; (2) Remember that if textured or perforated materials are used to "deaden" the wall area, these materials will be exposed to dozens of fingers each day.

The planners must think about the placement of doors which will be used as emergency exits. Remember that these exits may be potential sources of noise if they open into a regular traffic area.

The Floor of the Chamber

The covering for the floor will be determined by local conditions, and floor tile or carpeting is often used. Most planetarium directors favor the use of carpeting where it is feasible. It is attractive, easy to maintain, and it deadens the sound of shuffling feet.

The floor of the chamber may be constructed to be flat, slanted or as a series of level tiers. The seating orientation will affect the selection of the type of floor. If circular seating is selected, a flat floor will generally be used. A unidirectional seating plan will need a slanted or tiered floor.

Seating in the Chamber

A wide variety of seating is available for planetariums. A common complaint associated with seating is a "tired neck". Attempts to solve this problem are frustrated by the wide range of size of people who visit the planetarium. The committee members should participate in as many actual presentations as possible to evaluate the seating in existing planetariums.

High back, tilted back and standard seating with an adjustable headrest are available to help solve the "tired neck" problem. Each arrangement needs evaluation. The planners may need to think about the need for maintenance of sanitary conditions of the seating.

Final selection should provide seating which is very sturdy, stable and comfortable. For unidirectional seating, planetarium directors generally favour individual seats mounted permanently to the floor. While being properly used, any movement of the chair should produce no undesirable noise. As an option, many directors find the table arm option desirable.

Other Considerations of Chamber Design

The planetarium staff may have a standard science classroom assigned for their use, but sometimes the chamber is used in a classroom mode. This often involves science demonstrations. If their objectives include this use of the planetarium chamber, then the planning group needs to provide a demonstration area with a demonstration table. The table may need to be equipped with standard utilities.

Sometimes a planetarium program may include a small dramatic or music group. A stage area for the use of a small group can be considered. A portable, temporary stage could be set for special occasions. Some planetarium directors have used space behind a perforated dome for a person to stand while participating in a dramatic role. Considering the infrequency of its use, most directors set a low priority for a stage.

Other Space Associated with the Planetarium Facilities

The planning committee will need to consider space outside the planetarium chamber. An entry and waiting area, storage areas, office space and work space, and an associated classroom should be considered.

Entry and Waiting Area

In the entry area, plan a cloak room. Be certain that ample space is provided for the anticipated activity. Simple wall hooks on which younger visitors may hang coats may be better than the hangers provided for older visitors.

Drinking fountains should be located in the entry and waiting area. Restrooms should be located in the waiting area so that they are not adjoining the walls of the planetarium chamber. An attempt to keep all running water located far from the chamber will keep the noise level down.

As mentioned in the INTRODUCTION to this pamphlet, the needs of the handicapped visitor must be considered. The planning group will want to ensure that all areas, including the entry and waiting area, will accommodate the special needs of these visitors.

In the waiting area, space may be provided for both flat and three-dimensional displays. Depending upon the planetarium education program objectives, this space can be made rather extensive. Changed frequently, the displays become lesson material to be presented by a competent guide.

Subdued lighting is desirable in the waiting area. Even so, the planners will want to study the placement of any glass-enclosed display space to prevent glare from lights or windows.

An attractive entry and waiting area is desirable. However, the group needs to think carefully about the climate and the possibility that the visitors may arrive with wet or snow-covered boots. Some floor coverings can become very slippery when wet. A carpet may become quite dirty and unattractive in a daily exposure to high volume of traffic.

The size of all entry doors should be planned to accommodate large display material which may be desirable or needed. All doorways should readily accommodate AV carts, hand trucks, etc. A consideration: Will a piano ever be needed in the planetarium chamber?

Finally, the entry area should have a prominent, easy to read sign to announce "PROGRAM IS IN SESSION". This sign needs to be placed at entry (entries) to the chamber and be controlled from the central console.

Storage Space

A variety of storage spaces are used in the daily operation of a planetarium. One special storage problem relates to the orderly arrangement of slides. The planetarium staff will need to quickly locate particular slides to use in program preparation. The group will consider several slide storage systems as they choose to best fill the need.

Tapes and records will need proper storage space. If the planetarium staff obtains or develops a set of films, film loops, or film strips, proper storage will be needed for them.

For small parts used in the repair and maintenance of auxiliary projectors, orderly storage bins will be needed. Also, for a variety of parts which will be used to assemble special effects projectors, clearly marked storage bins should be provided.

Special material and equipment to be used in classes need proper storage. Globes, star maps, charts, photographs, grating spectroscopes, and flashlights are only a few from a wide variety of material to be stored.

As special shows are developed, many props and special effects which can be used in a later "replay" or in another program will need to be stored. These props may be odd-shaped forms and need unusual storage space.

> This statement was developed from conversations which I had with fifteen experienced directors. Inadequate and improper storage space was mentioned as the second of three most frequent problems which adversely affected the day-by-day operation of the planetarium. Be certain that ample room is planned because it is very difficult to generate after the facility is finished.

Work Areas for the Planetarium Staff

The staff members will need office space to be used for a variety of correspondence, scheduling, and program development. As the committee plans this space for the staff, it will consider the need for desks, tables and a wide variety of working storage spaces for books, pictures, posters, star charts, slides, film strips, etc. Standard office equipment such as telephones, typewriters, calculators and files will be needed.

Space for workshops will be needed. A matter for the committee to consider is that some workshop activities are "lean" and others are rather "dirty". Work on optical systems and electronic circuits are in the "clean" category. Sawing, drilling, and painting are in the "dirty" category. If possible, these work areas need to be separated. A variety of tools will be needed in the workshop area. A basic set of hand tools including screwdrivers, pliers, wrenches, hammers, clamps, vises, soldering irons, a drill, a wide variety of bits, and saws should be provided.

Space to store spare parts as screws, bolts, bulbs, wires, and connectors needs to be provided.

Space to be used in a variety of photographic tasks requires consideration. The photographic work surface will need to be in a "clean" area and a variety of equipment will be needed. A good camera body with a variety of lenses should be available to the staff. A copy stand and several floodlights must be provided. Consideration will be given to making a Repronar slide copier available.

A properly equipped darkroom will be readily available to the planetarium staff.

Space for Tape Preparation

The planning group must give consideration to the need for a totally quiet space to be used in recording of tapes to be used in a planetarium program.

Space for an Auxiliary Classroom

Depending upon the objectives developed by the planning group, it may be desirable to have a classroom to be used by the planetarium staff. The planetarium chamber itself may also be used as a classroom for an astronomy class which meets regularly. If the planners intend to include a heliostat, it may be used in conjunction with an auxiliary classroom.

PLANNING THE BUDGET FOR A PLANETARIUM EDUCATION PROGRAM

Introduction

The funding for a planetarium education program will depend upon the local situation. Some planetariums charge individuals for their services, while others provide services paid for by the local community. However the program is financed, the planetarium director should have a budget for which he is responsible.

For most expenditures, the director will follow the normal supply channels; but he should be able to purchase relatively inexpensive items locally when the need unexpectedly arises. Of course, any such petty cash fund expenditures should be verified by receipts.

The planning group must try to provide as much equipment and as many supplies as possible when the facility is built and first equipped. The viewpoint adopted in this pamphlet is that the initial equipment was adequate. If the committee deems it necessary to postpone purchase of some equipment and supplies, it will set a realistic plan to purchase the needed items over a period of a few years.

Annually, a budget should be prepared to meet the costs for transportation, equipment maintenance, repair and replacement of materials needed for planetarium supplies, general office supplies and conference costs.

The planning group cannot assume that the list shown below constitutes a complete set of budgetary items. It is given as an example for the planners to think about.

Transportation Costs

Depending upon the philosophy for the program, funds will need to be set aside to provide transportation for the students who will visit the planetarium. If the program provides the classroom visits by staff members before and after the students visit the planetarium, then their transportation costs will need to be estimated.

Maintenance and Repair of Equipment

Most suppliers of planetarium equipment offer a service contract to include an annual cleaning and lubrication of the planetarium projector. It generally includes a check of the electronic equipment associated with the control console. The planning group will want to weigh the advantages and costs of a maintenance contract against proposed alternatives.

One regular expense for which the budget must provide is the cost of replacement of the bulbs which generate the light to project the stars to the dome.

Auxiliary projectors will need bulbs and occasional adjustment of some moving parts.

Occasionally, a section to the console control circuit may need to be replaced. Plan for emergencies either through service agreements or by having staff members trained to analyze the problems, quickly obtain parts, and replace the parts.

Other equipment including the tape decks, record player, speakers, and photographic equipment may need maintenance and repair on a periodic basis.

Supplies Needed for the Preparation of a Planetarium Program

To prepare special effects and projectors, a wide variety of gears, motors, bulbs, lenses, mirrors, wires, metal, wood, plexiglass, plugs, connectors, and an assortment of electronic parts should be maintained. Some model kits found in local hobby stores can be used in preparation of special effects.

The staff will need photographic and darkroom supplies to prepare slides for special programs. Provision of funds to purchase supplies of fresh film and dark-room chemicals must be provided. Kodalith is used in rather large quantities by planetarium staff members.

The staff may need a supply of paper and cloth to prepare models to be used as special effects. Some simple costumes may be required for a dramatic presentation in a planetarium show.

The record collection for music and special sound effects will need to be expanded, although the copyright laws should be examined in relation to record use. Also, tapes used in the plan planetarium programs will need to be replaced. The planning group may wish to investigate the advantages of a subscription to a music service organization.

Books for the staff library will need to be purchased annually. Science books quickly become out-of-date. The staff library will need subscriptions to appropriate journals. The support given by a library justifies the money allocated in a budget.

Special programs can be purchased from large planetariums. Often these are made available for only the costs of copying and mailing.

Of course, funds must be set aside for office supplies and expenses. The office will have phone bills and equipment maintenance costs. The staff will need stamps, stationery, tape, glue, staples, pencils and pens.

Conference Costs

Every professional needs to participate in associated groups. The budget should provide money to permit the staff members to participate in the conference of groups such as the Great Lakes Planetarium Association and the International Planetarium Society. In each local area, planetarium directors beneficially meet often, using different facilities each time. The budget should provide funds needed to host an occasional local conference.

APPENDIX I

A CHECKLIST FOR PLANETARIUM FACILITY PLANNING

1. A Statement of Philosophy and Objectives

2. Site Selection

Student Transportation

- Walk
- Bus

Student assistants

- Script preparation
- Technical skills

Staff assistance

- Printing
- Photography
- Electronic
- Graphic arts
- Audiovisual
- Radio/TV

Basement desirable

- Utilities
- Storage
- Workshop

Telescopes needed

- Clear horizon
- Light pollution
- Portable telescopes
- Roof top use

Solar energy considered

- Consult local installations

3. Planetarium and Auxiliary Projectors

Types

- Lens projection
- Non-lens projection

- Precision

Star image location
Star luminosity

Automation

Azimuthal rotation

Auxiliary projectors in "package"

- Pointer
- Sun
- Moon
- Planet
- Celestial equator
- Ecliptic
- Meridian
- Coordinate grids
- Precession circle
- North celestial pole
- Zenith
- Twilight
- Sunrise
- Sunset
- Constellation outline
- Others

Other important auxiliary projectors

- Panorama
- Solar system orrery
- Cardinal points
- Geocentric earth
- Meteor
- Meteor shower
- Comet
- Aurora
- Eclipses
- Binary star
- Cepheid variable star
- Constellation outlines
- Star clusters
- Galaxies
- Astronomical triangle

Others

- Construct any of the above
- Purchase auxiliary projectors

2 X 2 slide projectors

- Remote control
- Dimmable

Overhead projector

- Dimmable

Film projectors

- 16 mm
- 8 mm
- Film loops

Other lens

- Zoom
- Image rotation

4. Planetarium Chamber

Entry

- Light trap
- Eliminate noise
- Proper width for equipment

Dome

- Perforated aluminum
- Plaster
- Thirty feet minimum
- Standard or tilted
- Space behind
  - Adequate
  - Catwalk/ladders
  - Lighted
  - Secure from "visitors"

Central console placement

- See sky that audience sees
- Install 1-inch, 2-inch and 3-inch conduits
  - Electric circuits

- Planetarium projector
- Auxiliary projectors
- Cove sectors

Lighting

- During programs
  - Daylight control
  - Light at seats
- During non-program times
  - Separate circuit
  - High level lighting
  - Emergency system
- Elevator for projector
  - Chamber used as classroom

Auxiliary projector installation

- Noise control
- Accessible
- Ventilation
- Adjustable mounts
- Placement
  - Booth
  - Cove
  - Behind dome
  - Other

Heating and air conditioning

- Philosophy of use of the facility
- Independent control
- Noise control
- Humidity control
- Dust control

Sounds in the chamber

- Unwanted
  - From projectors
  - From heating and air conditioning
  - From "the hall"
  - From bells

The sound system

- Specifications needed
- Microphone
- Stereo amplifier and mixer
- Speakers - at least four
- Stereo tape deck
- All components to be free of operational noise

Walls

- Light reflection
  - Black walls depressing
- Sound reflection
  - Easier to "deaden" then "enliven"

Floor

- Flat
- Tiered
- Slanted
- Carpeting preferred

Seating

- Unidirectional
- Circular
- Must be sturdy and quiet
- Solve the "tired neck"problem

Other considerations

- Demonstration area
- Stage area

5. Entry and Waiting Area

Cloakroom

- Adequate space

Water fountains

Restrooms

- Locate away from the chamber wall

Display space

- Permanent

Changing
Keep glare off glass

Floor covering

Door size adequate

Large displays
AV carts
Piano?

6. Storage Space

Adequate and orderly
Slides
Tapes/records
Films
Replacement parts
Classroom materials
Props and special effects

7. Work Areas for the Staff

Office

Desk
Table
Working storage
Phone
Typewriter

Workshop

"Clean"
"Dirty"

Tools

Basic set of hand tools
Special tools needed for equipment

Storage for spare parts

Photographic

"Clean"

Tools

Camera Body
Lens

Copy stand
Floodlights
Repronar copier
Darkroom

Tape preparation

Soundproof room

Auxiliary classroom

Astronomy classroom

APPENDIX II

A CHECKLIST FOR THE PLANETARIUM EDUCATION

1. Transportation

Students to facility
Staff to schools

2. Maintenance of Equipment

Annual
Periodic
Emergency

3. Supplies

For special effects

Gears
Motors
Bulbs
Lens
Mirrors
Wire
Metal
Wood
Plexiglass
Plug
Connector
Electronic parts

Photographic supplies

- Fresh film
- Fresh chemicals
- Kodalith

Paper materials
Cloth materials
Music supplies

- Records
- Tapes
- Music Service

Books for reference
Magazine subscriptions
Office supplies

- Staples
- Paper
- Paper clips
- Tape
- Glue
- Pens
- Stationery
- Postage

4. Conference Costs

Local conferences
Great Lakes Planetarium Association
International Planetarium Society

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L-H-S LEVEL SPECIFICATION OF PLANETARIUM CAPABILITIES (REVISION 1.0)

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Several years ago in the music industry, some major synthesizer makers–all competitors–got together and agreed upon a method for connecting each other's keyboards and playing them together. The specification they came up with was called MIDI, for Musical Instrument Digital Interface.

