Resource Materials & Proceedings of the Sixth Biennial Conference of the International Planetarium Society

July 26—30, 1982

H.R. MacMillan Planetarium
Vancouver, B.C., Canada
Welcome to Vancouver and the Sixth Biennial Conference of the International Planetarium Society. We've arranged a full four-and-one-half days of lectures, exhibits, banquets, guest speakers, tour and other activities, so there should be something for everyone.

Though a conference planning committee can lend a theme or overall flavour to a conference, the main content of any conference comes from the delegates and commercial representatives. Of the 250 delegates attending this year's conference, over 100 have submitted papers to be presented or printed in the resource book. In the commercial sector, requests for financial support of and participation in the conference were sent to about 35 companies. Only two failed to respond positively!

Two aspects of the Vancouver conference differ from previous I.P.S. gatherings. First, because of financial and physical constraints, the number of delegates was limited to 250. As it happened, this limit was reached precisely on the already-established cut-off day of July 1st. Second, prior conferences have discouraged intermixing commercial presentations with papers presented by I.P.S. members who happen to work at planetaria. By scanning the agenda, you'll notice that we have abandoned this idea. One session is devoted entirely to commercial interests (Laser Sound/Light Shows) and one session (computers) is a mix of papers from both the users and the sellers of automation systems. In addition, you'll find a number of papers with varying degrees of commercialism in other sessions throughout the week. These were selected because of their general interest, and include such topics as the latest from Zeiss Jena, an update on the Evans and Sutherland project, and the workings, aims and objectives of the Planetary Society. There are two reasons to include such papers. First, many I.P.S. members have indicated that they want to hear "what's new" in the commercial sector ... providing it doesn't dominate the conference. Second, there is only one type of I.P.S. member, whether they work at a planetarium or sell to a planetarium. Constitutionally, all such members must have the same rights to present a paper. It should be noted that this combination of "professional" and "commercial" papers does not comply with the I.P.S. conference guidelines, nor has the I.P.S. President or Council approved such a mix. Delegates' opinions would be appreciated.

Though we've completely filled the agenda with activities, please feel free to extend your stay or create time to see the many attractions in the Vancouver area. At the University of British Columbia, there is Nitobe Memorial Gardens, as well as Spanish Banks and Towers Beach. When you're at the MacMillan Planetarium, your delegate name-tag will admit you to the Vancouver Museum, and to the Maritime Museum with its recently acquired historic chronometer used by Captain George Vancouver. After the final luncheon, consider leaving the group for a trip up the famous Grouse Mountain Skyride and a magnificent view of the city.

We hope you enjoy yourself during the conference. If you have any questions or problems, contact anyone wearing a "Conference Committee" name-tag, and they'll be happy to help you.

Conference Committee
Over $45,000 worth of sponsorship was offered for the Sixth Biennial Conference of the International Planetarium Society. The conference planning committee, the delegates, and the entire membership of the I.P.S. wish to express their appreciation to the following organizations and corporations who have assisted so generously.

Over $10,000
Canadian Pacific Airlines, Head Office and District Sales Office
Vancouver Museums and Planetarium Association

$5,000-$10,000
VEB Carl Zeiss Jena and Jena Instruments, Toronto

$2,000-$5,000
Audio Visual Laboratories
Evans and Sutherland, Salt Lake City
Planetec Systems Inc., North Vancouver

$1,000-$2,000
B.C. Central Credit Union
Casabello Wines Ltd.
Commercial Electronics Inc.
Electrosonics Ltd.
International Planetarium Society
Kodak Canada Ltd.
Labatt Breweries of B.C. Ltd.
Laser Images Inc.
Laser Systems Control Inc.
Planetarium Association of Canada
R.A. Gray Inc.
Roundhouse Productions Inc.

Under $1,000
Audio Visual Engineering
Eye See The Light
Goto Optical Co.
Imax Corporation
Laser Presentations
Oakwood Audio Ltd.
Sky Skan Inc.
Spitz Space Systems
CONFERENCE

INFORMATION
1. P.S. CONFERENCE AGENDA

Coffee daily at 10:00 a.m. and 3:00 p.m., compliments of Commercial Electronics Displays 9:00 a.m. - 5:00 p.m. daily

Monday July 26 1982

8:00 a.m. - 9:30 a.m.  Breakfast (no host) - Student Union Bldg. cafeteria
10:00 a.m. - Noon        Opening Ceremonies - MacInnes Lounge
                       Official Greetings and Conference Outline
Noon - 1:00 p.m.        Lunch - Student Union Bldg. cafeteria
                       Sponsored by Planetarium Association of Canada

1:00 - 5:00 p.m.        CONCURRENT PAPER SESSIONS

1. Production Techniques   MacInnes South : Chairman : J. Hault

   The Future of Planetaria (J. Hooks)
   The Hidden Side of Production (M. Bakich)
   Planetariums : The Modern Myth (D. Rodger)
   Sunrise, Sunset, Seating, and Exit Music (R. Allen)
   Double Feature : Using Used Shows (M. Levine)
   Entertainment Value (D. Milbrandt)
   Sound Advice (P. Pitluga)
   Planetariums : The New Generation (M. Butler)
   The Voice Track (D. Zirpoli)

2. Education Techniques   MacInnes North : Chairman : S. Wieser

   - Edna the Alien (F. Biddy)
   - The Universe and I (J. Bishop)
   - Observational Astronomy for Parents and Children (D. Brinkman, R. Nerdahl)
   - In India with a Mobile Planetarium (A. Friedman)
   - Alberta's Mobile Planetarium Project (J. Irwin, C. Wannamaker)
   - Curriculum for Gifted Children (E. Koonce)
   Increasing Secondary School Visits (K. Miller)
   Creating A Mascot (S. Schafer)
   Courses at the Hayden Planetarium (A. Seltzer)
   Is There Life After Automation? (I. Chen)

5:00 - 6:00 p.m.        No Host Bar Service - Fireplace Lounge
                       Arts Show in Mary Murrin Lounge
6:00 - 9:00 p.m.        Salmon Barbecue and Museum of Anthropology Tour
                       (10 minute walk from Gage)
                       Sponsored by Electrosonic Ltd.

9:00 p.m.               No Host Bar Service - Fireplace Lounge
**Tuesday July 27 1982**

8:00 a.m. - 9:30 a.m. Breakfast (no host) - Student Union Bldg. cafeteria
9:00 a.m. - 9:30 a.m. Bus Transfer to Planetarium

Last Bus departs at 9:30 a.m.

10:00 a.m. - Noon PLANETARIUM ASSOCIATION OF CANADA Annual General Meeting (Junior Workshop)

10:00 a.m. - Noon CONCURRENT PAPER SESSIONS

3. Technical

Theatre : Chairman : C. Hagar

The Drop-In Panorama System (M. Koziniak)
Laser Animation (D. McCullough)
Seamless Matching of Panoramas (L. Toy, B. Smith)
Planetary Gatherings, 1982-84 (R. Victor)

4. Space Research

Auditorium : Chairman : D. Hall

NASA Projects (Dr. Gerald Soffen, Life Sciences, NASA Headquarters)
Canada in Space : The Canadarm (Christopher G. Trump, SPAR Aerospace)
NASA Resources for Planetarium Educators (Bill Horvath, Ames Research Center, NASA)

Noon - 1:30 p.m. Lunch - Whittick Lounge (Courtyard, weather permitting)
Sponsored by Evans and Sutherland
Official conference photograph follows

1:30 - 4:30 p.m. I.P.S. Council Meeting No. 1 (Junior Workshop)

1:30 - 4:30 p.m. CONCURRENT PAPER SESSIONS

5. Education Techniques

Observatory : Chairman : R. Ballantyne

Astronomy Teaching and Spatial Ability (M. Sonntag)
Where Is That Darned Moon? (E. Whitehouse)
Community Astronomy (K. Hewitt-White)
A Basic Astronomy Curriculum for Grades K - 6 (D. Brinkman)
Educational Shows for Children (G. Munoz)
Improvements to the Doane Observatory (L. Ciupik)
Halley’s Comet (R. Shubinski)
Southam Observatory Discussion and Tour (D. Dodge)

6. Technical

Auditorium : Chairman : H. Karl

Circular Formats for All-Sky Effects (J. Bushman)
The I.P.S. Video-Disc Project (E. Carr)
New Ideas on Panoramas and Models (D. Dundee)
Hardware, Software, and the Promotion of Laser Shows (J. Hare)
Modification of Constellation Figure Overlays (R. Hills)
Universal A/C Switching Modules (J. Hopkins)
Computer Graphics Study (D. Leise)
The $75.00 Synthesizer (D. Wharton)
Tuesday July 27 (continued)

4:45 p.m. Short Walk to Coast Guard Docks
5:00 - 8:00 p.m. Dinner Cruise - M.V. “Malibu Princess”
Sponsored by Zeiss/Jena and Jena Instruments, Toronto
(Ship leaves at 5:00 p.m. sharp)
8:00 - 10:00 p.m. Computer Demonstration - Planetec Systems Inc.
Reception - Sponsored by Roundhouse Productions Inc.
Planetarium Show - “The Mystery of SS-433”
Sponsored by the National Museums of Canada
10:30 - 11:30 p.m. Bus Transfer to Gage Residence
Last Bus departs at 11:30 p.m.

Wednesday July 28 1982

8:00 a.m. - 9:00 a.m. Breakfast (no host) - Student Union Bldg. cafeteria
9:00 a.m. - 10:00 a.m. INTERNATIONAL PLANETARIUM SOCIETY
Annual General Meeting (MacInnes Lounge)
10:00 a.m. - Noon CONCURRENT PAPER SESSIONS

7. Panel Discussion: “Light Shows - Rent, Buy or Build”
   MacInnes North: Moderator: I. McLennan
   I. Dryer, Laser Images
   K. Hewitt-White, Roundhouse Productions
   R. V-Werth, Omega Organization
   R. Webster, Laser Systems Development Corporation
   F. Rolfstadt, Laser Fantasy Corporation

8. Technical MacInnes South: Chairman: D. Zirpoli
   Making Your Own Music of the Spheres (S. Mims, W. Coskrey)
   Audio Production at Fleet Space Theatre (C. Hatchett)
   Special Photographic Effects (R. Villard)
   Slide Masking Techniques (E. Dunn)
   Retrofitting the Spitz Orrery to Geocentric (T. Stalec)
   Albert Einstein’s Ragtime Band (T. Callen)

Noon - 1:30 p.m. Lunch - Student Union Bldg. cafeteria
Sponsored by Laser Images
1:30 - 5:00 p.m. I.P.S. Council Meeting No. 2 (S.U.B. Board Room)
1:30 - 500 p.m. GENERAL PAPER SESSION

9. General Paper Session MacInnes Lounge: Chairman: J. Findlay
   The Major New Planetarium in Virginia (P. Knappenberger)
   The Evans and Sutherland Projector (J. Panek)
Wednesday July 28 (continued)

The Edmonton Space Sciences Centre (J. Hault)
Zeiss/Jena (L. Meir)
Determining Admission Fees (T. Clarke)
I'm Your Narrator . . . Give Me A Break! (M. Petersen)
The Netherlands: Vision of Light (R. Shubinski)

5:00 - 7:00 p.m. FREE TIME
Refreshments (no host) - Fireplace Lounge
Special A/V Presentation by Electrosonic Ltd. (Murrin Lounge)

7:00 - 9:00 p.m. BANQUET (U.B.C. Faculty Club)
(10 minute walk from Gage)
Sponsored by Audio-Visual Laboratories
Speaker: Dr. Geoffrey Burbidge, Kitt Peak National Observatory

9:00 p.m. No Host Bar Service (Faculty Club and S.U.B.)

Thursday July 29 1982

8:00 a.m. - 9:00 a.m. Breakfast (no host) - Student Union Bldg. cafeteria

9:00 a.m. - Noon CONCURRENT PAPER SESSIONS

10. Computers MacInnes South: Chairman: L. Palmer

Simplicity in Planetarium Control Design (B. Spainhower)
Survey of Non-Automation Microcomputer Usage (K. Wilson)
The Electrosonic System (R. Simpson)
The MC-10 System (R.A. Gray)
Choosing a Planetarium Automation System (J. O'Leary)
Selecting a Creative Automation System (G. Musgrave)
Designing a Planetarium Control System (A. Godoroja)

11. General Topics MacInnes South: Chairman: C. Madhosingh

1 Historical Aspects of I.P.S. (P. Engle)
5 I.P.S. 1981 World Planetarium Survey (C. Hagar)
2 Three-Dimensional Visuals (B. Sullivan)
3 Multiple Planetarium Shows (W. Gutsch)
4 Multi-Language Shows (T. Hamilton)
Galaxies and Black Holes (R. Stoller)
A Workshop for Teachers that Really Works (D. Schatz)
Eyes in the Universe (L. Baker)

Noon - 1:00 p.m. Lunch - Student Union Bldg. cafeteria
Sponsored by Goto Optical, Audio Visual Imagineering, Imax,
Laser Presentations, Oakwood Audio, and Sky Skan

1:00 - 2:00 p.m. Bus transfer to Planetarium
Last Bus departs at 1:40 p.m.
Thursday July 29 (continued)

2:00 - 5:00 p.m. GENERAL TOPICS

12. General Topics Auditorium: Chairman: A. Seltzer

Planetary Exploration (L. Friedman)
Hard Times for the Stars (D. Zirpoli)
New Evidence on the Christmas Star (E. Martin)
Common Errors in Christmas Shows (J. Mosley)
A 44,000 km. Planetarium Survey (N. Sperling)
The Festival of Lights (G. Payne)
Effective Media Manipulation (J. Wharton)
Commercial Revenue from the Planetarium Theatre (D. MacDonald)

5:00 - 7:00 p.m. Reception and Dinner at Cisco's Restaurant
(10 minute walk from the Planetarium)
Sponsored by Planetec Systems Inc.

7:30 - 8:00 p.m. Reception - Planetarium Foyer
Sponsored by Casabella Wines Ltd.

8:00 - 10:00 p.m. PLANETARIUM DEMONSTRATIONS:
Animation in the Planetarium (Strait Media)
Sound and Light Show Demonstration (Roundhouse Inc.)
Special Planetarium Show

Friday July 30 1982

8:00 a.m. - 9:00 a.m. Breakfast (no host) - Student Union Bldg. cafeteria

9:00 a.m. - 12:30 p.m. CITY TOUR: Queen Elizabeth Park, Gastown, Stanley Park,
Vancouver Public Aquarium
Departing Gage Residence from 9:00 - 9:15 a.m.

9:00 a.m. - 12:30 p.m. I.P.S. Council Meeting No. 3
Vancouver Public Aquarium (Shaw Room)

12:30 - 1:00 p.m. Transfer from Aquarium to Canyon Gardens Restaurant

1:00 - 3:00 p.m. AWARDS LUNCHEON
Sponsored by R.A. Gray Inc.
I.P.S. Service Awards
Regional Awards
C.P. Air Door Prize Draw
Presentation of P.A.C. "Aw Shucks" Award

3:00 p.m. Transfer to Gage Residence
A HISTORY OF AUTOMATION DEVICES
(All Dates Approximate)

1939 1st Automated slide projector. Projector advanced slide by push of button.
1940 Synchronizer invented. Responds to 2-second silence on disc or wire recordings.
1946 Tape recorder invented.
1947 Tape recorder used for synchronizing with hole in magnetic tape.
1948 Tape recorder used for synchronizing with foil put on tape.
1956 Synchronizer invented that worked from subaudible pulse. Couldn't change without erasing audio too.
1958 Stereo tape recorder invented. Pulse now on its own track.
1958 Universal standards set for synchronizers - 1000 Hz for .45 sec.
1961 Multi-image born with projectionists hitting buttons. Projectionists are swamped.
1966 Punched-tape programmer available. Can now program in leisure time.
1966 Tape recorders developed to run at constant speed (and therefore reliable tone) despite line voltage changes.
1966 Solid state tape recorders developed. Tone not dependent on environmental factors such as temperature and humidity.
1969 Multi-speed dissolve units developed. Projectionists now unglued.
1969 Multi-tone programmers developed. Projectionists grateful.
1970 Punched-tape uses logic.
1972 Machines used to punch tape.
1975 Electronic memory used to store data.
1978 Microprocessor uses logic and stores data in electronic memory. (The Early)
1980 Peripheral devices and functions added.
PAPERS
and
ABSTRACTS
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Sunset, Sunrise, Seating, and Exit Music used at the La Crosse Planetarium, University of Wisconsin

by Robert H. Allen, Planetarium, University of Wisconsin, La Crosse, WI 54601

A list of sources of music suitable for use before or after a program, or while dimming or raising house lights, follows (below). The list is composed of albums and specific cuts on them. It includes most music used at our planetarium over the past several years. Conference attendees not present at the talk, or other interested persons, can obtain the list by writing to the author. Choices of music suitable for use by planetarians is largely a matter of personal choice. At the University of Wisconsin - La Crosse Planetarium, we use various sources for sunset, sunrise, seating and exit music. The list mentioned above is a good summary of albums we have purchased for such use. It draws heavily on electronic music and science fiction movie sound tracks. However, there are non-science fiction movie sound tracks and other sources on the list as well. I would be interested in obtaining from other planetarians a list of the albums and cuts they use which are not on our list.


Star Wars : 20th Century Records - 2T-541 (0898). Princess Leia’s Theme, Sunset 4:18; Throne Room and End Title, Sunrise and Exit 5:28.


The James Gang Rides Again (also on the Best of the James Gang album) : The James Gang - ABC Records ABCX774. Ashes, The Rain and I (instrumental version), Sunset.

Summer of ’42 : Warner Bros. WS1925, Michel LeGrande. Summer Song, Sunrise and Sunset; Break into two parts with fade-ins and fade-outs; Montage, Sunrise.

The Red Tent : Paramount Records PAS6019, Enio Morricone : Farewell, Sunset; A Love Like The Snow, Sunrise.

Mary Queen of Scots : MCA Records - PL79186, John Barry : Mary’s Theme, Sunset; Mary at Chartley, Sunrise.

Blows Against The Empire: Empire RCA -LSP4448, Jefferson Starship. Have You Seen The Stars Tonight, Sunset; Tough fade at end but a classic (the album too).


Grand Canyon Suite: RCA3303, Arthur Fiedler/Boston Pops. Sunrise, Sunrise 5 min.; Sunset, Sunset 4½ min.; On The Trail, Exit 4 min. (Sunset and Sunrise a little long, but are great on a beautiful spring day or for Indian programs.)

The Life and Times of Judge Roy Bean: Columbia-S31948, Maurice Jarre/Andy Williams. Miss Lily Langtry, Sunset 5 min.; On The Way to the Opera, Sunrise 3:10; Old Ragtime, Exit 2:30.

Firebird: RCA ARD1312, Isao Tomita. A Night on Bare Mountain, Sunset 3 min.; Firebird, Sunrise 3 min.; Berceuse and Imale, Exit 4 min.

Abraxas: Columbia-KC31130, Santana. Singing Winds and Crying Beasts, Sunset 4:48 (a little long - you might want to fade in after it starts, and it has to be faded down carefully at the end as it blends into the next cut); Samba Pati, Sunrise 4:46 (a little long, but builds nicely - fade-in?).

Caravanserai: Columbia-KC31610, Santana. Eternal Caravan of Reincarnation, Sunset 4:25 (crickets and jazz saxophone at the beginning are a little too much, and can be left out to make it a suitable length).

Abbey Road: Apple SO583, Beatles. Here Comes The Sun, Sunrise 3:04; Sun King, Sunrise 2:31.

The Lion in Winter: Columbia-OS3250, John Barry. We're Jungle Creatures, Sunrise; To Rome, Sunset; How Beautiful You Make Me, Sunset.

2001 - A Space Odyssey: MGM Records SIE-13 stx. Also Speke Zarathustra, 1:37 (although this has been overused and is a bit short, it works well for sunrise).


Star Trek - The Motion Picture: Jerry Goldsmith. Ilia's Theme, Sunset 3:00; End Title, Sunrise 3:15.


Ferrante and Teicher - We Wish You A Merry Christmas : United Artists UAS6536. Santa Claus is Comin' to Town, Sunrise 2:40 ; Rudolph the Red-Nosed Reindeer, Exit 2:15.


Vangelis-Albedo 0.39. Pulstar, Sunset 3:30 ; Alpha, Sunrise 2:45 ; Nucleogenesis (Part I) Exit.


The Empire Strikes Back : The Duel, Sunset 4:05 ; Departure of Boba Fett, Sunrise 3:30.

Alan Parsons - I Robot : I Robot, Sunset 4:00 ; Nucleus, Sunrise 3:00 ; Day After Day, Exit 3:45.

Jean Jarre-Oxygene : Oxygene, Part IV, Sunset 4:10 ; Oxygene, Part III, Sunrise 2:50 ; Oxygene, Part V, Sunrise (fade-in).

Jean Jarre-Equinoxe : Equinoxe, Part V, Sunset 4:00.

Buck Rogers : Something Kinda Funky, Sunset 3:05 ; Wilma Saves Buck, Sunrise 2:40 ; Pirate Attack, Exit 2:20.


TIPS FOR THE NEW PLANETARIUM : (GLPA Tips Booklet) : Wm. F. Rush, Associate Director, Ritter Planetarium, Ritter Astrophysical Research Center, University of Toledo, Toledo, Ohio 43606
Eyes On The Universe: A New Concept in Planetarium Programming

by Lonny Baker, Assistant Education Director, Flandrau Planetarium, University of Arizona, Tucson, Arizona 85721

ABSTRACT: Eyes on the Universe is a series of free public programs presented weekly at the Flandrau Planetarium. The series, designed for the general public, presents programs on a variety of topics related to astronomy and space sciences from the perspective of the humanist as well as the astronomer. A similar series could be developed by most planetaria.

Flandrau Planetarium, on the University of Arizona campus, is literally surrounded by the research facilities of Kitt Peak National Observatory, the Lunar and Planetary Laboratory, Steward Observatory, and the Optical Sciences Center. Within a 50-mile radius of Tucson are the telescopes of Kitt Peak, the Catalina Observatory (operated by the University of Arizona), and the Smithsonian’s Whipple Observatory (formerly Mt. Hopkins Observatory). It is not surprising, therefore, that there is within the Tucson community a high degree of interest in astronomy and space exploration.

Like most planetaria, Flandrau has traditionally presented four or more public shows per year. They cover such familiar topics as the birth of stars and the end of the world (a popular topic in 1982). From Stonehenge to the Christmas Star, some of these programs have become traditional planetarium fare.

In recent years, the public has become increasingly aware of the need to better understand the origin and nature of the Universe and the physical and cultural forces that shape the planet on which we live. Are we alone or is there life in other worlds? Could people live and work in space? Can we survive changes in the Earth’s environment? Cosmology, astronomy, astrophysics, and planetary sciences attempt to answer fundamental and often perplexing scientific questions. In addition, scholars from the humanities frequently provide a different perspective.

Since 1922, Steward Observatory had sponsored a weekly lecture series in its largest lecture hall. The research papers met high academic standards. The audience had dwindled to a staunch 25 supporters.

The Flandrau Planetarium recognized the need to develop a forum for the rapid dissemination of the exciting research and discoveries taking place in astronomy and space sciences. Our speakers would be drawn from the arts and humanities, as well as the physical sciences. On September 4, 1979, Steward Observatory Public Evening was laid to rest. Flandrau Planetarium introduced a unique weekly series of free public programs: Eyes on the Universe, a series designed to inspire the mind and capture the imagination.

In three years and 51 presentations we have sent our audience on expeditions to the planets via the Pioneer and Voyager spacecraft, within weeks of encounter, travelled into a black hole, delved into the minds and myths of Native American peoples and held a press conference with Galileo. From the birth of stars to their death in the stellar graveyard, from a Jesuit priest-
astronomer’s personal view of the Big Bang vs. Creation to poetry read under the stars, from Herschel’s discovery of Uranus to the recent discovery of double and triple quasars, our audience has explored a vast range of subjects through the eyes and minds of humanists as well as scientists.

A frequent request from many of the visitors who had grown up near more conventional planetaria, was the inclusion of an evening sky segment in our public shows. Often it did not fit the format of the public show. To remedy this “oversight”, the speaker series alternates with seasonal sky shows. These bi-weekly programs appeal to scouts and backyard astronomers who want to learn about the constellations, identify the planets, search for fainter objects with binoculars or small telescopes and who want to become more familiar with the evening sky.

The series is held in the Planetarium Star Theater. The speakers may take full advantage of the Minolta Series IV star projector, special effects and the omniphonic sound system to enhance their presentations. We avoid the term “lecture” along with the use of graphs, charts or tables. By providing the speakers with a tour of the theater at least one month before their talk, and advising them during one or more rehearsals, we have helped them make the most effective use of the planetarium. Thus, a generally academic lecture can be transformed into a lively discussion suitable for the general public. Since the series’ inception, the theater has invariably been filled to capacity. Many programs have been so popular that additional presentations have been warranted. The uni-directional seating focuses the audience’s attention toward the front of the theater (South) which is used as a stage for introductory remarks. Following the introduction, most speakers prefer to present their talk from the console area (North) where they have the best view of their visuals.

During the Spring 1981 season, a survey, taken in conjunction with a grant from the Arizona Humanities Council, provided us with some interesting facts: 40% of our visitors have attended most or all of the Eyes on the Universe series, 28% attend frequently, 32% were attending for the first time. We imagine that first-timers were attracted to the planetarium by a specific topic, like folklore, living in space, or science fiction. Nearly 20% were retirees, 37% were professionals, 26% were students. Although the survey was limited to those programs which embraced the humanities, it showed nearly 68% of that audience also attended the science talks frequently. Of the total respondents, 61% felt the inclusion of the humanities added a new dimension to their understanding of astronomy, and an additional 31% felt it added “some­what”. This indicates overwhelmingly that in the opinion of the public, the sciences are enriched by the Humanist’s perspective.

While the series has been thoroughly supported by the entire staff of the Flandrau Planetarium, it has been primarily the responsibility of one person to design the schedule, contact and orient the speakers, coordinate their needs with any staff member who can assist in creating audio tapes, visuals or special effects (what’s the death of a star without a supernova explosion?). The programs are held on Tuesday nights, supplanting the public show which had the lowest attendance record. The same student staff members, plus the coordinator, run the console, 16-inch telescope (for post-show viewing of the “real” sky) and gift shop. As the same staff members work each week, a sense of warmth and friendship has developed between the staff and regular visitors. The benefits of this unusual relationship are outlined overleaf. A
brochure describing the series and the planetarium is printed each semester (Fall and Spring). This is our best mode of publicity, as the news media is reluctant to give much coverage to a weekly event. The series, which is free, provides tickets two weeks in advance. All tickets are gone within a week, frequently within a day. For some mysterious reason 40-50% of the ticket-holders do not show up, but an equal number arrive early and are admitted on a standby basis. Thus, the shows are generally filled to capacity.

While it is believed that the *Eyes on the Universe* series is unique, such a series could easily be developed by any number of planetaria. The benefits, as outlined below, justify the time and effort that the planetarium staff expends. Although the Flandrau Planetarium is situated at the hub of activity of astronomy and planetary science research, any planetarium with access to a university, Liberal Arts college, amateur astronomy club, pro-space organization, and/or space-related industry, etc., can with a little imagination and by developing a large number of contacts, put together a lively and diverse selection of speakers. *Eyes on the Universe* has presented not only astronomers and planetary scientists but geologists and atmospheric physicists. Among the most interesting, and often most controversial, speakers have been the poets, lawyers, medical technologist, folklorist, historian, archeoastronomer, engineer and Yaqui Indian. Except for the latter, most can be found in any community. Some programs deserve special mention: one was a press conference with Galileo, played by a Speech Communications professor complete with 17th century costume. Of the four interviewers, one was our ubiquitous Jesuit priest (now director of the Vatican Observatory) representing the loyal opposition, and another, his fellow astronomer-cum-historian. The program took place one month after the Pope had vindicated (exonerated) Galileo, so the "press conference" took on quite a different tone from what had been planned six months earlier. Another program began in the strictest sense of scientific decorum: a progress report on the Multiple Mirror Telescope, one year after its inauguration. Neither the speaker nor the audience knew that as the program ended, we would change gears and have a birthday party, complete with a specially decorated MMT birthday cake. On other occasions, a group of physics and drama teachers from our community college wrote and produced a dramatization of Isaac Azimov’s short story *Nightfall*: a physics professor from Phoenix created his version of an evening with Mark Twain, who loved science in general and astronomy in particular: a Pulitzer Prize nominee read his poetry under the stars and a desert panorama, which added enough romance to cause several couples to curl up together in each other’s arms.

What are the benefits of such a series? For the Flandrau Planetarium they have been threefold. First, it has attracted visitors to the planetarium for the first time, many of whom have returned as paying customers. Second, the series has enabled the planetarium to establish greater visibility in Tucson, both with the public and the academic community, by soliciting speakers from such diverse backgrounds, as noted above. Third, but perhaps most significant for all planetaria, is the base of support among the regular visitors that has been developed. At a time when many planetaria are suffering from reduced state funding, federal cutbacks, and a slowing economy, it becomes essential to obtain increased support from within the local community. As an outgrowth of the free *Eyes of the Universe* series, the Friends of the Flandrau was established in 1980. The first Friends were frequent visitors to the series, people who attended so often they had already established a special rapport and friendship with the staff. They have introduced others to the planetarium, to *Eyes of the Universe* and to Friends of the Flandrau. Today, we have over 100 Friends. In terms of their enthusiastic involvement in the Planetarium, they provide much more than just monetary support.
For many Arizonans, Tuesday evening is "a night at the Planetarium". Several people come each week from as far away as 75 miles. The series has given the University of Arizona extra reason to take pride in us. *Eyes on the Universe* has made the Flandrau Planetarium a place that not only reports the latest ideas in science, but also takes part in forming them.
The slide is projected on to the dome with a slight tilt, so that the subject, a young woman, seems to be leaning over. The opaquing techniques used to isolate her figure leave much to be desired. A distinct colored background can be glimpsed here and there near her outline. But these detractions seem hardly worth noticing, because the entire top of the slide is white, marred only in its purity by the regular line of sprocket holes that traverse its upper boundary.

"Not in my planetarium!" you exclaim. No, probably not. However, many planetarians are guilty of production errors that qualitatively rival the one described above. Some of these will be dealt with in this paper. First, I need to indicate exactly how I feel "show production" should be defined. Production, in its truest sense, involves more than finalizing a script and taping voice and music, more than choreographing slides and special effects, even (in addition to the forementioned) more than the finished product.

Indeed, for us to continue to function in a professional manner, we must henceforth redefine show production as follows: Everything that occurs before and during the allotted run of a particular program. (We do not take into account the celebrations that occur after the run!) With such a definition in hand, let us embark upon a descriptive account of the lesser considered aspects of show production...

THE "MAINTENANCE" MYTH. Maintenance is maintenance, and production is production, and never the twain shall meet. "But nothing is seriously wrong or broken! Besides, aren't we getting a little off the subject?" Not at all! The planets in your planetarium probably all work very well: none of your star cells (or bright star projectors) are missing, and no bulbs appear to be burned out in either slide or special effects projectors. All well and good. However, there may be some items that have been overlooked.

For example, do the objects in your sky all cut off at the springline? This is most annoying with projections like the Sun or Moon and most distressing with slides or panoramas. Sunset is very unconvincing if the Sun can be seen creeping down the projection gallery wall, and the bottoms of panoramas projected on said wall immediately transport the audience back to the room in which they sit. These can usually be remedied very simply by a person with some persistence (and patience), but in those extreme cases where there is no-one available who is confident working with the star projector, at least inform the console operators that they are to slowly fade the Sun as it nears the springline. It may add nothing to the show. However, like most of the items herein, if not attended to, they will surely detract from the performance.

Another example (much more noticeable) is the mid-show burned-out projection bulb. Once in a great while (at least, I assume this occurs infrequently) disaster strikes - a slide projector bulb blows out in the middle of a show! The console operator is faced with two choices, both of them bad: (1) he can pretend that nothing has happened and hope no-one notices (very unlikely) or (2) he can interrupt the flow, depth and build-up of the show by stopping the tape and changing the bulb, with apologies, of course. Not very good choices. To neglect the problem is to (literally) leave people in the dark about various, possibly important aspects of the
show. To correct the problem is to lose all semblance of professionalism, as well as to create the probability that the break will disrupt any activity in the minds of the audience that would allow a connection between the beginning of the show and its conclusion. There does seem to be a remedy. It lies in the application of a regular bulb replacement schedule. Not weekly, not even monthly; not the same from projector to projector, as each projector (or pan, as in the case of dissolve units) will have its own usage curve. But someone must decide on a regular replacement schedule and stick to it. Some of you may be thinking: “To replace a bulb before its life is through is a real waste!” Not at all. I did not advise you to throw out the used bulb: rather, I suggest you put it to use in one of the ways that we do. We put them in behind the dome effects (more than one at once), rarely used special effects (where, if they blow, it’s usually during a practice run), light show effects (there’s always something else you can use for a particular song), and in the slide projectors we use for our “out-of-the-planetarium” talks and lectures (two spares are always carried). Somehow, blowing a bulb in front of a group of Kiwanis after lunch is much less traumatic, and more easily accepted, than it would be in the star theatre. You’ll probably think of many others as well.

Maintenance cannot be isolated from show production. An error or oversight in maintenance will nearly always appear in the current production. But the Maintenance Myth is not the only one we have to overcome as we strive to obtain more professional shows.

THE “PERFORMANCE-IS-NOT-PRODUCTION” MYTH. I didn’t miss one cue! It was an excellent show! Maybe it was an excellent run. However, a few small items tend to be overlooked as we evaluate our performance. For example, at what level are the panel (mel reading lights on your console usually run? I have visited planetariums whose console illumination actually cast more light on the dome than the sunset glow projector! Not only is this level of lighting totally unnecessary for any but the severely visually impaired (I’ve yet to find such a one in a star theatre), it serves to distract from the show. Our patrons do not expect a total representation of the outside environment, so leave the light pollution to the real world and turn down those reading lights!