Recently in the computer industry, three of the major players– Lotus, Intel and Microsoft, got together and agreed upon a method of using a PC's extended memory; they called it the L-I-M EMS 4.0 specification.

Now in the planetarium industry, three companies have combined efforts and agreed upon a method of classifying planetariums. We call it the "L-H-S Level Specification of Planetarium Capabilities Revision 1.0," or simply the "LHS Level Spec." The L-H-S Stands for Loch Ness productions, Joe Hopkins Engineering, and Sky-Skan. The big question is, "Why have we done it?"

First, we wanted to create a detailed description of what we feel is essential for today's planetarium–no such listing existed. The various levels we've have come up with provide a picture of the state-of-the-planetarium-art–and we now have a point of reference.

With such a list prepared, we can now use it ourselves. For Loch Ness productions, we can classify the shows we produce. For example, our show "More Than Meeting They Eye" can easily be shown in a LEVEL 2 planetarium. A show like "The Mars Show" with 300 slides cannot, but it could be a LEVEL 3 show. If our show requires cross-fading pans or all-sky, we can recommend it for LEVEL 5 planetaria.

When a new planetarium is being built, the planning committees get various proposals from different vendors, and often don't have clear picture of all that's involved–they just know they want a planetarium. With this document in hand, Sky-Skan can now say, "OK, here's what's involved–what level of planetarium do you want to build?" It's a kind of shopping list.

Joe Hopkins can say, "Looking to upgrade your theater? Let's see what you'll need to move you up to LEVEL 4: you've got this and this, but you need that and that." It's right here on the list.

You can use the LHS Level Spec yourself–for support when you go to your administration for money to improve your theater. you can say, "Look, we're not even at a LEVEL 3 because we don't have a zoom or a slew, and we really could use this and this from LEVEL 4. And the planetarium in the next town is already a LEVEL 5–we need to get on the stick!" With it all in black and white, it'll be harder to ignore; it can simply plant the idea that there IS an upgrade path for improving your planetarium.

All the very least, it might stimulate YOU to investigate various ways you can enhance your theater's presentations–and it lets you know what we vendors feel is important for you and your planetarium to have.

The way it works is simple. To see what level your planetarium is at, you start at LEVEL 1, and work your way up. If there's a line item in the Spec that your planetarium doesn't meet, then you're not at that level yet. You can have some of the capabilities of higher levels, but you need to meet ALL the requirements of a particular level to be considered at that level.

LEVEL 1: Virtually every planetarium is at least at this level. However, some feel this is all that should be necessary for a planetarium. Indeed, some proposals for new planetarium constructions have included NO auxiliary equipment, specifying a star projector ONLY. Of course, if our three companies didn't feel differently, we wouldn't be in business.

LEVEL 2 calls for at least 2 slide projectors, and a tape playback system. We don't specify that they be a dissolve pair, although that certainly would be acceptable. We didn't specify a tape format; probably a cassette would be typical example. There are many Starlabs that are at this level, and there may even be some at LEVEL 3.

LEVEL 3: Now it starts getting interesting. Again, if there's a line item at this level that a planetarium does not have, they are not at this level yet. We feel that a planetarium wishing to present effective audio-visual programs at this level needs AT THE VERY MINIMUM these specified capabilities.

Three dissolve pairs, arrayed Left/Center/Right. Loch Ness customers are already familiar with this format. The screens don't overlap by halves or thirds in multi-image style, because the curvature of the dome prevents that. The dissolve pairs are just aimed roughly adjacent to each other.

A stereo sound system in the theater, fed by multiple sound sources. At a minimum, this means one player for entrance music, and a deck for the show tape. Stereo is mandatory–if you have a monaural sound system, you are living in the 50's; probably the 7-year-olds in your audience have more sophisticated sound systems than you do–they certainly hear better sound on their Walkmans than they will in your planetarium.

You should have the basic tools of the trade for creating motion- -a zoom and a slewing mirror. Creative people might even aim the zoom at the slew. At any rate, both are as basic as the green arrow.

You need the ability to project at least a partial panorama; whether it be one dedicated projector with a wide-angle lens or several, this too is essential for setting scenes in a planetarium.

You need to have the capability for showing animated moving special-effects–a comet, meteors, an orrery, rotating planets and galaxies–the "stuff" of space. Note that you don't HAVE to have all incandescent special effects: a video projector and special effects from a tape or videodisc can qualify for "having the capability;" Sky-Skan to sell you their special effects in either form.

You need have a facility to mount and opaque slides. Without specifically dictating it, this implies having at least a light table, Wess glass mounts, and opaquing fluid with a paint bush.

And you need to be able to dub a tape, since at the very last, you have to make an insurance copy of your show tape masters. This implies more than one tape deck, and while you could plug the cables from one to the other to meet the Spec, you'll probably want a mixer and additional audio equipment as well. While we don't specify that here, it is specified in LEVEL 4.

Now the debate over concentric versus uni-directional seating has been raging for the last few centuries, and will undoubtedly continue. But we feel so strongly about this point that we include the following statement in the spec: "The ability to present the same show information (audio and visual) to all seats of the theatre equally is paramount to professional presentation."

With concentric seating, from an audio standpoint, you simply can't present stereo sound to your audience–everyone's ears are pointed in a different direction.

Visually, you have two choices: either you project one image that's upside-down to half the audience, or you double up the images and everybody sees two images with one of them upside- down. Either choice is a compromise; neither makes for an effective program.

No matter how much equipment you have, the audience deserves to see and hear it used to its full advantage. To achieve LHS LEVEL 4, in today's planetarium, concentric seating is history.

You have at least one screen area that is 3 or 4 projectors deep, so you can do multi-image style animation, or at least a fast lap-dissolve sequence. This means the slide projectors have to be in stackers that allow for precise alignment.

You need an automation system that synchronizes your slide projectors and effects with your show tape. We're not specifying which system to use, and you might still run zooms, the star projector, etc., manually; but, some projectors are controlled from the tape.

By specifying a "multi-channel, multi-speaker professional- quality sound system," we've left it open to interpretation. Obviously, stereo sound takes two channels; and to synchronize to tape, you'll need a third channel to store the automation data. By specifying "professional-quality," that will pretty much rule out cassettes as the primary sound source.

You have more than one zoom, and more than one slew, and the ability to project a full horizon panorama, or as much as your tilted-dome will allow.

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Video projectors have been here for a number of years; it's time to jump on the bandwagon if you haven't already.

In LEVEL 3, you just had to have special effect capability; here at LEVEL 4 we say you should have multiple special effects, including rotators, revealers, polarizers, and the ability to do whole-dome effects: snow, clouds, etc.

If you're doing audio-visual programs, you need an audio studio, and we've specified some of the basic equipment to have.

Your visual studio has a camera and copy stand (which implies lights, a meter, filters, etc.). You need to be able to duplicate slides, either on your copy stand, or with a device like a Repronar or Illumitran. And you need to be able to mask and align slides. This implies that you have the capability to develop Kodalith and LPD-4 film, which implies a rudimentary darkroom setup–at least a developing tank and a sink. Of course, a clever planetarian will probably have a Wess Variable-registration mounting system and a goodly stock of VR slide mounts; but that's implicit in the specification to "align slides."

If you've achieved LEVEL 4, you've already got a pretty good setup, and you may even have some of the capabilities of LEVEL 5. Nonetheless, we've spelled them out for you.

You have the 6-projector, fish-eye lens, pie wedge style All-Sky system.

You're at least two projectors deep on your panorama systems.

In LEVEL 4, you had to have at least one screen area that was 3- deep in projectors; at LEVEL 5 you have more than one.

Your automation system is based on SMPTE (or equivalent) time code; at LEVEL 4, you could have a simpler beep-tone style of automation to control projectors.

You have a videodisc player, and an Oxberry or Forox type of pin- registered camera and animation copy stand.

Even if a planetarium is at LEVEL 5, it's certainly not the end of the line. Some have been at LEVEL 5 for many years now, and we'd certainly hope we haven't stopped evolving, growing, and improving. We've created the various levels to give all planetaria something to strive for, and LEVEL 6 specifies even more avenues to explore.

LEVEL 6: If a planetarium is going to do video and do it right, then it will need to equip a video studio: a camera, a switcher, editing VCRs and an edit controller, time-base corrector, monitors, effects units, etc.

Computers are used to generate artwork and graphics, and you'll have a film recorder to transfer the computer image directly to film.

Digital audio is here to stay, and the analog tape recorders of the 60's and 70's are going to be replaced by DAT's, and digital multi-track recorders.

You might wish to add the interactive audience-polling systems and programs currently in use in several planetarium theaters to provide your audiences with more reasons to return to your theater more often.

There was a proposal made a while back for "standardization," with details down to what format tape to use and even what channels to record the narration on. That is NOT what the LHS Level Spec is about. You can see it's general enough to allow for various configurations, yet still includes the basic categories for what we feel is important to have.

This is the best part–if you disagree with the levels we've devised, or don't like where your planetarium falls in the LHS Spec, no problem. You can always ignore it. No one's going to force you to accept your plan. Our companies have already come up with it, and we're giving it to you. It's done–here it is.

Of course, we hope that you WILL accept it and that you'll find it useful. If it becomes a kind of "industry standard", or at least an accepted guideline that everyone will know and refer to, great–so much the better. Our three companies are going to use it; and hope you will too.

L-H-S LEVEL SPECIFICATION OF PLANETARIUM CAPABILITIES REVISION 1.0

LOCH NESS PRODUCTIONS - JOE HOPKINS ENGINEERING - SKY-SKAN, INC.

LEVEL 1:

Star projector

LEVEL 2:

2 80/tray slide projectors

Tape playback sound system

LEVEL 3:

3 Ektagraphic (or equivalent) dissolve pairs, arrayed Left/Center/Right

Stereo sound system in theater, fed by multiple sound sources

1 motorized zoom

1 motorized slew

Partial panorama

Special effects capability:
- comet
- meteors
- orrery
- rotating planets,
- rotating galaxy, etc.

Visual capabilities:
- Slide mounting/opaquing

Audio capabilities:
- Tape duplication

LEVEL 4:

LEVEL 3 capabilities, plus:

Epicentric or unidirectional seating *

3-, 4-, or more projectors in precision aligned stackers with multi-image animation capability

Soundtrack-synchronized automation system controlling multi-image projectors and effects

Multi-speaker, multi-channel professional-quality sound system

Multiple motorized zooms

Multiple motorized slews

Full panorama system

Video projector/videocassette deck

Multiple special effects capability, including:
- Rotating image
- Revealing image
- Polarizer motion
- Whole-dome effects

Sound studio:
- Microphones
- Mixer
- Audio tape recorders
- Amplifier/speakers
- Noise reduction system as needed
- LP/compact disc player
- Music/sound effects libraries

Visual capabilities:
- Copy stand/camera
- Slide duplication
- Masking/alignment capability

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* "The ability to present the same show information (audio and visual) to all seats of the theater equally is paramount to professional presentation."

LEVEL 5:

LEVEL 4 capabilities, plus:

6-projector all-sky system

Cross-fading panorama projectors

Multiple animation-aligned projectors trained on multiple screen areas

SMPTE (or equivalent) time-code-based automation system

Videodisc player

Pin-registered camera/copy stand

LEVEL 6:

LEVEL 5 capabilities, plus:

Video studio: camera, switcher, editing VCR's and edit controller, monitors, time-base corrector, effects units, etc.

Computer-generated art/graphics system, film recorder, etc.

Digital audio system

Interactive programming capability

PART FIVE

FACILITIES OF A MODERN PLANETARIUM

12

TIPS FOR THE NEW PLANETARIAN

D.A. De Remer and G.E. Sampson
Great Lakes Planetarium Association
c/o Abrams Planetarium
East Lansing, MI 58824, USA

INTRODUCTION

Welcome! As you enter the planetarium field, you will have questions, uncertainties, hope, and excitement about your new responsibilities. What is expected of you? Where will you get your ideas? Who can help you?

Recognizing the great difficulties that new planetarians face, the Education Committee of the Great Lakes Planetarium Association has prepared this booklet of tips to help you begin the job of being a planetarium director. To many questions, you will find that there are no single answers, for there is much room for individual style and choice of method in the planetarium. In order to convey this feeling and to avoid giving the impression that there is always only one correct way to do something, this booklet presents the views of many planetarians, many of whom look at the same question from different points of view. We suggest that you read these pages for what they are – tips from experienced planetarians to those just beginning. To answer the many questions which can arise in different institutions is clearly impossible, but is our hope to provide some useful starting points.

In 1976, Jeanne Bishop, as chairman of the Education Committee summarized the feelings of the authors who had contributed their thoughts about planetarians:

Admittedly, there is diversity in what is expected from planetarium directors. Size of installation, museum or school facility, objectives of the larger institution to which the planetarium is attached and funds and staff which one has at his/her command are determining factors.

But it is not difficult to find common elements. Speaking from some years experience with both museum and school planetariums serving large and small populations, we offer the following orientation to you who are about to become a 'dome-keeper'. [Our] remarks are directed to those who would be the only or one of a very few staff in a relatively small installation.

> You are joining a world group of about 1000 who have the job of a planetarium director. Most of these people are the greatest anywhere, who will be glad to answer your questions and share their ideas and activities with you. Find out which planetariums are closest to yours and get to know the people in charge at

each. Attend local informal get-togethers as well as regional, GLPA and ISPE [now ISP] conferences to expand your horizon. Pretty soon you will be in a position to share your programmes with the rest of us. We'll be looking forward to your contributions. Welcome to this exciting profession, and GOOD LUCK!

WHAT MAKES A GOOD PLANETARIAN?

In speaking of the planetarium and its importance, Armand Spitz wrote:

> What justification to we have for the planetarium? In the technical world of the future, much of the responsibility for financial support for research, development and education will fall directly on the shoulders of the taxpayers. It can categorically be said there is no type of organization better fitted than the planetarium to prepare the electorate to vote intelligently on the support of future scientific endeavors. The success of such ventures may well hinge upon the effectiveness with which planetariums have played their individual and collective roles.
>
> The fact must never be lost sight of that the planetarium lecturer has an unparalleled opportunity to achieve his goal, whatever this may be. Much factual data about the physical sciences can be presented palatably, wonder and awe can be created for the processes of nature and man's fantastic ability to comprehend them. The planetarium can inspire almost to the point of being a semi-religious experience without being narrowed by sectarianism. It can be used to develop an appreciation of the abstract and give the most cynical members of the audience a sense of identity with other human beings who, like themselves, have the privilege of understanding something of the Universe of which they are part.