Another commonly overlooked problem is the color of the wall behind the dome projection screen. (This problem exists only in perforated domes.) Most such walls are black. Most, not all. This was a problem at Flandrau until six months ago. Bright slides viewed off-axis produced a second image on the pinkish-gold insulation behind the dome! Correction involved several coats of flat black paint, a rented sprayer, and one and a half days of concentrated staff effort. Total cost was less than $200, and no shows lost. Note: even if your wall is black, if it is smooth this problem could still exist in diminished form. Some simple tests with bright subject and word slides should be all that is necessary.

Other common problems in this area include light leaks from various projectors (we’ve found that panorama and single slide projectors are usually to blame), hyperdrive pointers (rare to actually see, as they are difficult to follow and usually don’t remain on long enough to point out the object), and two (or more) person discussions behind the console. When I go to a movie, I don’t want to hear the two people behind me carrying on a discussion about anything. Neither does the audience at a planetarium show enjoy hearing voices emanating from the area around the control console. It is very unprofessional and downright annoying! And while we’re on the subject of communication, don’t forget one of the most important aspects of perform-
The conclusion that I have come to, and I hope yours has been a similar experience, is that Show “production” is the all-encompassing, never-ceasing action of the staff to give our public more than they expected: the best show we can present, in a pleasant setting with well-maintained equipment. And don’t forget the cordial greeting. Oh, one other thing: all this is to be accomplished on a shoestring budget. Experience has shown that it can indeed happen. It can. And, if we are to survive as a profession, it must!
Edna the Alien

by Fran Biddy, Strasenburgh Planetarium, Rochester Museum and Science Center

Edna the Alien was built for use in Star Travelers, a show produced for family audiences. She’s seen in one scene at the beginning of the show, and then heard (but not seen) for the remainder of the program. When she appears, the audience sees only her head, through the window of her spaceship.

The head was constructed from polystyrene insulation panels, available 2” X 2’ X 8’. We first sketched out her side profile, then cut six pieces of the polystyrene in the shape of this profile on a band saw. These pieces were glued together with carpenter’s white glue, to construct the basic mass from which the head was then carved in the round. We used a pneumatic die grinder (with a rotary rasp, and then abrasive materials, at 30,000 rpm) to do the carving, but hand tools (rasps, files, and sandpaper) would also do the job.

Edna was painted with a sealer coat of latex paint (which doesn’t eat into the polystyrene) and then finished with paints sensitive to ultra-violet light. Fake fur, from the same hobby shop as the paints, was glued on for hair and eyebrows, as well as a neck-column, and dusted with the U-V sensitive paint. We placed her behind the dome, framed her with ultra-violet lights, and surrounded her with a front-projection of her spaceship. In lieu of a solenoid to operate her mouth, the monofilament could be tugged manually by the show operator.
The Universe and I: Excerpts from an Elementary Gifted and Talented Group Production

by Jeanne E. Bishop, Westlake Public Schools Planetarium, Parkside Junior High, 24525 Hilliard Road, Westlake, OH 44145

A special planetarium program was produced by 59 gifted and talented children in grades one through six in the Westlake Public School District during 1981-82. Following an orientation to possibilities, each student prepared an idea and submitted it in writing with an original or selected visual. Although interpretation varied, the program theme was expression of feeling about living within the universe. Declarations and wonderings about individual and human importance, possible distant life, and future space exploration dominated the student work. Each student recorded his/her idea, and one student composed a partial musical score played on an electronic synthesizer. A team of students helped with photographing the visuals, organizing the sub-themes of the program, and planning planetarium effects. The program was presented for parents, teachers, and students in afternoon and evening time slots as a culminating year event for the Gifted and Talented Program.
Teaching Observational Astronomy to Parents and their Middle School Children (ages 10-13)

by Dennis Brinkman, Eugene Gennaro, Patricia Heller and Rodney Nerdahl, Como Planetarium, 780 W. Wheelock Parkway, St. Paul, Minnesota 55117

The advent of the Space Shuttle, probes to the outer planets, and science fiction films have provided both parents and children with the motivation to become better informed in astronomy. Interested families often visit informal science centers such as museums, observatories, and planetariums to satisfy their curiosity about the objects and events that are observed in the night sky. However, researchers have found that in addition to this desire to learn, a prime motivation for families to visit an informal science center is the social aspect of “doing things together”. One of the predominant themes emerging from this research is the visitors’ need for interaction with other members of their family.

Most museums and planetariums offer short courses for adults or for children, but rarely do they offer courses for parents and their children to take together. At the University of Minnesota, with the support from the National Science Foundation, we have developed and taught an introductory course in observational astronomy designed specifically for parents and their middle-school-aged children (ages 10-13 or 14 years) to take together. The activities in the course were designed to achieve the following goals:

1. To strengthen family interactions through a shared parent/child learning experience.

2. To promote positive attitudes in both parents and their children toward observational astronomy.

3. To increase the knowledge as well as observational and interpretative skills of both parents and children with respect to the night sky.

Why middle-school-aged children? We thought it would be difficult to teach observational astronomy in a manner that is both interesting and profitable to young elementary school children and their parents simultaneously. Many high school students interested in astronomy have jobs in the evenings and on weekends or already know considerably more about astronomy than their parents. Hence, middle school children seemed a natural choice.

The Night-time Astronomy course was taught twice in the last year at two different planetarium facilities - the Como Planetarium and the Minneapolis Planetarium (operated by the Science Museum of Minnesota). The former institution has an automated Spitz Model 512 planetarium instrument and the latter a Spitz Model C (without automation). The sessions were team taught by Dennis Brinkman, Director of the Como Planetarium, and Rod Nerdahl, Program Assistant of the Children’s Center and Planetarium.

Each course was five sessions long and met for two hours on a weekday evening from 7:00 p.m. to 9:00 p.m. Some families registered as one parent and one child, some as two parents and one child, and still others as two parents and two children. Class sizes ranged from eight to twelve families (20 to 30 participants). Home activities were provided for parents and children to do together.
Each session of the course is composed of two segments, one in the planetarium and one in a nearby classroom or outside for night-time observation of the sky. To promote family interactions during the planetarium segment, each family was given a red-filtered flashlight, pencil, prediction or observation sheets, and a lap board (when planetarium seating lacked desk tops). Families were periodically given time to consult together and record their predictions or observations. For example, in one planetarium segment families recorded and predicted the consecutive monthly positions of Mars and Jupiter on an unmarked star map, and in another segment, families predicted and recorded the successive daily shape and position of the moon on a horizon map. The classroom segments were used for modelling the observations made in the planetarium or for building observational instruments. In addition, families were given home activities to complete together each week.

A brief synopsis of each of the five sessions follows:

Session One: Families are introduced to the night sky. Initially, most families view the night sky as a disorganized collection of stars. They are given an unmarked star map which also, at first glance, appears disorganized. Through projected constellation figures and a pointer, families learn how to divide the sky into easily recognized constellations. In their home activities for the week, families are encouraged to spend time outside locating and identifying constellations. They use parts of their hands to estimate the angular distances between the stars and experiment with astrophotography using 35 mm cameras.

Session Two: Families build a mental model of the celestial sphere by observing how the rotating earth affects the apparent motion of the stars. They first look at examples of astrophotography slides. These slides lead to a discussion of the cause of star trails. In the planetarium, families predict and record how star trails look when a camera is pointed in different directions, north, south, east and west. They also predict and record what star trails would look like at three other locations on the earth, the north pole, the equator, and the south pole. Families are then introduced to the concept of altitude and azimuth angles in the planetarium. In the classroom, they build an astrolabe and learn how to use it. For the home activity, families use their astrolabe to measure the altitude and azimuth of some bright stars.

Session Three: Families pretend they are ancient astronomers watching the heavens over a period of several months. They discover that not all of the “stars” remain fixed with respect to one another. These “wanderers” are the planets. By recording the changing positions of Mars, Jupiter and Saturn on a star chart, families discover that the planets move through constellations known as the zodiacal constellations. In the classroom, family members act out a model of the solar system in order to better understand the motion of the planets through the zodiac. The home activity prepares the participants for the last session by having them observe and record the position and shape of the moon at sunset.

Session Four: A field trip to a local observatory offers families an opportunity to observe celestial objects through a telescope and talk to a professional astronomer. For the home activity,
families build and use a small, hand-held telescope. They are introduced to the advantages that larger telescopes have over a small home-made instrument, while also discovering the surprising number of objects that can be seen with a relatively small telescope.

*Session Five*: Families observe and predict the position and shape of the moon in the planetarium over several consecutive days. The observations are first made at sunset (waxing moon) and then at sunrise (waning moon). In the classroom, families use illuminated ping-pong ball models of the moon to observe and record the phase of the moon when it is in different positions in its orbit round the earth.

We found teaching parents and their children observational astronomy to be an exciting and rewarding experience. It was not unusual to find some children far more literate in astronomy than their parents. However, children’s knowledge and enthusiasm were generally quickly matched by their parents as they explored the night sky together.

Since the activities in the course requires families to work together to solve problems and learn new skills, both parents and children have the opportunity to act as the “teacher”. In some instances, children interacted with their parents as educational equals and could share their knowledge with their parents in a new and different way.

*Evaluation*: Based on evaluations completed by 49 parents and children, the Night-time Astronomy course was very successful. The course was rated 4.8 on a five-point scale (1 equals “not very enjoyable” to 5 equals “very enjoyable”). All of the participants said they would recommend the course to a friend. When asked to comment on a particularly rewarding experience they had as a result of the course, parents tended to list “sharing a learning experience with my child” and “learning to observe and identify things in the sky”. Children, on the other hand, gave responses that dealt solely with particular activities, such as the trip to the observatory or building the astrolabe and telescope.

To the question, “Did you like taking this course with your child/parent?” both parents and children all responded positively. When asked, “Why?”, parents made comments like “It is not very often we get to learn with our children” or “It’s fun to realize there are so many areas and levels we can both share and learn about and not be a ‘parent’ or ‘child’, but students”, or “It was enjoyable to see her enthusiasm and provide another avenue of communication.” Typical child responses were, “I enjoy learning about the stars and so does my dad”, “It used to be no-one listened to me when I talked about astronomy”, “I have seen things I never saw before”, and “One night I took a pillow out on our deck and leaned back and watched the sky for about an hour”.

Since parents and children often exchange teacher and learner roles, both gained insight into the level of knowledge and learning behaviors of each other. Comments like “He (my son) is an even deeper thinker than I thought - he is very committed to his opinions and conclusions” and “They (my parents) know more about astronomy than I thought” were common. Using a pre- and post-test, we also found that both parents and children made considerable gains in their understanding of the course content.
Conclusions: Teaching a Night-time Astronomy course to parents and their middle school children may be an effective and enjoyable method of increasing scientific literacy about astronomy of two different age groups. A course similar to the one we developed could be offered through community education programs in many school districts which have a school planetarium, or with the cooperation of a local science museum or planetarium.

We have a comprehensive teacher's manual for the course, complete with marked and unmarked sky maps, constellation diagrams, and worksheets. If you are interested in starting a Night-time Astronomy course for parents and children in your community, please write to Gene Gennaro, Project Director, Out-of-School Science Experiences, 370 Peik Hall, University of Minnesota, Minneapolis, Minnesota 55455.
Planetariums: The New Generation

by Mary Jane Butler, Kansas Cosmosphere, Kansas 67501

ABSTRACT: The positive force which the Omni-Max system has had on the survival of the Planetarium in these hard times.
Circular Format for All-Sky Effects, or: Don't Shoot The Artist ... Yet

by Jennifer M. Bushman, Chief Artist, Calgary Centennial Planetarium, P.O. Box 2100, Calgary, Alberta T2P 2X5

With the trend towards replacement of the human by more compact and increasingly mechanical methods and the control of entire work processes in the "hands" of a computer, it would seem entirely likely that the need for the artist, as an entity of value, could rapidly diminish and follow the fate of the dinosaur.

In Calgary, as is also the case in other centres, we continue to move further into the automated and computer-controlled situation, yet the Art Department is larger and busier than ever. It seems that as the demand for automation increases, so also does the need for the old-style "hand work". One appears to nurture the need for the other, and while we have some of the best technical equipment we also have an Art Department larger than the norm - for a planetarium - three full-time artists, and part-time help from a high school student requiring on-the-job experience.

While we do have great photographic all-sky pans, it seems that there is still a place for artwork as well, to produce that which is not available to the camera: maybe because of the season of the year or because the requirement is for a purely imaginative interpretation: for example, the atmosphere of a planet, a backdrop for the laser, or for clouds in a particular weather pattern.

TECHNICAL INFORMATION

We paint all our skies on matt black Peterborough board, obtainable in sheets 71 cm x 113 cm. We mark off a circle, the diameter of which is pre-set by the width of the board. We found that there is a variation in the quality of the black boards provided by different suppliers and this is worth checking beforehand. Our first source provided a board with a smooth, rather hostile surface and not a true deep black. Recently we have located a source that provides a board with a slightly "toothy" surface, matt and velvety black in appearance. All black cardboards require some care in handling, as they scuff very easily: however, superficial marks may be satisfactorily removed with a gum rubber eraser.

Having now separated the circle from the remainder of the board, it is divided into six equal parts (we have a six-projector all-sky system) using a template, and leaving a border around the periphery of 5 cm to allow for soft-edging on to the horizon pans. A certain amount of overspraying is allowed into this border, fading quickly to all black. Matching overlap between the six parts is allowed for by omission: that is, detail is kept away from the overlap area. We know that overlap is non-existent at the lower edge, increases in the centre of the overlap area and tapers to nothing at the zenith. (See Diagram 1.) Therefore, although the projected images will have convex sides, our simple triangle shapes work well in the artwork stage as the convexity will later be allowed for in the photographic stage. The all-sky is consequently painted without obvious joins or overlaps, but the position of each join is marked at the outer edge and the centre pin hole is kept visible for a point of reference in the photographic stage.
Pelikan Plaka Designers Colours have proved very satisfactory when used on these black boards. These colours provide a very opaque coverage without underpainting and present good colours for photographing. They are also compatible with either airbrush or sable, although high concentration of white tends to cause clogging in the airbrush. This is, however, one of the more easily rectified foibles of the airbrush: simply increase the dilution of the paint and time taken to airbrush. One drawback to these designers colours is their tendency to “bleed” into successive layers of paint when disturbed by a thin glaze-type spray from the airbrush. This may be inhibited to a certain extent with the use of a matt-type fixative spray. One note of caution is necessary here - check the effect of the fixative on a sample before using on nearly finished artwork. There is a certain degree of inconsistency in the spray, however, if all goes well - and it usually does - the fixative will have the desired effect.

In order for the horizon line to appear level on the dome we keep details in that area such as a bank of clouds, for example, in a line straight across the base of each triangular section and not parallel with the outer curved edge. Perspective is exaggerated somewhat, detail kept very small at horizon points and becoming generalized at the zenith and near the joins. One of the six sections is painted with only the background colours of the artwork but no detail - this section disappears when fitting the flat surface on to the dome: much like curving a flat filter paper into a cone.
As may be seen in Diagram 1, the lateral guide lines give an indication of what will happen to perspective when the image is projected: therefore in order for detail to appear normal the lines indicate the degree of distortion which should be painted in: the higher the detail on the dome, the more acute is the distortion.

The size of the six divisions has been confirmed by measurements made in the dome by the technical department. That is, grids were projected on to the empty space provided by the all-sky projection system until the best fit was achieved, and the relevant points transferred on to a drawing of the section, until a very accurate reference to any variation in dome surface was gradually recorded. Proof that our dome does, indeed, have a few idiosyncrasies! This drawing, with reference points, was then photographed, projected again to the size which would fit our circle and drawn on to wet-media acetate for easy and permanent reference in the art room. It was from this source that our invaluable template was made.
When our painted panorama arrives at the photographic stage, the circle fits under the Oxberry copy stand. Each section is lined up to pre-set co-ordinates, using also the centre point and peripheral markings on the art work: and, as previously mentioned, the warp is created at this time by curving the circular board.

Some experiments are being made at the moment, with a view to creating a painted all-sky using a more specific subject matter: for example, a forest environment and a city environment. While, perspective-wise, the problems are quite stimulating, we have our template for reference and we feel excited by the prospect of this new approach to planetarium artwork.
by T. H. Callen II, Chief, Presentations Unit, National Air and Space Museum, Smithsonian Institution, Washington D.C. 20560

ABSTRACT: Many planetariums are familiar with the production of soundtracks for their presentations under the domed universe. The National Air and Space Museum’s Einstein Spacearium finds itself in the unique position of having original music composed and scored for their presentations, which is then narrated, recorded, and mixed at a commercial studio. This paper will follow this audio process from concept to finished tape, exploring the various steps and interactions between composer, sound studio, and Spacearium.

Having been in the planetarium business for over ten years now, I have had the opportunity to observe and be involved in the production of soundtracks at a variety of facilities. While a student at S.U.N.Y. Oswego’s Piez Hall Planetarium under Charlie Jerred, we thrilled our student visitors with the popcorn-like starfield of a vintage, 1961 Spitz A3-P, and records played on the planetarium’s turntable. At the Strasenburgh Planetarium I had the opportunity to watch original soundtracks being put together by Tim Clark and Cary Ratcliff. While there, it was not too difficult to conclude that original soundtracks were the way to go, in terms of getting the exact music for the exact effect you had in mind. Abrams Planetarium at Michigan State University took a half and half approach when possible, borrowing pre-recorded material, and using borrowed and on-campus electronic music synthesizers to provide sound effects and textural overlays such as imagining what it might sound and look like to be within a diffuse nebula.

I am now at the National Air and Space Museum’s Albert Einstein Spacearium, where I find myself in the unique situation of having original musical scores composed and orchestrated for our planetarium presentations. To the best of my knowledge, there is only one other planetarium in the country who takes this approach, though I would be pleased to hear that there are others.

When putting a soundtrack together in this manner, it may seem a natural conclusion to assume that everything is turned over to the music people, who then put it all together. Actually, it involves close communication between Spacearium, composer, and sound studio.

The process begins with the presentation’s storyboard, which shows both the content and visual flow of the show. What kind of topic is being covered: historical astronomy, 20th-century astrophysics, a montage of subjects? It is at this point that the decision is made as to who the composer might be. One composer might work better in a jazz idiom, while another can comfortably mix acoustic and synthesizer timbres together so that the two instrumentations work with, and not against, each other. Besides being able to work in different music media, the composer must also have an understanding of how planetarium shows are put together. As in scoring films, the composer needs to work initially from timings worked out with the Spacearium producer. A good imagination, familiarity with planetarium visuals, and a little astronomy background are also important. For example, you wouldn’t want to have cartoon-like music for a visually dramatic event such as a black hole. It is far more desirable to have something sound as ominous musically as what you are showing.

About the same time the composer is selected, a choice on the sound studio is made. When considering a professional sound studio, you need to realize your best dollar value, efficiency, facility set-up and equipment, and a cooperative attitude. It also helps that the studio engineer
have an understanding of the planetarium soundtrack process, though this is not critical as this is very similar to traditional AV show production, standard fare for many sound studios. Besides having the facilities and equipment for recording, editing, and mixing, the studio is also responsible for renting any non-standard instruments needed as well as hiring the musicians who will be performing the score. These musicians must be familiar with studio recording as there are stringent do's and don'ts for session players that go beyond a classical background: this knowledge can only be acquired through experience.

While the composer and studio are being lined up, the presentation's script has been completed, reviewed both inside and outside the Museum, and has been approved for the recording of the narration. A copy of the completed script is sent to both the composer and the sound studio as a common starting point for the final concept of the soundtrack. The composer, working with the Spacearium's producer, comes up with a rough timing for the show so that he can begin to put together a musical sketch of what the score might sound like. The storyboard helps to reinforce the direction the music is taking.

With the finished script, it is now possible to hire a narrator to provide the dramatic, or even the "you are there", reading the text requires. This becomes the first product of the finished soundtrack as the narration is recorded before final scoring for the music is begun, which is based on the delivery pace of the narrator. For the Spacearium's next presentation, Probe, a planetary odyssey scheduled to open in September, we were very fortunate to get Dr. Bruce Murray of the Jet Propulsion Laboratory in Pasadena, California, to be one of the co-narrators. While Dr. Murray is not a professionally trained narrator, his presence adds a very important factor: the audience is being addressed by a professional scientist who has participated in some of America's most successful space projects. The second narrator, professionally trained, provides dramatic color to the readings.

Once the narration has been recorded, edited, and timed out with paper leader to match the pre-planned pauses in the soundtrack, one has a reasonably accurate timing for the finished show. Now the composer can take and flesh out the rough sketches to make the musical score have the appropriate length of music for each section of the show. It is also at this point that musical hits, music which emphasizes a certain aspect of the narration, or visuals being seen, are worked into the score. Sometimes these hits are subtle, other times they are purposely obvious.

The Spacearium next receives a rough music composition tape from the composer, played out on piano with some sound effects where feasible: such effects are usually created on a synthesizer, and may end up that way in the final soundtrack, or be replaced by real sounds that may not have been available at the time the composer was putting together the rough music tape. This is the Spacearium's first chance to hear and comment on the progress of the music. It is at this stage that approval is given on the approach the composer is taking: does the music fit the purpose of the presentation? If there are questions concerning the treatment of a particular section of the score, the composer is obligated to change that part. When we received the rough music tape for Probe, it was generally felt that one of the musical sections dealing with Mars was too active for what was being conveyed in the narration and visuals, so a correction
was requested, which more closely matched the wistful mood we originally had in mind for the section.

After the composer adjusts his score to take any asked-for changes into consideration, he then sends a fine composition tape to the Spacearium to get approval for the changes made. It is at this time that a listing of the suggested instrumentation is provided to help fill in the textural gaps found in listening to only a piano version of the soundtrack. The composer also sends a listing of the required instruments to the sound studio so that they might begin to line up players and any special instruments, such as synthesizers, for the recording sessions.

While the composer is adjusting his score, he begins to make up a listing of the music cues that will require overdubbing to either help thicken up the sound of certain instruments, such as strings, or add new timbres, such as elements performed on synthesizer. These synthesized elements could include everything from melodic themes to sound effects, such as the launch of a Titan/Centaur rocket. This listing of overdub cues is passed on to the sound studio so that more of their pre-planning can take place in terms of outlining a timetable for when what musicians or instruments have to be in the studio to record certain music cues. This kind of advance work saves much expensive time during the actual recording sessions because all the participants know when they are required to be in the studio working.

Just before the actual music recording sessions are held, the composer, the project engineer from the studio, and the Spacearium producer get together for a final pre-production meeting, to make sure any last-minute details have been attended to. Such meetings in the past have ranged everywhere from finding a celeste in the Washington Metro area that would be in tune to A 440 (the standard music tuning reference), to making sure that a specific audio special effect device, such as digital reverb line, will be in the studio when required.

It is always an exciting moment for me when the actual recording of the music begins. Even with the fine composition tape, which has only the score played out on piano, it is often surprising to see how the music turns out once the proper instruments are applied to it. What may have sounded very nice with just the piano version often blossoms into an emotionally involving piece. This is especially true when all of the instruments have been added to a musical cue through the overdubbing process. Recording is usually scheduled in such a way that one set of days is for brass and percussion, the strings on another set, and the woodwinds on a third. Sometimes the cues sound funny at first without all of the parts, but the intertwining nature of all the parts can be heard, once more and more instruments are added to the tape. An important aspect of the entire recording process is that the composer conducts all of the sessions, something that I feel strongly yields better results: who knows better than the composer as to how the piece should sound and balance between the musicians?

Once all of the music has been recorded on the 2-inch, 16-track, 30 ips tapes, any final overdubs or electronic effects that do not call for any personnel outside of the composer, producer or engineer are done. Oftentimes this includes the electronic processing of traditional acoustic instruments to give them an unidentifiable quality.
The moment of truth finally comes when the 16 tracks of music and sound effects are mixed together down to four channel quadrrophonic. When we do our quad mixes, we try to follow a logical spacing of the various sound elements. If we are dealing with an orchestral piece, the music is spread in such a way that the listeners feel they are hearing an orchestra performing in front of them. An appropriate amount of digital reverb in the rear channels adds to the large, concert hall illusion. A very nice effect can be achieved when using the panorama system to take the audience down to the surface of an unknown world, such as Pluto, by using the quad set-up to its full advantage in adding sound effects that surround the viewer, adding a “you are there” feeling. This use of quad is not limited to planetary surfaces either, as it can be very effective during scenes which simulate the audience’s drifting through space: subtle movement of some of the sound elements within the quad format can heighten the illusion of movement without the viewers ever leaving their seats. Quad, however, can be a double-edged sword if one is not careful: do you remember the last time you sat through a presentation where the sound kept panning all over the place? Once might be nice, but after that it tends to get a little bit monotonous. In fact, if this audio trick is repeated too often, it can get downright tiring to the ears.

Mixing is one of the most fun parts of the entire process because this is one of the times when there are a lot of creative exchanges between the people putting the soundtrack together. One person may have an idea which is individually appealing, but it may not fit into the composer’s concept of how the music should go, or the composer may like the addition, and it becomes part of the soundtrack. In all, it is a very democratic process, with the Spacearium having final say on any possible conflicts (we are, after all, paying for all this, so we get a larger share of the votes). On occasion, such tie-breakers are hard to call as the composer and the engineer may both have very legitimate reasons for wanting the decision to go their way, but it is up to the Spacearium producer, acting for the Museum and the Smithsonian, who must make the final choice as to what will be the best move for the project as a whole. Fortunately, things usually run as smoothly as a Zeiss Model VI, with a minimum of problems, if any.

When all the soundtrack’s individual music cues are mixed down to the quad format on a half-inch tape, they are put together into what are known as A and B rolls, which are used to make the lay-up, the final combination of music and narration. The A and B rolls are ordered in such a way that the two alternate with one another on playback. In this way, crossfades of music can be accomplished by simply operating two different sets of audio faders on the mixing console. Since there is a lot of editing involved in getting these two rolls together, to help identify cuts on the rolls, and to prevent unnecessary static charge build-up during storage, paper leader is put between each musical cue as was done in the case of the narration master for timing purposes.

The last step in the process, as mentioned previously, is the lay-up, the summation of music and narration. Four tape recorders are involved in this process: two half-inch, four-tracks with the A and B music cue rolls, a quarter-inch, half-track with the narration master, and a one-inch, 8-track which is the record deck. All four are running at 15 ips, with the A and B rolls encoded during mixdown with dbx noise reduction. The first two planetarium shows which
premiered at the Spacearium, *Cosmic Awakening* and *Worlds of Tomorrow*, were recorded at 7½ ips without splices, but this also led to an extra generation because the lay-up was put together, edited where necessary, and then re-recorded in its completed form on to free splice tape. The last show, *New Eyes on the Universe*, and *Probe*, our upcoming presentation, were done at 15 ips with splices where edits were needed because we have found that splices cause no problems in terms of breakage, and the higher speed gave us a better frequency response. This also eliminates the need to do an extra generation which would have added an additional 3 db of noise we don’t want. This is particularly important, as the signal has to go through two more transfers once the master lay-up tape comes back to the Museum. An added plus this time around was that the sound studio had switched brands of tape since *New Eyes on the Universe* was recorded: this new brand biased at a higher level, so it allowed us to record at a higher level, adding just that much more to the signal to aid during the transfer.

We have found it advantageous to split up our narration over the left and right front channels when using two different narrators so that the audience can better discriminate between the two. It also adds a natural movement to the sound, as if the two voices were carrying out a dialogue. Since the narration is usually mono, this switching between channels is done manually by going back and forth between the line send switches of the narration master during the lay-up. Such switching is coordinated by using notes on the script.

It took four people to do the lay-up for the *Probe* soundtrack: one person to run the mixing console (the composer, because he was the most familiar with the timings and relative levels of the music and narration), one person to run the A roll and the narration master (the project’s studio engineer), one person to run the B roll (a second studio engineer), and one person to do the narration channel switching (myself, since I was most familiar with the content of the narration, being its author, and having originally divided it out between Dr. Murray and the professional narrator).

With the composer keeping track of the show time and relative levels of the music and narration, the group practices through the soundtrack a section at a time, up to a logical breaking point where we can put in a splice. Once everyone has their part down, with any needed notes made on their copy of the script, we commit ourselves to recording that sequence. The *Probe* soundtrack took us about seven hours to put together including practices, an occasional mistake, and recording. Like mixing, the lay-up can be a truly magical moment because this is the first time that we have heard the interplay between the orchestrated music cues and the narration. Small nuances in the music that had been only slight variations during recording and mixing now become hits with the narration, visuals, or both. The soundtrack, over a period of a few weeks, has gone from script, timings, sheet music, and clean tape to a finished planetarium soundtrack which fits the needs of the topic and those of the visuals we will show. Both work together like a hand and glove, each adding to the other what they cannot really do for themselves alone.

As a point of information, the following is a listing of materials and studio time required for a project of this scope:
NARRATION
6.75 hours 2 tr record time
10.5 hours 2 tr edit/transfer time
7.5 10½ X 1¼” master tapes
7 tape duplicates

STUDIO SERVICES
59.75 hours 16 tr record time
41.0 hours 16 tr quad mix time
19.0 hours 8 tr quad record/mix time
5.0 hours edit time
7 reels 2” master tape
4 reels 1” master tape
5.5 reels ½” master tape
6 reels ¼” master tape
288 hours musicians
9.75 hours producer/consultation
8 hours equipment set-up

EQUIPMENT RENTAL
4 tr equipment
Instruments
dbx unit
Lexicon 224X (Digital Reverb)

It is easy to take and list all of the items out in this fashion: what cannot be shown here is the amount of preparation that is necessary to coordinate such a project. In spite of the logistics required, I find the process to be one of the most satisfying in the world of planetarium show production. The ability to totally control the audio content of a planetarium show benefits all who are involved with it: from the composer who is creating a new arrangement of pitches, timbres, and durations, to the engineer who is challenged to capture the composer’s sonic image mechanically, to the audience who is at the receiving end of a long chain of events. It is with this goal that soundtrack production at the Albert Einstein Spacearium is directed: after hearing the final results, I’m sure it is a process that will be around for a long time to come.

(Note: “dbx” is the registered trademark of dbx, Incorporated.)
Optical Video Discs in the Planetarium

by Claire J. Carr and Everett Q. Carr, Hekiner BOCES Planetarium, N.Y. 13350

The optical video disc, often called the laserdisc, allows storage of up to 54,000 individual video picture frames on a single side of a rigid 2.5 mm thick plastic disc. We believe this disc system is the most significant advance in educational technology since the invention of the book. It also has great potential as a production tool in the planetarium. Possible uses in the planetarium include: (a) a source of individual picture frames, (b) a source of motion picture frames, (c) a source of digital data program storage, and (d) a source of laserdisc/computer instruction for public education material in a form for exhibit design, participative programming, informational programming, etc.

The features of the laserdisc that make this possible are:

1. There is no wear-out factor as with film or magnetic media such as video tape, audio tape, or electromechanical contrivances.

2. The characteristics of laserdiscs permit computer programs that interact with participants, exhibit "intelligent" reactions, almost human in response to the participant.

3. The construction of computer control programs that involve the participants in alternative open-ended paths of inquiry.

4. The digital encoding of video disc frames that allow non-linear programs permitting individual paths of inquiry - different for each participant.

5. Cost factors that encourage joint programs for a wide variety of educational institutions in exhibits.

6. The availability of bilingual exhibits or instructional modes from the two hi-fi audio tracks available on the disc.

7. Current laserdisc players allow a wide range of control functions, forward and reverse, single step and high speed operation, blanking, audio channel control, etc.

The field is ripe for the development of other laserdiscs that satisfy the needs of a number of institutions involved in a range of public education activities. It simply requires a definition of the needs, commitment of resources after a definition of the requirements and cost factors.

The International Planetarium Society's Astrodisc I, The Planets, a project approved by the Council of the Society, has resulted in an experimental disc, a description and sample of computer programs for disc use together with a listing of disc use has resulted.

The presentation illustrates the use of the Astrodisc I, a computer adapter for computers to develop interactive programs for astronomy education and a review of the opportunities for planetariums and their parent organizations.
Is There Life After Automation?

by Isabel Chen, H. R. MacMillan Planetarium

ABSTRACT: The use of live interaction with a tape-automated show track is discussed, along with implications for its use in educational programming at the primary school level.
A Special Effect Projector Illustrating SS-433

by Dave Conley, Calgary Centennial Planetarium

ABSTRACT: Some notes and diagrams are presented regarding construction of an SS-433 special effect. The effect as used in the Calgary Centennial Planetarium is based on four single-slide projectors, and shows expansion, precession motions and colour changes in the twin stellar jets, rotation of the accretion disc as well as the central binary star system, and the surrounding radio nebulosity.

SS-433 is a very peculiar star system. To a special effects technician, the challenge is to build a projector which shows this oddity on the dome of the star chamber, in colour and in motion, during a star show presentation.

We started with a square of aluminum, drilled a hole in the centre of it and filed two slots opposite each other, one on each side of the centre hole. A rod was attached to the top of the square and was driven in a conical path from the outer edge of a motorized disc.

Now to get these jets (slits) to change colour. A colour wheel was mounted behind the slit square which was dyed half red and half blue. Geared off the same motor, this colour wheel stays synchronized with the slits so that each time the upper slit is toward it, it is blue, and when the upper slit is away from it, it is red.
Completed Assembly
Behind all this, another plastic disc was geared up from the same motor so that its spin was faster than the rest. This disc was painted with black strokes in a spiral pattern which when projected through the slits gives the appearance of matter streaming out from the centre in both directions.

This whole apparatus was built into a slide projector where the slide would normally go, and the light turned on. So now we have two opposing jets of matter, alternating colour.

Next, planetarium artists painted a realistic picture of a small neutron star being orbited by a blue-white normal star while sucking a stream of matter from it. This was photographed and reduced to a 35 mm slide. The colour slide was placed in a motor-driven rotator so that the normal star appears to revolve around the central neutron star. This was built into a slide projector. A special lens known as an “anamorphic” was used to project the image because it flattens the circular rotating motion into an elliptical orbit. This projector was placed beside the first one in the star chamber dome and their images were superimposed.