Discussing the planetarium director, Spitz has said:

> He must be able to combine popular presentation with scientific accuracy. Under his guidance, the planetarium should be regarded widely as a dependable authority in technical matters. He must be prepared adequately to represent his organization before any type of audience, professional or non-professional.

Dr. Harry Crull, in speaking of what a planetarium director should be, has remarked:

> I think in the first place a planetarium director need not be a professional astronomer. I say this advisedly. I have directed three or four planetariums over the past thirty- five years. I am a professional astronomer, but I think that this is unnecessary. Indeed, one must shudder to think what would happen to the

> planetarium community if some of our very good friends who are professional astronomers, were suddenly saddled with the responsibility that some of you have. The director must however, possess accurate astronomical knowledge; and he must recognize when he doesn't have the answer that he not try to invent one.

Despite the room for difference of opinion which will be found throughout this booklet, all planetarians recognize their heavy obligation to astronomy and to the public. Jeanne Bishop stresses this point:

> Remember that you represent astronomy to your audiences and the larger population from which your audience come. You are a public-relations individual for astronomy generally, planetariums generally, and your planetarium and its programs specifically. You have the awesome responsibility to understand astronomy and the scientific method and present programmes which are accurate. They should also be balanced with respect to the sensational issues of astrology, extraterrestrial life, unidentified flying objects, and new, but as yet unproven theories, (e.g., black holes). Remember that the posture of science is skepticism until verified.

Bearing these responsibilities in mind, what background should a planetarium director have? Jeanne Bishop summarizes:

> To illustrate how experienced planetarium directors view background for the position, I share the following results from survey I conducted in 1967: The most desirable training experiences designed were astronomy and physical science courses and classroom teaching. Other characteristics judged important, and which are not obviously trainable, were speaking ability, appreciation of the scientific method and a respect for accuracy, imagination and showmanship.

Although there is a diversity of opinion on many subjects expressed by the contributors to this discussion, there is unanimity on two characteristics which are required of good planetarians–respect for accuracy and the ability to hold audience attention. In writing about the planetarium director, Harry Crull has said:

> He must have many other sides than simply [the] astronomical facet of his personality. He must have a sense of the theatre. I don't mean by this that one turns the planetarium into a grand show with no content and all facade, but one must get the audience to listen before he can tell them much. If you are dull as dishwater, they do not listen.

The magical ability to hold audience attention comes rather naturally to some people, but must be cultivated by others. Each person will have his own style and approach, but some suggestions by experience planetarium directors may help you to cultivate your ability to hold a high level of audience interest. Jeanne Bishop remarks:

> ...An accurate presentation is sterile without programme techniques which aim at relevancy. This is what makes a programme 'interesting'. If you will interpret astronomy for children of different ages and backgrounds, talk with them, observe how they learn, and find what interests them. Even high school students and adults do not have the ability to make inferences about topics with which they are unfamiliar. Participation experiences (such as drawing star maps or locating constellations from personal copies, plotting moon phases with respect to the horizon or Zodiac stars, or role-playing situations) provide concrete experience on which astronomical understanding can be built. For many adults relevancy can be achieved via possible participation, as evidenced by the psychologically well- planned programmes of super-dramatist Jack Horkheimer, Director of Miami Space Transit Planetarium. Length of presentation is important; one which is too long can kill interest. A programme which is too short is always better from a motivational or interest standpoint than one which is too long.

All planetarium directors stress the importance of knowing the audience whose attention you want to hold. One method of getting to know an audience is suggested by Dan Snow in discussing school programmes:

> In a school programme, given at a museum, he thinks it is best to find out how the planetarium experience can best help the class by asking the teacher directly; if necessary, this may be just before the programme. This helps eliminate criticism of not getting what was wanted and helps make the experience more important to the class. Dan is opposed to any 'cut and dry' school presentations.

Another technique for achieving familiarity with an audience is suggested by Jeff Hunt:

> A good relationship with the people who come to your planetarium is essential for your planetarium's survival. At the beginning of your programme, introduce yourself and your programme. If your programme is about comets, you might ask if anyone has seen one. If there is a positive response, you might ask the party which one he saw. You have probably seen how well television programs do that incorporate the audience into the show. People like to become involved in things of this nature. After the programme is finished, you might invite questions, and finally thank the people for attending your show and invite them to come again.

Recently, I attended a programme at a large planetarium, and none of my ideas about proper etiquette were used. The operator did not introduce himself or say anything when the programme was over. The lights were brought up and the doors were opened. Most of the people were not sure the programme was over, while others were very dismayed at the whole situation.

Bill Rush offers his thoughts about audience involvement:

I feel strongly that each planetarium programme should be concluded with an opportunity for the audience to ask questions. In addition to injecting a personal element into the programme and to clearing up any points on which the audience is unclear, such sessions provide a very direct and useful audience feedback to the lecturer. He immediately learns what topics were note made clear to the audience and also discovers what the audience found most interesting.

Jeff Hunt cautions that planetarians be conscious of programme length:

The key to your programme is attention. You want to grasp and hold the attention of your audience for as long as possible (which should be forty minutes). Overused words and special effects lose their impact with constant repetition.

Another factor important to holding the audiences' attention is the attitude of the speaker. Dan Snow remarked:

A presenter should not take himself too seriously. Also, he should sometimes keep his mouth shut and just let the stars roll silently.

GETTING STARTED

Once you have an idea of the general philosophy you wish to follow and know something of your audiences, it is time to begin dealing with specifics. Jeanne Bishop has some suggestions on getting started:

Assume that you will need to do many different things. Whatever you have learned previously may prove helpful in your new position. Take stock of your own skills as well as your contacts with people who have special talents. How do you score as a teacher, a dramatist, a journalist, a curriculum expert, a music buff, an artist or draftsman, a photographer, a mechanical engineer, an electrical engineer, and a reservoir of general creativity? If you lack some of these skills (half is about average among planetarium directors), look for helpers.

> Get to know teachers, club programmes, chairpersons, newspapers and radio contact people, and amateur astronomers in your area. Work with these people to promote your planetarium activities and serve them.

Bill Rush stressed the importance of knowing the right people:

> I suggest investing time in visiting the technical media department if your institution has one. Making friends with the staff can pay rich dividends when you need that special slide in a special hurry. Giving out free tickets to your programme will help you make friends, will help build your attendance, and will help convey to the technical media people what your goals and needs are. If your school or institution has machine shops, electronics shops, woodworking shops or a newsletter, visit the staff of each to tell them what you are doing, giving tickets to programmes to those who seem interested. Try to get listed in the 'things to do' section of your local papers and make sure to send out a 'press release' describing each of your activities.

If your astronomy background is not as extensive as you wish it were, Jeanne Bishop suggests:

> Review your astronomy by skimming a number of introductory college texts and current astronomy periodicals, such as Sky and Telescope and Astronomy. Attempt to fill gaps in astronomy knowledge as quickly as possible and continue to keep up with current events. Get on the NASA mailing list for educators. Check Scientific American and Science for in- depth articles on frontier topics of astronomy. Critically eye astronomy content for interactive relationships with other topics and subjects.

Dan Snow recommended additional sources:

> Reading books and journals is an essential part of a planetarium director's preparation. In addition to Stars in our Heaven, Dan finds merit in The Star Lover, Watchers of the Sky, and Star Names and their Meanings. A must for calculating local conditions of such events as eclipses and occultations is the Astronomical Almanac.

If you are not already a member, we highly recommend that you join the Great Lakes Planetarium Association (GLPA). GLPA memberships include a quarterly newsletter, other TIPS booklets, special publications, and access to the script bank and audiovisual file. We also suggest that you join your state and local planetarium associations and that you consider membership in the International Planetarium Society (IPS). The IPS journal, The Planetarian, contains programme ideas, technical suggestions, news, special effects projector plans, and other useful information. To join IPS, write to their permanent mailing address at:

International Planetarium Society
c/o Hansen Planetarium
15 South State Street
Salt Lake City, UT 84111.

Although at first it seems easiest to just remember where everything is, we recommend a good organizational scheme worked out as soon as possible. Music, books, magazines, spare parts, and slides should all have a place and be kept there. Slides should be marked as to subject and filed so that they can be found, as your initially small collection grows. A variety of formats for storing slides is available.

Jeanne Bishop offers some further advice:

> Expect to sometimes stay at work late and go in at unusual times to set up for programmes, make emergency repairs, and take care of tasks which pile up at an alarming rate in spurts. Try to work out a flexible schedule which allows time off in exchange for long hours during busy periods.
>
> You probably will have several 'bosses'. Do strive to be on good terms with all. If inexperienced, earn your employers' respect in an established planetarium with suggestions for small changes and in other ways before suggesting large, expensive modifications. Always be tactful.

DESIGNING A PLANETARIUM

Although most planetarians find themselves employed by an installation which is already functioning, some may be in the situation of having been able to oversee the design and construction of their planetarium. Jeanne Bishop offers some suggestions:

> If you are so fortunate as to have a say in the design of the planetarium you will operate before it is constructed, try to see that the following are included: no windows (!); light adaptation anteroom; a display area (possibly an extension of the light-adapting anteroom); adequate cove space and a phone; emergency light source; sound-proofing; quiet and reliable air-conditioning; dark walls with provision to hang pictures (I recommend beautiful color telescopic photographs, available from several sources); and doors with complete light seals. I suggest carpeting (indoor-outdoor type with heavy padding) for sound-proofing, warmth, eye-appeal, and the facility of accommodating young groups on the floor. Young students (kindergarten through second grade) are used to activities on the floor, and this situation permits a better simulation of an outdoor experience. For most demonstrations, I recommend the use of comfortable, light-weight, movable chairs, which can be arranged to serve any special purpose. Carpeting and chairs

provide a flexibility which you will welcome, if you anticipate creative and diverse use of your planetarium. (There have been planetarium directors who have had their fixed seating removed as they realized its limitations).

WRITING SCRIPTS

Jeff Hunt has several suggestions for preparing scripts:

> Script writing could be the most difficult job the new planetarian must undertake. It is very hard to keep the whole programme within a reasonable time limit. One tends to ramble when writing instead of producing a clean, crisp programme. It is best to keep your complete show within forty minutes; the shorter, the better. It will take several hours of diligent writing to produce a script to fit into the time limit.
>
> There are a few ways in which you can develop a script for your programme. The first and hardest way is to develop everything from scratch. Make a detailed outline on your subject and fill in between the lines as you research. After generating an outline, there is a simpler path to follow. Find the appropriate material in books and magazines and modify author's work to fit your ideas. Many college students have been failed for not giving credit to authors for their work. If you use another author's work, have the courtesy to write to the publisher and ask his permission to use the material. There should not be any problem if you do not charge admission to your planetarium.

You can exchange your work with others who are willing. The Great Lakes Planetarium Association has developed an extensive script bank. These scripts are available at nominal cost from the instructional materials chairman of GLPA, whose address is listed in the current issue of the GLPA Newsletter. Scripts are often available at local and regional planetarium meetings, again at a low price.

Yet another possibility to consider is the purchase of programmes from a larger planetarium. Although this may seem expensive at a few hundred dollars, the quality is usually high and it would probably be impossible to produce a comparable programme by yourself.

SPECIAL EFFECTS

Although a thorough discussion of special effects is more appropriate in another publication, the beginning planetarian ought to give this area some consideration at the start. Jeanne Bishop remarks:

> Generally, few special effects come with the planetarium instrument. Many planetarians consider the construction and use of auxiliaries a major part of their work. Others are philosophically disposed to think a limited number, with good teaching techniques, will adequately serve the purposes of good programming.

Bill Rush lists what he considers to be the two main types of special effects:

> The first type is what I think of as an 'observational effect' which reproduces some astronomical event (such as a lunar eclipse or meteor shower) as realistically as possible so that the audience can see the phenomenon as it actually looks. The second type of special effect can be thought of as an 'explanatory effect' in which the physical cause of some observed phenomenon is demonstrated (such as a projector which shows an image of the moon moving into the shadow of the earth and disappearing). Ideally, seeing an observational effect should make the audience thing 'so that's what it looks like' and the ideal explanatory effect is so clear that to see the effect is to understand the phenomenon with no need for verbal explanation. I always strive for at least one and usually two special effects of high visual impact in each of my programmes.

However, one must be careful to avoid the tendency to make the planetarium special effect (particularly the 'observational effects') so spectacular that realism is lost. Jeff Hunt comments further:

> Special effects can make or break your programme. You must remember that you are trying to reproduce mother nature as accurately as possible. Make a sunset look like a sunset, not an electrical blackout. Let the eyes of the viewers become adjusted to the darkness; it makes the effect of sunset more realistic.
>
> Whirling star balls tend to make some people nauseated. If you are going to produce some daily motion, start the movement very slowly to let the audience know what is happening. Then you can increase the speed of the motion, a little.
>
> Many times, the intensity of the special effects is too bright, permitting stray light to flood the planetarium dome. Keep the intensity of the projectors at a very low level. Your effects do not have to be bright to be spectacular.

Many planetarium directors feel that it is easy to overemphasize and overuse such special effects. Jeanne Bishop, after an interview with Dan Snow, writes:

> Dan also feels strongly about special visual effects: 'A slide should not appear unless it adds something to the presentation. It's impressive to see a panoramic landscape of Venus, but what really does it contribute? A planetarium is for astronomy. I recently saw such a landscape in a multi-media production. Yes, it dazzled, but the stars portrayed were for the wrong season! This situation is pretty grim! Dan said he thinks much of the spectacular and non-astronomical has appeared as the result of the thinking that the planetarium is a theatre which must pay its way.

As the spectrum of opinions indicates, there is no "right answer" as to how many and what type of special effects should be in a programme.

Assuming that you have decided that you need one or more special effects, the first question [that] arises is whether to build or buy what you want. The answer depends on your particular situation, as summarized by Jeanne Bishop:

> With sufficient budget, you can order a good number of commercial projectors. With talent and time, you can construct projectors which will produce the same effects at a fraction of the cost. The Great Lakes Planetarium Association Instructional Materials Committee and various planetarium periodicals can offer suggestions. I think you must be aware of your planetarium programming objectives, your initial and operating budgets, and your own interests, talents, and time limitations when you decide if and what auxiliary effects to obtain. A word of caution: Do not spend an inordinate amount of time on auxiliary-effect preparation at the expense of effective total programme preparation and presentation and important administrative duties (such as vigorous, positive public relations). Try to maximize the benefits of your planetarium for the population you serve.