Next another slide of a rendering of a spiralling, gassy, cloud-like accretion disc was placed in a motorized rotator, then into a slide projector using an anamorphic lens. This projector was set beside the other two and superimposed on their images.

Then a wide angle projector system (whose image is spread over the whole dome) was equipped with a slide of a gaseous envelope of the W50 shell and aimed to surround the whole system. And, from our darkened dome, SS-433 springs to life: one of the strangest stellar enigmas known to man, and featured in our current star show production, To Century’s End.
SS-433 Jet Stream Projector

SS-433 Binary Star & Accretion Disc Projector
Improvements to the Doane Observatory

by Larry A. Ciupik, Director, The Doane Observatory, Adler Planetarium, 1300 South Lake Shore Drive, Chicago, Illinois 60605

ABSTRACT: Improvements to the Doane Observatory will cover the ways in which an observatory built specifically with the public in mind can be improved to successfully handle large group observing.

The Doane Observatory of the Adler Planetarium opened in August, 1977. The observatory is located adjacent to the planetarium on the shore of Lake Michigan. It is the only observatory in the Chicago area which is open for use by the public on a regular basis. The observatory houses a 16-inch reflector which can be used at either the Cassegrain or Newtonian focuses. Attached at the Cassegrain focus is a low-light-level television camera held inside a focusing rack.

During the nearly five years of operation, the observatory has evolved into an integral part of the planetarium programs. A visit to the observatory for the typical Sky Show group of 200 to 300 people is scheduled after every evening Sky Show (Friday nights from September through mid-June and every night from mid-June through the end of August). And most attending one of our several dozen evening classes visit the observatory at least once. We have also presented a number of special "open house" observing events for the general public.

Our public observing events have been extremely popular. On Saturday, May 3rd, 1980, for example, we held an event to celebrate the planetarium's 50th anniversary and the close proximity of Mars, Jupiter, and Saturn in the sky. Although we had scheduled the event to run from 8:00 p.m. until midnight, more than 2000 people came to the observatory that night! By popular demand we extended our event until 2:00 a.m.

However, because of such events, we now have a much better idea of the effective use of the observatory under such extreme crowd conditions.

The clear problem is this - we must be able to provide an effective program for large groups of people on the observation deck, while at the same time smaller groups of people are inside the observatory dome.

The original television system in the observatory was designed to handle post-Sky-Show groups but it was never intended to deal with the number of people who want to participate in our public observing events.

The idea behind having a video system is to make telescope views available to several hundred people simultaneously. Until just recently, two black and white video monitors were mounted on the observatory wall, where they were visible to most people on the deck. The pictures on the video monitors can be either live camera, or videotaped views of the moon, planets, star clusters, nebulae, or other celestial objects.
Although we continue to believe the television system is an important facet of the Observatory program, we found the previous system to be inadequate in many respects. We have now studied the deficiencies in detail and have implemented plans to make the television system much more effective.

IMPROVEMENTS. In order to make the observatory visit a better experience, especially for large groups of people, we have added several new pieces of equipment to the present television system. Specifically, we have added a Beam Splitter, a Video-Captioning Device, a Colour Image Synthesizer, and a Video Editing System. We have also replaced the present camera tube and image intensifier with a more sensitive system. And we have installed five colour monitors and a public address system. Each of these items and the particular problem it is intended to solve is described below.

Beam Splitter. One thing the previous TV system could not do is provide a live camera image to the people on the deck when people inside the observatory are looking through the telescope eyepiece. This was especially unfortunate at public observing events when people came to the observatory specifically to see a certain object, grouping, or event in the sky that night.

This situation was remedied by adding a beam-splitter accessory to the telescope. The beam-splitter takes the beam of light which enters the telescope tube from a star, planet, or other celestial object, and splits the beam into two beams. One beam is directed to the television system, the other to the telescope eyepiece.

By using the beam-splitter we can now provide the same, real-time live image to people inside the dome and to people on the observing deck simultaneously. This was a great improvement over the previous situation, in which people on the deck saw only videotaped images if the telescope was in use inside the dome.

Video Captioning Device. Whether the image on the deck TV monitors is live or taped, we have found that the video images don't mean much to people who are unfamiliar with astronomy. To put it simply, people don't know what they're looking at.

To solve this problem we have acquired a video captioning device. The device, which is operated like a typewriter, can be used with both live and taped images. It gives people the information they need to understand the images on the video screen.

Colour Image Synthesizer. A second, related problem was with the character of the video image. In the past we could only provide a black and white image. But a colour image is much more interesting for the viewer, and much better as an aid to understanding the object shown on the screen.

We explored the possibility of using a colour camera rather than a black and white camera, but rejected this option as not feasible since colour cameras are not as sensitive. However, a similar effect can be obtained by using a colour image synthesizer with a black and white camera.
A colour image synthesizer electronically colours a black and white video image. Although the colour is not as realistic as it would be with a colour camera, the synthesized colour makes the images more realistic, and perhaps more importantly, helps the visitor distinguish different features of the image. For example, a colour-enhanced image of Jupiter would show the “red spot” as reddish and the several brown belts and white bands of clouds in their correct colours, which are distinguishing characteristics of the planet.

**Video Editing System.** There are many occasions on which it is extremely useful to be able to show taped rather than live images on the deck monitors.

During a public session to observe an occultation of Venus, for example, we showed a tape of a previous occultation so people would know what to look for when Venus appeared to “go behind” the moon, then “pop out” on the other side forty minutes later.

On nights when the sky is cloudy, taped images are used together with a tour of the observatory, which is much better than closing the observatory.

And many times a taped sequence provides an important comparison with the current night sky. Different phases of the moon, for example, can be shown on the monitor as a contrast to the view of the moon available that night.

All too often, however, the videotapes we were showing on the Observatory monitors looked like choppy “home movies”. This problem was more noticeable when we attempted to combine tapes made on several different nights to show a sequence of events. Each time the tape is “spliced” several frames are lost, the image blinks, rolls, and then suddenly jumps back into view.

We have now purchased a Convergence Editing Controller which operates two Sony Video Editing Recorders and two Sony 19” monitors to provide frame-by-frame editing of videotapes which can incorporate captions and synthesized colour.

We have also substantially improved the image visitors see by installing a new camera tube and modifying the power supply to the television system. These changes make it possible for visitors to see images of deep sky objects in “real time” instead of images which are created by time exposures. It also makes it possible to see images in motion, rather than just as still shots.

**Video Monitors.** To take advantage of the colour synthesizer we have replaced the present two black and white video monitors with colour monitors, and have installed a third monitor on the observing deck so that everyone on the deck will be able to see a monitor. We also have placed two monitors inside the dome, one for use by visitors and one for the observatory operator who needs to “monitor” the images appearing on the deck televisions.

**Public Address System.** Finally, a deck public address system has been added so that the astronomer in the dome can give a detailed description and explanation of each celestial object as it is being observed inside the dome and on the video system on the observing deck.
The public address system can also be used by an astronomer on the deck to speak to people on the deck or waiting in line even on the sidewalk outside the observatory.

CONCLUSION. After five years of experience we have become aware of shortcomings in the operation of the observatory for large groups and have implemented plans to correct these problems.

We have installed a beam-splitter to provide simultaneous group viewing of a live TV picture and eyepiece views for individuals, a video captioning device to label TV pictures, a colour image synthesizer to provide colour TV from a black and white camera, and a video editing system to give clean edits when compiling different videotapes. We also have upgraded our camera system attached to the telescope and have installed a public address system to address large groups.

The funding for the upgrading of equipment was provided by the A. Montgomery Ward Foundation.
Determining Your Admission Fees: Facts and Factors

by Dr. Thomas R. Clarke, McLaughlin Planetarium, Royal Ontario Museum

The McLaughlin Planetarium and the Royal Ontario Museum have recently developed a rational plan of determining admission fees, based on a number of factors: inflation, comparability with other institutions, operating costs. The use of these factors and relevant data from the McLaughlin Planetarium and other institutions will be discussed.

Inflation may be measured by the Cost Price Index (CPI) but the Recreation, Education and Reading Index may be more relevant to planetariums. All indices are published by Statistics Canada for major Canadian cities. As different institutions use different fee schedules (adult, student, child, senior) the concept of effective prices per patron will be discussed, which for the McLaughlin Planetarium is $1.75. Attendance breakdown shows 2.8% complimentary, 1.2% adult group, 5.4% student group, 53.3% adult, 42.1% children, student, senior.

Based on 1979 data for 23 North American planetariums, published by Sig Weiser in North Star (vol. 12 no. 1, 1980) and slightly more recent data (1980) gathered from 19 institutions by Hansen Planetarium, these rates apply:

<table>
<thead>
<tr>
<th>Year</th>
<th>Fee</th>
</tr>
</thead>
<tbody>
<tr>
<td>1979</td>
<td>$1.46</td>
</tr>
<tr>
<td>1980</td>
<td>$1.76</td>
</tr>
</tbody>
</table>

As of July 1, 1982, the McLaughlin Planetarium fees will be adults $2.75, children, seniors and students $1.75, school groups $0.75, with an increase projected but not approved for July 1, 1983, to $3.00, $2.00 and $0.85 respectively. This will increase effective earnings per patron in public star shows from $1.37 in 1980 to $2.25 in 1982 and $2.50 in 1983, and for school shows from $0.50 to $0.75 and then to $0.85 in 1983.
Observatories Attached to Planetariums, or Planetariums Attached to Observatories

by David Dodge, Supervisor, Gordon Southam Observatory, Vancouver Museums and Planetarium, 1100 Chestnut Street, Vancouver B.C. V6J 3J9

In an effort to augment the teaching/entertainment facilities of planetariums, many of us have constructed observatories that operate in conjunction with the main facility. This chapter of the resource book is devoted to these observatories. While the author is quite sure that the material contained herein is incomplete, it is a representative sampling of what other planetariums are doing with their observatories.

There are over 800 planetariums in the I.P.S., and one can easily imagine that a large percentage of these planetariums do have some form of telescope/observatory facility as part of the complex. Unfortunately, the I.P.S. mailing list that the author has at his disposal does not indicate this fact. Therefore, before condemning this chapter as being biased, please ask yourselves if you have indicated to anyone attached to the administrative arm of the I.P.S. that your facility has an observatory and that you wish more of your colleagues to know about your observatory.

Of the 800-plus planetariums on the I.P.S. mailing list, the author approached five planetariums that were known to have an observatory attached to them. They are:

The Grace H. Flandrau Planetarium

The Griffith Observatory

Calgary Centennial Planetarium

The Rochester Museum and Science Centre Strasenburgh Planetarium

The Adler Planetarium

The H. R. MacMillan Planetarium (natch)

The Adler Planetarium-Doane Observatory. It is hard to believe, but for fifteen years the Adler Planetarium of Chicago had a 16” telescope in their possession and couldn’t put it to good use until the last few years.

In 1974 the Adler Planetarium was the recipient of $250,000 from the estate of Mr. Ralph E. Doane which renewed the interest of the staff of the Planetarium in the construction of a proper home for this optic. The end result is the Doane Observatory, which is located just a few paces east of the Planetarium on the edge of Lake Michigan. Visually, the Observatory is unlike most observatories, with the notable exception of the Steward Observatory on Kitt Peak. These two observatories incorporate the truncated cylinder as a roof design. Inside the Doane Observatory is located the 16” Cassegrain/Newtonian telescope supported on a fork mount. The telescope has an f/4 primary that is used at the Newtonian focus, but the instrument is used primarily as a Cassegrain at f/20. With this configuration the telescope is capable
of up to 1000X magnification. This will give magnificent views of the planets and other objects with small angular size. The normal format of viewing is with the telescope's image intensifier television system. In this configuration the public view the subject that the telescope is aimed at, not directly but rather via a television screen. There are two 23" television monitors on the deck that surrounds the Observatory "dome" and the public "look" through the telescope on the TV monitors. This system avoids the tedious line that inevitably forms at the telescope when it is in use.

The telescope is not dedicated to the television system alone, but has a mirror that moves into play and redirects the light of the telescope out to the eyepiece holder for direct viewing. This format is used for smaller groups such as navigation and general astronomy classes. The Observatory also has smaller telescopes that can be used "hands on" for special groups such as the above.

Locating an object with this telescope is accomplished using the recently installed Right Ascension and Declination digital readouts. Fine adjustments are done with the telescope's 4½" Cassegrain guidescope.

If you were wondering what the limiting magnitude of the telescope is from their location, it is reported that with the image intensifier the telescope can see the central star in the Ring Nebula - magnitude 15!

The Doane Observatory is open to the public following the evening presentation of the Planetarium show during the summer, and is open Friday evenings during the rest of the year.

*Calgary Centennial Planetarium.* The Calgary Planetarium does not have an Observatory *per se* but has a roll-off-roof observing deck. On the deck are four permanently mounted Zeiss telescope piers. The Planetarium does have more telescopes, such as Newtonians, "spyglasses", Gregorians, etc., but they are only used when there is sufficient help to man them. As there is only one person assigned to operate the observing deck, it is normal to have only one telescope in operation at a time.

Generally speaking, the observing deck is open at least once a week for public viewing, and the average annual attendance is over 3,000. This includes the solar observing sessions from 3:00 to 3:30 p.m. each clear day. This number does not include the school groups that go to the observing deck following the school planetarium shows.

In her report to the author for this chapter, Orla Aquist cited an example of public buffoonery that testifies to the construction of the Zeiss telescopes: "Once I left two telescopes out, one pointed at the Moon and the other at the far end of the deck without an eyepiece. While tending the functioning telescope, a guy came in, spotted the lone telescope and went to confront it. Before I could say 'Boo!' he grabbed the poor instrument by the neck and had twisted it around to the tune of grinding gears, to point it at the Moon. Fortunately, Zeiss makes tough telescopes."

When it is cloudy, and that appears to be too often, they set up a couple of telescopes in the lobby of the Planetarium and allow people to look at some artifact inside the building.
Grace H. Flandrau Planetarium. Like the Adler Planetarium, the Grace H. Flandrau Planetarium has a 16" Cassegrain telescope attached to its facility, and is in operation every clear evening (which must be many) except Monday. This Observatory is free to the visitor and is operated by a student operator.

During the daytime an image of the sun is brought into the Planetarium's exhibit hall via a television system attached to a 6" refractor. This system is also used during those times when the moon is available.

One of the most interesting aspects of this facility is that they offer the telescope to "shutterbugs" around the time of the first quarter moon. With this service available, many high-quality pictures of the moon and/or planets have been taken by "rank amateurs". Of course, the telescope operator provides the exposure data and the Planetarium/Observatory provides the adaptor(s) for the camera.

Dennis Mammana, the Director of the Planetarium, has sent along a few anecdotes gleaned from the operations log of the telescope and I include a few here for your enjoyment:

"Tried to fix sidereal clock, but ran out of time."

"The bulbs in the outside stairwell have become extinct."

"One photographer, 7 interested people, zero weirdos."

"Here I am completely alone,
Beneath the stars and under the dome,
No-one has come for the heavenly sights:
No bums, fools, weirdos or jerks
I'm thankful for the absence of odd quirks.
Here I stay viewing the planets,
While on the mall run the strangest fanatics.
Some should choose the TV over the universe?
The thought is nearly a curse!
Up rises the ghostly Moon
Splashing its light over the room.
Some people came while others went,
Now my time is nearly spent.
For those who read this, have a good time,
Please excuse me, I've yet to master the rhyme."

The Griffith Observatory. Perhaps the best known of all the observatories attached to planetaria is the Griffith Observatory in Los Angeles. This Observatory houses a Zeiss 12" refractor and a 9" refractor on the same mounting. The Observatory is open six nights per week during the ten months of not summer, and seven nights per week during the summer. This of course is weather permitting (and it usually does).

Admission is free and the Observatory is open from dark until 10:00 p.m. The location of the
Observatory imposes severe limitations on what the telescope(s) can see (i.e. naked-eye limiting magnitude of 3), and as a result the telescope concentrates on the planets and the moon. During the day there is a separate telescope system that observes the sun in white light, hydrogen-alpha, and with a spectroscope. The average annual attendance for the Griffith Observatory is around 75,000 people.

**H. R. MacMillan Planetarium/Gordon Southam Observatory.** The newest observatory to be attached to a planetarium is the Gordon MacMillan Southam Observatory in Vancouver. This Observatory is the result of a grant of $500,000 from Mrs. Jean Southam to build an observatory in memory of her son Gordon. It was commissioned and built in 1979.

The Southam Observatory houses a 15cm Zeiss coude refractor in an 8.4 metre dome, and also has a 50-seat lecture hall, a small astronomical sales counter, and an office.

The Observatory is in use six days a week. Tuesday through Friday there are classes for school groups, grades 3 through 12, offered three times a day. The public are permitted to use the telescope on Friday, Saturday and Sunday from 12 noon until 10:30 p.m. (Fridays from 3:00 p.m.) during the school year. When school is out at Christmas, Easter, and during the summer, the telescope is available six days per week from 12 noon to 10:30 p.m. Admission is free.

The weather in Vancouver does leave something to be desired insofar as telescopes are concerned, and when it is cloudy the operator is available to answer questions about astronomy or the telescope. We also offer a slide show based on the sun or the Observatory.

The Observatory relies heavily on volunteer operators drawn from the Royal Astronomical Society of Canada (Vancouver Centre) and is otherwise a one-man operation.

The size of instrument vs. the size of the dome is often the subject of many questions, but they can be answered in one word: Bureaucracy. According to the City of Vancouver, there must be so many square feet per person in any building. When we told them how many people we thought were likely to be in the dome at one time, the amount of space was specified accordingly. And so it goes.

The Planetarium has been chastised by members of the local astronomical group for purchasing such a small instrument, but the choice was based on two prerequisites: (1) the donor requested that the Observatory be operational on a specific date, thereby requiring the virtually immediate delivery of an instrument (and only the Zeiss company could fill this requirement, with this size of telescope); and (2) the telescope was to be accessible to all visitors, including handicapped persons. With a coude arrangement, the eyepiece is at a fixed point in space at all times, thus allowing everyone to make use of the telescope.

Another restriction is shared by all the observatories mentioned in this chapter: light pollution. The only objects that "punch through" the haze of the city lights are the planets and the moon. This telescope does a nice job of presenting them to the patron. During the daytime the telescope is pointed at the sun, and we observe it in one of three ways, as previously mentioned: white light, projection, or hydrogen-alpha.
Pointing the telescope at night is accomplished in one of two ways: (1) using the setting circles, or (2) using the image intensifier television camera. This television camera is the same as the one mentioned in the May 1982 issue of *Sky and Telescope*. This system not only helps find the object of interest, but entertains and educates the waiting patron by showing the sky area under scrutiny down to 8th magnitude. With the zoom lens wide, the whole constellation can be brought into view, or the area immediately surrounding the object of interest can be magnified by zooming in the lens.

The Gordon Southam Observatory has proved to be very popular with the citizens of Vancouver, with 51,000 patrons during the year May 1981-May 1982.

*Strasenburgh Planetarium*. The Strasenburgh's Observatory, located on the roof of the Planetarium, contains a 12" Cave Astrola Newtonian, an 8" Criterion reflector and an 8" Celestron. The Observatory is a roll-off roof system and is operated by members of the Rochester Academy of Sciences Astronomy Section. It is interesting to note that a public-oriented telescope has been operating in Rochester since long before the Planetarium was built.

Don Hall points out that the Observatory opens just as the 8:00 p.m. planetarium show lets out. This Observatory appears to be open only during the summer months, with an estimated attendance of 4,000 people. Admission is free.

As was outlined at the beginning of this chapter, this is not supposed to be the definitive work on public observatories, but is an overview of what some planetariums have in the way of telescopes and facilities. If you feel that the I.P.S. should have a listing of all observatories attached to planetariums, then drop me a descriptive letter telling me what you have and the mode of operation, i.e. summer only: restricted hours: entrance fees, if any: public and school programs, etc., etc. I will endeavour to have this information included in some forthcoming issue of *The Planctarian*, or some such information package.
New Ideas on the Fabrication of Panels and Models

by David Dundee, Fernbank Science Center, Atlanta, Georgia 30307

ABSTRACT: This paper is a recount of production techniques recently used at Fernbank Science Center to add more realism to panoramas. The use of Clear Cast in the molds of rock crystals and back lighting for alien planet effects, also the employment of effervescent materials to add even more realism to the photography of models will be discussed.

At Fernbank we have been experimenting with some new techniques in show production. In the development of panoramas we have used models in the past. For example, in a lunar colony panorama we have used plaster for the surface. The smaller craters we created by splashing water on the wet plaster.

In our current program we have cast plaster in molds of rock crystals to form the terrain of an alien planet. We used Clear Cast in crystalline shapes to form lakes. These were lighted from below to produce the impression of crystalline lakes.

In conjunction with this alien panorama we constructed an alien spacecraft out of odds and ends. Of course, the construction of futuristic spacecraft out of miscellaneous leftovers is not of itself innovative, but we have been experimenting with some techniques to add some realism to the rocket engines by using an item found in most planetariums: Alka-Seltzer.

Glass tubes were added to the back of our spacecraft. The spacecraft was placed upright on its nose and powdered Alka-Seltzer was then added to the tubes. After the lighting was properly set, water was introduced to the tubes, and with slightly lengthened exposures the illusion of a working rocket engine was shown.
As planetarians, we are frequently called upon to show objects and phenomena which cannot be photographed. The surface of Pluto or a close-up view of a quasar are best shown, at least for the present, by artwork. Photographing such artwork for projection on the planetarium dome involves several problems. Care must be taken to ensure that lighting angles are consistent. Contrast and colour intensity are both diminished when artwork (or even photographs) are copied, so colour and contrast must both be exaggerated in the original. Perhaps the most critical problem with projected artwork is that of masking. Even if the artwork is done on a black surface, the unexposed emulsion of a colour slide is sufficiently transparent for a distinct grey rectangle to be visible around the artwork when the slide is projected in the darkened planetarium theatre. If there are enough other projections or special effects in the same scene, the resulting stray light may wash over the whole dome and subdue this grey rectangle (of ‘format’) to a point where it is unnoticeable. Normally, though, this format remains a problem to be dealt with.

Simply dropping the light level on the slide projector is the worst way of dealing with the problem. Brightness, contrast, colour and detail are all lost when this is done, and what colours remain are shifted in value as the projector bulb is dropped to a lower temperature, which produces a redder light.

The best solution is to use a film which gives a truly opaque background. Unfortunately, there are no such colour slide films. It is possible to get an opaque background by sandwiching two transparencies together, but faint details (e.g. thin wisps of nebulosity or the outer parts of galaxies) are usually lost if the exposures are dark enough to yield a really black background. We are left with the technique of masking colour slides with a sandwiched black and white mask.

The mainstay of the graphic artist for this sort of work is Kodalith film. Kodalith is black and white film with a vengeance: all tones are registered (when properly exposed) as either totally black or completely transparent. For this reason, Kodalith has traditionally been used for line drawings and diagrams, but it can be used for much more.

One technique for making Kodalith masks has been used to good advantage over the years in Vancouver. Suppose, for example, that a script calls for a view of an imaginary planet seen (at full phase) from a moderate distance. First, the planet is drawn on plain white paper. Colours, including any amount of shading, variations of tone, etc., may be added at this stage or after the next stage, which consists of photocopying the original artwork. This photocopy is then filled in with felt pen so that it becomes a totally black planet on a white background. After the finished artwork is photographed, it is replaced on the copy stand by the blackened photocopy. The camera, which must not have been moved, is then reloaded with Kodalith film. The resulting Kodalith negative will make a perfect mask for the original artwork, although it’s advisable to ink in a narrow black border around the original (after it is photocopied!) in case
of any slight mismatch between artwork and mask. There are other ways of making Kodalith masks for round objects such as stars and planets, but the beauty of this technique is that it can be used for any arbitrarily complex shape, provided only that the edges are sharp and clearly defined. It also enables the artwork to be done on a white background, usually much easier to work with, particularly if bright or intense colours are desired in the final projected image.

However, many of the most interesting astronomical objects don’t have sharp edges. Planets in crescent or gibbous phases can be treated by the method outlined above, provided that there is some excuse for showing the planet’s night side faintly illuminated, e.g. by moonlight, ring-light, aurorae, airglow, etc. However, galaxies, nebulae, accretion discs, comets, and most other astronomical scenery involve soft, diffused edges, which means they must be portrayed (usually by airbrush) on a black background. Masking diffuse-edged artwork is a more difficult affair, but we have had encouraging results with Eastman Fine Grain Release Positive Film 5302.

Despite its name, Eastman Fine Grain Positive Release Film 5302 is in fact a negative film. Originally intended for making motion-picture release prints, this film (known to its friends as FGP) is useful in masking because of its wide latitude and extremely fine grain. The penalty for this is slow speed - about ASA 10 with tungsten light - which is no great problem for copy work. Kodak lists the film as blue-sensitive, but we haven’t had any problems copying multicoloured artwork. Although Fine Grain Positive will respond to a variety of development times and chemicals, we have had best results with four minutes in Dektol.

To produce a mask, the colour-on-black artwork is first photographed and the resulting FGP negative is then recopied in a slide copier on to more FGP film. Careful control of exposures will yield a high-contrast mask which obscures none of the fine details of the artwork but completely conceals the format. This is possible because FGP emulsion is highly opaque when fully exposed and developed, yet remains as clear as Kodalith where it hasn’t been exposed. The intermediate tones are rendered with no appreciable graininess even though two generations of copies are used. Note that these characteristics make FGP ideal for masking photographs as well as artwork. A slide of a real galaxy, for example, presents exactly the same masking problem as as a slide of an artwork galaxy.

Whatever photographic technique is used to generate the mask, airpaintings on black media are most effective when they have the greatest possible range of contrast. If the faintest parts of the desired image are to look appropriately faint (and not simply invisible) this means that the black background should be as black as possible. For years, we have used Peterboro 1909 14 ply Dull Coat Black cardboard. This is a stiff, matte-finish showcard material which accepts airbrushed and hand-brushed paints easily, although it’s not as dark as might be wished. Recently, MacMillan Planetarium technician and sometime artist Michael Koziniak began experimenting with darker media, with considerable success. Our new medium of choice for airbrush space art is gloss black enamel paint on 14 ply (or thereabouts) showcard.
This is a difficult and challenging medium to work on, but we have found it worthwhile due to its excellent contrast: when properly lit and photographed, the gloss black background is up to two stops darker than matte-finish black showcard. This gives projected images which are brighter, more colourful, and have better contrast. The extra-dark surface also enables a Fine Grain Positive mask to be made which completely suppresses the format without obliterating delicate nebulae.

The card is prepared by applying the black enamel with a standard, house-painter's type brush. Be sure to use a brush of decent quality, as any bristles left on the painted surface will render it useless. Similarly, any dust or particulate matter which falls on the surface while it's drying will show up prominently in the finished product (although in some cases this may not be a problem, since point defects look very like stars). An even layer of enamel is crucial: be sure to avoid drips (if the panel is hung vertically to dry) or pools (if panel is left flat to dry). The finished artwork must be lit from the sides, and any unevenness in the enamel surface will show up as strange-looking, sinuous bright lines or patches.

Airpainting on high-gloss enamel calls for a very light touch with the airbrush. The surface is completely non-absorbent, so colours must be built up in successive thin layers to prevent beading of the paint. Lighting in the studio can be a problem, since the high-gloss surface frequently makes the artist's own reflection much easier to see than the airbrushed artwork. This is one situation where a black artist would have a distinct advantage. Similarly, reflections of the camera can be a problem when the artwork is photographed, but usually can be avoided by careful lighting and, in extreme cases, the judicious use of a little black velvet.

Another difficulty related to the non-absorbent nature of gloss enamel is that water-based paints bead hopelessly when applied by hand brushwork. Touch-ups, fine detail and hard-edged work can be done easily with acrylics, however.

Airbrush paintings on gloss black enamel have given highly encouraging results in recent trials. Brightness, colour and contrast range have all been improved. When combined with Fine Grain Positive masks, the result is a quantum improvement in our ability to depict low-contrast astronomical objects. We recommend this technique to all planetarians.
An Informal Reflection by the First President of the I.P.S.

by Prof. Paul Engle, Planetarium Director, Department of Physics and Astronomy, University of Arkansas at Little Rock, 33rd and University, Little Rock, Arkansas 72204

IPS has been active for ten years. This is a good time to reflect on what we have done during this time, as an entire organization and as regional affiliates. Look at the progress we have made and the strides we have taken. There is so much yet to be done in increasing public awareness of the planetarium field. Perhaps we can discover what we must accomplish in the future to reach this goal.
Travels Through India with an Inflatable Planetarium

by Alan J. Friedman, Director of Astronomy and Physics, Lawrence Hall of Science, University of California, Berkeley, California 94720

Between February and March of 1982, I had the fascinating experience of taking a Starlab Planetarium to schools and museums in eight cities in India: Udaipur, Ahmedabad, Bombay, Bangalore, Madras, Patna, Calcutta, and New Delhi. Perhaps the most remarkable outcome of this trip was that, despite major cultural differences between India and the West, small planetarium education techniques were completely transferable. A mix of participatory and lecture-type programming drew responses from Indian teachers and children which were nearly identical to those of their American counterparts. Kids laughed at the same sections and became bored at the same point in lectures. Skilful teachers were able to give successful participatory programs within two hours of first exposure to the Starlab. There were minor differences in children's responses, apparently due to the style of teaching prevailing in Indian schools, but the overall experience of offering planetarium programs in eight Indian cities is a welcome sign of the universality of planetarium pedagogy.
Designing A Planetarium Control System

by Andrei Godoroja, H. R. MacMillan Planetarium, Vancouver, B.C.

ABSTRACT: There have been many articles, not excluding this one, which have been dedicated to the discussion of the perfect planetarium control system. Excellent ideas abound, but few commercially available systems seem to match any or all of them. Perhaps the main problem is that many planetarians do not have sufficient experience in computer system design and, conversely, most computer manufacturers have never sat in a lecturer’s console and run a planetarium show day after day.

This paper describes how I, a planetarium lecturer and sometime-technician, sat in the console for four years and, while watching the existing control system do much of the work, dreamed up some ideas for the perfect system. The difference here is that I was able to gather together people with the necessary experience and technological expertise to make the ideas both technically and economically feasible. This group made a proposal to the H. R. MacMillan Planetarium, it was accepted, and, in June of 1982, the new control system was installed.
The M.C. 10 System

by Richard Gray, President, R. A. Gray Inc., San Diego, California 92123

ABSTRACT: The M.C. 10 System: A structure approach to planetarium control system design.

Pseudoscience Topics

Mini-Show Formats (Magazine Format)

- set up as a common theme
- unsolved mysteries from planets to the cosmos
- accidental discoveries in astronomy
- assorted catastrophes

Use existing S-F stories for themes.
Pursuing the Multiple Planetarium Show Concept

by William A. Gutsch, Jr., Ph. D., Chairman and Associate Astronomer, American Museum-Hayden Planetarium, Central Park West at 81st Street, New York, N.Y. 10024

ABSTRACT: Any of us for whom monthly mortgage payments depend on the creation of concepts and story formats for planetarium shows may occasionally fear reaching a "burn-out" stage in which we will have somehow exhausted all possible ideas for new shows or at least all good ideas. Drawing on over eight years of show conception and script-writing experience, this paper will pursue a variety of show topics, themes and formats which appear to lend themselves to multiple shows, i.e. the creation of several shows over a period of years instead of just one.

ET Life:

Search For Life

Explorers From the Stars - Von Daniken

Other Worlds - Other Life - origin of life

- search in S.S.
- UFOs

Encounter - speculation of life (old ideas)

- modes of travel /search
- radio

- and 1/2 in 5-f re after radio contact

Messages to the Stars

- 1/2 as Pioneer /Voyager documentary

- 1/2 as SF shots re what aliens might conclude about us

Alien Odyssey - mind trips to an assortment of spots in the universe
Audio Production at the Fleet Space Theater

by Clint Hatchett, Production Supervisor, Reuben H. Fleet Theater, Balboa Park, P.O. Box 33303, San Diego, California 92103

ABSTRACT: The Reuben H. Fleet Space Theater and Science Center has a modern, well-equipped audio facility but no full-time composer or audio engineer. Freelance engineers are hired for in-house production and some film soundtrack work. A description of this work is given, along with a preliminary report on the mixing of an Omnimax film soundtrack.
The Elizabeth Space Sciences Centre

by John A. Hault, Queen Elizabeth Planetarium, Edmonton, Alberta

ABSTRACT: A discussion of the design, planning and development at the Edmonton Space Sciences Centre.
Beyond The Planetarium : Teaching Astronomy in the Community

by Ken Hewitt-White, Lecturer, Community Astronomy Program, H. R. MacMillan Planetarium, Vancouver, B.C.

Think hard. If you were asked what you thought was the planetarium’s single biggest limitation, what would you answer? Something to do with your sound system, perhaps? Or maybe your lighting control isn’t adequate. I’m thinking of planetariums in general, however, and I’m wondering more about their raison d’etre than their technical prowess in communicating astronomy.

If you asked me that question, I’d say that the planetarium’s biggest limitation is simply that it sits in one place and can only communicate to those who make the effort to go through its doors. The corollary to this is that the patrons inside those doors are treated to a type of astronomical communication that relies on some person’s interpretation, through special visual effects, sound, and narration, of phenomena in the universe.

The H. R. MacMillan Planetarium’s free Community Astronomy program is an effort to expand the boundaries of the planetarium’s influence by sending out lecturers to schools, community centres and parks to deliver carefully prepared illustrated talks on every kind of astronomical topic. The program owns a modest fleet of telescopes with apertures in the 8” to 12½” range and this equipment forms the backbone of Community Astronomy’s underlying theme: to allow the public direct access to the heavens through telescopic observation. In the winter, we are obliged to rely heavily on our lectures with only occasional viewing sessions, but in the summer just the opposite is true, as we head off to British Columbia’s interior to tour the provincial parks and set up our telescopes under clear, dark skies.