Each planetarium director has his or her own particular favorite special effect projector and you must decide for yourself what you want and can afford. Jeanne Bishop has passed along her suggestions as to what she has found most useful:

> Special effects which I have found most useful in a variety of programme situations (public adult and mixed groups, school science students, and multidisciplinary school classes) and which may be commercially purchased are: lunar and solar eclipses, comet, aurora, and evolution-of-a-star. Although a meteor shower is a useful effect, I have not yet seen a commercial projector which conveys the correct idea– that even in the heaviest annual showers, one or two detectable streaks per minute (not one hundred or so!) are normal. Moreover, an occasional arm movement with your projection arrow can suffice to give this idea. You will want at least one carousel slide projector, and if money is available, four to eight would be useful. Also acquire as many small single-frame slide projectors without fans as possible, for you will find that they have endless uses. Install rheostats on projector light (not fan) sources, for best effect in use. If you will not have panorama skyline projections, make a silhouette with buildings, trees, and other skyline objects of heavy, black construction paper (available on rolls) for your dome. Remember to keep the scale small to keep the impression of "vastness".

MUSIC

Jeff Hunt offers several suggestions on music:

> Selecting music to accompany your script can be made effortless, if you select a theme for your programme.
>
> If you go to the cinema frequently, you may find a good idea for a programme by listening closely to the music soundtrack. It may take more than one viewing of a movie to discover its musical score.
>
> Many times music is overused in planetarium shows. I like to introduce a new idea with ten or fifteen seconds of music fading it down to a level that suitably mixes with my voice. I let the music play for about two more minutes at this level and then fade it away. When another new idea is introduced, I do the same thing. Once in a while, I let the music play through the whole idea that I am presenting. When that section of the script is completed, I immediately stop the music and start the next piece of music. This is a good 'attention getter'. Never use music with singing in it because it can draw attention away from your words and to the singing.

TAPE OR LIVE

Perhaps no single question has generated as much debate among planetariums is whether or not programmes should be taped. Virtually all planetarians feel that the best shows are those given by a live speaker. Unfortunately, a slip of the tongue, a series of closely spaced programmes, or a stubborn cold can result in a less than satisfactory presentation. The question of whether to tape or not is a question of balance between the closer audience contact of a live lecture and the greater convenience of a taped programme. Jeff Hunt describes some of the relevant considerations:

> How are you going to present your show: You can either tape it, or do it live, but which is best? There have been many discussions about the best way to present a planetarium programme, but your experience will eventually tell you what is best for your style. Before you decide the method of presentation, you may want to ask yourself these questions: How many times will the programme be used? Will there be several presentations within a short period of time? Will the programme be used again sometime in the future? If the programme is going to be used several times, you may want to tape it. That way you have an option when it comes time for your show.
>
> Another point to consider is the amount of special effects you have in your programme. If you decided on a large number of effects that take an enormous amount of concentration to operate, you will want to tape the programme. Operating special effects and talking is not unlike walking and chewing gum at the

same time; it is a difficult situation. When in doubt, tape your programme. You may find that the operation of the special effects may not be as difficult as you first thought.

Jeanne Bishop, in interviewing Dan Snow, gives us a reaction of one planetarian who dislikes taped programmes;

Dan is totally against a completely taped programme for any audience. He believes that it is an insult to one's audience if a live presenter is not there. He likes taped music at the beginning and end of programmes, however. His preference is for quiet, mysterious passages to introduce the stars, which he has termed the 'darkness falls on the wings of night' approach. For sunrise he uses music which contributed an uplifting mood (he likes to let stars gradually fade to such music with no voice). He also uses various sound effects, such as bird calls. But he cautions to use special care lest the birds depicted are not in season! In this age when so many public–and even some school–planetarium programs are completely taped, this philosophy probably seems unusual. Dan believes the value of the live presenter has been overlooked.

GIVING A SHOW

The diversity of programmes and individual styles makes it difficult to give any rules for presenting a programme, but the late Ruth Howard had a few general tips:

Start the pointer at the zenith and call the attention of the audience to the direction in which it is going to move.

Move the pointer slowly and as steadily as possible. It is very easy for the audience to lose the arrow, especially if that audience is unacquainted with the sky.

Turn on rheostated switches slowly. You will see any error in switching before it becomes apparent to the audience and can make a correction without their ever knowing it occurred.

Although some 'purists' may object to a lightly oval sun, I have found that by projecting the orrery onto the curving portion of the dome, rather than directly overhead, you can create the illusion of elliptical orbits and illustrate Kepler's first law more effectively. Few of the audience will be aware that the sun is not round! The orbit of Mercury, in particular, will show this effect.

Despite the fact that many planetariums do not allow children under 6 or so, we have found that the preschoolers- -4-year olds, especially–respond well to a 20-minute programme entitled, 'What Happens at Night'. This works best when the group leader has prepared them for the dark before they come to the planetarium. This programme is a good introductory programme for kindergartners, too.

Keep within the time limits you have publicized for each programme, especially for public programmes, as many in the audience may have times their parking meters to correspond. They will become fidgety if they feel trapped and know that their meters are running out!

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SCRIPT

Reaching your Audience

What do people expect to see? How do they react to your shows now? What turns them off in a show? What turns them on in a show? It's important to know the answers to these questions.

Idea: use questionnaires and surveys on a regular basis to find answers to these questions. Surveys and questionnaires aren't perfect, and you will have to interpret the results to a degree, but they are very useful tools.

Listen to people as they leave. Are they animated and excited about the show? Are they shuffling out like zombies? No single crowd reaction is an indicator of show effectiveness, but over time you can get a feel for the public's reaction to the show. You can even post an 'unmarked' staff member/volunteer near the exit to gauge peoples' reactions.

Recognize topics which tap in to the interests of your audience. This means steering away from topics which are of academic interest to planetarians (and a small percentage of audience members) only.

Target your audience. Design a show for "college age and adults", "10 to 18 year olds and their parents", "1st through 3rd grades", or whatever... But you need to have a clear idea of who it is the show is going to be playing to.

Have others review your concepts and your script. Usually we are too close to our projects to be objective about whether they work or not. Bounce ideas, and especially your scripts, off non-planetarium people... educators, script-writers, storytellers, science people, ordinary folks, etc.

Should we do this Show?

Can you hold the audience's attention for the duration of the show? If the topic is genuinely interesting, but not enough to base a show on it, don't try to stretch it to fit 30-40 minutes.

Some topics are best left alone, and we shouldn't 'beat dead horses' just to satisfy our own intellectual urges. Ask yourself (and ask others) would an audience really want to see this show, and why. Some topics could best be covered as a small part of a larger show.

Can you support the show visually? Most especially, can it be supported with the resources at your disposal? Avoid topics & ideas altogether if these questions can't be answered to your satisfaction.

How Long?

How much is too much? Entertainers are at their best when they leave the audience wanting more, and we should do the same. Don't leave out vital information, but don't let the audience leave wishing the show were over sooner.

For general audience shows in most situations, 35 to 45 minutes is an ideal range of lengths. Go more than 45 minutes, and you'll probably need fireworks to get the audience excited. This has almost as much to do with being in a comfortable, darkened environment as it has to do with how good the how is.

Breaking the mold...

Make use of standard literary devices:

theme	drama	humor
conflict	problem solving	characters
storytelling	etc.	

Strive for different styles of shows

Direct narrative	Storytelling	Science Fiction
Conversation	Game Show	Poetic treatment
'Literary' treatment	Adventure	etc.

Just the facts, ma'am

Pay attention to the role of scriptwriter as interpreter and 'translator' of knowledge...does the audience understand the information as well as the author thinks they do?

Avoid overindulgence in details. There is only so much that the audience can remember (and tolerate) in one show. Keep the facts direct and simple whenever possible.

Strive for accuracy. Get professionals to look over the content of the script, even if you are a scientist yourself. We need second opinions.

Most things we know about space are not facts, they are theory or 'current state of knowledge'. Don't portray all our knowledge of space as FACT.

Focusing your thoughts

Create shows for children and school groups that are specific for that age range. Don't make them just watered-down adult shows. The music, style of dialogue, choice of voices and visual style should all be chosen with your specific audience in mind.

Remember the "Edgar Allen Poe" principle...everything in a story should work towards the desired effect- every character, every 'aside', every visual. If a detail does not contribute towards this goal, it should not be in the story.

AUDIENCE & MUSIC

Choose the right voices. Avoid the DJ/Voice of God/Newscaster narrator. They may sound silky and smooth, but they usually don't have enough vocal variety and expression to stimulate the audience.

A single narrator in a show usually cannot hold audience attention for the duration of the show. Only a strong, arresting personality or a celebrity narrator can pull this off. If you are using narrators, use a variety (2 to 4) of vocal styles. It's also useful to have both male and female voices.

Don't always go for the 'perfect' voice. More often than not, they won't be the most effective for your show. There are wonderful voices out there that are fascinating to listen to, and the most interesting are often 'flawed' or offbeat in a small way (or even a large way).

Radio/TV people and other announcers rarely make good narrators. Actors often make the best readers. You can find a ready source of good voice talent at local university and civic theaters- contact the artistic director at these places and they'll be happy to help you find the right voices. And most of these actors won't want an arm and a leg to read for you... many will do it for free if you are on a tight budget.

You can also find a ready source of voice talent by placing a casting call announcement in your local paper, where they announce calls for local theaters. This usually costs nothing.

"Music hath charms to soothe..."

Music sets the mood in a show...it helps the audience to suspend 'disbelief' & get absorbed into the show...it helps focus the audience's attention on what you want them to learn. It is not there just because a show would be boring if the narrator was reading alone.

Select music that complements and enhances each new section or theme in the show. Don't just create a 'bed' of music that just lies there throughout the show.

Just because we are space theaters doesn't mean we should use 'space music' in our shows. This usually comes off as trite and does nothing to enhance your show (and usually will put your audience to sleep).

Strive for a greater variety of musical styles in our shows. Even 'offbeat' styles can be very effective for entire shows or sections of shows...Orchestral, rock, calypso, jazz, hip, hop, reggae, etc. And don't think you have to avoid music with any trace of rhythm or beat. Properly chosen, such music can really add life to a show and help the audience 'get into' what you're trying to get them to learn.

The changes of music in a show are nearly as important as the musical selections themselves. Musical crescendos, sergues, changes for change of scenes, and the use of sound effects are important elements in a successful soundtrack.

Use variety within your show with the mixture of voice and music. For certain sections, you can vary things by using 'cold' narration (no music), total silence (no music, no voice), sound effects only or as a background for voice, or single instrument music.

We need to strive for legal use of music in our productions! Grabbing music from a CD or record is not a legal use within a show...unless you have secured an ASCAP/BMI license, obtained synchronization rights from the composer of the music, and obtained editing and mechanical rights. There are sources of music that are legal and useful for our shows.

Musical libraries are available from Mark Petersen, Barry Hayes and other planetarium composers. If you are aware of a composer who has done work for planetariums, you might be able to purchase a library of their past work for a nominal fee, even if such a library has never been offered before.

There is a gigantic selection of commercial music available in music libraries offered by music companies. Dozens of companies offer a wide variety of styles, including classical music recorded by symphonies. This is not schlocky, brain dead music either. In the past, commercial music libraries were either glitzy or boring. But there are many today that offer some incredible music. Fees for using this will vary with use, and some companies offer discounts for education use of music. Many will even send you CDs on approval, which you've chosen from a detailed written list. You can then listen to the cuts, choose which ones you like, send back the CD's you don't want, and pay only for the tracks you wind up using.

Original music scores are not just for the 'big domes'. You can find many people locally who can create good music for your shows that is original. Contact university music departments, music stores and music clubs to find the musicians in your area. There are many struggling artists out there who have talent, and would love to create music for your for a reasonable cost. If you are really on a tight budget, you can even find some who will create music for no cost, if they receive credit and exposure for their work.

VISUALS

Achieving 'realism' - "Star Wars" on the dome?

We can rarely hope to be hyper-realistic on our domes, except with our stars. But we can create an effective setting for our script, much as live theater does. Theater sets are rarely literal and realistic- they are more often suggestive of the locale, and they are only realistic enough to stimulate the audience's imagination.

It is important to maintain the illusion of a wonderful space larger that the dome itself. Our star projectors begin this illusion...the other visuals should enhance and strengthen it.

It is better to use fewer high quality visuals than use many low quality visuals.

Vary the style of presenting visuals. Mix slides & video, mix slides and special effects, vary fade rates, vary screen locations, and use animation or dissolve effects.

Models and props can be used to create great looking visuals that are more effective than flat artwork. They can also be photographed from varying angles to get multiple visuals from the same piece. You can build your own, and do it very cheaply. Or you an find model makers locally who will do it for you, for reasonable rates or even in exchange for a credit.

Make sure that everyone in the audience can see the show as much as possible. This may mean multiple visuals. Much of how you present the visuals will hinge on how the script is written.

Quality slides

Maintaining an effective setting is important; dirty slides, unmasked slides, faded slides, poorly registered slides, and grody-diagram-from-a-textbook slides help destroy the setting.

Mask slides creatively. There is a wide variety of ways to vary the presentation of even mundane images, by using imaginative masking. They can be purchased from DSC Labs or Wess Plastics (fuzzy edged or hard edged), or made 'at home'. It is incredibly simple to design a snazzy mask and shoot it on kodalith.

Choose typefaces that are readable and distinct. Don't choose odd typefaces just because you think they look 'cool'. Unusual type can be used very effectively for titles, and even throughout the show, if chosen wisely. Strive to maintain a uniform type style throughout the show, especially in graphics and diagrams.

To learn more about photography and slide techniques, you can enroll in photography or graphics courses offered by local universities or adult continuing education programs. Tuition for these classes is often very cheap.

The incredible Zeiss-o-matic

Our star projectors are our single most effective special effect. But the stars will get old and won't be impressive if we overuse them. If we use the right mix of effects, slides and whatever, then the audience will ooo-aaah when we use nothing but stars. This is true even in skyshows. The sky will be more impressive if we vary the presentation of the stars. For example, you can start with some blue skyglow from the moon or city lights, discuss some of the planets and constellations, then go ‘out to the country’, wow them with a dark sky, and continue your show.

Conversely, don’t use the star machine as just a background of dots for your slide show.

Avoid unrealistic sky motions when your show is depicting the real sky. Don’t have the sun setting in the east or north; and don’t run the stars backwards, even for a short time. Audiences often pick-up on more than we suspect.

MISCELLANEOUS

The Planetarium should look the part of a space theater. This doesn’t mean we need to make it look like a spaceship interior. This does mean that your theater is a part of the show, and it gets the audience in the mood, even before the lights go down. Junky, funky looking theaters give the public a low expectation to begin with. Avoid the ’construction in progress’ look, and make the environment as sharp as you can. And sharp = expensive.