Our Community Astronomy extension work began inauspiciously in 1977. David Hurd, then Science Officer for the MacMillan Planetarium, sent out an 8-inch telescope and a university student with a strong background in amateur astronomy to provincial campgrounds for a few weeks in the summer. Although we had difficulty in convincing some park authorities that the program would work (similar attempts elsewhere had met with dismal failure years before) this trial proved very successful indeed. A portion of grant monies from the National Museums of Canada was earmarked for more slide shows and telescope demonstrations in the public schools that fall. And then, with an extremely generous offer from Placer Development Corporation, a British Columbia mining company, money was made available for the purchase of a 12½” reflector in the spring of 1978. Soon after this, sustaining grants were obtained from the National Museums, and through diligent efforts by the then-Director, David Rodger, Dave Hurd and even myself (I was presented to donors as the sample lecturer!) we obtained an exceedingly generous operating grant from Placer Development. So, the 12½” telescope was stuffed into the back of my van, an old Kodak Carousel was pulled out from the planetarium storage room, we pilfered some slides from the theatre files, and presto! Community Astronomy was born.

In the five summers since, a variety of part-time staff have set off on four, five and six-week tours through the larger and more suitable campgrounds in B.C. The “suitable” campgrounds
are those that already have interpretative nature programs and the necessary open spaces required to allow the use of a telescope. Unfortunately, many smaller parks are set in secluded forested areas or beneath the towering peaks of any one of a million B.C. mountains: their access to the sky is restricted, to say the least. But many others are ideally suited for telescope use, and some offer spectacular views not only of unpolluted skies but also of beautiful park settings. Possibly our favourite spot in this regard is Manning Provincial Park, located in the Cascade Mountains, some 150 miles east of Vancouver. From an open-air amphitheatre nestled amid tall, straight pines that focus everyone’s attention on the sky, campers hear an illustrated talk about everything from the moon to the galaxies. As the stars peek out one by one, the lecturer identifies each, and then, via the slides, explains in detail what it all means - just like in the planetarium - except that this is the real thing.

Following the talk, when the long Canadian twilight is at last giving way to the velvet mountain night, the whole ensemble of campers, naturalists and lecturers motor up the side of the mountain where, from a lookout located at the 5,000-foot level, all of Manning Park spreads out below and all the sky above. It is an awesome sight, witnessing the last washes of twilight illuminating the snow-capped peaks to the south, and seeing the last traces of daylight ebb from the fir valleys below. Then, in silhouette against the glitter of thousands of stars, we watch the telescopes swing upwards to grasp the light of the distant objects discussed earlier in the talk. Line-ups begin, questions start popping from the mouths of the inquisitive, and the peeking goes on into the night. The show is over when the last camper treks back to the campsite.

Of course, not all parks are as beautiful as Manning, and not all slide shows end up under a clear sky. We select a tour schedule that makes use of the best possible park sites, and the rest is left up to the weatherman. Next to the weather, though, manpower is the stickiest problem that faces a program of this type. We like to hire people who have a strong observing background along with skills in public education and a demonstrated understanding of all kinds of astronomical phenomena. In addition, our roving lecturer has to have his own vehicle, and a work schedule that permits month-long forays into the wilderness. These details don’t always work out, as one of our new operators recently found out. Our 12½” reflector won’t fit into his Volkswagen Rabbit! We have been trying for years to get additional funding for a special Community Astronomy van, so that using one’s own vehicle isn’t a requirement. The efforts have paid off: the MacMillan Estate in Vancouver has offered half the necessary funds that, if matched, will give the program a specially equipped van in time for its 1983 operations.

I probably do more Community Astronomy sessions that any of our other part-time staff, and because of that, and because the program forms an important component of my employment, I use my own van which has been specially modified for transporting the large telescopes. While camperizing the interior years ago, I steadfastly stuck to a plan that would keep the telescope completely out of the way, yet accessible in an instant. The rear 18” of the van was blocked off from the rest, padded with foam and shaped in plywood forms that would hold the telescope and mounting (in fact it holds both the 12” and the 8” very snugly). While my partner slumbers in the cabin amid the relative luxury of a fold-out bed, plush walls, bar and stereo (yes, I know what you’re thinking, but it’s true only on cloudy nights!) I can load or
unload the telescope from the rear in about three minutes. Efficient set-up and breakdown are important, as are the “luxuries” already noted, since we are often miles from the nearest accommodation and must camp in the park like everyone else.

A summer tour is organized and carried out in consultation with the parks branch staff. We attend their naturalist training seminars in the spring to tell the new naturalists who we are and what we do. We like to complement their existing interpretative programs, rather than replace them, and park staff help us evaluate the mating of the environmental and sky presentations. The results have been pleasing. All the park naturalists look forward to our coming to their parks each year. We are often referred to as the “favourite” or “most exciting” by the campers themselves. In the past four years we have visited 163 campsites over some 241 nights, and communicated astronomy to some 20,200 people. The statistics may sound impressive, but who knows what arguments could be created in comparing the “man-hours-per-patron” of this program with those of the planetarium over a similar period. It doesn’t really matter. What counts is the quality of the education and the unique style of the communication. Using telescopes and slides and casual discussion, we have attractively and entertainingly communicated many scientific concepts to these twenty thousand people in a manner that allows a large degree of one-to-one communication. I’m not referring to the question-and-answer periods that follow the slide talks, I’m referring to the situation at the telescope, where people can wander up to the eyepiece and enquire as they inspect. The questions often come thick and fast, and as the line-up moves along, most folks get a chance to air their pet questions about the universe. In many instances the answer can be demonstrated with a skyward pointing of the finger right then and there. I think the concept of “one-to-one” communication is very important. How many patrons enter the planetarium wondering about “that star” or “that constellation” and leave the theatre still wondering? At the telescope they ask and they find out. Usually, that is ... on one occasion I recall a chap asking if I could show him a black hole!

So, what is it that people see through the telescopes that turns their crank? First, consider the telescopes. Our “flagship” is a modified Starliner 12½” f/5 reflector. You need at least that aperture to reveal deep sky objects as something more than mere blobs of light. Although we do have some smaller equipment, it’s not often used on its own. We like to set up two or three telescopes at the larger parks, where we might easily get several hundred people lining up at once. It’s a funny thing, though : you can set up an 8” on the moon or a planet and tell people we have arranged for the 12½” telescope to be looking at something really faint (such as a galaxy) just so that everyone won’t converge on the big ’scope. But they do anyway. Everyone likes to gather around a large telescope. It is an exhibit in itself.

To be honest, though, a 12½” is not a giant by today’s standards. The huge Dobsonian reflectors made popular by the San Francisco Sidewalk Astronomers are now available off the shelf at startling low prices, and many, many amateurs have them in 13” and 17” apertures. The Sidewalk Astronomers are, of course, without peer in the area of public observational astronomy. Using apertures in the 18” to 24” range, this hard-working group of volunteers have been able to show tens of thousands of people distant clusters and nebulae in almost as much detail as the finest photographs. Any group considering the development of a Community Astronomy style program would do well to take the lead from the San Francisco group and take advantage of commercially available kits - to equip their lecturers with these easy-to-use and easy-to-move telescopes. Our field activities have developed quite independently of theirs,
but we can hardly continue without taking note of their grand scale of operation and their subsequent success. With this in mind, Community Astronomy is sponsoring a tour of the San Francisco Sidewalk Astronomers through southern B.C. this August. Our vehicles will tour together, and the exchange of teaching ideas along with observational techniques will no doubt enrich both parties.

While the very large Dobsonian machines can haul in the light from a wide variety of distant and subtle phenomena, our smaller equipment must necessarily stick with more obvious subjects. But occasionally, real keeners will stay on past midnight after the other campers have gone off to bed. These folks can’t seem to get enough, so, as the conversation turns to such titillating topics as the size and age of the universe, we look at fainter but more cosmologically significant items like the Whirlpool Galaxy, the Veil Nebula, or even, on the best nights, Stefan’s Quintet! Otherwise, the regular crowds get to see such objects as the Ring Nebula (“It looks like a lifesaver”), a fully resolved M13 (“It reminds me of the ending to Star Wars” exclaimed one youngster), and sundry other clusters or coloured doubles that are conveniently placed. You might be surprised to learn that one of my favourite targets is the obscure but very lovely open cluster M11, in the constellation Scutum. With its jewel-like sparkle of bright stars set against an extremely rich portion of the Milky Way, this little gem attracts considerable oohs and ahs. So not all of the best sites have descriptive names. On the other hand, you may also be surprised that the most famous name of all rates way down on our list of observational goodies. The Andromeda Galaxy doesn’t rise far above the horizon haze on July evenings and even for those who do stick around to see it (many insist because it’s the only sky object they have ever heard of) they find it indistinct and formless in the eyepiece. The untrained eye finds it difficult to pick out the dust lanes, the central nucleus, or the companions to M31, even in the 12½”. My statement that it is the nearest spiral offers little consolation. Said one expectant camper as he peered into the eyepiece, “It looks like it’s two million light years away”. Alas, we cannot please everyone.

One rather odd consequence of summer observing is that the planets are never well placed for viewing (sometimes not at all if the mountains are high), so we rely heavily on the more fascinating yet arguably much less spectacular deep sky material. It is a little ironic that the subjects we give a lot of attention to in our planetarium shows - Mars, Saturn, Andromeda Galaxy - are those that, for one reason or another, receive less emphasis in the field. Unless the moon is available, our long twilights can be absorbed only by the slide talks, and even then we must begin the observing with preliminary subjects like Vega, Arcturus or an obvious double like Mizar, just to kill time - or we lose our audience. It is important to build up a list of successively more impressive objects to look at. You develop a technique to keep your audience keen during the long period it takes twilight to completely slip away. The technique gets tougher when the cold and fatigue begin to seep in. You’d be surprised at how many campers won’t dress warmly no matter how much you tell them to. When we have large groups and only one or two telescopes (a predicament we try to avoid), we haven’t the luxury of going through too long a list of subjects. Many folk stand in long lines and have the patience for only one look. In setting up an observation program, then, notice must be given to the problem of the ratio between telescopes and people. It is a more important factor than you may think.

Our summer tours don’t reach a huge number of people compared to, say, what three or four planetarium shows would pull in for the same period. So, what does it cost? For the record,
we spent $9,368 in 1981 to fund 113 man-days in order to reach some 8,200 campers. That's $83 a day. If the campers were paying to get in, then a ticket price of $1.14 a day would pay off the honorariums. The money quoted is strictly for honorariums, and if it seems high it is because our honorariums are calculated to include average daily driving and accommodation/food expenses. An "expense account" approach is of course possible, but it would be costly to administer. We prefer the simpler approach, and it seems to work well.

On Labour Day each year, our travelling show undergoes a change. The parks empty and the schools fill up, so we come home and change gears. The telescopes are taken apart and relieved of their many layers of assorted campground dust and grit. Our slides are rearranged in preparation for the many school talks that will take place from September to June.

Although the school season is long, our work is less concentrated. A principal reason for this is that we don't publicize our free programs to any great extent because it would be easy for us to become swamped with requests. We have a budget that can handle about fifty or so school appearances a year, and it would be easy to run over that limit if we advertised too much. As it is, we accept invitations from interested schools as our time permits. Teachers learn of our services mainly through our school show brochures or by word of mouth, and still we get backed up with requests. My schedule does not always allow first choice of dates, and we don't have much back-up help. Our part-time people are those who go to school or take on full-time work in the winter, so they are not always available. An improvement, I suppose, would be more part-time staff, if you can find them. There is probably room for one or two full-time lecturers in this field, but the nature of our supporting grants can't allow this. In any case, part-time staff do have greater flexibility to deal with the surges and abatements in activity this work inevitably experiences. If you are going to set up a community astronomy program, the problem of staffing may seem awkward at the least. Our attitude is to get people suited to the job and forget about numbers. Lecturing of the type I am describing is fairly specialized stuff: we prefer to do carefully prepared and professionally executed classroom lectures and stretch out the requests until our people have time to get to them.

We visit lots of local classes without much difficulty. Going into B.C.'s interior to visit schools takes a little more forethought, but we do so whenever possible. We get the school district to pick up the tab for accommodation while our grant covers transportation and honorarium. To stay cost-effective, we'll work a small town for a week or more, visiting perhaps a dozen elementary and secondary schools, giving teacher workshops if desired, and doing a public show at night. If we fly (in the dead of winter we prefer to) then we take up a Celestron-8 on the plane. If we drive up, then the 12½" telescope is with me, and the public shows at night are accompanied by rather impressive viewing sessions. These public shows often attract attention in the local papers and radio, so pictures of the equipment or descriptions of sky events are transferred to an even wider audience in this manner.

By visiting small town schools we get to people who wouldn't ordinarily be able to take advantage of the planetarium's service. Many of these classes (or even those in Vancouver, for that matter) simply don't receive much education in astronomy. We give them introductory slide shows and demonstrations that are designed to stimulate their imaginations and perhaps spur them on to further reading. We include lots of NASA solar system stuff (it really impresses)
and aim our content almost as much at the teachers as at the students. We hope the teachers will look up some films, or prepare notes themselves, to help the students after we are gone. More than one teaching unit in space science has sprung up as a result of the visits we have made to these schools.

Happily, more and more classes from primary right through to senior high are getting some sort of space science in their curriculum. In advance of our visits we find out what the kids already know, and what to include as review material or brand-new information. Because most students encounter astronomy only briefly, and because the astronomy units are so elementary in nature, the decision is left largely up to us. Whether we show the NASA material or concentrate on the work of the major observatories, students and teachers alike are very impressed indeed. On rare occasions we will receive special requests to give tailor-made talks to a class that is going through a really well done space science unit. These requests come from truly motivated teachers and the resulting talk usually meets with excited discussion and questioning from the students. I wish there were more of these.

Our school visits take on many forms, from addressing gymnasiums full of kids squirming cross-legged on the floor, to visiting science labs with only twelve seniors in them. Our favourite event is visiting school camps. These camps, mostly for elementary school children, will last up to a week, and take place out of town in environments more conducive to our double-barrelled approach of classroom/telescope sessions. We conduct academic sessions indoors, and then, if the weather is clear, go outside to study constellations and look through the telescope.

Recently, our Community Astronomy program has begun to dovetail its class sessions with those of school shows in the planetarium theatre. We are visiting schools just before or after they come to the planetarium, according to their preference. My choice is to visit a class a day or two after they have been to the planetarium, in order to reinforce their experience there and clear up any questions about what they saw. One of the biggest concerns teachers have about school visits to major public planetariums is that, with some 250 kids in the theatre at once, there is little opportunity for questions and answers. Our class visits give them that chance. We can’t do a large number of follow-up programs, but the few we have done have met with considerable success. The children’s experience in the theatre can be enhanced, and in the absence of classrooms right next to the planetarium (every new facility should have one) this concept is the next best thing.

After being kicked around the Planetarium as the sometimes unwanted portfolio of several different very busy staff, Community Astronomy’s occasionally time-consuming administration has finally found a home. Our newly completed Gordon Southam Observatory is the headquarters for the program, where observatory manager David Dodge, himself a long-time observing buff, arranges schedules and performs book-keeping duties with cheeriness and care. In setting up the a/v and observing programs at the Observatory itself, David is now the co-ordinator of an almost perfect twin project in which Community Astronomy is the in-the-field extension of similar programs held under the dome.
Community Astronomy exists today because of the initial hard work and effort given to its creation by David Hurd and David Rodger, who saw the potential of such a scheme back when the money and manpower didn’t even exist. As for me, I just picked out the telescope, and I’ve been having fun ever since. So have the half-dozen lecturers who set up their own talks, supply their own vehicles and work with little supervision to make the program successful today. They include amateur astronomers Roman Stoiber and Richard Schiller, MacMillan Planetarium part-time staff Tony Puerzer and Isabel Chen, and the former Director of the Manitoba Planetarium, Frank Shinn.

I think each of our lecturers would agree that Community Astronomy is more than just a planetarium on wheels: it is in fact a form of communicating astronomy that the planetarium simply cannot carry out. Not that the field work is a superior form of communication, for we can find areas where each medium is better or less effective than the other. For example, the sessions at the telescope are much more effective in dealing with individuals than the planetarium. On the other hand, the marvellous machine at the centre of our planetarium theatres has it all over telescopes when it comes to explaining the mechanics of the sky. There must be other comparisons, but the essential point is simply that the extension work makes a perfect companion to the planetarium’s in-house programs. To my way of thinking, they are inseparable buddies, the star projector and the telescope, and I believe no facility is complete without the pair.

In addition to his duties with Community Astronomy, Ken Hewitt-White conducts evening classes in astronomy, performs school shows at the MacMillan Planetarium, and produces light shows there as a member of Roundhouse Productions Inc. He was editor of the Planetarium Association of Canada newsletter NORTH STAR from 1977-78.
Lining up for a look, at Thunder Hill Provincial Park.

Addressing the campers at Norbury Lake Park.
Squeezing in a 12½" reflector. There's an 8" in there too, with the fork mount on the left, and the smaller tube underneath.

While it rains outside, we present a talk at the Mt. Robson Nature House.
One last look at the moon before they’re off to bed.
Modification and Projection Techniques for Constellation Figure Overlays

by R.G. Hills, Layton P. Ott Planetarium, Weber State College, Ogden, Utah

During the Night Sky portion of our planetarium shows, we generally work in about fifteen constellation figure overlays and are always impressed with the delighted response of children and adults. An interactive quiz at the end usually demonstrates that even small children are able to identify a surprising number of the constellations shown. We have put together a collection of transparencies suitable for the seasonal and polar constellation groups and have discovered some entertaining projection techniques.

Good constellation figures are available from standard sources but require some modification. We have adjusted the size and added or subtracted some details on transparencies made from postcards (Hansen).

For transparencies made from slides, we have added color (Science Graphics) and adjusted size, modified details, and deleted background (Spitz).

Transparencies are projected from behind the dome, the acoustic perforations being adequate. By using a mixture of techniques, successive enhancement, transverse motion, rotation and expansion, we are able to sustain momentum and interest throughout the presentation.
by Joseph M. Hopkins, Technical Director, Bishop Planetarium, Bradenton, Florida

ABSTRACT: This paper examines a multi-purpose optically-coupled AC switching device from the component, module, and system design standpoints. Based on a low-voltage DC control element which is optically coupled to a triac switch, system designs from ultra-simple circuits easily built by novices to complex, computer-controlled systems are explored. Pulse-width modulation and computer time-code dimming, manual and automated flashing, and sequencing are discussed. System wiring layouts and advantages are covered and application examples such as automatic dimmers, animation flashers, chaser lights, soundtrack-modulated dimmers, and solid-state relays are given.

Basic system design concepts are stressed.
INTRODUCTION. Early in 1979 the staff of the H. R. MacMillan Planetarium in Vancouver were planning a presentation which was to explore the various theories on the extinction of dinosaurs. Even at the early planning stages it was evident that the complexity of the subject matter would pose unique problems which would require sophisticated technological solutions. Because of the amount of realism required, two major obstacles were identified. The first was to depict the environment which existed in Western Canada 64 million years ago. The second was to simulate dinosaurs moving within this environment.

The concern over portraying prehistoric locations yielded a choice between graphic representation such as paintings, or actual photographic images of present-day locations which still exhibit foliage similar to that of the dinosaur age. The photographic medium was chosen on the basis of its ability to exhibit a greater degree of realism. This choice required a great deal of location photography, but the Planetarium staff included professional photographers with extensive experience in shooting the required 360-degree panoramas.

In order to investigate the second area, depicting life-like dinosaurs, the Strait Media Group Inc. (then known as Synch-Pop Animation Studios Ltd.) was contracted as a consultant. Strait Media was given two mandates:

- to produce, on motion picture film, life-like dinosaurs with realistic animated movement:

- to incorporate these images into the Planetarium’s 360-degree panorama.

Mal Hoskin, production manager for Strait Media, was appointed to investigate all possibilities of utilizing animation for this purpose, and later to direct the actual production. An initial decision was made, once again based on requirements for realism, to use three-dimensional model animation. Associate Bill Maylone, with many years of experience in model-building and animation, was assigned to the project.

AVAILABLE OPTIONS. Previous use of animation in the Planetarium dome was of two types:

- graphic images processed as high contrast negative film. This system is limited to simple line images but has the advantage of an absolute black background - thus eliminating the film frame “format”.

- traditional full colour animation film projected in a normal fashion with the format being shown and accepted.

The requirements for the proposed Dinosaur presentation were to eliminate the format, maintain a full colour image and incorporate the background slides with the animation.
Five options for combining the animated and static images were considered:

*Optical Mattes* - Film footage of dinosaur animation and a motion picture copy of the background slide printed together as one strip of film.

*Rear Screen Projection* - Dinosaurs filmed in front of a screen on which background slide is projected from behind.

*Co-Axial Front Screen Projection* - Dinosaurs filmed in front of a specially treated screen. Slide images are projected via mirrors from a position in front of the screen.

*Model Set* - Dinosaurs animated within a miniature set built to duplicate images on background slide.

*Matte Set* - Dinosaurs filmed behind cut-out silhouette images shaped to duplicate foreground of slide.

The first four systems would involve removing one slide from the panorama and projecting film into the resulting space. The last option would require the motion picture film image to be projected and superimposed on to the slide image.

**ANTICIPATED PROBLEMS.** Several technical problem areas were identified. Foremost was the need to eliminate the film format during projection: the viewer should not be aware of the projected screen area as a separate entity. In conjunction with this was the need to register the film image accurately in relationship to the panorama slides at either side to avoid any visible “joins”. This problem was further complicated by the incompatibility of format ratio between slides and motion picture film. 35 mm slides project a 3.2 ratio, whereas film has a 4.3 ratio.

In any of the systems involving the transfer of a background slide on to motion picture film, the light level and colour of the final print would have to match that of the other nine slides in the panorama exactly. Also, the projected light level of the animated images would have to be appropriate in comparison to the background.

Other considerations regarding unity of dinosaurs and background were to match relative scale, light source direction, and camera angles. Because the animated images were to be seen in a fixed panoramic background during a “real” time continuum, normal filmic techniques such as cutting from long shots to close-ups could not be employed.

**FEASIBILITY TEST.** In order to overcome these problems and to choose the most practical system of combining images, a series of tests was set up. The tests were designed to accommodate both production considerations and options for projection of the finished product. This testing procedure took place a full year before the anticipated opening of the show.

At the time of testing, the script was not finalized and decisions had not been made as to what types of dinosaur would be represented. Consequently, a decision was made to use existing dinosaur models for the tests. Movement of dinosaurs was not tested extensively as this was
considered an established area of expertise.

Suspension and anchoring systems for models were tested in conjunction with required camera angles.

Options for backgrounds and foregroungs were tested using existing slides.

Comparative light levels between dinosaurs and background slides were tested.

Experiments were conducted in filming with an anamorphic lens to produce a wide screen image equivalent to two panels of the dome panorama.

Footage was designed for a pterodactyl (flying reptile) to be projected in motion around the planetarium dome via a mechanized mirror system.

All testing was done on 16 mm film stock because of existing projection equipment and cost considerations. 35 mm production was to be considered as an option for final production only if the light throw and steadiness of 16 mm projection was found to be insufficient.

TEST RESULTS. The result of testing was that all systems involving the transfer of background slides on to film were eliminated, due to the impracticality of matching the re-filmed image to the other slide panels in the panorama.

The Matte Set option was chosen for final production. In this system, the subject matter is animated against a black background. In front of the models are black card cut-outs of relevant foreground details traced from the projected image of the panorama slide. The film and the slide, when projected together, create a “double exposure” : the slide image fills in all black areas of the film image.

It is necessary for the background area of the panorama slide to be dark and have very little detail, so that the projected film image has a greater light value. If the background is not dark enough, detail shows through the subject matter.

16 mm was deemed an acceptable quality and light intensity when used with a good quality projection system. (In this case, the light source used was a 1,000 watt Xenon arc lamp.) Ektachrome Negative (E.C.N. 7247) was chosen as the appropriate film stock.
PRE-PRODUCTION. Over the next few months, details of production were established. Three sections of the script were identified for inclusion of dinosaur animation. Each section was to be of approximately 20 seconds duration. Final choices of dinosaurs to be represented were *Tyranosaurus*, *Ornithominus*, and *Platecarpus*.

Consultation was held with MacMillan Planetarium staff photographer Robin Goldie concerning the types of background required for panoramas, including camera angles and lighting. This aspect of co-ordination between planetarium staff and animation crew was crucial because the panoramas were being shot on location in New Zealand and Fiji, thus eliminating any chance of reshooting if any detail was overlooked.

During this same period, work was begun on building the dinosaur models. The system employed by Bill Maylone starts with scale drawings showing front and side views. These drawings include blueprints for the armatures which will become the “skeleton” of the dinosaur. The armatures are built with stainless steel rods and are articulated by means of brass clamps and nylon sockets. Small joints such as fingers are constructed with lead wire. The actual form of the dinosaur is sculpted around the skeleton with plasticine. Next, a multi-piece plaster mold is made around the plasticine. After removing and cleaning away plasticine, the armature is re-positioned within the mold cavity. The model is cast by injecting a latex foam rubber compound into the cavity. The mold and its contents are then baked. After cooling, the mold sections are taken apart, model seams are trimmed and repaired, and paint is applied. The average time for construction of one model is over 100 hours.

STUDIO SET-UP. The next phase was to set up the film studio. A 12-foot by 20-foot room was allocated to the project for an anticipated preparation and shooting period of four weeks. The first two weeks were used to build sets, instal equipment, and test the camera, lighting, models and matte system. Basically, the animation was to take place on a flat table top. Black velvet, chosen for its non-reflective quality, was used as a backdrop. Flat black cardboard was positioned around the lights and camera to eliminate any reflection or glare.

For the first two sequences requiring foreground mattes, a 35 mm slide projector was set up facing the table. Panorama slides were projected on to the set in order to trace the foreground detail. This detail was then cut out of flat black card and attached on the leading edge of the table.

Dinosaurs were positioned between the foreground matte and the black velvet. Once the set was established the 35 mm projector was removed and the animation camera set up in its place.
The camera used in production was a 16 mm Arriflex converted to externally operated electric single frame drive. The camera was initially tested for accuracy of registration, as any “jitter” from frame to frame would prevent the projected animation from lining up with the static background. Because the shooting would be taking place over a two-week period and even the slightest change of position in either equipment or set would be visible on film and necessitate a reshoot, everything was anchored firmly to the floor.

Finally, test footage was shot and projected in the planetarium dome. The only problem discovered in this final test was with the foreground matting system. When tracing and cutting mattes in the studio, the slides were projected on to a flat surface, whereas in the planetarium the slides took on the curvature of the dome. This discrepancy caused the black matte image on film to be misaligned with the slide detail. A solution to this problem was devised by projecting the slides on to one side of the dome and re-photographing them from the opposite side with a 35 mm still camera. The resulting slides were accurate in aspect and became the basis for a new set of mattes.

FINAL SHOOT. With testing satisfactorily completed, the final shooting was undertaken. Because the set had to be modified for each dinosaur, the equipment and materials were left intact between each shoot until film was returned from the lab and approved. Each sequence took from 15 to 20 hours to shoot.
The first sequence was of a Tyranosaurus emerging from behind a clump of trees, roaring, and exiting away from the camera down a hillside. The table top was built in two sections and hinged to imply the slope of the hillside. The dinosaur was anchored to the table by removable screws which could be positioned in a series of holes in the table top. The table top itself was concealed by black cut-out matte. The finished result on film was of the tyrannosaurus “floating” in black with silhouetted tree shapes in the foreground. When projected in the dome the slide images “filled in” all black areas.

The second sequence was of two ornithomimus grazing. Only one model was built and this was filmed twice. The two separate pieces of film were later combined optically in the lab. A simpler foreground matte was employed for this sequence and the same sloping table top was used. The key feature of this sequence was to accurately document the frame-by-frame timing of the animation so that the “two” dinosaurs would interact correctly on screen.

The final sequence, a platecarpus (marine lizard) swimming underwater, required no mattes. The model was supported on one side by a metal rod connected with a ball and socket. This suspension system was hidden from view by the camera angle.
A zoom lens was utilized to create the impression of the creature swimming towards the camera from a distance and away again. This effect was combined with the Planetarium's existing mirror system which moves the projected image around the dome. Great care was required to co-ordinate the angles and movements of the animation within those of the mirror system.

For all sequences, the film was spliced into loops and coated with wax for projection. Extra footage of matte outlines and dinosaurs was shot so that the film could easily be lined up with slides before projection.

SUMMARY. Key considerations for incorporation of animation in planetarium dome:

1. Background panorama slides should be of a low light level to facilitate superimposition of film images.

2. Matting of foreground images is effective if cut-out detail is not too complex.

3. Matte slides must be re-photographed as projected in dome for accuracy of registration.

4. 16 mm projection is sufficient providing it has a strong light source.

For further information contact the Strait Media Group Inc., 103-1237 Burrard St., Vancouver B.C., V6Z 1Z6. (604) 682-8375
Project Fund-Raising for the Planetarium

by David F. Hurd, Director, H. R. MacMillan Planetarium, Vancouver, B.C.

In the last five years, the H. R. MacMillan Planetarium has raised $120,000 for show production, $300,000 for new equipment and facilities, over half a million dollars for renovations, and $50,000 for an extension astronomy program. Bragging? Well, perhaps. We’re certainly proud of the accomplishments of staff and board members. Their success emphasizes what can be accomplished by way of project fund-raising with even a small staff and limited resources and time.

Understand from the outset that many people think that fund-raising is beneath their individual or institutional dignity. If your institution can afford such high ideals, great. However, this “ideal” is often used as an excuse, since many people lack the courage to ask for help. Although this is certainly not an article on planetarium psychology, many people display the fear of being turned down ... a bruised ego can be very painful. The following are a few very basic pointers on techniques that have been successful in Vancouver. They may help you.

1. The Rejection Syndrome. This is basically a two-part problem. First, the novice fund-raiser feels that he or she is doing something very new and unusual, and that it is a terrible inconvenience to potential donors. Wrong! Almost all large companies, foundations, levels of government, and just plain ol’ rich folk get asked constantly to sponsor one event or another. One of the major I.P.S. conference sponsors, Canadian Pacific Airlines, gets twenty or so requests per day! It is not an inconvenience: it is routine. There are staff on the other end of that phone line who are paid to listen to your request, give you an honest response, and work in your best interests. Take advantage of it.

Second, the fear of being turned down is largely your problem to solve. If you’re selective, well prepared and documented, successful fund-raising efforts will overshadow the failures. Returning to the Vancouver example, twenty percent of applications made since 1977 have produced results. That’s not a high percentage, admittedly, but a few $50,000 or $100,000 successes can quickly erase the memories of failures.

2. Who Does Fund-Raising? That’s simple ... everyone. It is self-defeating to rest the responsibility with the Director alone. He may not be qualified and is most likely to suffer from item 1 above. (Sorry about the slander, all you directors.) You certainly can’t leave the responsibility to a Board of Trustees, although their contacts yield the richest field of potential donors. In addition, Trustees are essentially volunteers who may not have the answers to the questions a potential donor might ask. You can’t leave the responsibility to the “junior” staff, they don’t carry the necessary clout with their job title. It is interesting to note, however, how short a time junior staff stay junior if they raise $50,000 or $100,000. (Incidentally, we’re often asked how many junior and senior staff members we have, and how many are professionals or non-professionals. To set the record straight and by tradition, they’re all senior and all professional.)
It's everyone's responsibility. Anyone can prepare a request. Then they join with the Director and/or Trustees to present the request. The originator has to be involved and, most importantly, he or she has to be credited or rewarded for the effort involved. This may sound like a Pavlovian reward system, but be aware that there is no quicker way to eliminate staff initiative in fund-raising than by giving the credit to the Director or the Board of Trustees alone. If the janitor came up with the idea, let the world know!

3. What Kind of Fund-Raising? Yes, there are various types: corporate, government, individual and general. In essence, they fall into two broad categories. The general fund-raising scenario is when you send out 10,000 letters and hope everyone sends $10. It works, but it takes a lot of time, secretarial help, and organization. If you can supply the manpower, by all means try it.

Far easier, though, is project fund-raising, a specific project and price tag submitted to a selected company or individual. Included in this area would be specific show topics (for public and schools), a new piece of equipment, an extension program ... any endeavour with a specific objective. In our case, examples include shows (Stars of Mauna Kea, Death of the Dinosaurs, The Mystery of SS-433), construction of the Southam Observatory, our extension program Community Astronomy, and other programs and events.

4. The Presentation and Follow-up. Every funding effort starts with a phone call. However, after that, good documentation is needed (see example photo). For our fund-raising, we generally contract a small printing house to produce our applications from text produced by the staff. For the last three show applications, $2,200 worth of printing costs have produced $125,000 in grants.

Please curb your desire to write fifty pages on a subject. Donors only want to know what, when, why and how much. Be concise. As one of our major contributors said, “If you can’t say it in two typed pages, don’t bother saying it at all.”

If possible and appropriate, use slide a/v or video presentations. Donors want to know their money will be spent “professionally” and the best way of assuring them is by making a “professional” request. Always keep one or two projects prepared ahead of time. Money does become available on short notice (bequests, or local philanthropists needing an immediate project at tax time). The Southam Observatory was funded in just such a fashion.

The follow-up is as important as the initial request. If a donor gives to a project, it is because he liked the project and your institution. If you complete the project successfully, convey the necessary progress reports, and supply a detailed final report, your chances of securing another grant from the same source are greatly enhanced.

5. Credit and Corporate Input. If you’re not willing to give excessive credit to sponsors, turn the page and start reading the next article: fund-raising won’t be successful for you. Everyone likes to see their name in print: governments, corporations and individuals. Most companies
come right out and state their expectations. One of our sponsors has given an annual $10,000 grant for five years on the proviso that they see their name in the newspapers as sponsors "four or five times". That's all it takes.