Human relations are very important. Friendly knowledgeable staff members play a vital role in how your audience enjoys a show. They also need to dressed to impress, and this doesn’t mean a coat and tie. This could mean jeans and an astronomy t- shirt, or it could mean a uniform. However you achieve it, a sharp appearance is important. If we look sloppy, it says something about us.

People have already formed an expectation in their minds before the show starts. Building environment, staff, the look of the theater and the music they hear when they walk in- these all work together to enhance or degrade your show.

We need to create shows which fit our planetarium environment. We can’t outdo movies, but we do have a unique theater which offers an experience a movie can’t duplicate. Play up our strengths, and minimize the weaknesses.

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THE EDUCATIONAL VALUE OF THE PLANETARIUM

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The Great Lakes Planetarium Association here sets forth a synthesis of scientists' and educators' ideas on the value of the planetarium in the educational process. Because the planetarium is an astronomical laboratory, the first question which is addressed is "why study astronomy?" The contributions which the planetarium can make in learning astronomy are next considered. The unique role of the planetarium in education beyond the bounds of strictly astronomy is then discussed. Finally, arrangements which help to optimize the presence of a school planetarium are given.

The value of all students of learning astronomy. There are many reasons why astronomy should be included within the K-College curriculum:

1. This is indeed a "Space Age with daily announcements of achievements and discoveries in the space sciences. As Superintendent Richard Rea of the Western School Corporation, Russiaville, Indiana, stated, "There are now youngsters in kindergarten who are going to be in space - regularly!" (Spring, 1978). Some of today's students will be directly involved in space activities, but all will be surrounded with space-related events and information.

2. Astronomy is the most fundamental of sciences, as well as the oldest. It gives each individual a perspective on his place in space and time. Man has an intuitive desire to know more about the universe about him, to push back barriers of ignorance and comprehend the mysteries of the greater environment.

3. Astronomy is useful to each individual. Time units have astronomical bases. Standard Time, Daylight Savings Time, the seasons, and the calendar are integral aspects of our social- political culture. Some understanding of the celestial sphere and astronomical motions is useful in estimating time and finding directions.

4. Astronomy has an aesthetic value found in few other subject areas. The intricate and awesome dimensions and composition of the universe can produce the perception that

the earth is a delicately balanced ecosystem with limited resources and time existence. An additional source of wonder is that Man of insignificant size has the capability of understanding much about his position in time and space.

5. Astronomy is inextricably linked to energy topics. The sun is the source of fossil fuels, wind, and direct solar energy. Radioactive elements important in nuclear energy and the source of geothermal energy are the remnants of processes once inside stars which ended their lives with tremendous explosions. Tidal energy is caused by the gravitational pull of sun and moon. Probably the important energy discoveries, vital to the continued existence of Technological Man, will depend on knowledge of astronomy as well as of other science areas.

6. Astronomy appears in unexpected places: in fictional as well as non-fictional books, in popular songs, in arts, and the comics. It has been harmfully presented within the pervasive speculative topics of UFO's and astrology. Students mislearn astronomy from the media. The schools have a responsibility to help students critically regard media presentations. To do this effectively, they must include responsible introduction to astronomy in their curriculum.

7. Responsible study of the vast numbers of stars and the process of star formation combined with data from interplanetary space missions can promote constructive thought on great philosophical and psychological questions: Are there other intelligent beings somewhere else in the universe? Is earth alone an abode of life?

The value of the Planetarium in Astronomy Education. Astronomy learning can be greatly assisted by use of the planetarium.

1. Any topic involving the appearance of the sky can be viewed in three dimensions. Text and chalkboard diagrams cannot reproduce the omni-directional perspective of the planetarium. Classroom models normally present an outside - earth perspective, while the planetarium recreates the from - earth perspective.

2. The sky may be viewed comfortably with no interference from bad weather.

3. Students do not need to wait half a day or more after receiving teacher directions for night-sky observations before viewing night-sky phenomena. Students immediately respond to directions, and there is far less chance of forgetting or misremembering.

4. The sky as seen from other places than the student's home, for other times of the day and the year and at times in history and in the future, can be effectively shown by the planetarium.

5. Sky motions can be illustrated, with entire cycles compressed to intervals which permit students to determine that they are periodic.

6. Many children in cities grow up unaware of most aspects of the sky, because light pollution washes out the stars and planets. Very few children, except those who live in rural areas or who have had rural camping experiences, have seen the Milky Way, the faint banner of light that is the extension of the Galaxy. The planetarium can show the Milky Way and other sky bodies in simulated darkness.

7. Auxiliary effects (e.g. slides, audio aids) can contribute to the realism and promote an aesthetic (peak) experience in the planetarium.

8. The planetarium can motivate students with its interesting, stimulating learning situation. Surveys have shown that students like astronomy more than other sciences, and the stimulating environment can build on initial interest and help it develop into a lifelong interest.

9. Planetarium learning is consistent with many theories of psychology and instruction. Some are:

    - The research of Jean Piaget over the last fifty years has shown that most children, many adolescents, and even some adults, apply concrete reasoning patterns to topics. The planetarium can concretely illustrate astronomy topics, so it should facilitate learning in the majority of the students, who are incapable of abstract learning.
    - Hemispheric brain research has revealed that different functions are performed by the two hemispheres of the brain. The schools have traditionally directed their attention to the left-brain functions - verbal and logical learning. The students who are "right-brain dominant" have not been able to learn as they prefer, utilizing the right-brain capabilities of spatial imagery, form and color discrimination, and holistic learning via the senses. The planetarium, where spatial representation is excellent, can help right- brain learners.
    - Perception studies have shown that what is seen in an effective presentation, is much better remembered than something which is simply told or discussed.
    - Cognitive mapping studies have revealed that students vary widely in their preferred modalities of learning. In the planetarium many modalities can be employed simultaneously–visual sky simulation, slide or model interpretation, lecture, discussion, student drawing or plotting, and prediction- problem solving.

The Value of the Planetarium Beyond Astronomy Learning. In addition to the planetarium serving astronomy learning, as it is incorporated in science programmes K-college, planetarium utilization can supplement other subject programmes and serve additional objectives. Astronomy is related to many subjects. A few are:

1. Mathematics. There is no better place to present a lesson on circles and spheres in the geometry curriculum than the planetarium. Celestial navigation can enhance a study of trigonometry .

2. Social Studies. Programmes K-college can benefit from planetarium lessons: Concepts of the sky of native Americans, Eskimos, Aborigines, Chinese, and others can bring ancient and present cultures "to life" for students. Physical geography concepts of longitude, latitude, and climatic changes at different latitudes can be vividly illustrated in the planetarium.

3. Language Arts. Creative writing in the stimulating planetarium environment, where poetry and music can be combined with sky views, can be effective in unleashing student potential. Classical mythology units become more meaningful when presented in coordination with at least one planetarium lesson on the mythology of the constellations.

4. Foreign Language. A planetarium programme can be presented in the foreign language, with the assistance of the language teacher and/or class. The sky can be shown as it appears from a city where the language is spoken, and the students can be asked to pretend they are taking a trip to that country where a lecture on the night sky is presented to them in an outdoor amphitheatre. Each country has had famous astronomers, and the main contributions of some can be discussed in this setting.

Additional Value in Planetarium Learning:

1. Student observing, hypothesizing, and drawing/plotting skills can be developed with appropriate activities.

2. Right brain hemisphere capabilities in all students can be developed – spatial imagery can improve in left-brain dominant students.

3. Students with learning disabilities in reading have a chance to succeed in the visual-aural techniques of the planetarium environment.

4. Students become interested in their school work, when tied to the planetarium visit, and express a desire to know more about many topics (history, math, science). This is the experience of many planetarium teachers who have had feedback from classroom teachers).

Recommended Arrangements for Optimizing the Presence of a School Planetarium.

A planetarium can accomplish a great deal and be of value in the ways listed above. However, a planetarium is not guaranteed to accomplish a single objective independent of other vital considerations. These considerations and recommendations relating to them are given below.

1. Establishing Initial Objectives: Goals, which incorporate a recognition of the potential of the planetarium in education, should be established which are integrated with the goals of the school or school system. Who shall visit and when will be in part determined by the total population which a planetarium must serve. However, the planetarium curriculum will fall short of its potential if articulation of science and other school programme objectives and planetarium capabilities does not take place. If it occurs when a planetarium is first established and continues, with planetarium objectives evolving with school programme objectives, the facility can be a maximum impact planetarium.

2. Planetarium Personnel: "No other single factor can impose a stronger influence on the effectiveness of a planetarium than the personnel assigned to it." (McDonald, 1966). It is essential that those who operate and give presentations in the planetarium have a wide range of capabilities. A panel of 35 experts have identified the following characteristics, some trainable and some inherent, in effective planetarium teachers: astronomy knowledge, classroom teaching ability, public speaking ability, enthusiasm, knowledge of planetarium methods, creativity, scientific aptitude, mechanical-electrical aptitude, flexibility, ability to write, and dedication to and great enjoyment of, planetarium activities. The planetarium director should be able to work well with both teachers and students. To optimize the skills of the planetarium personnel, schools should make provision for flexible schedules, opportunities for two-way communication with the administration and with teachers, and opportunities for participation of personnel at professional planetarium association conferences.

3. Planetarium Budget: Planetarium curriculum costs in a number of school systems have been analyzed. The cost per student is less than for most other "special facility programmes" - including athletics, science laboratories, industrial arts, and home economics. The educational benefit of the planetarium has been observed to be so great that in a cost-benefit comparison, the planetarium frequently surpasses other system programmes. However, adequate operating budgets must be provided so that 1) transportation of students can occur as directed by objectives of the curriculum, 2) Planetarium personnel have adequate time in their schedules (are not too thinly spread with teaching and other responsibilities) to pursue a quality programme, and (3) adequate materials (office supplies, audio-visual supplies and equipment, and facility replacement items) and services (planetarium projector maintenance equipment repairs) are available.

4. Population Served: Every child should have the opportunity to benefit from planetarium experiences during his/her elementary and secondary school years. Many educators recommend a minimum of several visits within grades K-6, two visits during junior high, and two visits during high school; however, some recommend many more. School programme objectives as well as the total number of students to be served are important considerations in determining the ideal planetarium curriculum for grades K-12. Teachers (in-service programmes) and adults (in classes and special programmes) should be considered as segments of the population to be served by a planetarium facility. If cost prohibits a school system from owning its own planetarium, plans should be made to use the services of a museum, college, or other school district which does have one. Every effort should be made to coordinate the planetarium experiences with the using school's curriculum objectives. A number of planetariums provide services to a number of schools, and usually they provide printed materials which help teachers integrate planetarium experiences with class programmes.

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PART SIX

OBSERVATION OF SATELLITES

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LIVE OBSERVATION OF BRIGHT ARTIFICIAL SATELLITES

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Planetaria and other educational institutions around the world were invited to participate in a project to promote real-time observations of bright artificial satellites during the International Space Year 1992. Originally proposed by amateur astronomer Paul Maley of Houston, this initiative is one of nearly two dozen educational activities recommended by the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) and organized by the Office for Outer Space Affairs (OOSA) of the United Nations Secretariat in New York. These activities should assist all countries, particularly the developing countries, to gain an understanding and appreciation of space science and technology, and its utilization in social and economic development activities.

SELECTION OF SATELLITES

The following bright satellites were selected for observation:

Satellite	Magnitude	Inclination
Space Shuttle	- 3 to + 2	28 to 57
Mir Space Station (Mir)	- 1 to + 1	51.6
Hubble Space Telescope (HST)	+ 2	28.5
Compton Gamma Ray Observatory (GRO)	+ 2	28.5
Upper Atmosphere Research Satellite (UARS)	+ 2.5	57.0

While other satellites may sporadically reach naked eye brightness, these objects do so with constant regularity. In cases where visibility is limited (e.g. high latitude stations in Finland and Sweden), some other bright satellites were added to the above list.

PREDICTIONS OF VISIBILITY

If latitude of the observing station is between 30 degrees north and 30 degrees south, predictions are issued for all satellites listed above. For higher latitudes, predictions are issued for high inclination Space Shuttle missions (4 are planned for 1992) and Mir and UARS transits. The frequency of predictions could be twice per month or as low as once every two months depending on the station location and satellite visibility conditions. Since the Space Shuttle launch schedule is often subject to often changes, predictions are issued only immediately after launch and for places with good visibility conditions.

Because of orbital maneuvers and/or variations in the atmospheric drag parameters, typical predictions are ageing rapidly. Therefore, they were issued only up to a week to ten days from the day of origin (epoch of orbital elements). This is why the fax distribution is crucial. To minimize costs, data are normally provided for one city per country only (see the list of participating institutions at the end of this article). Extrapolation 50 to 75 km away from the given location is possible, but for low satellites the geometry can change noticeably. The fax message generally contains multiple city names, selection from which is made locally.

The easy to read standard format of the predictions is shown on the following example:

CITY	SAT	DATE	GMT	MAX EL	ABOVE	TRAVELLING	HT
Vienna	Mir	Sept.7	19:14	79	SSE	SW-NE	392
		Sept.8	18:18	46	SSE	SW-E	392
		Sept.9	18:58	70	NNW	W-NE	392

CITY:	name of the observing location
SAT:	name of the satellite
DATE:	month and day
GMT:	Greenwich Universal Time (in hours:min)
MAX EL:	maximum elevation (at culmination) above the horizon (in degrees)
ABOVE:	the direction to look at the satellite in culmination (South, East, North, West and combinations)
TRAVEL-LING:	direction of apparent motion of the satellite (for example SW-NE is from southwest to northeast)
HT:	height above the Earth (in kilometers)

While most people are more interested to observe at the evening rather than morning hours, predictions for the morning hours have been included for some of the Mir and Space Shuttle transits.

SUGGESTIONS ON PROMOTION AND INFORMATION FEEDBACK

Since the purpose of this project is to promote public awareness about satellite observations, feedback information about the media and public response was very important for its success. The Office for Outer Space Affairs of the United Nations Secretariat is collecting and evaluating this material which will be used in future studies on the methods of promoting space science and technology and its use in education.

Satellite fly-bys have been announced in television, radio and local newspapers. Establishing a good rapport with each medium proved to be very important since news media are often not interested in being completely factual. The least timely medium is newsprint since there is a multiple day lag and very often one or more numbers may be misinterpreted. Very often, a current news story involving one of the satellites in question have been used as grounds for the media to advertise the fly-by (some background material is included in this article). For Mir and Space Shuttle, there were humans on board and this of course added to the uniqueness of the drama. Planetaria possessing of a satellite simulator have found it advantageous to utilize the fly-bys as part of a planetarium show devoted to space travel.

COMMENTS AND COMMUNICATION

During the realization of the project, all comments as to changes or improvements in the format of predictions or selection of objects were encouraged, as long as they helped to make a better predictions and did not involve an increase in workload. The whole project was organized without any additional financing or man-hours allocated specifically to it.

Some problems were encountered because both Mir and Space Shuttle are altering their orbits during missions. Errors in predicted times have nearly always been attributed to unpredicted maneuvering, the effects of which were minimized wherever possible (e.g by distribution of the revised predictions). Also sudden changes of the solar activity resulted in variations of the higher atmosphere densities which in turn influenced the accuracy of predictions. However, there were only a few cases where the predictions were in larger error than 4 minutes.

AN EXAMPLE OF BACKGROUND INFORMATION WHICH WAS PROVIDED TO PARTICIPATING INSTITUTIONS ON SPACE OBJECTS OBSERVED

Hubble Space Telescope (HST)

The HST is the first of four planned "Great Observatories" – large astronomical satellites each operating in a different portion of the electromagnetic spectrum that collectively will examine the full range of phenomena in the universe. A 2.4 meter diameter telescope, the HST was launched during a Space Shuttle flight into a 609 km (378 statute miles) high orbit inclined 28.5 degrees to the Earth's equator on 24 April 1990. The HST makes one trip around the Earth every 96.8 minutes. HST weighs 10,900 kg (22,000lb) and is 12.4 meters (41.2 ft) wide with its solar arrays deployed.

HST has already taken spectacular images of unprecedented detail. Within the solar system it has recorded atmospheric features on the planet Saturn, including the evolution of a dramatic storm measuring 80,000 km (50,000 status miles) in size during 1990. It has sent back clear imagery of very distant objects such as an exploding star some 160,000 light years from Earth defining a shell of material surrounding the star. This type of data is expected to provide important insights into the evolution of massive stars and their deaths as supernova explosions. While technical problems have inhibited some experiments, a Space Shuttle repair mission is planned for late 1993.

Upper Atmosphere Research Satellite (UARS)

This satellite is six times as tall as an average person in size and weighs 6,000 kg (13,000lb). It was placed into a 580 km (360 statute miles) orbit on 12 September 1991 by the Space Shuttle. It makes a complete orbit around the Earth once each 96.2 minutes and its orbital inclination of 57 degrees to the Earth's equator provides visibility from virtually all population centers in the world. However, the satellite has a very peculiar shape and therefore is not as easily viewed as are other large spacecraft.

UARS major mission is to monitor the fragile ozone layer in the Earth's atmosphere. Its mission lifetime will span two northern hemisphere winters during which time the largest natural variations in the atmosphere occurs. By far the biggest impact will be on research to understand how the atmosphere is structured and what its effects have been and are expected to be on human activities and natural events. The $US 740 million satellite has recently discovered surprisingly violent, continent-size windstorms in a rarely studied part of the atmosphere nicknamed "the ignorosphere". Weather in the lower atmosphere generates small wind waves that become bigger and bigger as they spiral upward. UARS found that these 300 km/hour waves form storms that are from 1000 to 10,000 km wide.

Gamma Ray Observatory (GRO)

This major science instrument was launched into space from the Space Shuttle on 5 April 1991 into 440 km circular orbit where it travels once around the Earth in 93.3 minutes. Once in space, it was re-named Compton Observatory (in honor of Arthur Holly Compton, a joint-winner of the 1927 Nobel Prize for Physics). GRO's mission is to investigate gamma radiation, the most energetic form of radiation known, and its exotic and violent sources – pulsars, white dwarfs, neutron stars, cores of active galaxies, quasars and possible black holes. The gamma ray band in the electromagnetic spectrum offers insight into some of the most enigmatic and energetic processes related to the origin and evolution of the universe. Unlike conventional telescopes which look at light in the visual spectrum and measure energy of a few electron volts, the gamma ray detectors can pick up energy bursts of billions of electron volts.

Three of GRO's science instruments are each as large and heavy as a subcompact automobile. They are specially built to filter out troublesome cosmic rays which are 10,000 times more common than gamma rays. Unlike the Hubble Space Telescope which is one optical eye, GRO has four large independent telescopes that monitor the entire sky continuously for gamma ray events. Unlike HST, the GRO's pointing needs are much less sensitive in order to complete its 4-year mission. In addition, this 16,000 kg (35,000 lb) observatory has small thrusters on board that can help boost it into a slightly higher orbit as atmospheric drag causes it to decay.

Mir Space Station

The Soviet Mir Space Station has been in orbit since 19 February 1986. It is currently in an orbit inclined 51.6 degrees to the Earth's equator and situated approximately 400 km above the Earth. It travels once around the Earth in about 92.5 minutes. Unlike the Space shuttle, the Mir is occupied by crew members during most of the last 5 years. Guest cosmonauts from other nations visit the station for short periods of time and usually 2 crew persons remain on board at all times. Periodic visits are made by remotely piloted supply ships. Its relatively low orbit means that the crew must use onboard engines to boost Mir higher in order to prevent it from reentering the Earth's atmosphere. The station complex consists of a number of modules linked together with ports that can accommodate both manned and unmanned vehicles at either end of the Mir. Experiments are performed both inside and outside as required. During 1992, guest cosmonauts from Germany, France and Spain are expected to fly and perhaps one or 2 large modules may be added to the expanding Mir complex.

Space Shuttle flights

The United States Space Shuttle is a piloted, reusable space vehicle that makes trips into space of 14 days or less duration. It is shaped very much like an airplane with a length of 37 meters and width of 24 meters from wing to wing. It is painted white on the upper body with a dark underbelly. Crews are composed of 5 to 7 persons who operate in an informal shirt-sleeve environment in their pressurized cabin. When required, designated astronauts may don space suits for working outside the Shuttle in various tasks. The Shuttle is mainly used to launch satellites which cannot more easily be lifted by expendable rockets. It is also used to retrieve and/or perform space repair of other vehicles. Many different experiment types can be conducted from within the confines of its 5 x 18 meter (15 x 60ft) payload bay which is open to the space environment shortly after orbit insertion or from inside the cabin.

LIST OF PARTICIPATING INSTITUTIONS AS OF MARCH 1992

Planetario de la Ciudad de Buenos Aires
Galileo Galilei
Prof. Antonio Cornejo
Av. Sarmiento y B. Roldán
Buenos Aires
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Argentina

OMNI Theatre City West
Unit 29, City West Home Centre
Ms. Susan Contos
Railway Parade
West Perth, WA 6005
Fax number: 61-9-481-6530
Australia

Planetarium der Stadt Wien
Prof. Hermann Mucke
Oswald-Thomas Platz 1
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Austria

Barbados Astronomical Society
United States Information Service
Mr. Wakefield Sutherland
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Bridgetown
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Barbados

Europlanetarium
Limburgse Volkssterrenwacht
Mr. Johan Gijsenbergs
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Fax number: 32-11-303336
Belgium

Planetario "Dr. Mase Sahaier"
Universidad Boliviana
Mr. Manuel de la Torre
Casilla N 10392
La Paz
Fax number: 591-2-359491
Bolivia

Planetario da Cidade de Rio de Janeiro
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Planetarium Dow
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Canada

McLaughlin Planetarium
Royal Ontario Museum
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Canada

Planetario
Universidad de Santiago de Chile
Mr. Luis Dunstan Alfaro
Avda. Bernardo O'Higgins 3349
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Chile

Observatory and Planetarium
Ing. Marcel Grűn
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Fax number: 422-375-970
Czechoslovakia

Liverpool Museum
National Museums & Galleries on Merseyside
Mr. Martin Suggett
William Brown Street
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England

Ursa Astronomical Association
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Planetarium
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Germany

Budapest Planetarium
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Hungary

B.M.Birla Science Centre
Dr. B. G. Sidharth
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Fax number: 91-842-222483
India

Wise Observatory
Tel Aviv University
Dr. Noah Brosch
Tel Aviv 69978
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Israel

Nagoya City Science Museum
Mr. Takashi Yamada
17-1, Sakae 2, Naka-ku
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Fax number: 81-52-203-0788
Japan

Sociedad Astronómica de México
Mr. Guillermo M. Mallen
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Carter Observatory
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Space Research Centre
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Armagh Planetarium
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SUPARCO
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Pakistan

Planetario Calouste Gulbenkian
Museu de Marinha
Mr. José Cyrne de Castro
Praca do Imperio
Lisbon
Fax number: 351-1-363-1987
Portugal

Planetario de Madrid
Ayuntamiento de Madrid
Mr. Asunción Sánchez Justel
Parque Tierno Galván
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Fax number: 34-1-468-1154
Spain

Planetario de Pamplona
Mr. Javier E. Armentia
Arrieta, 16
E-31002 Pamplona
Fax number: 34-48-226309
Spain

Kosmorama Space Theater
The Future's Museum
Ms. Mariana Back
Jussi Bjorlings vag 25
S-78150 Borlange
Fax number: 46-2-432-6977
Sweden

The Bangkok Planetarium
Centre for Educational Museums
Mr. Nibondh Saibejra
928 Sukhumvit Road
Bangkok 10110
Fax number: 66-2-391-0522
Thailand

Planetario Municipal "Agr. German Barbato"
Prof. Osvaldo Vaio
Avda. Gral. Rivera 3245
Montevideo
Fax number: 598-2-923494
Uruguay

Ethyl Universe Planetarium/Space Theater
Science Museum of Virginia
Mr. Ken Wilson
2500 West Broad Street
Richmont, Virginia 23220
Fax number: (91)-804-367-9348
USA

Adler Planetarium
Dr. April S. Whitt
1300 S. Lake Shore Drive
Chicago, Illinois 60605
Fax number: (91)-312-322-2257
USA

Griffith Observatory
Mr. John Mosley
2800 E. Observatory Road
Los Angeles, CA 90027
Fax number: (91)-213-663-4323
USA

PART SEVEN

THE INTERNATIONAL PLANETARIUM SOCIETY

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THE INTERNATIONAL PLANETARIUM SOCIETY REGIONAL ASSOCIATIONS

ASSOCIATION OF FRENCH-SPEAKING PLANETARIUMS

The purpose of the "Association des Planétariums de Langue Française" (APLF) is to promote the creation of planetariums all over France and the French speaking countries such as Quebec (Canada), Switzerland, Belgium, and to assure their development in order to diffuse a better knowledge of astronomy to the public. The association wants to contribute to the teaching of astronomy (school and university level), and to participate in the development of the scientific culture. In these tasks, the association is granted of the financial help of the French Ministry of Research and Technology.

The meetings of the APLF take place each year in a different place: 1986 in Paris, 1987 in Nantes, 1988 in Paris, at La Villette, 1989 in Mribel, 1990 in Nice, 1991 in Pleumeur-Boudou (Brittany), 1992 in Garching/Munich (European Southern Observatory) and Munich (Deutsches Museum). Every four years, the meeting takes place in the framework of the Colloquium of the European Planetariums (1984, 1988, 1992).

The APFL has been legally existing since 8 May 1989. It is composed of physical, moral members, benefactor members. At this day, it regroups 72 members amongst 30 planetariums.

The members of the APLF enjoy certain advantages:

- Three free entrances a year to the planetariums members of the APLF (each planetarium can design 4 persons of its staff for the utilisation of the member card)
- Participation to the annual meetings
- Regular information through the annual bulletin
- Information all over the year (call for jobs, colloquiums, etc)
- International representation at the International Planetarium Society
- Special prices for astronomical hardware and software (special effects projectors, shows)
- Priority for inscriptions to educational courses (e.g. Diploma for planetarium animators)
- Invitation to the highlights of astronomy, workshops for animators

ASSOCIATION OF MEXICAN PLANETARIUMS

The Association of Mexican Planetariums, a civil non-profit association, was founded in 1980 with five planetariums, and has grown to have a membership of 19 institutional members at present, from travelling planetariums to big domes, predominating the midsize type, spread throughout the Mexican Republic.

Its purpose is to associate all planetariums in Mexico, to share experiences in their common task to disseminate space-related science, exchange ideas and educational material as well as human resources among affiliated planetariums, procuring their improvement in general.

We are certain that science is culture and its growth and enrichment should be stressed and supported by public and private sectors, specially in developing countries. Planetariums are true science centres for popularizing science, where the ideas about the Universe come to life. The experience of viewing the celestial bodies augmented with photos, music, a narrated history and special effects can make us travel beyond our wildest imagination and motivates, especially among the youths, an interest in scientific knowledge, awakening a vocational pursuit in scientific and technical careers so much needed in developing countries.

In Mexico, astronomy is within reach of all its inhabitants at all its planetariums.

If our ancestors developed such magnificent cultures around the observation of celestial bodies, it is time to retake that commitment and look into the future preparing our new generations for our ever changing world where scientific knowledge will open new opportunities and a better life for all.

BRITISH ASSOCIATION OF PLANETARIUMS

The British Association of Planetariums (BAP) was initiated in 1978 by Terence Murtagh, then Director of the Armagh Planetarium, Northern Ireland. Out of our first meeting in Armagh developed a larger body, the Association for Astronomy Education. This has now grown to the point where the BAP has become a sub-grouping of people specifically interested in planetarium matters. This is an informal group without officers which meets once a year in one of the member planetaria. Discussions take place on show production, marketing, cooperative ventures such as merchandise and assorted technical matters.

The BAP covers the whole of the British Isles and the Irish Republic. The individual planetaria range in size from London - 418 seats to Starlab Mobile Planetaria for 20-30. There will be an addition to the number next year with a new facility on Isle of Wight.

GREAT LAKES PLANETARIUM ASSOCIATION

The Great Lakes Planetarian Association (GLPA) is the oldest and largest regional planetarium association. GLPA is an affiliate of both the National Science Teachers Association and the International Planetarium Society.

GEOGRAPHICAL AREA

Although GLPA has members from across the world, GLPA's primary geographical area entails the states boarded by any of the Great Lakes (Illinois, Indiana, Michigan, Ohio, Wisconsin, and secondary emphasis on Minnesota, Western New York & Western Pennsylvania.

NUMBER OF MEMBERS

The 1992 membership roster stands at over 250 members.

PURPOSE OF GLPA

1. To promote professional communication between members of the planetarian profession.
2. To strive to improve the quality of planetarium programming and activities by providing educational opportunities to its members.
3. To promote a public awareness of the value of planetarium as an educational institution.
4. To solicit and receive grants, contributions, and other property, to enter into contracts, to engage needed personnel and services, and to transfer, hold and invest such real property as may be required to carry out the purpose of the association.

WHEN ORGANIZED

GLPA was formally organized in October of 1965.

MAJOR COMMITTEES AND ACTIVITIES

Committees

1. Member services

2. Education
3. Instructional materials (to distribute materials)
    - Slide library
    - Video tape library
    - Planetarian script library
    - Audio tape library
    - Computer software library
    - Printed curriculum and resource material library
4. Publications
    - Newsletter
    - Proceedings
    - Source booklets
    - TIPS booklets
5. Conference planning (to aid in the planning of conventions)

    Note: The newsletter is distributed quarterly. The Proceedings is a printed transcript of the talks delivered at our annual convention. The Sourcebook is the "yellow pages" of the planetarium profession-company listings of resources utilized by planetariums. TIPS booklets are special, one topic publications.