A strong word of warning: always check the precise credit wording with the sponsors involved. Giving credit for free booze or free airline tickets just urges members of the public to ask the same companies for the same things. This will not amuse your corporate donor. We lost a major corporate donor through such an oversight.

With respect to corporate input into a sponsored project, be firm and clear in your professionalism. If you're doing a show on energy and Acme Oil Company sponsors it, remember ... they pay the bills, they do not specify content.

6. The Big Question ... Who to Ask? That depends entirely on the project involved. In most cases of corporate support, approach a prospective donor with a potential need or desire to get involved. If you are doing a show on space travel, approach travel-related companies. Extension programs designed to travel to non-urban areas should be offered to companies that work in such areas. (For example, Placer Development Ltd., a mining firm, operates in the B.C. interior and sponsors our extension program Community Astronomy.) For science fiction, approach a publishing house. If you're doing a NASA or Harvard story, approach them. Try for some connection.

Major private donations need not relate to the individuals involved. You can be sure that the local millionaire won't approach you, though. Work through your Board, the cocktail party circuit and any and all other methods of meeting the private donor. Don't worry if this sounds calculating or callous. The wealthy didn't get that way by being naive. They'll fund a project if it's a good project, and well presented, but they have to know the project exists. By the way, the end of the taxation year is the best time.

Don't forget your regular funding bodies or the original donors to your institution. If someone built the place or funds regular activities and programs, they may be interested in new activities, renovations or expansions. The Vancouver Museums and Planetarium Association gave the Planetarium an extra $10,000 for a new 1982 activity, the I.P.S. Conference: Mrs. Jean Southam, daughter of original Planetarium benefactor H. R. MacMillan, gave the Observatory: the City of Vancouver gave $500,000 in renovations. The cliche about going to the well too often does not apply to fund-raising.

Do not exclude any level of government or any government organization (including foreign governments). Doing a show on Soviet space travel is ridiculous without some sort of aid from the Soviet Embassy.

Be prepared to accept goods and services "in kind", in fact, actively solicit such sponsorship. It matters little if a corporation gives you $1,000 in cash or $1,000 in film developing, for example. Both save you money that can be used for other things.
Summary. By far the most difficult aspect of fund-raising is building up the initiative (read courage) to ask for assistance. If you get nothing else from this article, realize that companies will not laugh at such requests or unilaterally reject them. To a majority of corporations and individuals, planetaria are still at the leading edge of high technology and entertainment. If you’re properly prepared and present a well-documented case, an entirely new source of programming funds is available.

As a last example, the I.P.S. Conference budget for in-Vancouver expenses amounts to over $50,000. The delegate fees bring in less than $12,000. The difference is made up by monies raised from interested parties in Vancouver and around the world. In fact, this book was produced through three separate donations.

Give it a try!
An Introduction to Alberta's Mobile Astronomy Project

by Judith Irwin and Cynthia Wannamaker, Mobile Planetarium Instructors, Alberta Natural Resources Science Centre, P.O. Box 3182, Sherwood Park, Alberta T8A 2A6

Canada's first mobile planetarium began operating in 1976 and since that time has visited 40 Alberta communities. The project has now expanded to include an inflatable planetarium on loan to teachers, a resource service and an annual lecture series. This slide presentation will show various aspects of the project and point out some of the operational problems.
A New Planetarium in Virginia

by Paul H. Knappenberger, Science Museum of Virginia, Richmond 23220

ABSTRACT: The Science Museum of Virginia is constructing a major Planetarium-Space Theater. The facility includes a 76-foot tilted dome seating 280, the first Digistar computer graphic projector, an Omnimax film projector, a sophisticated sound system, multi-media and special effects capabilities, a large astronomy exhibition area, and other features. It is scheduled to open in the spring of 1983.
Three-Year Planetarium Curriculum for the Gifted Elementary Student

by Eloise W. Koonce, Richardson ISD Planetarium, Dallas, Texas 75243

During the 1980 IPS Conference, I reported on my first year’s experience in working with the gifted and talented students of my school district. Since that time, we have developed a three-year planetarium curriculum cycle for this program. The Richardson School District selects intellectually gifted students in grades four through six. They spend four days a week in their home school classroom and the remaining day in a smaller gifted and talented class of fifteen students. The small class size allows a more individualized curriculum. This focuses on sharpening thinking ability through providing experiences in:

- critical and creative thinking
- problem-solving
- logic
- communication skills
- research.

The Planetarium Challenge was to create lessons fulfilling the program objectives. With these students, we “couldn’t tell - we had to pull”. The three-year cycle was necessary because the same student might be in the program from fourth to sixth grade.

The initial lesson was “Charting The Height of the Noonday Sun”, corresponding to the total curriculum theme, “Connections From the Past to the Future”. The activity was selected because it provided student involvement and afforded opportunities to practise problem-solving and logic skills. Upon entering the planetarium, each child was given a graph form and the lesson was introduced with a discussion of why 90 degrees had been selected as the scale limit on the left and why the months were listed across the bottom. Starting at sunrise on January 1st, the sun was moved to noon and the altitude marked on the form. The exercise was repeated at two-week intervals until students chose to shorten the process by going to monthly periods for the remainder of the year. The students were given question sheets and asked to find answers based entirely on their plotted data, the planetarium teacher serving as facilitator. Questions were asked, such as: “By observing your graph, what is our task today?” “What do you think is the meaning of 0 degrees in relationship to the dome and the real sky?”

Helpful ways to stimulate or redirect student thinking were:

- restating student questions
- opening the discussion to brainstorming
- rewording questionable responses
- letting the student restate or explain the meaning of his response
- asking for predictions and the reasons behind them.

"Communication" was the second year's theme, and the planetarium lesson topic was creative writing. Three five-minute moods were created in the planetarium through use of music and special effects. The resulting compositions ranged from a three-act ballet to a science fiction short story.

The third year, the thrust was "Economics and Free Enterprise" and with the help of Dr. Carolyn Summers' planetarium program, The Near Frontier, we created a space-shuttle journey. The students' mission was to build the first orbiting U.S. Space Station in the year 2,000 for the economic exploitation of space. Planetarium staff members became shuttle crew members. In preparation, the class divided into mission specialist teams and designed team logos. Team meetings were held during the flight and projects were created as culminating activities.

Close coordination between the gifted program director, teachers, and planetarium staff members during all phases of program development has resulted in a curriculum that well serves the special needs of the gifted.
The Drop-in Panorama, All-Sky System

by Michael Koziniak, H. R. MacMillan Planetarium, Vancouver, B.C.

Designed for the lazy, this environment projection system has proved a reliable workhorse in all our productions in recent years. A tripod (equipped with a spirit level) has been calibrated with marks indicating 10 panoramas and 5 sky positions (see photo A). Taking lenses are a 45mm Nikkor and 17mm Fisheye-Takumar (with full barrel distortion).

The key to orienting the projectors in the array shown (see photo B) lies in the production of identical alignment slides. Two rock-solid projectors imaging simultaneously from both sides of a rear screen enable one to “clone” any number of identically oriented images from a master slide. This alignment machine (see photo C) mimics the gate of our Leitz Pradovit projectors in that the two edges of the slide holder which determine the slide’s position in the projector gate also determine its position in the alignment machine. The transparency is positioned by hand and held with a single piece of tape. The slide holder is removed and its covering half snapped on. We use Gepe holders because the transparency cannot move within the mount.
Projectors are oriented using simple devices (see photos E and F) which take advantage of the three "feet" on each projector. Projectors can be removed and replaced in a mid-show emergency with good preservation of alignment.
There is about a 10% projection overlap in adjacent panorama (and sky) panels, i.e. 5% on each side. The adjustable wands (see photos *G* and *H*) allow controlled shadowing where projections meet to create invisible joins. A set of clear slides is a critical test to help adjust joins. A focus standard slide (fine grid) and a filament alignment slide (1/8 inch hole) in each projector help maintain the system.
Our projection lenses are 90mm (Leitz) in the pans and 1½” (Navitar) in the all-sky projectors. The image of the all-sky slide as seen by the lens is magnified a few percent by the addition of a 7” telescope objective acromat placed directly in front of the slide (see photo I), making an exact size match with the pan system.
Another “funny” design detail of our system is a piece of textured plexiglass which grazes the top of the image in the pan projectors, diffusing it somewhat and allowing a pan to be used with or without an all-sky (see photo J).
ABSTRACT: This paper reports on the computer graphics investigation of filling a hemisphere with projections from a minimal number of projectors using 1" and 1.4" projection lenses.

A basic problem in the planetarium medium is "How to fill a hemispherical screen with projected images from commercially available projectors so as to perfectly fill it - 360 degrees - horizon to horizon".

To answer this and related questions, a SIGGRAF core standard graphics package, DIGRAF, application program was written, and ran on the Cyber 172 at the University of Colorado at Boulder. The program constructed a 5 degree Phi angle by 5 degree Theta angle spherical coordinate grid pattern of the portion of the sphere to be investigated. The perspective point position of the projector was given and the focal length of the lens specified. Then it was aimed and tilted to make a best fit of the image on the film. For this investigation the projector was always at the bottom edge of the hemisphere. This was done for three reasons:

1. Most planetariums have space available to position projectors in this area - i.e. it does not impede or compete with the star projector.

2. The throw of the projectors is longest from the edge, thus allowing fewer projectors to fill the dome.

3. The position is easily and positively identified.

One important property of projections from the bottom edge of the dome to the surface of the dome is that the film image size and shape is dome size independent, i.e. these grids work for any size dome if projected from the base of the dome.

The focal length lenses used were 1 inch (25.4mm) and 1.4 inch (35.5mm). These were chosen because they are commercially available and lead to the smallest number of projectors in filling the dome - thus the lowest expense and the least number of butted edges.

The image size of the film was specified at 24mm by 36mm for standard 35mm and at 38mm for super 35mm. These sizes are slightly larger than some standard glass pin registered mounts. However, all the images generated will fit inside the slightly smaller image mounts.

Included with each image is the aiming diagram. Essentially it is a view from above, looking down on the dome. The circle is the base of the dome. The pie section or the smaller circle is the portion of the dome pictured on the film. The line from the circle (projector position) into the pie section (on the dome) is the line travelled by the centre point of the film (see fig. 1).

Below the aiming diagram the location of the centre line end point inside the pie section is given in standard Phi and Theta spherical co-ordinates (origin at the centre of the dome). Theta is measured counter-clock-wise from the projector. Phi is measured from the zenith. The
position of the projector is at 0 degrees Theta and 90 degrees Phi.

Many of the images are offset to the right side. This was done to eliminate any shadow from the star projector if it cannot be lowered. Even if the star projector can be lowered, the star field projected from a lowered star projector is not correctly positioned by as much as 10 degrees on the horizon. This is important if overlays are to be projected with the stars from film in the manner being described.

Most of the offset images had to tilt the projector in order to fit the image on the slide. The amount of this tilt is given below the centre point Theta, Phi angles. To implement the tilt angle simply stand behind the projector and pick up the right side until the proper amount of angle is described between the table top and the bottom of the projector. Maintaining this tilt angle, now aim the centre point of the film at the correct point on the dome.

The grid patterns are described as being either 3, 4, or 6 projector depending on whether the grid covers 120 degrees, 90 degrees or 60 degrees Theta. What it means is that with 3, 4 or 6 projectors the entire sky - 360 degrees - horizon to horizon can be covered. Grid patterns for 1 and 2 projector systems are included for completeness, but neither system fills the entire dome.

CONCLUSION. The system that seems to have the most number of positive attributes is the offset 4-projector system. These positive attributes are: (a) An intermediate expense for implementation, maintenance and slide production, (b) Standard 35mm format, (c) No star projector shadow, (d) Pictures could be taken with standard 35mm equipment. The negative aspects are: (a) It fits very close to the edges of the frame, thus demanding very good registration, (b) Pictures must be shot once, developed, projected on a jig and re-photographed - thus all pictures are second generation. However, computer-generated slides can do the transformation internally and do not suffer from this problem: (c) Larger dome sizes may have problems with intensity if standard intensity projectors are used.

FUTURE. For a very modest set-up cost of projectors and lenses a planetarium with an existing fixed star projector can be upgraded to show computer-generated overlays of the latest scientific discoveries, x-ray sources, pulsars, radio maps, globular clusters, etc. These most recent discoveries demand to be brought to the eyes and consciousness of man, and we stand in a position to be of service.
THETA = 0 deg.
PHI = 0 deg.
TILT = 35 deg.
FORMAT = SUPER 35mm
SYSTEM = 1 PROJECTOR
LENS = 1.4 INCH
THETA = 180 deg.
PHI = 60 deg.
TILT = 45 deg.
FORMAT = SUPER 35mm
SYSTEM = 2 PROJECTOR
LENS = 1.0 INCH
Fig 1. The Theta and Phi angles on the following pages describe the location of Point A on the dome. B and C are the Theta angles, measured counter-clockwise from the projector position, of the edges of the film image projected.
THETA = 70 deg.
PHI = 50 deg.
TILT = 0 deg.
FORMAT = STANDARD 35mm
SYSTEM = OFFSET 3 PROJECTOR
LENS = 1.0 INCH
THETA = 180 deg.
PHI = 45 deg.
TILT = 0 deg.

LENS
SYSTEM = 2 PROJECTION
FORMAT = STANDARD 35mm

1.0 INCH LENS
THETA = 90 deg.
PHI = 45 deg.
TILT = 0 deg.
FORMAT = STANDARD 35mm
SYSTEM = 4 PROJECTOR
LENS = 1.0 INCH
THETA = 116.5 deg.
PHI = 48.5 deg.
TILT = 6 deg.
FORMAT = STANDARD 35mm
SYSTEM = OFFSET 6 PROJECTOR
LENS = 1.4 INCH
Double Features: Capitalizing on "Used" Sky Shows

by Mark Levine, Vanderbilt Planetarium, N.Y. 11721

Following the run of a public sky show, the audio tape, slides and key special effects are put into storage. Usually, with slight informational updates in the audio tape and slides, the show can run at a future date. At the Vanderbilt Planetarium, these "used" shows are brought back as a second feature to the new main sky show. This, especially during the summer months, leads to substantially greater attendance and income. Visitors can see each of these shows individually for a full admission price, or, during evenings, buy a joint ticket at a reduced rate.

90.7% of people who see 1st show also see 2nd.

Doubles run mainly in summer due to tourists.

Now have 'an evening at the planetarium':
- 2 shows
- night sky segment
- telescope visit
Lasers and the Future of Movie Animation

by Doug McCullough, President, Audio Visual Imagineering, Inc., 7953 Twist Lane, Springfield, Virginia 22153

From a future perspective, the laser light shows of the past few years may look much like the early days of movies, when many considered it a novelty that would fade as time passed. However, recent breakthroughs in laser/imaging technology have opened up the potential to produce sound and light shows of a quality comparable to the animated cartoons of Walt Disney. In this article, I will briefly discuss the laser animation process developed by our company, Audio Visual Imagineering, Inc.

THE LASER. At the heart of laser animation is the laser itself, which is the light source for our projector. We utilize primarily two types of laser, argon and krypton, either separately or in combination. The main difference between an argon laser and a krypton laser is the color range given off by each. Argon will yield lime green, green, turquoise, deep blue, and violet; krypton yields the primary colors, red, yellow, green, and blue. A further difference is that while argon is fairly efficient in terms of light output power, an identical laser filled with krypton will yield approximately one quarter of the output power. Lasers that are bright enough for planetarium shows require a water cooling system and three-phase, high current electrical supply. Also, any laser light show operating in the United States must be approved by the Federal Bureau of Radiological Health. This, along with water and power requirements, is of major importance in designing a laser system.

LASER PROJECTOR. The laser’s main output beam is routed (via mirrors) into our projector, which was designed by laser optics specialist Floyd Rollefstad and our technical director Ward Davis. The inside of the projector resembles a micro-optics bench loaded with precision-aligned electro-optical components. A spectroscopic prism separates the main beam into its component colors, which are individually routed to a pair of magnetically driven motors called scanners. Attached to each scanner is a tiny mirror which directs the beam onto the projection screen. One scanner moves the beam up and down (y-axis) while the other moves it from side to side (x-axis). Simultaneous movement of both scanners will move the laser beam in complex trajectories. Due to the persistence of vision, rapid movement (i.e., scanning) of the laser beam is perceived as a solid line image. By introducing textured plastics and diffraction gratings into the beam path, a wide variety of laser aurora and multiple beam grids can be generated.

PROGRAMMING. Programmed control for such a projector is achieved through two quite different types of computer. Analog computers are most commonly used for generating the familiar lissajous patterns, while digital computers are ideally suited for synthesizing realistic images.

We use analog computers for the more intuition-oriented applications, such as in recreating harmonic rhythms in nature (i.e. a flower petal, atomic model, spiral galaxy, etc.) The “spirograph” toy is a good example of the analog aspect of laser imaging. While the spirograph uses plastic gears and rings all meshed together to guide a pencil point through loop-de-loop designs, our analog computers use infinitely variable oscillators (similar to a music synthesizer) to control the scanner amplitude and frequency in generating similar spiralling designs.
Digital computers are used in tasks that require down-to-the-last-decimal-point precision. The interface of a "bit pad" (x/y coordinate digitizing tablet) permits us to interact with our computer in much the same way as a painter would with his canvas. Using a pen-like stylus (called a "cursor") we can plot over 2,000 point coordinates of an image on the bit pad and store this information on floppy disc. When this stored information is fed to the scanners, a laser graphic is projected. Another popular toy, "Etch-A-Sketch", draws pictures in much the same way as a digital computer.

The limiting factor, however, in our image resolution remains the scanner itself. Although we use the fastest, most precise tracking scanners, trade-offs must be made between accurate representation of detailed images and the "flicker" effect that occurs when the scan recycling rate is slowed down. Through careful planning by our artists in keeping the number of x/y coordinates to a minimum and attenuation of the scanner amplifier/feedback circuitry, we have been able to produce spectacular results in image quality.

Early laser graphics involved the projection of a simple, continuous line drawing. However, by the term "laser animation", I'm referring to a series (or moving stream) of representational laser images that evolve in a complex way, similar to a Disney cartoon. During the past year and a half we have worked closely with a robotics engineer, Dave Bowles, who has designed a hybrid computer system capable of the lengthy and complex operations required to animate cartoon characters and graphics. Some of these new capabilities include:

METAMORPHOSIS, where one image slowly transforms into another.

SEQUENTIAL ANIMATION, where multiple images rapidly cut from one to another like frames in a movie.

SKYWRITING, where an image is gradually traced out on the screen as if it were being drawn with a pen in real time.

HIDDEN LINE, where precisely selected areas of an image can be removed, or blanked out.

INTENSITY, for subtle shading and highlighting of an image.

COLOR PALETTE, for blending the primary colors into soft pastels or any hue at specific points within the image.

Any and all of the above capabilities can be combined to produce laser animation of unlimited length and complexity! For example, a laser beam could appear on the screen, slowly draw out a character like Mickey Mouse who walks and talks, then transforms into a starfield constellation of the Big Dipper ... or whatever you can imagine.

FOR MORE INFORMATION

We are now ready to create new audio-visual experiences with new tools - the laser and computer. For more information, see our program Laser Animation: A New Light on the Future, on Thursday, July 29, 9:00 - 12:00 a.m. at the Gage Foyer.
The problem at the Pacific Science Center in Seattle was one common to too many science museums. A world’s fair in 1962 left a shell of buildings surrounding dozens of exhibits designed for the general public. Then, a private foundation took over the operations, and began to serve the public and visiting school groups. The foundation soon realized that well over 90% of school groups were at the elementary school level. As a result, the staff began to cater to their desires, creating new exhibits which filled the general public/elementary school needs. They started an education department, staffed with outstanding elementary educators, which began giving activity lab classes for the elementary school visitors. The Science Center obtained a reputation throughout the region for having excellent science and math programs - for elementary students.

But what of the secondary student? No special laboratory classes were offered to supplement the students’ work at school, and the exhibits still provided only introductory level science content. Few secondary science teachers could justify the time, expense, and hassles of bringing their classes to the Science Center.

An education advisory board, made up of area administrators and teachers from all levels, K-college, decided that the secondary school student deserved better from an institution with a goal to promote better understanding of science.

They suggested that the Science Center must have some unique facility or equipment. After all, every high school has chemistry, physics, and biology labs, so why bother duplicating those facilities at the Science Center? Elementary teachers are seldom well prepared in the sciences, and are often not expected to do all their own science teaching. Secondary teachers, on the other hand, are hired for their science teaching expertise, so for them to request a field trip to the Science Center for a lab class, there must be something there that the teacher could not do without the trip. There was also the problem of secondary schools’ class schedules. While a self-contained elementary class often has a flexible schedule, the secondary teacher has to be “back at school by third period” or request the additional expense of a substitute. (In today’s financial climate, that is not a very popular request.)

The advisory board then examined the possibilities. Computers? No, too costly at that time. Electron microscope? No, specimen preparation took too long for a single visit. Finally, they came up with what they thought was a workable idea: a planetarium! Part of the beauty of a planetarium in Seattle is that it would be the only planetarium readily available to the public and school groups in the entire state! If students could not see the sky through the clouds, at least they could use the planetarium. After studying other museums with planetaria, it soon became obvious that a planetarium could easily fall into the same elementary school service pattern that museums alone do. This had to be a planetarium with a difference.

It would be a planetarium built and dedicated to participatory programming at the secondary level. To facilitate use of the inquiry/discovery method, the planetarium would seat only 38
people. The dome would be 8 metres in diameter with a single bench seat around the perimeter, leaving most of the floor space available for student movement, to see the sky without the distortion of sitting “in the wrong place”. The dome would be lower than most, giving a more realistic horizon.

All programs would be live, to encourage a true dialogue between presenter and audience. The operator’s console would be at the centre to make that person a part of the action and help minimize the “magic” that happens in too many planetaria. To help with the secondary teachers’ scheduling problems, there would be an adjacent classroom and darkroom where a second class could be taught other astronomy concepts in a laboratory setting. Lessons in this adjacent lab could involve optics, spectroscopy, or other disciplines in astronomy. Then, at the end of the first of two hours, the two classes could “flip-flop”. The whole facility, named the Regional Astronomy Education Laboratory, represented a commitment of staff and equipment to teach astronomy by student activities rather than by lecture techniques.

Plans were drawn, staff hired, and construction begun through a capital appropriation from the State Superintendent of Public Instruction (later the facility was purchased from the state by providing science programs at reduced rates to public school students). In the fall of 1977, the Starlab Planetarium and the Regional Astronomy Education Laboratory opened to secondary school groups. Since that time, there has been a steady growth of visits by secondary level students. Today, twenty-nine percent of the lab lessons given are for junior and senior high groups.

Secondary teachers in Western Washington now have six planetarium programs and two classroom lessons from which to choose. Students find constellations using a star chart, do stellar parallax observations, observe spectra, explore telescope characteristics, model moon phases and planetary motions, and more. This type of activity-based program is one which is adaptable to any size planetarium, and one which has been shown to be superior to the standard “passive” planetarium show in its learning outcome. (See footnotes to this article.)

All visiting teachers attend a two-hour pre-visit workshop several weeks before their first visit. At this workshop, activity packets are distributed for use back at school and excerpts from the programs are given so the teachers may choose programs which complement their own curricula. A bi-monthly newsletter, the Galactic Gazette, goes out to teachers to keep them informed of changes in programs and other items of astronomical interest.

Other components of the program which have enhanced secondary planetarium visits are monthly “star party” telescope sessions in a local park, summer and academic year teacher in-service workshops for college credit, a slide library and duplicating equipment available to teachers, and a high school astronomy seminar series for highly motivated students.

The most recent element added was a portable, inflatable planetarium which travels to schools for about one-third of the cost of sending students to the Science Center for planetarium programs. As transportation funds get cut from more and more school budgets, this travelling program will replace some field trip experiences. Besides astronomy programs, the Science Center also maintains good secondary teacher contacts in other subject areas through museum programs and published curriculum materials in anthropology/archaeology, and marine education.
To other planetarium professionals, we can only suggest a renewed effort to involve secondary students in their programs. Teacher workshops and free “open house” evenings have been helpful in bringing in new users. The program you offer will have to be one which can’t be done in the classroom or a “canned” one which is available to the public. Secondary students need to ask follow-up questions. The presenter needs to continually quiz the group to see that they are following the presentation, and, in fact, to have them present by a guided discovery method - some of the material. Even more than elementary students, they need to take part in mental or physical activities during every program.

Now, these programs must be done for small groups, must be done by a live, fairly knowledgeable presenter, and must last one to two hours to really “get into” the concepts being taught. These factors make these programs much more expensive than the typical 250-student, 45-minute “Cosmic Wow!” show. In these financially tight times, they might seem a foolish undertaking. Strangely, the reverse is true. As we have increased our prices over the past five years, attendance and revenue have continued to edge upward. Our current price for a secondary planetarium/lab is $4.50 per student!

If you are tiring of managing the elementary mobs every day, consider blocking some times for secondary level programs. You will enjoy the chance to talk astronomy at a more mature level. These students will benefit from a personalized program with a few clear concepts studied in some detail. And, perhaps best of all, you will be tapping a new audience, and, hence, a new revenue source.

**FOOTNOTES:**


*Special Report on Student Achievement and Attitudes in Astronomy, Gerald L. Mallon, Methacton School District, Fairview Village, Pa. 19403.*
Kepler was indeed correct - the heavenly bodies should be accompanied by music. Though some of the primordial planetarians may disagree, most domes have graduated from the solitary monotonic lecturer to shows which use both music and extensive sound effects to spice things up a bit.

You can get along fine for a while by digging into the album collection and picking up a few sound effects records at the record store, but sooner or later you will need the sound of an alien piloting his ship through hyperspace and it won't be among the elephants and steamboats on the effects record. And then you might get that ominous call from ASCAP or BMI wondering how many of their songs you've pirated, how loud you played them, how many people listened to them, and whether you had paid the royalties or not. Then you might consider, as we did, alternatives to prerecorded and copyrighted sounds.

There are two legal alternatives to the dilemma: use someone's non-copyrighted music, or create your own. The first alternative may be the best if you can't tell an orchestra from a rock and roll band, but the second alternative gives you unlimited freedom, and if you have any ear at all, it's a good way to go. This freedom to fit the music exactly to the show may be reason enough to produce your own music, even if you didn't have to worry about paying royalties, etc. If done tastefully, it can greatly enhance your shows, and it's just plain fun as well.

**MOOD AND STYLE**

Mood and style are the two most important aspects of soundtrack music. The best way to get acquainted with these two guys is to listen to a few motion picture soundtracks. Exciting scenes use fast-moving, dynamic music, while the normal dialogue scenes have smooth, flowing music that has a narrow dynamic range. Unless you're putting on a production of *Star Wars* in your planetarium, the latter type of sound is what you will use the most. Understandability of the narrator is the most important: the music is not, so it shouldn't be distracting. Vocal songs are usually taboo, except for an opening or closing theme song.

For background music, stick with being simple (no complex or fast chord and note changes), *legato* (smooth and flowing), and about the same volume - low in the background, except for breaks in the narration for visual effects or something. Fortunately, this is the easiest style of music to crank out.

The mood is just as important. You certainly don't want a Sousa march during your black hole scene, nor do you want scary music behind a light, humorous part of the show. It's easy to decide on the mood - you had it in mind when you wrote each part of the show. So now that the mood and style have been determined, it's time to collect some musicians and instruments.

**WHO VOLUNTEERS?**

Of course, there is a musician on the planetarium staff, he just volunteered, right? Or perhaps you tickle the ivories yourself every now and then. If you need more (or better) musicians, try putting a notice in the newspaper or at music stores, or call whoever you know or have heard of. On our most recent show, I did all the background music on keyboards and synthesizer,
but I needed more instrumentation and a vocalist to do the theme song. So I contacted a good band, and they were delighted to record the music simply for the exposure. The results were excellent.

In any case, accomplished musicians will usually give you a quality sound just for the exposure (now be sure to make a nice credit slide). Don't call in your dad to do it just because he played the triangle in sixth grade. But, just as importantly, don't forget that you are the producer, meaning that you have the final word on what goes. If the guitar player wants to put a heavy metal solo during your sunrise, it's your job to deal with that. Let the musicians know from the start that you are the producer. Tell them basically what you want (style, mood, etc.) and give them some freedom, but don't let go of the reins. They can probably come up with a satisfactory chord progression, melody, and rhythm (keep it all simple!)

You may be able to work with just a keyboard player, as this is how the majority of electronic music is done. Keyboards today are so versatile that you can get just about any sound or effect that you want. With rare exceptions, I do my music basically by myself using a Rhodes electric piano, a string machine (for orchestra sounds), an organ, a clarinet (an electronic "funky" piano sound), and a Yamaha synthesizer. Having one person on many instruments is much simpler and more efficient than having many people on one instrument each.

THE RECORDING PROCESS

This is the easy part - tape deck's on, we're rolling! Right? Nope! Recording music is much more complicated than normal recording operations. First of all, you need a synchronized tape deck - one which records each channel separately, but in synch with the others (while the other tracks play back). The more channels you've got, the better and easier your project will be.

Each instrument should be recorded on a separate track, but since most planetariums don't have very many to work with, you may have to compromise. Here, a four-track deck is the smallest that is practical. An eight-track would be very nice, a sixteen-track would be a dream. Since most of us can't afford more than a four-track, I'll stick with this for examples. (One other alternative would be to go to an outside studio, but this can be expensive. Costs range from about $30 to a few hundred dollars an hour, plus charges for the tape, etc.)

To get things plugged up, remember that most instruments (guitars, keyboards) have microphone-level rather than line-level outputs, so plug them into the mic inputs of the mixer or recorder. (You may need special patch cords to do this, depending on your set-up. The instruments will have ¼-inch phono plug outputs.) There are a few exceptions to this, with some electric pianos and organs having built-in pre-amps and line-level outputs. The guitar player might want to get that sustained distorted Jimi Hendrix sound, in which case he will need to play through his stage amp and into a microphone. It's best to stick him in a soundproof booth for this, both to protect your ears and to keep extraneous noises out of the mic. If you don't have such a booth, they are a cinch to build. When using drums, it's best to isolate them as well so they won't bleed over on to other tracks, and you will certainly need to isolate the vocalist (or record that track after the rhythm tracks are down.)
You will never have enough tracks to keep everything separate (at least on a four-track deck) so lay down three rhythm tracks, say guitar, bass, and keyboard on tracks one, two and three, and then mix them on track four. Then you have one, two and three free again. But don’t erase them until you’re satisfied with the mix on track four! In general, put the rhythm tracks down first and “bounce” them, i.e. re-record on a separate channel, mixing in the process, and save the most visible parts (lead vocal, solo instruments) for last.

Before you start recording any instruments, you may want to put down a “click track” with a metronome, so everyone will stay together. You can record over this once the rhythm tracks are down.

Use the best quality tape you can afford, and be sure the equalization on the tape deck is set right. You can generally record pretty “hot”, i.e. recording with a good strong signal level occasionally exceeding Odb on the VU meter, on today’s tapes. So don’t worry about peaking the VU meter a time or two. This will give you a better signal-to-noise ratio and a cleaner-sounding recording, as long as you don’t overdo it and distort the signal. Clean the heads on the tape deck before you get started (at each session!) and record at the highest tape speed available to get higher fidelity.

Be sure to record the count-off into the song (which will not be included in the mix) and keep the musicians quiet for a couple of seconds after the song ends, to save headaches during the mix.

DON’T GET MIXED UP DURING THE MIX-DOWN

Keep good notes on just who is on what track, and whether the level needs to be changed during the song, etc. Then you will be sure of how to adjust things for the mix-down. It’s best to mix on to another reel-to-reel machine, again at the highest tape speed the machine has. A good two-track deck is ideal for this. The “master” tape is then used to dub the music on to your show tape, or to make copies of the music, etc.

It’s best to do all your equalization and effects during the mix rather than during the actual recording. Putting in reverb, for instance, during the mix, will allow you to change it if you don’t like it, but if it’s already on the original track, there’s nothing you can do about it short of doing that track over.

If you’ve got lots of tracks to deal with, mixing can get pretty complicated, so you may need more than two hands. With a four-track, though, things stay pretty manageable. And again, remember that you are the producer, so don’t let that wild guitar solo cover up the show narration, no matter what the guitar player thinks of it.

SOME TOYS YOU WILL WANT

There are gobs of sound reinforcement and modification devices on the market, and many of them are quite useful in preparing planetarium audio tracks, both musical and narrative. The ultimate planetarium toy is the synthesizer. Even if you’ve never heard of middle C, you can use a synthesizer for all kinds of effects. Remember the sound you needed of an alien rocketing through hyperspace? No problem. Or Venusian winds? Great! Depending on how much you want to spend, you can get synthesizers that will duplicate everything from violins to
chickens. Synthesizer technology is rocketing, so the prices are dropping constantly. They range from a few hundred dollars to about $20,000 for a computer-controlled digital machine.

Many synthesizers also have input capabilities that will allow you to modify an external signal with their electronics. This is great for doing alien voices and the like.

Another toy you will definitely need (if you get serious about producing music) is a noise-reduction system, like a Dolby or a dbx unit. (Both are registered trademarks.) You will see the need for this after bouncing a few tracks: about 3 dB of noise is picked up with every bounce. Most professional studios use a dbx encoder/decoder to eliminate this.

A reverb system is useful, if your mixer doesn’t already have one built in. This gives echo effects to the signal, usually by means of a mechanical spring system. Even better is an analog or digital delay unit, which accomplishes the same (and much more) electronically. Some of these can repeat echoes over and over for many seconds. They start at a few hundred dollars.

A flanger adds a nice spacey touch to both music and voices (for aliens). This causes a sweeping sound like a jet plane passing overhead. These are about a hundred bucks a shot.

These toys add a nice extra touch, but they certainly aren’t mandatory for producing your own music. Use whatever you’ve got and then decide where you need to expand or improve.

So, don’t be intimidated by original soundtracks - make your own. If you or your staff is not musical, there are hundreds of musicians out there waiting for their talents to be exploited. We have more musicians ask us if they can do a soundtrack than vice versa.

And if you’re still not sure or if you have a problem, I’ll be glad to help out. Making your own “music of the spheres” is not hard to do, and it sure beats paying royalties!
Common Errors in “Star of Bethlehem” Planetarium Shows

by John Mosley, Program Supervisor, Griffith Observatory, Los Angeles, California

Since the 1940’s, most of the planetariums in the western world have presented a show on the Star of Bethlehem in what has become one of the newer Christmas customs. As the first Christmas shows are older than most planetariums (and most planetarians!) we have learned from each other and from those who went first, and for the most part we all present shows that are quite similar and that have not changed dramatically in at least a generation. (How did you learn to give your first Christmas show?)

Unfortunately, we have copied each other’s errors along with everything else, and these errors have been repeated in lectures and in print to a point where they have become planetarium folklore and myth. Yet despite their time-honoured status of respectability they are still errors, and if we represent ourselves as trusted sources of information we have an obligation to be as accurate as possible, even on minor points. Each of the following eleven statements often heard in planetarium shows is either factually incorrect or is misleading and requires qualification.

1. **Kepler suggested that a triple conjunction of Jupiter and Saturn was the Star of Bethlehem**. Although Kepler was the first person to calculate that the triple conjunction had occurred in 7 B.C., he actually suggested something quite different. In December, 1603, Kepler watched a conjunction of Jupiter and Saturn that took place in Sagittarius in the morning sky. (Note: this was a single conjunction.) The conjunction was astrologically important because it took place in a constellation that was one of the points of the Fiery Trigon, and was to be followed the next autumn by a triangular grouping of Mars, Jupiter and Saturn - a fiery triangle in the Fiery Trigon. As an omen, this was surpassed only by a comet, and many astrologers in 1603 predicted that a comet would be produced by the planets’ close proximity late in 1604.

In Kepler’s day the location of a conjunction was as important as the conjunction itself. The twelve signs of the zodiac were divided into four trigons, each made of three associated and equally-spaced constellations. Pisces, Cancer and Scorpio were the Watery Trigon, while Sagittarius, Aries and Leo were the Fiery Trigon. Jupiter-Saturn conjunctions occur at 20-year intervals and 117 degrees apart, and shift westward (clockwise) through the signs of a given trigon, remaining within the signs of one trigon for almost 200 years and then shifting into the adjacent trigon. After nearly 800 years (actually 794.4) they begin a new cycle back at nearly their original position as measured with respect to the vernal equinox. The conjunction that Kepler watched had occurred in essentially the same position 800 years before that: Kepler believed the event had happened only eight times since the creation of the world.

The massing of Mars, Jupiter and Saturn in 1604 was awaited with anticipation. “Some watched to correct their ephemerides, some for the sake of pleasure, some because of the rarity of the occasion, some to verify their predictions, and others, indeed, to see if there would be a comet as had been expressly predicted by the astrology of the Arabs,” Kepler wrote (Kepleri Opera Omnia, vol. 11, p. 617, as quoted by Burke-Gaffney). Mars came first
into conjunction with Saturn, on September 26, and then with Jupiter on October 9. Although Kepler missed this last event because of clouds, others in Europe saw the two planets and noted nothing amiss.

On October 10 a new star, as bright as Jupiter, was spotted essentially between Jupiter and Saturn, which themselves were only 9 degrees apart. Kepler observed it carefully until it faded into the sun’s glare the following year, and later wrote a book, *De Stella Nova In Pede Serpentarii (About the New Star in the Serpent’s Foot).*

While writing this book, Kepler came across a work by Laurence Suslyga of Poland that argued that Christ was born in 4 B.C. Kepler immediately noticed that this was shortly after a triple conjunction that he calculated had occurred in 7 B.C., and wondered if there was a connection. In 1614 he published his conclusions: the triple conjunction of 7 B.C. was followed by a massing of Mars, Jupiter, and Saturn in 6 B.C., and just as the conjunction and massing of 1603-4 had produced a new star, so the events of 7-6 B.C. had produced a miraculous nova, and *that nova* was the Star of Bethlehem. The biblical triple conjunction took place in Pisces, but the massing that followed took place in Aries - one of the fiery signs - just as the massing of 1604 had also taken place in a fiery sign.

Kepler believed that the star over Bethlehem was a nova placed there specifically to alert and guide the Magi. He wrote: "I do not doubt but that God would have condescended to cater to the credulity of the Chaldeans."

Today the supposed nova of 6 B.C. is often forgotten, and it is stated that Kepler identified the triple conjunction with the Star of Bethlehem. This incorrect statement dates to the early 19th century, when Bishop Munter of Zealand, Denmark, who apparently did not know of Kepler's work or of the nova of 1604, independently suggested that the *Triple Conjunction* alone was the Star. He wrote that since the two planets were only one degree apart, weak eyes would have made them out as a single star - clearly a false impression. In a popular chronological handbook published a few years later, Ludwig Ideler, who did know of Kepler, incorrectly attributed Munter's hypothesis to Kepler. Munter's book was widely read while Kepler's was not, and the error became entrenched in the literature.

2. When determining the date of the birth of Christ, Dionysius Exiguus forgot that Caesar Augustus had ruled under the name of Octavian for four years, and thus made a four-year error. Dionysius Exiguus (Dennis the Little) was a Scythian monk and prominent scholar who lived in Rome and who had access to the state and church archives, including many records now lost to us. It is true that Julius Caesar's grand-nephew Octavian ruled as part of a triumvirate under his own name for four years, and was not proclaimed emperor Caesar Augustus until after he defeated the combined forces of Antony and Cleopatra at the naval battle of Actium in September, 31 B.C., but this was common knowledge. Schoolboys were expected to know the story, and a prominent historian working in Rome would not have made such a simple blunder.

Dionysius carefully selected the year we would call 1 B.C. for the birth of Christ, and set the date at December 25th as was customary in his time, and commenced the Christian Era with
January 1, 1 A.D. (six days later) to agree with the start of the ordinary Roman year, and was probably not far from the mark.

3. When Christ was born the old Roman Calendar was in use, and years were counted from the founding of Rome (753 B.C.). Although the Romans had devised a system of counting years consecutively beginning with the founding of Rome, in practice this system was seldom used. It would have been nice if it had been, because then the problems that occupy so much of historians' time would be that much simpler.

The date of the founding of Rome was not known, and various dates were given by different authorities. The most commonly accepted date was April 21 of the third year of the sixth olympiad (=753 B.C.) as calculated by the antiquarian Varro (116-27 B.C.) In the Varronian Era, 753 B.C. is set to AUC 1. “AUC” is from ab urbe condita, or “from the founding of the city”.

The most common way of designating the year was by referring to the two consuls who were in office that year. For example, “In the following year, when Quintus Fabius and Lucius Fulvius were consuls ...” The Annales Maximi, compiled in 130 B.C., was one of the earliest list of consuls and was incorporated into later longer lists. The other common way was to refer to the year of the reign of the king or emperor, as in “In the ninth year of Hadrian ...”

By the time of Dionysius Exiguus a more modern system was in use, and years were counted consecutively from September 17, 284 A.D., when Diocletian was proclaimed emperor by his troops at Chalcedon. This was the “Era of the Martyrs”, or aera martyrum, and the years were Anno Diocletiani. The system was modern in that the count did not begin again with each new emperor. Each year began on August 29th, the Egyptian New Year’s Day Thoth 1 (for example, Anno Diocletiani 100 ran from August 29, 383, to August 28, 384).

While preparing new Easter tables in 525, Dionysius broke with tradition and began the system now in use. He wrote: “We have been unwilling to connect our cycle with the name of an impious persecutor, but have chosen rather to note the years from the incarnation of our Lord Jesus Christ.” Dionysius set A.D. 1 (from ab incarnatione Domini) equal to 754 AUC, according to reckoning current in his time. His new Christian Calendar was not immediately accepted, and the Diocletian Calendar continued in use until the 8th century.

In short, the Romans knew of a counting system that began with the founding of Rome in AUC 1, but unfortunately did not use this system to any significant extent, and the true situation is much more complex.

4. The word for “star” used in Matthew is the same in the singular and plural forms, like “fish”, and so the “Star” could have been a single object or a group of objects. The New Testament Greek word for “star” is aster, and the word for “stars” is asteres, and the two are clearly distinct. The word “star” occurs four times in Matthew, and each time it is singular.

Less clear is why Matthew, if he did want to refer to a group of objects, either planets or stars, did not use the word astron which means “constellation”. For that matter, he could have used the words for “planet”, planes aster. (Our word “planet” comes from the rural form planetes.)
He did not, perhaps because he preferred to use the more traditional and familiar *aster*, which appears 24 times in the Old Testament, instead of *astron* or *planes aster* which do not appear in the Old Testament at all. Although the word Matthew used means a single star in the literal sense, we cannot exclude the possibility that he was deferring to poetry or drama.

In current planetarium shows at the Griffith Observatory we tentatively identify Matthew’s “star” with the planet Jupiter, as Jupiter came into close conjunction with Venus twice and with Regulus three times in a 10-month period near the time of the nativity.

In any case, the Greek word for “star” is not the same in its singular and plural forms.

5. “We saw his star in the east” can be translated to mean either “We saw his star while we were in the east”, or “We saw his star (as it rose) in the eastern sky”, and is ambiguous. The Authorized King James version of this passage in Matthew reads: “... there came wise men from the east to Jerusalem saying, Where is he that is born King of the Jews? for we have seen his star in the east, and are come to worship him.” And later: “... they departed, and, lo, the star which they saw in the east ...” This has been interpreted to mean either that the star was in the eastern part of the sky or that the wise men were in the eastern part of the world when they saw it, but the actual situation is not so ambiguous. The Greek phrase *en te anatole* simply means “as it rose” or “at its rising”, which of course is always in the eastern sky, and does not refer to the location of the observer. Some authors interpret the phrase to mean that the Magi observed the star’s pre-dawn heliacal rising with the sun, and although this may be the case it is an assumption not contained in the *en te anatole*. The error is the fault of mistranslation by the committee of scholars working under the sponsorship of King James of England, and has been corrected in the New English Bible to read: “We observed the rising of his star” and “the star which they had seen at its rising ...”

Both translations of the Bible agree that the Magi came from the east of Jerusalem, probably from Persia.

6. *Joseph and Mary went to Bethlehem to pay their taxes. According to an inscription found on a temple in Turkey, this was probably the general Roman tax of 8 B.C.* The “tax” that sent Joseph and Mary to Bethlehem is often cited as the major clue in establishing the earliest date for the birth of Christ, and is generally linked with the universal taxation of 8 B.C. This is incorrect for several reasons.

The error dates from the incorrect translation of Luke’s word *apographe* as “tax” in the King James version. The correct word for “tax” is *apotimesis*, while *apographe* is properly translated as registration or enrolment, and does not imply the payment of goods or money. Contrast the King James version: “And it came to pass in those days, that there went out a decree from Caesar Augustus, that all the world should be taxed. (And this taxing was first made when Cyrenius was governor of Syria.)” with the corrected New English version: “In those days a decree was issued by Emperor Augustus for a general registration throughout the Roman world. This was the first registration of its kind; it took place when Quirinius was governor of Syria.”

There was a tax in 8 B.C. (and others in 28 B.C. and 14 A.D.) as is recorded on the walls of the Monumentum Anncyranum at the Temple Augusteum in Ankara, Turkey, but this tax cannot
be the registration described by Luke, for several reasons. That tax was levied specifically on Roman citizens who lived within the empire, and who then normally paid at their place of residence or birth. Joseph and Mary were not citizens and were exempt, and in any case would not have had to travel to the place where their family originated. Nor in a general taxation would Mary have had to accompany her husband. And Herod’s semi-autonomous kingdom was outside the empire proper until 6 A.D., and any tax levied before then would have been ordered and collected by Herod under his own rules.

The correct identity of Luke’s has been a long-standing puzzle to historians. Recently Dr. Ernest Martin suggested that it was an oath of allegiance made on the occasion of Augustus’ Silver Jubilee in 2 B.C. (see chapter 5 of the second edition of his book). On February 5 of that year, Augustus was awarded the title Pater Patriae, Father of the Country, in a year of celebrations that commemorated the 750th anniversary of the legendary founding of Rome as well as Augustus’ 25th year of rule. In the autograph account of his own life, the Res Gestae, Augustus wrote : “While I was administering my 13th consulship the senate and the equestrian order and the entire Roman people gave me the title Father of my Country.” The 5th century historian Orosius told how in the same year Augustus “ordered that a census be taken of each province everywhere and that all men be enrolled ... This is the earliest and most famous public acknowledgement which marked Caesar as the first of all men and the Romans as lords of the world ... in this one name of Caesar all the peoples of the great nations took oath, and at the same time, through the participation in the census, were made a part of one society.” Josephus relates that “therefore the whole Jewish nation took an oath to be faithful to Caesar and the interests of the king (Herod) ...” An inscription from Paphlagonia in Asia Minor from 3 B.C. records an oath “taken by the inhabitants of Paphlagonia and the Roman businessmen dwelling among them ... The same oath was sworn also by all the people in the land at the altars of Augustus ...” Note that the common thread here is an Oath of Allegiance required of all the people, citizen and non-citizen alike, both in the empire and its provinces, for the purpose of establishing fealty. This oath was either ordered by Augustus at the time of his jubilee and completed that year (2 B.C.), or was conducted during the year prior to the jubilee (3 B.C.) and the results presented to him as part of the ceremonies.

If Luke’s registration was Augustus’ loyalty oath we can understand why both Joseph and Mary went specifically to Bethlehem. We are told that Joseph, being of the house and lineage of David, went to the city of David (Bethlehem), while everyone else went into his own city. As a descendant of David he was obliged to return to Bethlehem along with other claimants to the throne of Israel : under Jewish law the right to kingship could pass to Mary’s descendants, and so she had to accompany her husband.

Planetarians who like to delve into the historical clues used to date the nativity will find that the oath of allegiance to Augustus on his Silver Jubilee is a more dramatic story than the one about taxes.

7. The “Star” was a triple conjunction of Mars, Jupiter and Saturn. This conjunction, however, could not be seen because the planets were too close to the sun. This statement contains two separate errors.
A triple conjunction is, by definition, three consecutive conjunctions between the same two planets (or a planet and a star) and happens when the nearer of the two goes through its retrograde loop in front of the more distant. Three planets cannot be said to be in conjunction unless they have precisely the same longitude (or right ascension), and this never happens. The grouping of Mars, Jupiter and Saturn is more properly called a massing of the planets. There was a triple conjunction of Jupiter and Saturn in 7 B.C. followed by a massing of Mars, Jupiter and Saturn in 6 B.C.

The massing was clearly visible. Mars and Saturn were in conjunction on February 20, 6 B.C., when the longitudes of Mars, Jupiter, Saturn and the sun were 351.2, 358.6, 352.0, and 329.8 degrees respectively as interpolated from Tuckerman's *Planetary Lunar and Solar Positions*. (Mars and Saturn were at equal longitude 12 hours later but had set by then: the numbers given here are for 7:00 p.m. Babylon time.) The sun was 21 degrees west of the westernmost two planets and 29 degrees west of Jupiter. All three planets were still visible above the horizon after the end of evening twilight. Robert Victor of Abrams Planetarium clearly saw the Mars-Saturn conjunction of February 20, 1966, even though these planets were much closer to the sun than in 6 B.C. and were observed from a higher latitude than the Near East.

8. A triple conjunction of Jupiter and Saturn occurs on the average once every 120 (or 139) years. Single conjunctions of Jupiter and Saturn occur regularly once every 20 years, but triple conjunctions are not periodic.

Each year Jupiter advances about 30 degrees along its orbit and Saturn advances 12 as seen from the sun, and Jupiter gains on Saturn by 18 degrees. Every 20 years (actually 19.8592) Jupiter overtakes Saturn and there is a conjunction, but this number is an average because we must take into account the position of the earth and the eccentricity of the orbits of the three planets. This conjunction is triple if the earth passes both Jupiter and Saturn within about 40 hours of each other - then Jupiter's motion carries it retrograde back past Saturn a second time and then forward again for a third time. These three conjunctions occur within a seven-month period.

A search through the published lists of planet longitude positions shows that Jupiter passes Saturn 180 times during the 3600-year interval from 601 B.C. to 3000 A.D., and that 20 of these passings are triple. This implies an average of 180 years between triple conjunctions, but the actual interval varies from 40 to 377 years and is not periodic. The accompanying table illustrating this appears courtesy of Robert Victor of the Abrams Planetarium in East Lansing, Michigan.

Incidentally, surprisingly few of us now alive will see another Jupiter-Saturn conjunction, and none of us will see the next triple conjunction. The next single conjunction occurs on May 28, 2000, but the planets will be on the other side of the sun: the next occurs on December 21, 2020, and will be visible in the evening sky. The last triple conjunction happened in 1980-81, but the next will not be until 2238.

9. During the years around Christ's birth (8-1 B.C.) there were no comets or novae seen. If we include within the period when Christ might have been born the years 5 and 4 B.C., it is incorrect to state that no comets or novae were seen. William’s Comet Catalog of 1871 identifies
two - one in 5 B.C. and a second in 4 B.C. Both are described in detail in Chapter 7 of David Hughes' book *The Star of Bethlehem: An Astronomer's Confirmation*.

The comet of 5 B.C. (number 52 in William's Catalog) was first seen between March 10 and April 27, and was visible for 70 or more days. It was a "hui" comet, also called a "sweeping star" or "broom star", and had a tail or rays. It was seen in Capricornus and there is no mention of motion. It may have been a nova, but the description best fits a comet.

In 4 B.C. a "po" or tailless comet was noted on April 24 in Aquila. There is no way of knowing whether it was a comet or a nova. Incidentally, older references state that Halley's Comet was seen in 11 B.C., but modern calculations identify it with one seen for 56 days from August to October of 12 B.C.

10. Christ was born in the spring because that is the only time of the year when shepherds are out in the fields watching their sheep. At first sight this might seem a useful clue for limiting the time of year when Christ was born, but it is probably of no real value. Shepherds are in the fields with their sheep during most of the year except the rainy winter months, when nighttime temperatures average in the 40s and snow is not uncommon. Even so, there is no guarantee that the shepherds were not out in the inclement weather if there was reason for it. And some sheep, the "wilderness flocks", remained out all year long, while sheep used in temple sacrifices were watched over all the time.

In short, the shepherds give us no reliable information about the time of the nativity.

11. Early Christians celebrated Christ's birth on December 25 because this is the date of the Roman Saturnalia, and the Christians hoped to go unnoticed while the Roman Pagans were occupied with their own rowdy celebrations. December 25 is an interesting date that has astronomical connections, but it is not the date of the Saturnalia.

The Saturnalia was originally a harvest festival roughly equivalent to the American Thanksgiving. It began with a public sacrifice at the temple of Saturn and was followed by feasting. Although originally a one-day festival celebrated on December 17 and followed by two days of general holiday, it grew to eventually encompass seven days (Augustus limited it to three for the sake of business, but it grew back to five). It was a popular holiday when gifts were exchanged, schools were closed, and slaves were given special considerations. At no time, however, did the holiday extend to include the 25th.

December 25 became a major holiday in the Roman world in 275 A.D. when emperor Aurelian proclaimed the date as *Dies Natalis Invictus* or *Dies Natalis Solis Invicti* - the Birthday of the Unconquerable Sun - and with the followers of Mithra dedicated a temple to the sun in Rome's Campus Martius. Christmas originated at a time when the sun cult was particularly strong in Rome, and traces many of its customs to sun worship.

The earliest Christians had no reason to keep a low profile on the 25th, because it was not until Aurelian that meaningful celebrations took place on that date. When Christmas began to be celebrated in the 4th century, Christianity was legal and there was no reason to hide. Avoiding the Saturnalia would have been comparable to a modern religious sect avoiding Thanksgiving. When Christianity finally became the dominant religion in the empire, older pagan
holidays and ancient customs were given new meanings. An obvious example is Easter, which is celebrated with rabbits and eggs - springtime symbols of fertility. Early church fathers found it impossible to stamp out popular pagan practices and compromised by Christianizing them. Mexico provides interesting examples of how the native Indian festivals acquired a thin veneer of Catholicism. Christmas is celebrated at the time it is, to give Christian meaning to previously existing pagan celebrations.

The exact date is important astronomically. December 25 is the date of the winter solstice in the Julian Calendar. (January 6th is the date of the solstice in the Egyptian Calendar, still a day of celebration in many countries.) The Julian Calendar lost one day in 128 years, and Christmas had slipped to December 22nd by the time of the Council of Nicaea in 325 A.D. By 1582 it had slipped to December 12th. When Pope Gregory reformed the calendar he restored the date of the solstice to the time of the Council of Nicaea, the first great Christian gathering, rather than to the time of the birth of Christ or to the time of the founding of the Julian Calendar. That is why the holiday remains on the 25th - the day of the sun’s rebirth as proclaimed by Aurelian - although the solstice now falls on the 22nd.

In our new annual Christmas show at the Griffith Observatory, we like to explore the astronomical and pre-Christian origins of many modern Christmas customs.

SELECTED REFERENCES


### JUPITER-SATURN TRIPLE CONJUNCTIONS (IN LONGITUDE)
601 B.C. TO 3000 A.D.

<table>
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<th>Year of Triple Conjunction</th>
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Selecting a Creative Automation System

by Garry Musgrave, Commercial Electronics Ltd., 1335 Burrard St., Vancouver B.C. V6Z 1Z7

ABSTRACT: A conceptual design for a Special Effects Automation System is discussed. The chief design parameter being that of a single integrated system that is human-engineered to the point that creativity is not sacrificed to system compromises.

Topics include turning Ideas into Reality in the simplest, most direct way: synchronization of effects to the audio program; and editing.

Creativity is vital to the production of high quality planetarium shows. With the growing demand for sophistication from the public, these shows are becoming more and more complex. While it has become a necessity to incorporate elaborate automation into the planetarium, it is not necessary that this powerful tool, that is supposed to help you create shows, becomes so unwieldy that it hampers your creativity! These problems can be easily avoided by intelligently selecting a system that was designed to do the job effectively, with little or no compromises. It is important, when analyzing automation, to consider the fact that once you have a working show, almost any kind of system will play it back - the difficulty lies in actually creating the show. Let us look at the question of automation and how a system can be designed to be a truly usable tool, and not a millstone around your neck. This insight into the design parameters of a viable system will aid you enormously in selecting a system you can truly live with.

THE MANDATE. Today's planetaria are required to be much more than an interface between interested members of the general public and the astronomical community. Shrinking operating budgets, government cutbacks, and a receding economy dictate that you must become increasingly self-sufficient. This is not all bad! It can serve as the impetus to thrust us all into a Golden Age of planetarium shows - shows designed and produced to draw large segments of the public into the theatre.

In order to successfully compete with films of the calibre of Star Wars, for the public's attention, a planetarium show of the '80's must be a creative tour-de-force.

The star of any planetarium show is, of course, the star projector. With due respect, however, these fine instruments do not themselves a show make. Multi-channel sound, slide projectors, zoom and mirror systems, overhead projectors, motorized effects, film projectors, lighting, and special effects projectors must be added to produce the additional "pizzazz" expected by a modern audience. The problems of controlling these devices rise exponentially with the complexity of the effects desired. An automation system, therefore, moves from the luxury class to a necessity.

To survive in today's "market", then, a planetarium must possess a flexible and sophisticated automation system for both effects and sound. Unfortunately, the problems associated with the automation of a planetarium are unlike those encountered in any other aspect of either the theatre or audio/visual industries. The compromises inherent in trying to fit an automation system, designed for either one of these purposes, into the planetarium environment, tends to result in a system that hampers the creative abilities of both you and your staff. Consider the
Volkswagen Rabbit Diesel, a superbly engineered mode of transport, and the problems you would encounter if you decided to use it as a school bus! Let us take a look at the design considerations of a creative system.

THE CONSIDERATIONS. The secret of producing a creative multi-media planetarium show lies in selecting an automation system that is designed specifically for this application, and that will grow with you as your needs change. There are several key factors that must be considered when evaluating a system:

- Synchronization between the effects and the program source

- Ease of editing a show

- Overall simplicity of operation: the system should not "get in the way"

Let us discuss these considerations in turn.

The synchronization between the effects and the program source is one of the most vital, yet most overlooked, aspects of an automation system! The average member of the public has become very conscious of sound and very sophisticated when it comes to sound reproduction (it is for this reason that movie theatres have gone to six-channel DOLBY sound and both AM radio and television are about to go stereo). With this societal emphasis on sound, it is only natural that there must be an interplay between the sound and the visuals in any truly effective planetarium presentation. In order to successfully pull this off, precise synchronization must be maintained - just as between a motion picture and its sound track.

Another, less obvious, requirement for synchronization manifests itself during the editing of a show. In an ideal world you should be able to program an entire show in the comfort of your office for later playback in the theatre - in reality this just doesn’t work! In order to produce a truly creative show you need the biofeedback associated with viewing certain effects as they are being programmed. In addition, since you are a human being, you will probably have to go over the same effect several times in order to get it “just right”. Imagine the inconvenience of resetting all of the devices to their starting positions and levels every time you wish to go over a portion of the program! You would probably be amazed at the number of automation systems that require you to do just that - an inconvenience that cannot be fully appreciated until you have tried to program a show on one of these systems! It is vital that you should be able to move the audio tape to any point, and have all of the devices controlled by the system move to their appropriate levels and positions automatically.

This brings us, quite naturally, to a discussion on editing. The single most important contributing factor to a dynamic and exciting presentation is flexibility of editing - editing power cannot and must not be compromised! It would really make life simple if a planetarium show could be mathematically divided into definable components that could be mapped on paper, input once into the system, and flawlessly executed. While it is, of course, possible to do just this, the result is generally a very mechanical-looking show. A truly creative show is the result of an attempt to translate the subtleties and flow of human thought and emotion into an audio/visual experience. To accomplish this requires the biofeedback mentioned earlier, coupled with the ability to adjust and polish a particular effect until it “feels” right - this
requires a system with incredibly powerful and flexible editing features. The end result is the difference between Shakespeare and computer-generated “poetry”.

The last point, that of ease of operation, should be obvious. Yet an amazing number of systems are sold each year that look great on paper, sound good when the salesman gives his pitch, and turn out to be so clumsy to operate that you, the hapless purchaser, wind up configuring your shows around the limitations of the machine! The key to producing a creative planetarium show is having automation equipment that is so well interfaced to the human operator, that using it becomes second nature - freeing up your concentration for creating.

THE DESIGN. Using the criteria that we have just established, let us design an “ideal” system that will truly free your creative abilities for the task at hand - creating drawing-card shows that will have them lining up to get in!

After you have committed your narration and sound effects to audio tape, you are ready to begin programming the visual effects. Your first consideration is synchronization of these effects to your program tape. There are only two ways to guarantee perfect sync : absolute time-code can be recorded on to the tape and referenced to the automation system (which must store its “commands” relative to time) : or record the “commands” directly on to the audio tape itself - this last approach, obviously, assures perfect synchronization. Systems that rely on recorded pulses to advance “cues” in the programmer should be avoided due to the nightmarish problems which may be encountered when you want to move or add cues.

Next, in order to save yourself immense frustration, you must provide a method whereby you may advance the program tape to any point and all of the devices will move to the levels and positions appropriate to this point.

Your system must also be capable of controlling all of the different types of devices you may conceivably ever use. Here are a few examples to illustrate the tremendous range of flexibility required :

Moving sound sources in the audio system : slide projectors (lamp, tray movement, fan, shutter, bulb status, etc.) : film projectors (from 16mm to IMAX) : contact closures for simple “on/off” or “start/stop” devices : lamps (from grain of wheat bulbs to lighting scoops for dome illumination) : X-Y mirror systems : special effects projectors (as you know, these can be almost anything!) : zoom lenses : motorized effects : puppets : elevator controlled skylines : etc.

Even if you don’t use all of these types of devices now, your system must be capable of controlling them if you want to be able to compete in the ’80’s. Let’s face it, your present requirements are undoubtedly very different from those you had five and ten years ago (if they aren’t, kindly stop reading this article and reinsert your head in the sand).

Next, you should consider the input into the system. The two most popular methods to date are a control console and a keyboard. Both work extremely well - however, for subtle effects (such as a variable fade that flows with the music, or a blending of several coloured lights to form a wash of a particular hue, etc.) a console wins hands down. Our marvellous computer
In order to create a friendly system that doesn’t “get in the way” of your creativity, the input end should accommodate all of the peculiarities of the different devices you will have to control. In other words: a slide projector will have a very different set of operating parameters and controls from a zoom lens or your sound system. You want to avoid, therefore, a system that will handle projectors very well, but requires interfaces and/or compromises to position a zoom or move sound - you particularly want to avoid a system that requires you to fool it into “thinking” that all of the devices under its control are projectors (or lamps), but they’re really not (only your technician knows for sure!).

It is always good design practice to ensure that you are developing a totally integrated system (this avoids interface problems and future expansion problems). To this end it is strongly recommended that your main automation system is specifically designed to work with any sub-systems that must work in tandem with the main system. This avoids the hodge-podge system syndrome where each part is a system unto itself, and not designed to work with any of the other parts.

The next consideration is operator feedback of the system status. Because of the nature of the planetarium theatre, it is important that your control system provide you, at a glance, with quite a lot of status information both during the programming of the show and, very importantly, during the playback of the show. It certainly must give you alarm indications, such as bulb status or control module power status, to enable a swift location and repair of a problem, sometimes before it is even noticed by the audience! For your slide projectors the system should also be capable of telling you the absolute slide position: whether or not the fan is on: whether the shutter is open or closed: and a “homing” indicator.

Let us recap our system thus far:

We have a console with different sections configured for the different kinds of devices we are controlling - thus we have human-sensitive input coupled with an ergonomically structured inputting system. Also on this console are status indicators allowing us to very efficiently monitor all of the devices, and their controllers, from the console. We are in perfect time-sync with our program tape to such a degree that we can move the tape to any random point and have all of the devices move to the levels and positions that are appropriate to this point.

Great - we’re halfway there!

EDITING. We have now created a system that will facilitate the recording of our show commands, but we still must provide an editing system. Editing is vital for two reasons: unless you
are an octopus with a ten-level mind, you cannot record the commands associated with all of your devices in one pass: since you are a human being, and hopefully are a little fussy about what you do, you will want to correct and/or polish parts of the show.

Don't fool yourself - editing is an absolute necessity! Every article or book you read, every movie or television show you watch, every recording you listen to, have all been extensively edited to transform them from the first crude draft into the finished artistic triumph. Your planetarium shows (if they are to be better than mediocre) are no exception. If, however, powerful editing facilities are not available to you, then it will be with a futile and gargantuan effort that you will attempt to raise yourself above the unspectacular.

Let's think about how editing is accomplished for a moment. Generally, the need to edit a particular effect first becomes apparent upon playing back the first “draft” of the show - you notice that "it just doesn't look right", or "it's too early/late", etc. Wouldn't it be convenient to simply wind the tape back to just before the offending effect and fix it: and, in fact, to be able to do this as many times as is necessary to get it just right? Obviously the answer must be a resounding "Yes!" - this then is how our system should operate (most systems, incidentally, don't allow you to patch things up quite so easily!)

Perhaps, on reflection, you decide that an additional effect (possibly involving some new devices that have not yet been used) should be inserted - this is perfectly reasonable. Your system, then, should allow you to do this without shifting or altering any of the other previously recorded effects.

This is where the downfall of cue-based systems becomes apparent. A cue-based system records the commands in the form of a list of sequential clues. Each cue controls one, or a number, of devices at an appropriate point in time. Problems may start to develop when you decide that you want to change the start or stop point of one or more of the devices controlled by the cue without affecting the remaining devices in the cue or the rest of the show. A vastly superior system is one that gives the audio/visual equivalent of a multi-track sound recording. In other words, each device is recorded on its own totally separate “channel” in such a way that any changes made to any device do not affect in any way any of the other devices. This very powerful feature assures you of compromise-free editing - you are able to add/subtract/change any and all devices with ease, with no effect whatsoever on the other devices in the show. It also permits you the luxury of building the show in layers, thereby providing the means by which near-perfect productions can be produced with as little effort as possible. An example would be the construction of an automobile: normally you would make an engine, a transmission, a differential, wheels, a body, etc., and assemble them into a complete unit. You would not build the front 6" of the car, then add the next 10", then the next 24", then the next 3", etc.

In order to further facilitate the type of editing that makes life easy, rather than a nightmare, it should be as simple as possible to quickly see the results of any edit, and easily and accurately edit the edit if it still isn't right. There is no excuse for editing to be so cumbersome that you find yourself putting up with "small imperfections" in your show because they are too much trouble to fix. The real danger here is that, due to human nature (i.e. always take the easiest route), the "small imperfections" that are "tolerable”, gradually become bigger as time
goes on. You then find yourself, a year later, turning out sloppy shows, and probably not being aware of it!

A REAL-WORLD SOLUTION. All of this is great ... but!

There are all sorts of A/V computers available for controlling banks of slide projectors, and, after all, a real computer looks impressive in the theatre (besides, maybe it will do your books for you!) but these don’t meet this kind of criteria. There are theatre lighting consoles with CRT’s, and nifty-looking wheels and things, but these aren’t up to snuff either.

The problem here, of course, is that none of these devices were designed for this quite unique application. “Why?” you ask. “Doesn’t someone, somewhere, make a system that is designed specifically for a planetarium, and that will meet all of these perfectly reasonable expectations?”

Someone does.

The Omni Q system has been around now for over twelve years. It has the distinction of being the oldest system with the most fully operational installations in the business. If it was still the same system as twelve years ago (or even two years ago) it would simply be an entry in the Planetarium Hall of Fame - a conversation piece. Fortunately it has not stagnated. The past two and a half years have seen a flurry of design activity. Whole new concepts have evolved. Good old concepts have been polished. The ubiquitous micro-processor has crept into various parts of the system. Now that the dust has settled in Omni Q’s R & D department, an all-new Omni Q Special Effects automation system and a world-class Omniphonic Sound system await your inspection. Compare. Apply all of the foregoing criteria to both the Omni Q and any other system - the choice is clear.
Choosing a Planetarium Automation System

by Jim O'Leary, Maryland Academy of Sciences, Baltimore, Maryland 21230

In the fall of 1981 we installed an AVL Eagle to control the functions of the Davis Planetarium theatre. The Eagle is an audio-visual control unit which runs carousels, including panoramas and other dissolve frames, special effects, star projector functions and theatre house lights. It was installed by Sky Skan, Inc. of Rochester, New York, with the help of our staff.