Activities

1. One major annual conference attended by over 100 planetarians and company representatives.
2. Five state or local one day meetings annually.
3. Distribution of slides, scripts and other materials useful to planetarians.

GLPA has a long history of producing materials that are extremely useful to new planetarians as well as seasoned professionals.

GREAT PLAINS PLANETARIUM ASSOCIATION

Geographical Area:	USA: Minnesota, Iowa, Missouri, Nebraska, Kansas
Number of members:	50
Purpose:	To provide a format for planetarium professionals and corporate vendors to exchange information on astronomy teaching, public science education, and specifics of planetarium operations.
Organized:	1972
Major activities:	Annual professional meeting Quarterly newsletter

ITALIAN PLANETARIA AND THE PLANETARIA FRIENDS ASSOCIATION

The new planetaria built in Italy in the last years gives us a general vision on the main existing types of planetaria of various sizes and activities. Rome (1928) and Milan (1930) planetaria are of historic importance: the former was closed down several years ago and is waiting for a new seat and a new projector, the latter is one of the most visited planetaria in our country and it is also the biggest. The most part of Italian planetaria - more than 50 all together - is found in school buildings (total number of school planetaria: 30; the biggest is in the Nautical Institute of Brindisi), carrying out exclusively a didactic function. Large public planetaria, rather, are limited to few cities, such as Milan, Modena, Ravenna and Venice's Lido. Even in these planetaria the lessons are dedicated predominantly to a scholastic public, while there is a growing availability of instruments other than the star simulator or those tied to the didactic use of the planetarium. In Milan, recently, the use of the video projector combined with the computer and the laser video discs was introduced. Milan planetarium (19.8 meter dome, the biggest in Italy), for the first time in our country there was a theatre performance dedicated to old cosmologies. The actors play in the four different point of the compass and in the centre of the star room, while the movement of the star projector are assured by the scientific chairmen of the planetarium. In Ravenna (8 meter dome, besides conference hall and a large sunroof for astronomical observations organized by local amateur astronomers), concerts combined with the projection of the starlit sky have been organized for some time now. In Venice's Lido (8 meter dome, situated in a convent, management and construction by Venice amateur astronomers) numerous, original self-built special-effects are used. Modena planetarium (10-meter dome, conference lounge, room for school lessons, workshop and a sunroof for sky observations) is situated in the precincts of a high school. In the building (total covered surface of 400 square meters) there is also a room for a small 3- meter diameter dome planetarium, which has been used for ten years, before construction of the big planetarium, and is now utilized for practical exercises with teachers. Milan, Modena and Ravenna planetaria are managed by local municipalities. Also public institutions manage the planetaria in Florence (5-meter dome) at the Science History Museum, Livorno and Pordenone Natural History Museum, Napoli (Observatory of Capodimonte). Amateur astronomers manage the small planetaria of Ferrara, Marghera, Padova, Rivanazzano, Rovigo (6-meter dome), Treviso and Brescia. The first Italian public observatory has been operating in this city since 1953. The local association of amateur astronomers is also planning a new public observatory with conference hall, workshops and an 8-meter dome planetarium in the near small town of Lumezzane, in collaboration with private sponsors and the local municipality.

The Italian Planetaria Friends Association, which is situated at the Science Museums of Brescia, has been working in our country since 1986 to promote the diffusion of these scientific entities. The association organizes planetaria national annual meetings, edits newsletters and other publications free on request in exchange of other astronomical publications. The association is coordinated at the national level by Professor Mario Cavedon (Milano) and by Professor Franco Gabici (Ravenna), while Brescia amateur astronomers deal with its organisation. In March, the association organized, since 1991, the National Day of Planetaria. The aim of this initiative is to promote the knowledge and the diffusion of the planetaria. The annual day of planetaria will be held on the Sunday before or after the spring shows, exhibitions and practical sky viewing. The day of planetaria intends to involve every year a foreign planetarium, which is different each year, for each European nation. The planetaria of London, United Kingdom, Genk (Belgium) and Saint Etienne (France) have accepted the 1992 day of planetaria and we are interested in making contacts with other planetaria for 1993 and the following editions of the day of planetaria.

MIDDLE ATLANTIC PLANETARIUM SOCIETY

The Middle Atlantic Planetarium Society (MAPS) is comprised of more than 420 planetariums in 18 states throughout the northeast and mid-Atlantic region of the United States. The regional boundaries extend from Maine to northern Virginia and west to the Ohio River.

The Middle Atlantic Planetarium Society was founded in 1965, making it the oldest of the 7 regional planetarium organizations in the United States. MAPS holds an annual conference (usually in the Spring sometime between the middle of March and the middle of May) in different cities throughout the region.

There are currently 204 members within MAPS of which 159 are school or university affiliated, while 26 are affiliated with science museums or nature centres and the remaining 19 are with portable planetariums or privately operated Membership dues for the organization are $10.00 U.S. per year. Membership includes the following benefits; a quarterly subscription the MAPS Newsletter, THE CONSTELLATION, a copy of the conference proceedings from the previous conference, an invitation to attend the annual conference and educational, technical or production materials developed by various committees.

The Middle Atlantic Planetarium Society is governed by its constitution and by-laws and is managed by the offices of President, Secretary, Treasurer and 3 Board Members. The officers and board members hold office for a two year term. The officers are elected on even-numbered years and the board members are elected on odd-numbered years.

There are several active committees that work with the MAPS officers and board members. These committees are: Education Committee, Publications Committee, Membership Committee, Program Committee, Nominations committee, Constitutional Review Committee, and the Audit Committee. The activities of each committee are led by a committee chairperson and the final results of each is disseminated to the general membership.

The purposes of the Middle Atlantic Planetarium Society are:

1. To promote excellence in all facets of planetarium education and programming.
2. To upgrade the professional and ethical development of the personnel and the facilities of its members by becoming a source of information and a medium for exchange of ideas among its members.

The Middle Atlantic Planetarium Society is affiliated with the International Planetarium Society (IPS) and the National Science Teachers Association (NSTA).

NORDIC PLANETARIUM ASSOCIATION

The Nordic Planetarium Association (NPA) was first formed as a network in 1984 between planetarians in the Nordic countries, i.e., Denmark, Finland, Norway and Sweden; we are still lacking planetariums and members in the fifth Nordic country, Iceland. The Network became IPS affiliate in 1985 and an Association in 1990.

NPA has some 40 members. The Association arranges an annual meeting and occasionally courses/seminars. It publishes at irregular intervals the NPNewsletter. First president of the Association is Lars Broman.

NPA has two Working Groups, NPMG (Nordic Planetarium Management Group) and NMPG (Nordic Mobile Planetarium Group), as well as an Educational Committee.

PACIFIC PLANETARIUM ASSOCIATION

The Pacific Planetarium Association (PPA) was founded in 1968 and incorporated as a non-profit corporation in 1989. The organization is committed to improving the quality of planetarium education and public programming.

PPA is a regional affiliate of the International Planetarium Society. It encompasses the western region of the United States and includes Hawaii, Alaska, Washington, Oregon, California, Arizona, Nevada and Idaho.

While the majority of our members come from our region, we also welcome planetarians from anywhere in the world. Our current roster includes active members from Japan and Ireland, as well as many other regions of the United States.

Membership currently numbers 132 active members. We have one meeting in even years when IPS meets and two meetings in alternate years. We also hold an informal meeting during the IPS conference.

"Panorama", published twice a year, is the official journal of PPA. It includes the published record of our conferences and features articles submitted by members, many of which were first presented as papers at the previous conference. The journal also features an annual status report on member planetaria.

ROCKY MOUNTAIN PLANETARIUM ASSOCIATION

The Rocky Mountain Planetarium Association (RMPA) was organized in 1969, eventually becoming a regional affiliate of what is today the International Planetarium Society. RMPA serves the U.S. Rocky Mountain region, including Colorado, Idaho, Montana, New Mexico, Utah, Wyoming, and adjacent states.

The purpose of the association is to promote astronomy and science education, planetarium operations, and the educational, entertaining, and innovative use of the planetarium environment; to support the planetarium profession; and to foster professional growth among its members. RMPA advances these objectives by promoting communication among planetariums and offering service in the Rocky Mountain region through conferences, newsletters, special initiatives, and other methods.

Major activities include the annual RMPA conference, customarily held in the early fall at a regional member facility. The conference features planetarium shows and demonstrations, paper sessions, workshops, panel discussions, speakers, the RMPA banquet, and the traditional model rocket launching session. Conferences are sometimes held jointly with planetarium associations from adjacent regions. The association also publishes a quarterly newsletter called The High Altitude Observer, containing articles and items of interest and information for the membership in the areas of science, education, planetarium techniques, and RMPA business.

RMPA officers include a president, secretary-treasurer, and past president, elected for two-year terms. Appointed posts include the RMPA historian, the newsletter editor, and the elections chair. Among the association's standing committees are the Publications Committee chaired by the newsletter editor, which publishes The High Altitude Observer, the Conference Committee, which plans the annual meeting and is chaired by the conference host; and the Elections Committee headed by the elections chair, which conducts RMPA elections.

Among current ad hoc committees are the Service to Members Committee, which proposes and develops projects providing practical service and benefit to RMPA members; and the Service to the Professions Committee, which explores ways in which RMPA can offer service and benefit to the planetarium profession as a whole.

In recent years, the organization has established scholarship programs in which eligible RMPA members receive financial assistance in attending in-region conferences. RMPA membership currently stands at approximately 80; membership is open to interested individuals outside of the Rocky Mountain region as well as within.

SOUTHEASTERN PLANETARIUM ASSOCIATION

The Southeastern Planetarium Association (SEPA) is an organization of planetariums and staff members who are located in the states of Virginia, Tennessee, North Carolina, South Carolina, Georgia, Alabama, Louisiana, Mississippi, Kentucky, West Virginia and Florida, and the all U.S. territories off the southern coast of North America. Formed in 1971, S.E.P.A. has the following goals:

1. To promote the spread of knowledge of astronomy and related disciplines in the school curriculum and among the general public at all levels of age and interest.

2. To encourage planetarium and educational institutions in planning the development of the planetarium as an effective educational and cultural medium.

3. To seek to improve professional standards among our members, and to provide assistance to those wishing to improve their knowledge and skills in this field.

Major activities include an annual conference, held at one of the member planetariums (usually in early June) and the publication of the Southern Skies, the association's journal.

Full membership is extended to those who are employed in a planetarium in the geographical area served by the association. Associate membership is extended to anyone interested in the goals of the organization. Annual membership is approximately 150.

SOUTHWESTERN ASSOCIATION OF PLANETARIUMS

The Southwestern Association of Planetariums was organized on November 11, 1966 and is composed of planetarians from the states of Texas, Oklahoma, Arkansas, New Mexico, and Louisiana. The purpose of the association shall be to promote and improve the planetarium field and the communications within the field. As of March 1992, the association has fifty paid members and ten paid institutional members.

The H. Rich Calvird Award is given by the Southwestern Association of Planetariums, in honour of foundling member Rich Calvird from El Paso, to a planetarian for outstanding professionalism and service to the planetarium field. The Bent Planet Cage Award is given for a major disaster suffered by a planetarian and/or planetarium facility.

Annual conferences are held the week-end following Easter except when voted by the membership one year in advance for a change of date. The Historical and Membership Committees are working on their 1992 reports and will be presented at the annual conference at the Clyde Tombaugh Space Theater in Alamogordo, New Mexico.

PLANETARIUMS: A VIEW FROM JAPAN

Goto Optical Mfg. Co.

Of the over 1000 planetariums in the world today, over half are in the United States. Japan claims half of the remaining 500 or so, with the other facilities spread throughout Europe and other parts of the world. In Japan, medium to large scale planetarium theatres are especially numerous.

Japan started pouring its efforts into education in the 1870's. A feudalistic country closed to the outside world, except for a small amount of trade via a single port in Nagasaki, Japan found itself far behind the rest of the industrialized world when finally forced by Commander Perry to open its doors to trade with the West. In an effort to quickly assimilate western technology, even though relatively poor, Japan lavishly spent resources on education. This commitment to improving education provided the driving force behind the sudden expansion which followed.

After 1945 the strength of education revived a scorched and devastated Japan from the ashes of defeat. The number of planetarium facilities increased in direct proportion with the growing nation. In the 1930's only two planetariums existed in Japan, but by 1950 there were over 10. The numbers increased to 50 - 60 in the 1960's and reached 140 - 150 by the 1970's. As of 1991 over 300 active planetarium facilities existed in Japan, their number expected to grow throughout the decade. The contribution of planetariums to education and the resulting economic success of Japan should not be underestimated.

The planetarium can be roughly thought of as having two main roles. The first is social education for the general public, not only for the local community but also for people from far away who come to see the planetarium. An astronomical information centre for the visitor, the planetarium helps awaken public awareness of the stars, celestial bodies and space. More importantly it helps us realize that the Earth, while only one of billions of objects in the vastness of space, is rather special. In an age when the carelessness of humankind threatens our environment, planetariums have a special responsibility to educate the public about the uniqueness of our spaceship Earth.

The planetarium also plays an important role in school education. Large scale facilities are not necessary for classroom use, since 3 to 6 meter dome diameter systems are fully capable of the functions desired for introducing fundamental concepts. The future depends on skilfully cultivating eager young minds. Students with a high degree of interest in space science and astronomy accordingly have much higher achievement rates on tests of mathematical principles introduced by such studies. In order to bring up excellent researchers and teachers this interest should be awakened and nurtured from an early age. Increasing a student's opportunities to visit the planetarium is one very effective method of doing exactly that.

Beyond education the planetarium also has entertainment value. As a Space Theater it actively cultivates aesthetic sensitivity towards the natural beauty available to anyone taking the time to look up and admire the night sky. Finally, planetariums provide a base for local astronomy clubs. Activities of these clubs, such as holding monthly observation sessions for the public, also promote science education. Not only does the planetarium benefit the local community, but by increasing general knowledge about science and technology; in the long run it probably raises the economic level of a nation as well.

Suginami Science Education Center

Since 1957, the year the first artificial satellite was launched, planetariums have been gaining more popularity year by year, particularly in the United States and Japan. It is chiefly because they have been made much of for their effectiveness as tools for astronomy and space science education. Governments have decided to help with the building of planetariums, thinking it will make contribution to the promotion of science education in general as well.

Today there is a growing tendency for young people to learn astrophysics and space science rather than classical position astronomy. In order to meet their demand, many planetariums are now equipped, in addition to the main projector, with various kinds of supplementary apparatus such as special effects projector, all- sky panorama projector, video projector, etc. We believe a planetarium is not only the place to show us the beautiful nature of the sky, but also that which provides us with recent results of astronomical researches.

There has been a recent trend towards building space theatres with tilted domes rather than the traditional type of planetariums with domes of horizontal spring lines. The former are meant to give audience the pseudo-experience of space flight, while the latter are usually more convenient and suitable for the teaching, especially of classical astronomy. No doubt, the new type with so- called space simulator provides amazing, incomparable experience for us, but it is not an all-purpose, upper compatible model of planetarium. I think we ought to have a better opinion of the traditional type as being better qualified for astronomy education.

The activities to be practised in planetarium depend on the functions it is furnished with. So, it is important for the person planning a new planetarium to know and take into account the difference of ability between the two types, their respective features, and then to decide on the system of the planetarium most suitable for the purpose.

A planetarium, we must remember, is the place that provides us with a perfect view of the starry sky with its intrinsic beauty, inspiring wonder and arousing scientific interest. It brings back that clear night sky unaffected by air pollution which, in fact, is on the way to being lost to those living in urban areas. Thus, it can also function as a kind of touchstone by which to estimate the extent of air pollution. Can't we say it is still another use of a planetarium to be available for the scientific study of the environment?

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THE INTERNATIONAL PLANETARIUM SOCIETY: LIST OF ADDRESSES

The International Planetarium Society was founded in 1971 for the purpose of exchanging information, sharing professional techniques and expertise, and becoming aware of technological advances by planetarium personnel throughout the world.

I.P.S. provides for the dissemination of information to its members through publication of a quarterly journal, The Planetarian, special publications on specific topics, and biennial conferences of the membership. Past conferences have been held in the United States, Canada, Mexico, and Sweden. The 1992 biennial conference of the I.P.S. will be held in late June in Salt Lake City, Utah, and the 1994 conference will be held in Cocoa, Florida. Membership in the International Planetarium Society can be individual, institutional, or corporate, and currently numbers approximately 500.

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REFERENCES FOR FURTHER READING

Research and Articles Relevant to Participatory Planetarium Programming

Bishop, Jeanne, "The Development and Testing of a Participatory Planetarium Unit, Emphasizing Projective Astronomy concepts and Utilizing the Karplus Learning Cycle, Student Manipulation, and Student Drawing," 1980, unpublished doctoral dissertation, University of Akron, Akron, Ohio. A unit on astronomy was developed to enable students to learn the relationship between two perspectives (on Earth and from space) of common astronomical phenomena. The unit was presented to one group using a traditional method of instruction and to another group using the Karplus Learning Cycle, a specific "articipatory" approach. Both groups performed better on an immediate post-test than did a non-treatment control group, but there was no significant difference between groups exposed to the two instructional methods. A delayed post-test, however, revealed that the students exposed to the participatory approach retained significantly more of what they had learned than did students exposed to the traditional approach.

Curtin, John T., "An Analysis of Planetarium Program Content and the Classification of Demonstrator's Questions," 1967, unpublished doctoral dissertation, Wayne State University. Curtin analyzed 38 recording tapes and 35 questionnaires of planetarium programs presented to school children. "According to Bloom's criteria, all but 9 of 413 questions were in the knowledge class." Seven questions were in translation. One was in analysis of relationships, and one was in extrapolation.

Fletcher, Jack, "An Experimental Comparison of the Effectiveness of a Traditional Type Planetarium Program and a Participatory Type Planetarium Program," 1977, unpublished doctoral dissertation, University of Virginia. Fifteen planetarium instructors presented participatory and traditional versions of a program on Stonehenge and how it relates to the annual rising and setting points of the Sun. Since discussion was permitted during the "traditional" programs, the only difference between the two presentations was the physical activities. When data from all of the instructors was combined, both methods were found to be educationally effective, but no significant difference was found between them. However, the students of six of the instructors learned significantly more from the participatory program than from the traditional program, and a significant difference in the opposite direction was found for two instructors. This finding led Fletcher to conclude that the instructor was a more important factor in student achievement than the method of instruction.

Friedman, Alan J., "Alternative Approaches to Planetarium Programs," 1973, Mercury, v.2, Jan/Dec, pp.12,18. Presents two alternative approaches to planetarium programming: 1) actively involving the visitors in activities during the program; and 2) presenting astronomy concepts within their cultural context.

Friedman, Alan J., "Interactive Public Planetarium Programs," Proceedings of the 1974 Conference of ISPE, International Society of Planetarium Educators, Special Report #6, Atlanta, GA, pp. 52-55. Describes interactive programs at the Holt Planetarium. A variable star observing activity is offered as an example of how visitors can interact with materials and the instructor during the program.

Friedman, Alan J., "Participatory Planetarium Shows," Planetarium Director's Handbook, 1975, no. 32, Spitz Space Systems, Chadds Ford, PA. Presents six activities that can be used during planetarium programs to enable the visitors to learn about the concepts and process of astronomy.

Friedman, Alan J., Dennis L. Schatz, and Cary I. Sneider, "Audience Participation and the Future of the Small Planetarium," 1976, Planetarian, December, pp. 3-8. This article offers a more precise definition of "participatory" programs, and extends the rationale for this approach to include economic considerations and research in the fields of education and psychology.

Mallon, Gerald, "A Pilot Study: Tape vs. Live Teaching," 1974, Science Activities, vol. 11, no. 5, pp. 10-11. Mallon performed carefully controlled experiment to see if the physical presence of a planetarium instructor makes a difference in learning by the visitors. The same programme was presented by automated tape and by an instructor. The group who saw the live presentation performed significantly better than the group who saw the taped presentation.

Mallon, Gerald, "Student Achievement and Attitudes in Astronomy: An Experimental Study of the Effectiveness of a Traditional Star Show Planetarium Program and a participatory-Oriented Planetarium Program," 1980, unpublished doctoral dissertation, Temple University, Philadelphia, Pennsylvania. The study found that the participatory program was more effective than the traditional star show in both content and attitude change. Conclusions regarding content learning were based on a significant effect of large magnitude across five separate but coordinated studies. The major study involving 324 students in Pennsylvania supports a highly valid test of the hypothesis, while corroborating evidence from four smaller studies at widely separated regions in the USA indicates that the result can be widely generalized.

Mallon, Gerald, "Student Achievement and Attitudes in Astronomy: An Experimental Comparison of Two Planetarium Programs," Journal of Research in Science Teaching, 19:53-61, Winter 1982.

Schafer, Sheldon, "An Experiment in Participatory Planetarium Programming," 1977, Planetarian, vol.6, no.2, pp.10- 21. Planetarium audiences were polled at the conclusion of various programs. The primary results showed that 48 percent preferred the participatory show, 21 percent preferred the theatrical multimedia show, and 31 percent had no preference and enjoyed both shows.

Schafer, Sheldon, "A Brief Negative Encounter With Participatory Shows," 1977, Planetarian, vol.6, no.3. The author reports the results of a post-visit survey of school groups that experienced participatory planetarium programs. Although students claimed to prefer participatory shows, teachers expressed the following reservations: 1) there was too much questioning and answering, 2) the show was not visually interesting as conventional shows, 3) only the brightest students tended to participate, and 4) the teachers believed that the students enjoyed the conventional show more.

Schatz, Dennis, Greg Swanson, and Dave Taylor, "Cerebral Participatory Programmes: Their Role in the Planetarium," 1978, Pacific Science Center, Seattle, Washington (paper presented at IPS Convention in Washington, D.C.). Describes a study which compared two types of interactive programmes: A program which involves the visitors in physical manipulation of star maps, and a program in which a slide was substituted for the actual maps and verbal discussion was substituted for the actual performance of the star map activity. Both groups performed equally well on paper-and- pencil tests of the visitors' abilities to use star maps. Cerebral participation seems especially suited to large planetariums in which some types of physical activities are difficult to arrange.

Smith, Theodore V., "The Effectiveness of Constellation Figures," 1974, Planetarian, vol.3, no.3&4, pp.74-83. This research report on methods for teaching constellation recognition first describes previous studies and critically reviews their weaknesses. The central focus of the article is a well-controlled study which showed that constellation figure outlines used during the program do not help visitors recognize the constellations on a test.

Reviews of Research Relevant to Participatory Planetarium Programming

Bishop, Jeanne E., "United States Astronomy Education: Past, Present, and Future", 1977, Science Education, vol.61, no.3. This comprehensive review of activities in astronomy education sketches the changes in public policy, curricula, professional organizations, and the role of astronomy in the schools from 17th century Colonial America to the present.

Reed, George, A Bibliography for Planetarium Educators, Parts I and II, contained in ISPE Special Report #2, 1972, and #4, 1974, International Society of Planetarium Educators, renamed the International Planetarium Society (IPS). See the Planetarian in PERIODICALS, and IPS in ORGANIZATIONS. This is the most comprehensive listing of research available to 1974, although the bibliography is not limited to research. Each study is annotated in detail.

Sunal, Dennis, "Analysis of Research on the Educational Uses of a Planetarium," 1977, Journal of Research in Science Teaching, vol.13, no.4, pp. 345-349. Since Sunal rejected all studies which did not provide data on visitor learning, he was left with nine studies to review. Perhaps the most important finding of this review was that research does not support the traditional one- visit planetarium unit–more can be done in a classroom.

Wall, Charles A., "A Review of Research Related to Astronomy Education," 1973, School Science and Mathematics, vol.73, no.8 (November), pp.653-669. This article describes a number of interesting studies which are neglected in other reviews, since studies outside of the planetarium setting are included.

Warneking, Glenn E., "Planetarium Education in the 1970's–A Time for Assessment," 1970, Science Teacher, vol.37 (October), pp.14-15. This is the earliest review of research studies, and raises a number of points which should be considered in planetarium research.

Related Astronomy and Space Science Education Research

Sneider, Dr. Cary I. and Steven Pulos, "Children's Cosmologies: Understanding the Earth's Shape and Gravity," Science Education, 67(2): 105-221, 1983.

Sneider, Dr. Cary I., Kevin Kurlich, Steven Pulos, and Alan Friedman, "Learning to Control Variables with Model Rockets: A Neo-Piagetian Study of Learning in Field Settings," Science Education, 68(4): 463-484, 1984.

Sneider, Dr. Cary I., "Understanding the Earth's Shape and Gravity," Learning 86, Vol.14, Num.6, February, 1986.

Publications of the International Planetarium Society (IPS)

The Planetarian: The quarterly journal of the International Planetarium Society, filled with articles, features, and news. Strongly recommended to anyone in or entering the planetarium field. Contact:

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For back issues of The Planetarian and for all other International Planetarium Society back publications, contact:

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Conference Proceedings: The International Planetary Society has published proceedings of some of its recent biennial conferences:

Borlänge, Sweden	1990
Richmond, U.S.A.	1988
Tucson, U.S.A.	1986
Monterey, Mexico	1984
Vancouver, Canada	1982

We recommend the 1990 proceedings, entiteled The Boundless Planetarium (ed. by L. Broman and M. Back) for its many international contributions and its comprehensive reports on planetariums in Asia, Europe, and North America.

Special Publications: The International Planetary Society produces occasional special publications. Recent ones include:

#14 Naked I Astronomy Revisited, G. Reed
(a thorough presentation of naked eye astronomy with many activities)

#13 27 Steps to the Universe, L. Broman
(student activities to illustrate the various distance scales of the Universe)

#12 Cosmic Artoons, G. Reed
(astronomical cartoons)

#11 Special Effects Projector Sourcebook, D. Aguilar
(construction of special visual effects projection)

#10 Planetarium Education's Workshop Guide, A. Friedman et al.
(education's workshops to develop student planetarium activities)

International Planetary Society Directory (1990): Lists 1700 planetariums worldwide with address, personnel, telephone numbers, and facility information.

Publications of the Regional Associations

Conference Proceedings: Some regional associations publish proceedings of their annual conference. These include:

Great Lakes Planetarium Association (since 1984)
contact: Gary Sampson
Great Lakes Planetarium Association
Instructional Materials Class
Wauwatosa, Wisconsin 53222
U.S.A.

Mid-Atlantic Planetarium Association
Contact: International Planetarium Society representative

Pacific Planetarium Association
Contact: International Planetarium Society representative

European Planetariums (1984, 1988, 1992)
Contact: A. Acker
International Planetarium Society representative
of French-Speaking Planetariums

Mid-Atlantic Planetarium Association

Under Roof, Dome & Sky, M. Brodinsky, 1973
(45 student-centered activities for the planetarium)
Contact: F. Jackson
Mid-Atlantic Planetarium Association
P.O. Box 353
Providence, Rhode Island 02901
U.S.A.

Great Lakes Planetarium Association

1990 Planetarium Sourcebook, B. Williams et al.
(lists over 200 vendors of products and services of interest to planetariums, arranged by category of product)

Planetarium Bibliography, G. Tomlinson et. al., 1992
(a complete list of all published papers on planetariums up to 1990, excepting The Planetarian and main items in

association newsletters)

Tips Booklets

Great Lakes Planetarium Association publishes a series of booklets on many aspects of planetarium work. These include:

No.	Titles	Year
1	Tips for the New Planetarian	1976, 1991
2	Tips on Developing and Presenting Interdisciplinary Planetarium Programs	1977
3	Tips for Orientation Activities	1977
4	Tips for Preparing & Presenting School Programs	1978
5	Tips on Printed Materials for the Planetarium	1978
6	Tips on Planning for a Planetarium Education Program	1979
7	Tips - Sits	1979
10	Tips on How to Handle the Handicapped in the Planetarium	1983
11	Tips on Writing Planetarium Scripts	1983
12	Tips - Anthology of Astronomical Poetry	1984
13a	Tips - A Guide to the Phases of the Moon	1985
13b	Tips - Astronomical Poems	1987
14	Tips - Astronomical Pronunciation Guide	1991

Contact: Gary Sampson
address above

Other Publications

Planetarium Activities for Student Success

A grant-funded series of books on participatory planetarium programming for students. The eight volumes include:

- Vol.1 Planetarium Education's Workshop Guide
- Vol.2 Planetarium Activities for Schools
- Vol.3 Resources for Teaching Astronomy and Space Science
- Vol.4 A Manual for Using Portable Planetariums
- Vol.5 Constellations Tonight
- Vol.6 Red Planet Mars
- Vol.7 Moons of the Solar System
- Vol.8 Colors and Space

Contact: Eureka
Lawrence Hall of Science
University of California
Berkeley, California 94720
U.S.A.

America's Planetariums and Observatories, R. Beck, 1991
(descriptions of many large and small facilities
written by the planetarians)

Contact: Sunwest Space Systems, Inc.
P.O.Box 20500
St. Petersburg, Florida 337424
U.S.A.