We have been very pleased with its performance. I would like to tell you about our selection process: the criteria we used in making our decision, the control systems surveyed in the process and why we chose what we did.

Some of you may remember our past history. Several of our staff presented papers at the 1977 PAC Conference in Vancouver about our then-new facility. We were several months short of opening with our new automation system when we spoke, and we expressed hope that our choice would not turn out to be a lemon. Unfortunately, it did. The system was removed and replaced by a modest manual control system while we took the manufacturer to court and began a search for a replacement. We were awarded damages from the insurance company and the manufacturer. While we recovered almost half the cost of the automation from insurance, the manufacturer, Gyrosystems, Inc., of Farmingdale, New York, was never again to be found. They have since gone out of business.

There were some basic requirements any automation system would have to meet to be considered. We were looking for a reliable system to run the theatre. While this seems obvious, our previous experience with Gyrosystems had burned us badly, and we were proceeding cautiously. We had lost much revenue while installation and trouble-shooting droned on for over five months with our first system. That kind of performance could not be tolerated. Secondly, ease of maintenance was important. Any system would have to require little or no sophisticated maintenance from our limited staff. Dealer servicing was uppermost in our minds.

Ease of programming was also important. The system must provide a programmer with manageable software, making the programming of complex visual sequences easy and rewarding. With potential shows containing hundreds of slides, we placed great emphasis on the "human engineering" of the system software and hardware. This was very important to us. Any system requiring long keyboard entries or using cumbersome programming language was seen as a definite disadvantage.

Fourth, we hoped to include all our projection systems in any new control system. This is the only point which we were not able to satisfy because of cost. We hope to be able to add those projectors not presently included, sometime in the not-too-distant future.

Finally, the control equipment should be able to fulfil our needs well into the foreseeable future. Updates in the system software should allow us, for a small cost, to advance our system as the manufacturer introduced new features.
We could, of course, have proceeded in one of two general directions. A custom system, designed to meet our exact specifications, was one option. Several reputable companies expressed interest in designing such a system, including Giddings and Lewis, an industrial control manufacturer from Wisconsin, and Martin Marietta, the aerospace firm. We were cautious about another custom system for several reasons: the high development cost; the lack of experience and refinements from previous users; the fear that being one of a kind would rule out spare part availability; and the long delay of design and construction. Our other option seemed more appealing: go with one of the “off the shelf” control systems that were currently available. While this might necessitate some concessions on our part, it seemed the safest path to take.

We investigated a total of eight systems. They included several theatre lighting systems. The ILS, manufactured by Electro Controls, was seen at the Calgary Centennial Planetarium. The Strand Century Light Palette was investigated at the John F. Kennedy Center for the Performing Arts in Washington, D.C., and at a local community college. Kliegel manufactured a theatre lighting system which we also considered. R.A. Gray and Associates demonstrated the MC-10 control system in San Diego at the Fleet Space Theater.

Back home at the Maryland Science Center, we investigated several audio-visual control units, including those of Spindler and Sauppe, Arion, Clear Light and, of course, AVL. Of these eight systems only four received serious consideration. These were the MC-10 from Richard Gray, the Strand Century Light Palette, Electro Control’s ILS and the AVL Eagle.

For evaluation we devised a number of criteria we thought important for our application. These criteria ranged from the quality of the software and ease of programming to the availability of battery back-up in case of power failure.

A report was issued in the spring of 1980 reflecting the status of each system at the time. We were comparing systems that, in some cases, were designed for very different purposes. So some comparisons were a little difficult to make.

Individual criteria were weighted in importance as we saw them. Each control system was then given a score as to how well we thought it satisfied each category. From this method we hoped to achieve an unbiased ranking of which system served our purposes best. The accompanying list (fig. 1) shows some of the criteria we chose to score the systems on, along with the rankings of the four main control systems in question. As you can see, some of the important items we considered were software design and updates, service and repair record, ability to interface special effects, animation capability, 16mm control and so forth.

The AVL Eagle was the clear winner in our automation sweepstakes. Its ability to easily control carousels (with a minimum of keyboard entries), the interest of the company in the needs of the planetarium field, the excellent service record and the large number already in use placed the Eagle far above the other contenders, in our opinion.

The only remaining stumbling block was money. In the spring of 1981, a local foundation granted the Science Center $67,000 for the purchase and installation of the AVL Eagle. This
Figure 1. Evaluation criteria for the four contending control systems.

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<td>Overall image control</td>
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amount would allow us to complete the first phase of our theatre automation. All functions being controlled manually at the time were automated. This included panoramas, special effects, all important star projector lamps, house lights, and all skys. All Skys are our wide angle projectors splitting the dome into six pie-shaped wedges. They are dissolvable, making for a total of 12 projectors. Future funding would allow us to finish automating the theatre. Originally, our entire dome was covered by a grid of 25 carousel frames, including the panoramas. Some version of this carousel system will be reinstalled and automated at a later date, if funding becomes available.

Assigning projectors to particular Eagle channels was a constant juggling act, trying to attain the best possible programming arrangement. The Eagle allows control of 30 projectors in two grids of 15 each (fig. 2). Our panoramas (12 dissolvable frames) take up a good portion of this matrix, one chain assigned to channels 6, 7, 8 and 9 A, B and C. While this panorama arrangement may look a little awkward at first, the assignments become second nature after a short while.

Figure 2. The Eagle video screen shows the 30 projectors controlled in two 15 projector groups. The projector tray position is displayed as the number in the matrix. For example, projectors 3A and 3B are on slide number 4. 3C and 4C are on slide 3. Projectors 6, 7, 8, 9 and 0 A, B and C are on the zero position.
As you can see, the panorama projectors almost completely fill the available space. To make room for other circuits, we added an AVL CX-120, an expander unit that quadruples the number of projectors that can be controlled. This gives us 120 channels (fig. 3). These other banks gave us room for special effects, all sky carousels, house lights, star projector lamps, a zoom projector and the instrument elevator.

With this format we use most of two of the available four banks. For automating additional projectors we need only buy the peripheral control units. The control channels on the Eagle already exist.

Only one of these banks' status is displayed on the Eagle's screen at a given time. An operator can see whether the lamp is on or off and the tray position of each projector. In addition to the current cue, the previous five cues and the next five cues are displayed, as well as the projectors addressed at each of those cues.

The beauty of the Eagle is its ability to move freely among the cues. The programmer can go from cue one to cue 2,000 in a few seconds. All the projectors immediately follow. The program can be opened up to insert a cue or another whole program from the library. Individual cues or groups of cues can be easily deleted. The AVL software is very forgiving of programming errors and changes. Within seconds, fade rates, projector assignments and show status can be altered. When slides or timings change at the last minute, as they always will, the Eagle is very quick to respond. Without this feature, much valuable programming time would be lost.

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Since last fall, we have programmed three planetarium shows on the Eagle. *Star of Bethlehem* was the first, containing about 100 slides and 450 cues in 20 minutes. After Christmas, *Winter Starwatch* opened with about 175 slides and 600 cues in a 30-minute show. The first real programming test came in April with *Worlds of Wonder*, a 35-minute planet show with about 700 slides, 40 special effects and over 1800 cues.

The Eagle performed splendidly. As sequences and slide locations changed during production, the programming was also changed quickly. The programming case put new life into what would have been rather static sequences. For example, a constant lightning display on Venus used one panorama, five special effects and 91 lightning slides in 35 seconds. The Eagle provided smooth slow fades for environmental scenes and fast-paced crossfades for the newest planetary pictures.

In summary, the AVL Eagle has performed up to our expectations. After becoming familiar with the projector layout and working with it for a short time, addressing special effects and carousels is very easy. And, to repeat, the system is very forgiving. New cues can be added or changed very easily and old cues or sections of the program can be quickly deleted.

We hope to be able to add more carousel projectors in the near future to further enhance the visual appeal of our planetarium shows. We certainly recommend the AVL Eagle if you are looking toward automation.
The Film Loop Rack: An Alternative to Film Loop Boxes

by Warren Ostrom, H. R. MacMillan Planetarium, Vancouver, B.C.

Film loop boxes, as commonly used in planetariums, have many drawbacks. Among these are: scratching, static, tension troubles (with long film lengths) and the necessity of having to order prints on Estar base stocks (not all print stocks are available on Estar base). Mechanical stresses in film loop boxes will devour any other film base, but the very strength of Estar base stocks can pose its own problems. Estar base prints are so difficult to break that they have been known to wrap around the sprocketed and idler rollers on projectors, causing damage to both roller and shaft.

At the H. R. MacMillan Planetarium, we have been moving in the direction of more film effects, so to minimize our film loop problems, we have borrowed technology from the film laboratory business.

When the film lab has to make a large number of prints, the original is put on a loop rack that is designed to eliminate any tension and scratch problems. Being a closed loop, the original can be printed many times. In the planetarium, a film loop rack allows a print to be projected many times with little difficulty, thus avoiding the drawbacks of the box system.

Loop racks consist of three main parts: an upper and lower bank of film rollers and a frame which must be adjustable yet hold both banks of rollers rigidly in place. For the rollers, we use processing machine rollers that can be fitted with ball bearings or bushings. These can probably be obtained from a local motion picture film lab. The rollers are mounted on metal rods. We would recommend that one-half-inch steel rod be used, because it has a finer diameter tolerance than aluminum. Nylon bushing stock is used to make the end fittings for the rod. Both top and bottom banks of rollers can be moved up or down in the nylon fittings attached to the projector stand. 6/32 machine screws are used to lock the various components in position. The tension of each strand of film can be individually adjusted with this type of system.

The system described is a refinement of the loop racks used at the H. R. MacMillan Planetarium for several years now. The old loop racks (whose rollers turned on bare steel rods without bearings or bushings) have given steady, reliable service by and large. We have had some film loops running for as long as one year without trouble. An occasional cleaning in situ with a “velvet” (a piece of soft, lint-free cloth) was all that was necessary. We expect the new systems to be even more trouble-free.
**Digistar: A New Planetarium Technology**

by Brent Watson and Jeri Panek, Evans and Sutherland Computer Corporation, Salt Lake City, Utah

At Evans and Sutherland Computer Corporation, work has been progressing on an entirely new way of projecting the stars and planets on to the dome of a planetarium to offer a unique voyage through space and time.

This new technology uses an extremely bright five-inch diameter cathode ray tube (CRT) to display an image received from a computer image generator. This image is then relayed to the surface of a dome, using a custom-designed wide-angle projection lens. Although not immediately obvious to the casual observer, this approach allows considerable flexibility that has not previously been available.

`DIGISTAR's computing hardware consists of a Digital Equipment Corporation PDP11/34A computer with 256K bytes of memory, Floating Point Accelerator and Cache memory. Bulk data storage is on two removable 5M byte hard discs and two 8" floppy discs. The graphics processor is an Evans and Sutherland Picture System 11 with 256K words of memory and a writeable control store. There is also a full complement of pushbuttons, dials, and joysticks that have been integrated into an operator's console. A 72" tall smoked-lucite pyramid houses the projector. This pyramid measures three feet square at the base, and weighs less than 500 lbs. When the pyramid opens for a show, it is 42" tall and is always positioned below the springline of the dome, thus making every seat "the best seat" in a star chamber.

The date for projection is compiled from the *Yale Catalog of Bright Stars*, Fourth Revised Edition. All stars to magnitude 6.25 are converted from the standard Right Ascension, Declination, and parallax to a cartesian co-ordinate position (X,Y,Z). Also included in the data base is the luminosity of each star, its colour index, and proper motion and radial velocity parameters.

The stars are placed within a sphere with a radius of 200 parsecs (652 light years) with the Sun at the centre. More distant visible stars are placed at 200 parsecs and their luminosities are then adjusted to provide proper visual magnitude.

Using the facilities of the PDP11/34 host computer, any catalog information can be recalled immediately. This information includes positional data, magnitudes, spectral type, multiple star information, Flamsteed and Bayer designations, and proper names. This information can be displayed on the dome, the operators' screen, or both.

A series of lines can be used to draw constellation outlines from star to star to show any of the 88 standard constellations. These lines actually connect the stars in three-dimensions. This allows the user to see a true representation of the constellations from any viewpoint. The viewer may also define his own constellations for the purpose of showing, for example, Indian or Christian constellations.
Since the stars are represented numerically in a high speed computer graphics processor, the point of view of the observer can be changed at will. This means that it is now possible to leave the Earth and travel to any point within the defined data base. For example, by travelling to the star Alpha Centauri, we can turn and see our own Sun shining brightly in the constellation of Cassiopeia. If we had been watching Sirius as we travelled, we would have seen it move up near Betelgeuse to form a brilliant optical binary in Orion.

By travelling out farther from the earth, we can see the relative population of bright and dim stars. The more distant we are from the Sun, the fewer stars we see. This is because only the highly luminous stars can be seen from a distance, and they are by far in the minority.

As we travel back to earth we can watch the constellation outline of, say, Ursa Major as it unfolds back to its familiar shape, once again giving us an idea of the three-dimensionality of the stars of which it is comprised.

We can take advantage of the fact that we are no longer “fixed” in the data base but rather can move by travelling through time. Each star in the sky is really travelling at hundreds of kilometers per hour. Over a lifetime we see very little change, however, because of the great distances between stars. Using DIGISTAR we can allow time to pass by more quickly and see this proper motion and radial velocity actually happen. We can travel up to one million years into the past or future and see the position of the stars. A trail can be drawn behind each star to show its path through space.

Another type of time travel shows the positions of the planets against the background of stars. In this simulation, Kepler’s laws must be obeyed very carefully to show all of DIGISTAR’s fifty-five catalogued solar system objects in their proper location in the sky. This is done in real time, using a method that yields accuracies of one minute of arc in 300 years.

Once again, it is not required that we stay at the same location in the solar system. An interesting exercise is to travel one hundred astronomical units northward from the plane of the ecliptic and then look down on our solar system. We can specify our point of reference to be the Earth and see the epicyclical paths of the planets in the Ptolemaic model of the Universe. It is just as easy to have any other planet for a point of reference. It is possible, for example, to travel to Neptune and watch Nereid and Triton as they revolve about their planet.

A major advantage of DIGISTAR is that it is really a high performance graphics projection system and is not limited to just projecting the stars. The user could just as easily have a series of simulations for different areas available to him. For example, resonances in molecules can be explored by letting the host computer calculate the molecules’ vibrations and the display processor display this information. Any picture composed of lines, dots, or alphanumerics can be projected on to the planetarium dome. Entire shows can be recorded and shared between planetariums, simply by sending an 8” floppy disc through the mail.

A variety of special effects can be displayed, either instead of the starfield or superimposed on it. Starfields and tactical displays on the bridge of the starship Enterprise in the movie Star
*Star Trek: The Wrath of Khan* were photographed using DIGISTAR. The Milky Way, Magellanic Clouds, surface features of the earth and moon, eclipses w/corona, and meteor showers are just a few of the features included with the system. Additional capabilities can be simply added by re-programming the computer. DIGISTAR offers flexibility and expandability not found in mechanical systems.

DIGISTAR can take an audience on a thrilling three-dimensional voyage through time and space where the stars are just the beginning - a journey limited only by the imagination.
Most planetariums give a *Star of Bethlehem* show at the end of each year. Indeed, for a small planetarium the attendance at this show can exceed that of all other shows given during the year. Seasonal shows directed to specific groups in the community are one way of meeting the task of making your planetarium a recognized part of the community. It is certainly to be encouraged, even if the planetarian does not share the group’s opinions and beliefs himself.

A planetarium can be a unique setting for the transmission of information to members of a group from their recognized leaders. By creating an atmosphere and a state of mind under the darkened dome, the planetarium can be an unequalled medium for transmitting cultural and historical information. I am speaking of the information which defines, identifies, and propagates the group, its history and values. A book of such information is often unread, a lecture is often unlistened to. But beneath the dark dome with the stars brilliant above, an audience’s attention can be awakened and gently directed to the information it is of cardinal importance to transmit.

On December 21, 22 and 23, we gave a show, *The Festival of Lights* at the Buckstaff Planetarium. The show was prepared by myself (I teach astronomy at the University of Wisconsin-Oshkosh, which owns the planetarium), a student of mine, Rob Nixon, and by Rabbi Steve Mason of the Temple B’Nai Israel in Oshkosh. To avoid misunderstanding, let me say that I have also successfully given *Star of Bethlehem* shows. When I gave these shows, I was neither a Jew nor a Christian, just a physicist past forty, respectful of others’ beliefs. The show’s purpose was to convey some information on the historical background and significance of the minor Jewish festival of Hannukah. It was directed to the Jewish members of the community, though all were welcome and the show was advertised in the media.

I had long wanted to do a Hannukah show. At the biennial meetings in Washington, D.C., and in Chicago, I talked with many other planetarians. Everyone was interested in the possibility of such a show, though no-one knew of anyone who had done one. I think the major reason for this is that no-one had worked out the concept of what such a show should consist of. If one gives a *Star of Bethlehem* show, one should really give a *Hannukah* show. It establishes the planetarium’s neutral position on religious questions.

But how on earth does one give a *Hannukah* show? Exactly what would make the planetarium setting appropriate? How would the community respond? How would the Jewish members of the community respond?

First, some information. Hannukah is not a Jewish version of Christmas. It is entirely unlike it. Christmas is a major occasion to the Christian, Hannukah is a minor festival for the Jew. It is for children: it is the festival of lights. What more appropriate setting can there be for a festival of lights than the darkened theatre of a planetarium, with the stars twinkling above?
Hannukah commemorates a historical event, the time when four centuries of foreign rule were brought to an end by a successful rebellion and a Jewish monarchy was established in Israel. In the second century B.C., Jewish kings ruled for the next century and a half. The rebellion was sparked by a religious outrage. The Syrian-Greek king, Epiphanes, violated the sanctity of the Temple in Jerusalem. He ordered a statue of Zeus to be placed in the Temple and pigs to be sacrificed in its precincts. The face of Zeus in the statue was modelled on Epiphanes' own. When the rebellion succeeded, Judah Maccabee, the leader and new king, caused the Temple to be purified. Candles were lit for eight days, to celebrate several eight-day religious festivals that Epiphanes had prevented from being celebrated. Jews today light eight candles to remind themselves of this event.

It is a joyful occasion. One candle is lit the first night, two the second, and all eight on the eighth day. In the candlelight, games are played by children in the candlelight, with a spinning die called a Dreidal, for raisins and nuts.

There are many more than eight stars in the planetarium dome. How can a planetarium suggest the eight lights of the Hannukah? With the sky set for the night of the show (Hannukah began December 21 in 1981) set the sun. Sunset is the start of the day in the Jewish Calendar. Just coming up over the horizon is our constellation of Orion. Two thousand years ago Jews called it Shemhazi. Point this out to the audience, raising Shemhazi to the meridian. You may want to set the latitude at 31°, the latitude of Jerusalem. Now point out to the audience the eight bright stars around Shemhazi, our Sirius, Procyon, Castor, Pollux, Capella, Aldebaran, Betelgeuse and Rigel. Here are eight lights in the sky for Hannukah.

There is not enough space in our journal for the full script of our show, but I would be pleased to send a copy to any of you who wish one. It is 25 pages in length, written double-spaced, with text on the left three-quarters of the page and slide notes on the right quarter. We used 100 slides. Your audio-visual department could easily duplicate them, as we took most of them from six readily available books. About 12 of the 100 slides were personally taken by the Rabbi in Jewish homes in the community. This was a much appreciated feature of the show, and I recommend it to any planetarian. Audiences dearly love to see pictures of themselves projected on the dome. It would possible to use our script without these slides. We did tape our show and used a half-dozen musical passages as background, and several songs in foreground roles. About half of the hour-long show concerned astronomy or star myths, and half was on the revolt and the significance of Hannukah. For this part of our script we used material prepared by the Institute of Creative Judaism.

How did the community respond? The community newspaper put large announcements and articles in several editions the week before the show. Newspapers from several surrounding towns contacted us to do interviews. The attendance was good. At one show there were two to three times the number of people that were seen at Sabbath services the preceding week. More than that, as many people who didn't come to the show, as did, mentioned to us how good a production they had heard it was and were anxious to know when our next show would be.

We are now preparing a Passover Show. I invite you to examine our Festival of Lights script and consider it as a possibility for your planetarium next December. There are a hundred people in Oshkosh who had never been in our planetarium before, who are now eagerly awaiting our next show.
I'm Your Narrator ... Give Me A Break! or Several Steps To Follow When Preparing Your Narrator's Script

by Mark and Carolyn Collins Petersen, Loch Ness Productions, P.O. Box 3023, Boulder, Colorado 80307

The purpose of any planetarium program is to convey information to your audience. To fulfill this purpose with a pre-recorded soundtrack, one should find a good narrator - one who can take a written script and read it on to tape, yet make it sound as if he is speaking to the audience rather than reading to them. (We'll use the male pronoun when referring to the narrator, but course a narrator may well be female.)

A properly prepared script will go a long way towards making your narrator feel at ease, both with you and your show, and this will be reflected in his improved delivery. Likewise, a poorly prepared script will be reflected in his delivery: if your narrator frequently stumbles over typos, unfamiliar words and abbreviations, and has to stop to make corrections in the copy, his efforts will sound as if he's just trying to get through it, rather than speaking it as it should be spoken. So your job is to provide him with "good copy" - this paper will provide some helpful pointers to help you make your scripts the proper narrator's tools that they should be.

The basic rules we will outline have evolved from our past experience with planetarium productions, as well as soundtracks for our recording studio clientele and our familiarity with the needs of professional announcers and narrators. In a professional setting, time is money, and the less time the narrator takes to read the script, the less it will ultimately cost - if not in actual dollars, then in time and frustration. If you follow some of our basic "housekeeping" rules about typing your script - cosmetic suggestions which contribute so much to a script's readability - they will work as well for you as they do for us.

1. Don't be stingy with paper, typewriter ribbon, and the photocopy machine. Use a good, heavy bond paper: not only does it look nice, but it's quieter than thin "ditto" paper when pages are turned or rubbed together. Don't use onion-skin or other flimsy stock: similarly, Thermofax R paper has a shiny surface which causes a glare under a narrator's light - don't make his job any more difficult. Thin pages will stick together, making them difficult to handle, and will probably result in the paper-rustling showing up on the tape. (For the ultimate in quiet page-turns, you might try attaching your script pages to pieces of lightweight cardboard.)

2. Break out a new typewriter ribbon, and clean out the O's and E's and any other letters that may be "filling in" when you type. Your copy will look fresh and clean, and your narrator will have an easier time reading copy with the highest possible contrast between black type and white paper. Replenish the toner supply in the photocopy machine too, and set it on the highest contrast setting.
2A. If you have a word processor or computer, you'll obviously want to use it for your scripting. Unfortunately, if you don't have a typewriter-quality printer or a pretty sophisticated word-processing program, you're probably not going to like what we have to say. Dot-matrix printers, those which print all-capital letters etc., should not be used when preparing your narrator's copy. The letters are not as easily recognizable as a typewriter, they don't always print black letters (gray doesn't count) and folding computer paper is not the easiest to handle. Many of the rules we list later on tend to be ignored by less-sophisticated word-processing software. So we advise you to use your computers up until the final reading copies: then mark up the last print-out and give it to your secretary to retype. Your narrator will appreciate it, but you'll probably have to take the secretary out to dinner.

3. Do a complete job of erasing typographical errors. Your narrator will have a difficult time trying to read a line coherently if he has to jump over xxx-outs: and may try to read words that have been partially erased. (Sometimes a mental set will cause him to continue to read a word you’ve told him to take out - don’t give him the chance.)

4. Type the script using a form like the one in the example. It's what we use - use it as a model for your own. Make up a blank “master script” page and print up all you need, and type directly on it. It has columns for time indications (either elapsed time from the beginning, or time between paragraphs or scenes - whatever you want), visual descriptions, narrator’s text, and most importantly: line numbers.

The line numbers are double-spaced, not only because it makes the copy easier to read, but the narrator can pencil in notes to himself - breaks, pauses, emphasis etc. - between the lines.

The primary reason for having line numbers, however, is that they can save a great deal of time and headaches when directing the narrator for re-takes and editing. For example, you can simply say: “Start again at line seven” instead of: “Why don't we go back a ways to the middle of that paragraph after the bit about Saturn's rings, and start where we talk about the clouds ... no, not where it says 'ammonia and methane' ... before that ... no, after the winds ... yeah, there!”

You'll be amazed at how much easier line numbers will make your narrating sessions.

It works out that, on our form, one page of text roughly equals about one finished minute of soundtrack. When you've finished typing your first draft, you can tell at a glance about how long the show is by counting page numbers.

The visuals column can be very useful to the narrator. Your description of an intended visual can give him an idea of the scene the audience will see, and help him to use the correct voice inflections to follow the mood. So, describe the visual in words, rather than putting in console directions such as: “Windy desert sand dune panorama” not “Pan 3, dimmer 2A”. (You can always make a console copy with operator’s instructions after the narration is done.)
While what you put in the narration column is important to you because it is *your* show, to the narrator it is only what he has to narrate. Do not put anything in the narration column other than what you want him to say, unless you've made it obvious that he is not to say it, by putting the words (a) in parentheses, and/or (b) in a different type style, e.g. italics, and/or (c) in a different color and/or colored highlighting pen.

It's frustrating for a narrator to run across a line (and say aloud) : "... and the distance to the Andromeda Galaxy is two point two million light years. Fade pan." Certainly it is important to indicate music and scene changes so that your narrator can catch the feel of the show. We place the music and scene changes in parentheses, and on a line by themselves, separated from the body of the text.

5. Never hyphenate a word over the end of a line, or split a sentence over two pages. Hyphenated words are not immediately recognizable, and your narrator may stumble, particularly if the word is unusual. For example: *The instrument that we will use is called a heli-* , followed by *ostat* at the beginning of the next line. When typing the copy, skip down to the next line if it appears that a word won't fit, rather than hyphenating it.

Similarly, if a paragraph ends a few lines before the bottom of the page, leave the rest of the page blank and start the new paragraph on the next page. The sentences in the paragraph won't sound "together" if you've stopped in the middle for a page-turn, since the narrator will probably begin the first sentence of a page with a different pitch than what he used finishing the sentence on the page before.

At worst, you'll also get the sound of the paper rustling with his narration as he turns the page. Besides, narration can be mentally taxing work, and every page that your narrator finishes correctly - with a minimum of errors - will heighten his (and your) feelings of accomplishment. It doesn't hurt to give him a short page every so often - paper is cheap, and you'll get a better reading as a result.

6. Do not type in abbreviations, especially in measurements and numbers : spell out the words as they really sound. Sorry, you can't be lazy : use *minus one hundred fifty degrees Celsius* not -150 deg. C. Use *ten kilometers per hour,* not 10 km/hr. Even long numbers should be spelled out (including the decimal point), with special attention given to commas and the word *and.* Use *The moon is two hundred thirty-eight thousand, eight hundred sixty-eight point oh one miles away,* not *The moon is 238,868.01 miles away,* or *The moon is 200 and 38 thousand, and eight hundred and 68.01 miles away.*

When spelling out numbers, it's easier to recognize the numbers between twenty-one and ninety-nine if they're hyphenated.

7. Work out a system for emphasizing words in your copy. If your typewriter can make italics, use them. If not, try our method : underline the word for some emphasis : capitalize the word for MORE EMPHASIS : underline and capitalize for the MOST emphasis.

8. When you want to indicate a pause, do not write "pause" : use a long dash (----) or an ellipsis (...). Tell your narrator how long a pause you want in each instance. It will also be helpful to
use an indented list form to indicate pauses between the items on the list, as in this example:

“The three bright stars in the Summer Triangle are:

Vega...

Deneb...

and Altair…”

It will be easier on your narrator’s eyes, at least, to use the above form, rather than:

“The three bright stars in the Summer Triangle are Vega, pause, Deneb, pause, and Altair. Pause.”

9. Unusual names and scientific terms present potential stumbling blocks to your narrator. Give him a break, and spell those words as they actually sound, rather than correctly. Do not try to impress your narrator with the correct Latin spelling for Chryse Planitia: he just wants to pronounce it correctly. If you can’t bring yourself to deliberately misspell a word, at least include a pronunciation (in parentheses and/or a different color and/or …) so that he can get it right. Here are some examples of misspelling for pronunciation: DEE-mos, RY’jel, Serious, PLEE-uh-deez, Air-us-STAR-cuss. Sometimes a superfluous hyphen can help clarify a compound word, such as: photo-polarimeter, infra-red, ultra-violet.

10. If there is dialogue in the script, use a colored highlighting pen to indicate the lines your narrator should not read. Leave his lines in white (for consistency and maximum black/white contrast). Prepare different copies for each narrator: don’t make them all read from the same copy, of course. This will eliminate the need to put in the character’s name before his lines, keeping the pages as clutter-free as possible. In case you haven’t discovered it yet, dialogue works best when all the characters are recorded at the same time, in the same room.

11. When you have finished typing and proofing the script following the above rules, bring in someone else (not the narrator) to read it back to you cold. Go ahead and set up a microphone as if you are actually recoding the session for real (in fact, you might as well record it, to evaluate afterwards). This will be a sort of trial run to help you iron out the rough spots in the script. Ask a student, your secretary, your assistant, your spouse - better yet, ask an English teacher, who will (hopefully) point out grammatical errors you may have inadvertently put in. (Be humble when you ask - tell them you can’t possibly be good at everything.) It might not hurt to read the script yourself into your tape recorder, before bringing in your trial narrator - it might save an embarrassing moment or two.

If your practice narrator stumbles during the reading, it may be something you have or haven’t done. Find out why - the chances are that your real narrator will do the same thing at the same point. It’s very likely that something will not sound right, even though there is nothing grammatically wrong: now is the time to fix and rewrite - not in the final recording session.
If your practice narrator is turning pages as he's reading, maybe you've split sentences over two pages: if he has trouble pronouncing words, maybe you haven't misspelled them correctly. But when he reads through the script with a minimum of mistakes, he'll feel good about having accomplished the feat with such relative ease (and both of you will think that you're a pretty good scriptwriter).

After the "trial run" and final corrections to the script are done, then - and only then - should you present your narrator with his copy, prior to the recording session, of course, so that he'll have time to practise it. (Your photocopy machine should have gotten a real workout by this time.) Be sure that the copy you give him is the FINAL version: nothing is more frustrating to a narrator than to arrive at the recording session all rehearsed and ready, only to find that wholesale changes have been made to the script. (On the other hand, don't be afraid to make changes during the final recording if something doesn't sound right to your ears: but by this time, that probably won't happen too often.)

The more copy your narrator can read without having to stop for mistakes, the smoother the reading will go, and the better his delivery will be. He'll probably make enough mistakes on his own: he should only have to worry about those retakes, not the ones caused by poor script preparation. Each time he has to stop for a retake will tend to worry him, if not actually tire him out from increasing frustration. He'll begin to pay attention to how he's reading, not what he's reading, and his delivery will suffer.

Since all that ultimately matters is what the audience will hear from the tape, every effort you can make to provide the narrator with a properly prepared script will make him feel more at ease. You'll get a better reading: your soundtrack will be easier to understand, and your show and your audiences will ultimately benefit.
**Show Title:** "LIGHT YEARS FROM ANDROMEDA" Version: NARRATOR'S COPY

<table>
<thead>
<tr>
<th>TIME</th>
<th>VISUAL</th>
<th>AUDIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00</td>
<td>Blue haze lights fade, stars come out</td>
<td>(opening music: 37 seconds)</td>
</tr>
<tr>
<td>0:37</td>
<td>Large rotating galaxy</td>
<td>A long time ago -- in a galaxy far.</td>
</tr>
<tr>
<td></td>
<td>Blazing light beam effect</td>
<td>far away ... a beam of light left</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a blazing blue star ... just one</td>
</tr>
<tr>
<td></td>
<td></td>
<td>of countless beams of light escaping every second, in every direction,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>into the black cold of space.</td>
</tr>
<tr>
<td>1:00</td>
<td></td>
<td>This beam of light--traveling in a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>particular direction from the star --</td>
</tr>
<tr>
<td></td>
<td></td>
<td>was joined by rays from surrounding stars, and together they hurried out</td>
</tr>
<tr>
<td></td>
<td>Light beams leave galaxy, Galaxy shrinks into distance</td>
<td>from the galaxy at a tremendous speed</td>
</tr>
<tr>
<td>1:21</td>
<td></td>
<td>(music bridge: 9 seconds)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(music segue: 15 seconds)</td>
</tr>
<tr>
<td>2:11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2:21</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- Centuries passed while the light sped on its journey outwards from its galactic home ... thousands of centuries ...
- Post Office Box 3023
- Boulder, Colorado 80307 (303-465-0811)
Phyllis B. Pitluga, Senior Astronomer/Program Supervisor, The Adler Planetarium

Planetarium visitors experience sky shows as holistic experiences. The left brain responds to the new discoveries, ideas and concepts. At the same time, the right brain is being stimulated by the beautiful vistas and gorgeous music. The words, too, can be poetic. Their timing can be written to have the most impact. The narration can be dramatic when read by a professional actor. When the blend of the audio and the visual is done with a flair, it both communicates and emotes in a way that makes the whole experience more than the sum of each part. Neither the left brain nor the right brain should be overpowered. As with stereo sound, the universe comes together in the head.

For years we Planetarians have knocked ourselves out with home-built, colourful, whirling, swirling, dazzling, orbiting, zooming, flickering, exploding images.

More recently taped shows have allowed perfection of the words, cross-fading of the music, and even synching of the visuals. Now we are knocking ourselves out to get the most out of the taped aspect of the show. These are the considerations I incorporate when creating the audio part of the show :

WRITING

- Style of writing is for the way we speak and hear words, not read them

- Sentences that conclude scenes

- Introductory words to introduce visuals

- Last words to allow effects to happen

- Words that evoke other senses, especially smell and feel (temperature, wind)

- Words that relate to what is being seen

RECORDINGS

- Choose voice that complements experience (not lecturer)

- Underline contrasting words and words that need emphasis

- Let narrator experience sky theatre first

- Writer should direct recording session
EDITING
- Time to add or subtract visual
- Time to enjoy a scene
- Time to comprehend an idea
- Time to match music

MUSIC
- Blended in under words
- Specific beginning of piece as introduction to scene
- Specific ending of piece as conclusion to scene
- Special effects sounds to enhance visuals
- Light ethereal music for tenuous images
- Rich full music for big, dramatic, dense visuals

CUES
- Match visual to come on and go off with correct words or music

EAR TEST
- Does the tape flow and have nothing technically jolting?

PREMIERE
- Is the show informative in a clear, exciting, and beautiful way?
The Planetarium and the Modern Myth

by David A. Rodger, Information Officer, Science Council of British Columbia, and Astronomy broadcaster and columnist, Vancouver, B.C.

ABSTRACT: In these troubled times, it seems that more and more people are turning to such practices as astrology and looking to various manifestations of extraterrestrial gods in their search for solutions. As well, there is a self-destructive streak in modern society that appears from time to time in the morbid fascination with Skylab returns, the Jupiter Effect, and possible collisions with asteroids and comets.

I will argue that the Planetarium has a vital role to play in counteracting these trends. That may seem obvious to some, but the record shows that not all planetariums take this role seriously. Some even encourage popular hysteria as a means of encouraging higher attendance and local notoriety.

I will look back over a number of the myths that have taken form in recent years, look at some examples of how planetariums have dealt with them, and offer some suggestions as to how planetariums can cope with the inevitable myth-forming events lying just ahead.

"Where did the notion of fairness appear from?"

Planetariums should not be in the business of falsely presenting the 'crackpot' views.
The Creation of a Mascot

by Sheldon Schafer, Science/Planetarium Director, Lakeview Museum, Peoria, Illinois

FOSTER-PARENTING A COSMIC CHICKEN. Planetariums today are struggling to survive in a media-drenched society filled with Star Wars superheroes, popularized astrology, and computer video games. Short of teaching all of our star projectors to play PAC-MAN or Space Invaders, new methods need to be found to increase the public concept of a Museum/Planetarium as an enlightened form of entertainment. At Lakeview, we have discovered that adopting a stray cosmic creature as a mascot can provide an effective bridge between the realities of science and the fantasy habits of the community.

Mascots do not come in kit form, easily assembled by one person alone; and despite what cosmic creatures tell you, they neither originate in swirling clouds of gas and dust in foreign galaxies, nor are they mysteriously formed when massive stars go supernova and spew forth large quantities of blue velvet and satin. Last fall, a peculiar chain of events, or rather, a patchwork piecing of related but separate parts resulted in the magical transformation of a bored housewife and astronomy student into an ethereal, exotic creature from another galaxy, and probably the only stand-up comedienne to play Peoria that was not born on Earth.

QUILTING YOUR CHICKEN. Hearing and sympathizing with a plaintive call for an extra-terrestrial sidekick was Director of Education and part-time genie at Lakeview, George Ann Danhower, who, with the speed of light (or at least the speed of light on a cloudy day), began researching and sketching a myriad of possible designs to give a physical reality to the proposed creature. Rejected almost immediately were those designs which assuredly would have driven small children to flee in terror from the Planetarium, which was not the desired effect. The final line drawing incorporated familiar humanoid features with celestial symbols in an original combination. Early character conceptualization called for the creature to be elegant, mysterious, and to emanate a silent and regal aura. (Silence has not proven to be anywhere within its repertoire - it hasn't stopped talking since January 1982.)

Following staff consensus on the sketch, a costume maker, Martie Ogborn, was yellow-paged into existence to stitch and piece together ten yards of blue velvet, five yards of blue satin, and an incredibly long and exciting zipper.

The alien's head was ordered from a catalogue "head shop" in California, which prompted a brief but urgently requested explanation in the office of the museum's purchasing supervisor. Walter Kinsman, a renowned spacescape artist, placed inter- and intra-galactic travel pictures on the costume's jumpsuit and cape lining with glow-in-the-dark glitter paints.

Sandwiched amidst the various stages of costume fabrication was a brief talent-scouting for suitable human stuffing to bring the space being to life. Not too remarkably, the first person asked to forever forsake a normal existence and become a cosmic chicken, accepted with enthusiasm and signed an invisible lifetime contract to perform under often bizarre conditions any time or place, and all without being paid.
(Those of you who did not obtain a post-graduate degree in Svengali-type manipulation of volunteers will find yourselves at a disadvantage in repeating this type of procurement.)

With a kind of luck from Olympus unseen since Pygmalion had his statue turned into a real person, the individual selected to be the mascot was able to assemble her own entourage and back-up crew: a husband who is an electronics technician to design and continuously refine the creature's sound and lighting system, and a friend who contributes artistic talents and repairs costumes when needed.

We hope that by illustrating from our own experiences just how a covert character actor can be set free, other planetariums will also be able to transform a human into something from the front cover of a science fiction magazine. While there is no infallible template for creature creation, perhaps some of our freshly professionalized expertise will guide those wishing to join the "new wave" in the spectrum of planetarium special effects.

CHECKING CHICKEN COOPS. Probably the most fertile fields for potential mascot-harvesting are college campuses. If you are fortunate enough to be involved in teaching basic Astronomy at one or more colleges, all you need to do is repeat the same course material over and over, semester upon semester, until just the right personality stumbles into your trap. This will inevitably be the student who refuses to recognize the seriousness of science and treats everything you say as a straight line, carefully balancing humor with impertinence. On the first day of a class when you ask why each student signed up for Astronomy 110, let your mascot-finding radar be activated by the one who answers: "I'm looking for the beginning of Time, Immortality, the meaning of Life, and a chance to meet Carl Sagan. Besides, I'm sick of staying home and rearranging my grocery coupons. I've been reading a book called Astrophysics for Housewives and don't understand a word of it. Can you help me?"

This student, unwittingly, has just auditioned. Let this person, however, continue unaware throughout the weeks of class until you are thoroughly convinced of her uninhibited compulsion to improvise original humor on any topic within Astronomy or Physics. Following are some examples of the kinds of situation and response which could lead to an "A" student being rewarded with a new career and the ultimate solution to a lifelong identity crisis:

Instructor: The mnemonic device for remembering the order of the planets from the Sun is "Very Educated Mother Just Served Us Nine Pickled Pizzas". This mnemonic is not nearly as much fun as the OBAFGKM sequence, and I'm rather tired of it. Can anyone think of a better one?

Student: Mean Vicious Evil Munchkins Just Stole Uncle Ned's Playboy Centerfolds (or, Munching Vicunas Eat Mostly Juicy, Succulent Underbrush Near Precipices And Cliffs).

Instructor: Students may submit questions for any of my tests. If you have any for the next test, please give them to me by next Wednesday.
ESSAY QUESTIONS FOR FINAL EXAM - ASTRONOMY 110

1. What is the sidereal period of the Milky Way Galaxy in reference to the point (in space) of singularity of the Big Bang? - 15 Points, plus a Nobel Prize in Physics

2. If you were an Anasazi Indian in 1054 A.D., why would you make a handprint, star, and moon picture on a rock ledge? - 10 Points, plus an Art Scholarship

3. How many politicians have you written to, protesting the destruction of the U.S. Space Program? - 2 Points, plus a free planetarium pass for each letter. (If you made your point without swearing, scatalogical references, slurs on the politician's ancestry, or insinuations about his current sexual practices, add 10 points each.)

4. Estimate Carl Sagan's income to the nearest billion. - 5 Points.

LAB REPORT QUESTIONS

Question: From your observations and computations, derive the periods of revolution of the outer planets. Why do your methods fail to work for the inner planets?

Student: Inferior planets are like small children, you just can't tell where they've been when your back's been turned.

Question: Based on your Planetarium star counts, what is the shape of the Milky Way?

Student: The Milky Way is the shape of a nine-months-pregnant woman - a large central bulge, tapering at either end.

SELLING YOUR CHICKEN. It cost the United States Government billions of dollars and massive amounts of man-hours to collect a few pounds of moon rocks. You can have something "spacey" for nearly nothing, if your alien believes in itself. Our mascot has had no trouble assuming its role. As soon as the person was inserted into the costume, the personality burst forth.

Its first words upon being activated were: "I think I've been extraterrestrial all my life. I was just born in the wrong body - a trans-terrestrial. This is like being Born Again: I've just had a Religious Experience!"

Set loose upon this planet, the new convert, in its first official act, rounded up 147 grade school teachers who were attending a meeting at the museum and then pounded on the door of the Planetarium demanding storage space for its collection. Collecting interesting specimens of Earth life forms has proven to be its most exasperating, persistent hobby. It once collected 300 pre-schoolers during NASA Aerospace Lecture Week and then asked the entire group if they had to use the rest-rooms.
At this point, planetarium directors need to be apprised of the necessary attributes of alien management, which are a great deal of patience, previous experience with the mentally disturbed, and the ability to go into shock while your career flashes before your eyes, without any perceptible signs. Strange behaviour is to be expected from aliens. When an adult human asks your purposely neuter-looking alien which it is - man or woman - do not even flinch when it says: “I don’t have any sex. I’m not allowed to have any. Besides, when you’re the only one of your kind, what difference does it make?”

Our creature believes that the reason it received a name is because it grew weary of being called “Hey, You Thing, Stop That And Sit Down!”, but the naming process was actually a part of the master plan to publicize the planetarium. A contest to name a new immigrant to planet Earth could have a wide variation in response, depending on in what city and region the hosting planetarium is located. In the Peoria prototype, efforts to promote such a contest surprised us with their success, as it seemed to have scratched the conscious mind of the community. It was a good beginning in an area not much accustomed to novelty.

Armed with 15,000 contest entry forms, our alien could have used them as burrito wrappings and opened a Mexican restaurant, or handed one to every child under eighth grade with whom it came in contact. It chose to be an obedient creature for a change and did the latter.

“It” was also escorted to a major area shopping mall to hand out contest forms and planetarium show schedules. There, it tried to take the Pepsi Challenge, revealed its true sex by stopping in front of every dress shop, and tried to book a charter flight back to its home galaxy at a travel agency. Many adults were unhappy at not being allowed to enter the contest to name the creature. Those who were in drug-induced altered states were particularly creative in suggesting names.

It happened that the best places to find children to enter the contest were the grade schools - they are full of them. It grew particularly fond of telling the schoolchildren just how difficult it was to land on a water planet, spinning 1000 m.p.h. at the Equator when it knew it wasn’t waterproof - or even dry-cleanable! It also claimed to have been first discovered in Peoria by the pilots of a black-and-white metal ground vehicle that had some delicious red pulsars on top.

It was allegedly then taken to Lakeview Planetarium, as it was well known in the area that if anything weird from space fell out of the sky, it should be taken to the director there at once. At each school, before explaining about the contest, the creature sometimes had to explain what a planetarium is, what space is, and why spiral galaxies are like MacDonald’s Restaurants - if you’ve seen one, you’ve seen them all.

Besides creatively begging about town for a name, the creature discovered that, like many earthlings, it loved a parade. It was entered in the Peoria St. Patrick’s Day Parade as an “other” inasmuch as it was not a float, marching band, or mounted unit. It was profoundly appreciative of the consideration shown it by the parade marshals, who let it trail behind two planetarians instead of the horses. Planetarians are generally much tidier in their habits than are horses. It may never replace Santa Claus or the Easter Bunny in local parades, but from now on it intends to be not far behind.
Over 1000 names were submitted by area children before the Vernal Equinox closing date of the contest. Of these thousand names, fewer than twelve were actively considered. After comparing its list of preferences with mine for duplicate names, the creature helped to decide the winning entry by threatening to hold its breath until it turned blue unless its favorite was selected.

Not knowing what would happen if a cosmic chicken were angered, I conceded: although it had been a fairly empty threat - the creature was already quite blue. An eight-year-old boy named Jesse Miller won with his suggestion, Suluna, created in honour of the alien’s half-sun, half-moon head. One of his prizes was a private laser light show, which he used to celebrate his ninth birthday. He persisted in looking a bit embarrassed whenever Suluna called him “Mom”, even though the creature explained: “On Earth, new arrivals are named by their mothers. I am a new arrival. Jesse named me. He is, therefore, my mother. Do all Earth mothers blush when they are called ‘Mom’? Mine does.”

Until it receives an offer for a half-hour weekly television show of its own, Suluna will content itself with the usual four-minute spots on local a.m. programs and educational channel special events. It appeared once before and twice after the naming contest on morning talk shows.

EXPLOITING YOUR CHICKEN. What does a planetarium director do with his alien mascot after the publicity spearhead of a naming contest ends and the thing now has a name to answer to, if it pleases? The choices are uncomplicated. He can either cringe and hide in his office chanting his mantra: “Why did I ever think I needed a cosmic chicken?” or he can bravely assist the creature in its attention-seeking efforts to explore the outer limits of absurdity.

Just like young children and puppies, cosmic chickens require the discipline of a regular schedule in order to achieve a margin of control, which is the reason our creature has the responsibility of “warming up the crowd” at every 4:00 p.m. Wednesday planetarium show, and at the 10:30 a.m. Saturday children’s features. With no material objects other than its own costume, Suluna can usually manage to confound its average audience. One of its favorite routines is the “planetary run-down” where it combines its own personal travel pictures and experiences with real planetary exploration and science.

Often, Suluna will give an audience night-life lessons by turning on its ultra-violet light and glowing in the dark. What Suluna can do by simply talking is pale compared to the impression it can make by using its “props”. After it received a name, it also received (unsolicited) its first credit card, with which it charged a yacht to the planetarium, as it thought that a ship made more sense on a water planet than did a sportscar. Suluna has especially enjoyed showing children its “TV dinner”, which it likes to snack on during shows.

Probably the most frequent target of Suluna’s interest has been the (Mark) Spitz 512 star projector, with which it has shared the earth emotion of “mutual attraction”. Suluna sent Mark 512 a bunch of balloons for Valentine’s Day, presented it with an engagement ring, threatened to unbolt it and elope, and left a cosmic egg in its care on Mother’s Day. Mark 512 has responded by shooting stars out of its head on to the planetarium dome whenever it thinks of Suluna. We are, since the egg incident, attempting to chaperone them more closely. When asked where the egg came from, they tried to look innocent: and Suluna slyly replied: “Dome Power!”
Annoying humans are frequently told to “go fly a kite”. This, they rarely do. When cosmic chickens are subjected to such an outburst, they regard it as a direct order. Suluna not only entered the WIRL Radio Station Kite-Flying Contest, it did so as a “flyee”, not a flyer. Suluna the Kite battled gravity mightily: but even with brisk winds, a delightful nine-foot tail, and the assistance of a varied number of Earth creatures it was unable to become airborne.

In between running attempts to get high, Suluna held conferences with experienced kite-flyers to gather suggestions on how to defeat this planet’s messy gravity problem. After admitting aviation failure, Suluna passed out planetarium show schedules and posed dozens of times with that day’s collection of interesting specimens.

Normal circumstances in which to expose an alien mascot creature are easy enough to realize, given a telephone and a dash of bravado. Suluna has been scheduled to assist in the Lakeview Museum’s “Summer Circus” program, as well as being projected to appear at the Peoria Courthouse Plaza “Brown-Bag-It” lunchtime concerts over the summer. It will also return to the shopping center and will undoubtedly be greeted by its many acquaintances, as well as incredulous strangers. However, even the most pragmatic of administrators must, on occasion, use special ammunition and a gambler’s instinct to target the elusive goal of publicity. Two letters were sent to the Department of Immigration and Naturalization, reporting the museum’s acquisition of an unregistered alien. Suluna claims that the illegal aspect of its arrival on Earth was unintentional: there are no customs ports-of-entry in the upper stratosphere.

Regardless of the creature’s disclaimer, its personal freedom and safety were deliberately risked in the hopes of having it arrested as an illegal alien, preferably on national television news or at least Real People or That’s Incredible. Mostly expecting my efforts to be another prelude to disappointment, I nevertheless prepared a few notes for the typical news interview, and offered to help Suluna find a good attorney - one who would not get it released until after every possible moment of free publicity had been “pressed” from the situation.

These are the incidents that cause a cosmic being to spend hours searching for and scanning the invisible contract that it signed - the one that also guarantees it air conditioning in the summer and promises it the opportunity to see the world.
An Astronomy Workshop for Teachers That Really Works

by Dennis Schatz and Ken Miller, Pacific Science Center, Seattle, Washington

ABSTRACT: During the past six years the Pacific Science Center has offered astronomy education workshops for 5th through 9th grade teachers. These have ranged from one-day, eight-hour programs to six-week-long classes that meet Tuesday afternoon and all day Saturday, to two-week-long classes in the summer that meet a half-day every day. Over this period of time the workshop has evolved to present what most participating teachers consider the best workshop they have ever taken.

The secret, in our opinion, is the intensive use of learning activities that the teachers do themselves and then can use immediately with their classes. As the teachers do the activities, they not only learn much astronomy content, but they build their confidence that they can teach the activities. The following is an outline of a typical extended workshop, along with several of the activities that are most popular and effective.

ASTRONOMY WORKSHOP FOR TEACHERS: OUTLINE OF COURSE

Objectives of Course

- Teachers will be able to use star finders and star clocks to locate constellations and astronomical objects in the night sky, and to use the stars to tell time.

- Teachers will complete a planetarium project for use with their students in their classroom.

- Teachers will be able to understand why eclipses occur and how best to observe them.

- Teachers will know the traits of various planets in our solar system, and how various life forms on these planets might adapt themselves so they could exist.

- Teachers will understand how spectra are used in astronomy.

- Teachers will know comparative mythological stories from several cultures, for a number of constellations.

- Teachers will understand what causes the phases of the moon, and how this information can be used to predict the time of day.

- Teachers will become familiar with using interactive-discovery activities in teaching astronomy. Specifically, they will participate in activities which they can use with their students to teach the above concepts.

- Teachers will have developed at least one activity in astronomy for use by their students.

- Teachers will have spent one night using various astronomical equipment to observe the night sky.
Day 1

Administrative Details
- distribute objectives of course, outline of course, and course requirements
- distribute questionnaire concerning teacher's background and interest
- arrange phone chain for night observing session
- take attendance, discuss parking problems, and break time during class

Using a Star Map (see sample immediately following outline)
- use one-page star map in planetarium to familiarize teachers with evening sky
- place observable planets and other significant objects on map and discuss their traits

Create a Constellation Activity
- students create constellation forms and mythological stories for set of star patterns
- comparative mythological stories for these star patterns

Moon Gazing Activity (see Moon Gazing activity following outline)
- students start recording phase of the moon on each night for one week (activity completed on Day 5)

Distribution of Astronomy Content Sheets
- distances in the universe

Day 2

Star Finding Activity (see Star Finding activity following outline)
- teachers construct star finder and use it to locate constellations for various seasons of the year
- also used to determine motion of the stars in the night sky and to generate a general description of celestial motions

Star Clock
- alternative star wheel is used to turn star finder into star clock
- teachers use star clock to determine date and/or time of night sky

Construction of Planetarium Projector (see description following outline)
- teachers begin assembling projector stand and punching holes in star ball

Distribution of Astronomy Content Sheet and Astronomy Word Game
- colours of stars

Day 3

Sun Watching Activity (see Sun Watching Activity following outline)
- teachers construct sun clock and use it to tell time
- they also see how it can be used as a sun compass


*Observe Sun using Telescopes, Binoculars and Pin Hole Projectors*
- construction for a simple pin hole projector is described, along with techniques for observing with optical equipment

*Planetarium Projector Construction*
- teachers continue to construct star ball (half of group shown a completed projector, and use their star finder and star clock with it)

*Distribution of Astronomy Word Game and Content Sheet (see most popular word game following outline)*
- solar activity
- solar neutrinos

**Day 4**

*Moon Phase Activity*
- analysis of moon phase activity distributed on Day 1 (simulate the activity in the planetarium)

*Construct Simple Spectroscope*
- teachers use spectroscope to examine many light sources over the next four days

*Continued Work on Planetarium Projector*
- teachers done early test theirs on Science Center’s mini-dome

*Distribute Astronomy Content Sheets and Word Puzzle*
- lunar tides

**Day 5**

*Eclipse Description*
- teachers model moon-earth-sun system to understand nature of eclipses

*Planetarium Projector*
- teachers continue work on projector
- those done early test theirs out using Science Center’s mini-dome

*Assignment of Invent or Alien Project*
- teachers construct a plant or alien to exist on a planet from our solar system (the planet is assigned, and background work to learn traits of the planet is left up to the teachers)

**Day 6**

*Retrograde Motion Activity*
- teachers observe the motion of several planets in the planetarium sky and analyze model of solar system to understand the observed motion
Completion of Planetarium Projector and Testing of each Projector

Distribute Astronomy Content Sheets and Crossword Puzzle

Day 7

Invent an Alien Activity
- teachers exhibit their plant and alien being constructed for rest of class
- class attempts to determine the nature of the planet, and which planet it is, by the traits of the plant and alien being

Message from Outer Space
- teachers analyze message from intelligent life outside our solar system and fabricate a reply (follow-up option for this activity will be to invent plant and alien being for planets orbiting this planetary system)

Distribute Astronomy Information Sheets
- article on each planet
- assign planet mnemonic contest as homework

Day 8

Examine Mnemonics Contest Results

Spectra Activity
- look at results of spectroscope take-home activity
- analyze several sources in the laboratory to see how astronomers use spectra to determine the traits of astronomical objects

Distribute Astronomy Content Sheets
- uses of spectra

Presentation of Individual Activities Developed by Teachers for Use in Their Classes

Day 9

Complete Presentation of Individual Activities

Content Lectures on Topics of Teachers' Choice (as indicated on questionnaire submitted on Day 1)

Night Observing Session - first clear night of class (except Day 1)
- teachers identify constellations using their star maps
- teachers use small telescopes to discover interesting objects in the night sky (e.g., double stars)
- teachers use large telescopes to observe faint objects in the night sky
Constellation names are in all CAPITAL LETTERS, bright star names are in italic print.
Course Offerings at the American Museum - Hayden Planetarium

by Allen Seltzer, American Museum - Hayden Planetarium

The American Museum - Hayden Planetarium conducts an extensive program of course offerings in the disciplines of astronomy, aviation, telescope making, navigation, and meteorology for adults and young people. A total of 26 different courses was given during the fall, winter, and spring terms of academic year 1981/1982.

Adult courses are taught on weekday evenings with most classes meeting once every week from 6:30 to 8:40 for five to ten weeks each term. Tuition, largely determined by the number of sessions for each course, ranges from $50 for a five-week course to $175 for the aviation ground school courses meeting twice a week for a total of 14 sessions.

Three classrooms and the Sky Theatre permit up to four classes per evening. In addition, courses in telescope making are conducted by the Amateur Astronomers’ Association Inc., in the Optical Division workshop at the Planetarium.

Classes for young people are held on Saturday mornings. The tuition for all young people’s courses is $25.

The instructional staff is made up of several full-time staff members and a core of 13 part-time personnel, most of whom teach at the high school or college level on a regular basis. The aviation ground school instructor is a veteran pilot and F.A.A. certified flight instructor. Course instructors are paid $30 per academic hour, which is competitive with the salary adjunct instructors receive from local colleges.

The Planetarium’s courses are informational and practical, appealing to the curious adult or bright youngster who wants to know more about the subject. One staff member remarked, “People from all walks of life have taken courses at the Hayden Planetarium, from an exotic dancer to a Justice of the Supreme Court.”

No exams are given and no papers are required. A Course Completion Certificate is awarded to all those who have attended at least 75% of the sessions.

Courses are promoted in several ways. A course catalogue is prepared and mailed to those who have taken courses at the Planetarium in the past, and to special interest groups. The catalogue is also sent to teachers and to those who call or write requesting it. Course listings for each term are provided in Rotunda, a newsletter for Museum members. Free catalogues are provided at the box office, in the Sky Theatre, and in the gift shop for all visitors. A billboard is projected during the walk-in music preceding each Sky Show, alerting visitors to the course offerings each term. These are promotional instruments that are used extensively.

The Hayden Planetarium derives about $52,000 per year from the almost 1,000 students who enrol in its courses. The gross income from courses represents about 5% of the Planetarium’s total income. Expenses (instructors’ salaries, printing of catalogues, mailings, promotion, supplies etc.) approach $37,000. This surplus contributes to the Hayden Planetarium’s operational funds.
Ist Mirant Stella and The Netherlands: Vision of Light

by Ray Shubinski, Planetarium Director, Memphis Pink Palace Museum, 3050 Central Avenue, Memphis, Tennessee 38111

ABSTRACT: Ist Mirant Stella. The reappearance of Halley's comet in late 1985 and early 1986 presents some tremendous opportunities for the planetarium community. We have the choice at this point of developing proper public relations and information outlets to avoid another Comet Kohoutek incident.

This paper will present a short history of Halley's comet in following some of the interesting ideas about the comet's origins and the effects it has had on the human psyche as well as history. Also, a very quick review of a number of the publications that are becoming available will be given in this paper.

The International Halley Watch is well under way, and the possibilities of close planetarium ties will be included in this discussion. Also, the question will be answered: "What will Halley's comet look like in 1985 and 1986 from your latitude?"

In all, the paper hopefully will be useful to the planetarium community in general in planning its Comet Halley activities for the near future.

ABSTRACT: The Netherlands: Vision of Light. This is a new and original production of the Pink Palace Planetarium, produced in honour of the Dutch-American Bicentennial. The program has been appointed an official Dutch-American project and has already gone out to another planetarium for presentation.

The production of this show has been more of an adventure than any other show ever produced by this staff. There have been new problems in both the script and the audio-visual production to overcome that would not have been present in a "normal planetarium program". The project presents many interesting aspects for other planetariums as far as both community and even national projects which could develop into some exciting programming.

The paper will go into some of these possibilities: also, it will address some of the more interesting technical problems which arose through this production.

End:

"The Comet is Coming"

Nigel Calder

International Halley Watch Book

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Planetarium presentations take many forms. At one extreme the aim is to have a completely recorded presentation with as near full automation as possible. At the other, a live presenter may be giving an informal presentation to an educational or scientific audience where audience feedback may itself determine the course of presentation.

In recent years it has also become the case that effects projection, special lighting, slide projection and other “auxiliary” functions have become an important part of the planetarium presentation, to the extent that while manual operation of the star projector is still practical and can often be the most cost-effective method, the manual operation of all the effects can be out of the question. Various systems of automation have been tried over the years, initially based on the use of proprietary mini-computer products and more recently by pressing into service equipment designed for commercial audio-visual presentations. Neither has been entirely satisfactory.

The author poses the questions:

- What makes the automation of planetarium presentations difficult?
- Why cannot planetaria take advantage of the apparent low cost of “off the shelf” computer power?

and gives the answers as:

- The great number and diversity of the items to be controlled.
- Planetaria can use standard computers, provided the controlled devices have an intelligent interface, and provided that planetarium producers are prepared to think in terms of breaking down the show production task into clearly defined areas.

The author sees the development of the “intelligent interface” as being the key to simplified automation. Devices are described which from simple instructions carried in ASCII code at standard data rates will carry out complex routines related to the specific device they are controlling. Such an approach obviously includes such items as slide projectors, effects lighting, motion projectors, etc., and less obviously can include the star projector. The advantages of this approach are seen as:

- Low cost of central computing power. To some extent that it can be written down very fast, so, if - as is likely - still more powerful and lower-cost machines come on the market in the near future, the investment to be written off is small and the user can afford to update.
- Much less demand on the central computer in carrying out tedious real time tasks. This results in much simpler computer software and realistically allows the user to develop his own variants.

- The ability to do off-line programming and show development at low cost.

The author further reviews the type of computer software that is already available and suggests directions for future software development suitable for both the small and large installation. Mention is also made of different ways of running the final shows to ensure maximum security combined with flexibility.

The Author: Robert S. Simpson, 42, received his M.A. Degree in Physics from Oxford University in 1961. After three years as Technical Manager of a sound recording and service company he and two colleagues founded Electrosonic Limited. This company was one of the pioneers in the use of thyristors for lighting control and in the development of multi-image programming systems. They have been responsible for installations on a world-wide basis. Mr. Simpson travels widely, working with both users and potential users of his company's expertise and seeing the many applications of programmed sound, lighting and audio-visual systems firsthand. He is a regular speaker and writer on audio-visual topics.
A completely crossed two-factor experimental design was utilized to compare the effectiveness of three different teaching methods (planetarium lecture, classroom-celestial globe lecture, and planetarium/classroom-celestial globe lecture) and the effect of student spatial orientation ability (high, medium, and low ability groups) on the learning of selected positional astronomy concepts. Seniors enrolled in the elementary science methods class at the University of Colorado during the Fall, 1980 semester were randomly assigned to treatments. Spatial orientation ability of the students was assessed using the researcher constructed Spatial Orientation Ability Test (SOAT) prior to treatments. Those scoring in the top one-third were assigned to the high ability group, those in the middle one-third to the medium ability group, and those in the bottom one-third the low ability group. The treatments (teaching methods) were administered, and the posttest was given to each group. The posttest was the Positional Astronomy Achievement Test (PAAT) and was constructed by the investigator expressly for this study. Group mean differences on the total PAAT and four subtests were tested for statistical significance using analysis of covariance with grade point average, number of astronomy credit hours, and class attendance used as covariates.

A significant difference on posttest means across teaching method on the total PAAT was found with the classroom-celestial globe lecture method favored. The spatial orientation ability factor showed highly significant differences in mean scores on the total PAAT and three of the four subtests with the high spatial orientation ability group being superior. Significant interactions between teaching method and spatial orientation ability on the total PAAT and two subtests were also found. All interactions were in the same direction with the low and medium spatial orientation ability groups performing better on the posttest, if they were in the planetarium or planetarium/classroom-celestial globe sections. However, students in the high spatial orientation ability group favored the classroom teaching method.

This study found that spatial orientation ability of students is a factor that should be considered when designing instructional techniques in college astronomy classes that teach positional astronomy. Two-thirds of the students in this study favored planetarium or a combination of planetarium and classroom instruction.

The results of this study imply that students who have low and medium spatial orientation ability need the more observable and concrete instruction provided by the planetarium. Pretesting on the spatial ability construct should prove quite useful in prescribing the most effective teaching method to be used when teaching positional astronomy concepts to elementary teacher education students.
GROUP MEANS ON POSITIONAL ASTRONOMY ACHIEVEMENT TEST (PAAT) AND SUBTESTS AND STATISTICAL SIGNIFICANCES ACROSS TEACHING METHOD, SPATIAL ORIENTATION ABILITY GROUPS AND SIGNIFICANCES OF INTERACTIONS

<table>
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<th>PAAT Diurnal Motion</th>
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<th>Seasons</th>
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<td>4.02</td>
<td>7.63</td>
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<td>0.106</td>
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Interaction between teaching method and spatial orientation ability on the PAAT.
Simplicity in Planetarium Control Design

by Bruce Spainhower, Kendall Planetarium, Portland, Oregon

In order to cut cost but still achieve a fully flexible planetarium control system, this paper covers a "clean slate" approach to control design. The system described utilises LSI technology and features full automation plus manual control without the use of redundant hardware.
From Winter Solstice to Astronomy Day I toured America in my mobile home, covering 44,709 km, making two or three contacts a day among planetaria, observatories, amateurs, professionals, companies, ATMs, writers, and a haphazard sprinkling of unclassifiables: also a couple of professional conventions and a Shuttle launch. Well, people are people, and I already knew that, but visiting removes a lot of mystique. Some general lessons: important people can be just as ignorant and human as the rest of us. Unknowns can be just as knowledgeable and fine as the rest of us. Facilities don’t get jobs done, people do (corollary: organizations’ images are proportional not to their quality or inherent importance, but to their staff sizes). Astronomical unemployment is astronomical. Most planetaria are terribly depressed, most lecturers move their pointers too fast, most Hansen programs end up as mere slide shows, Omnimax and Digistar seem to be the waves of the future, and most sales-counter managers are turkeys. Among astro-folks I visited, cats outnumber dogs 3-1, Apples outnumber pets and TR-80s 4-1, and everybody is itching for Halley’s Comet.
Some Tips for Future Survival of the Planetarium: Establishing a Standard of Excellence

by Garry T. Stasiuk, Stasiuk Enterprises, 3150 NE 30th Avenue, Portland, Oregon 97212

ABSTRACT: Planetarium Philosophy: will there be a planetarium in the future? Two scenarios describe possible futures: a description of a planetarium in the year 2218, from Robert Silverberg’s novel, Tower of Glass, and a true story about the death of a planetarium. A discussion then follows which outlines steps that can help you make your planetarium a community cultural asset.

The question that I pose to you is: Will there be such a thing as a planetarium in the future? Consider the following scenarios. Scenario No. 1 is Robert Silverberg’s description of a planetarium in the year 2218, from his novel Tower of Glass. Scenario No. 2 is the true story about the death of a planetarium.

SCENARIO 1.

“Vargas deftly inserted the cube and activated the scanner... The stars blossomed on the planetarium ceiling.

Krug was at home in his galaxy. His eyes picked out the familiar landmarks: Sirius, Canopus, Vega... He sought the near stars, those within the dozen light-year radius that man’s interstellar probes had reached in his own lifetime: Epsilon Indi, Ross 154... Again and again the pattern shifted as focuses narrowed, as distances grew...

‘Well?’ Krug demanded at last. ‘What am I supposed to see?’

‘Look toward Aquarius,’ said Vargas.

... Krug struggled to recall the names of some major stars in Aquarius, but came up with nothing.

...‘Watch. We sharpen the image now.’

... Krug braced himself as the heavens rushed toward him. He could no longer make out the patterns of the constellations; the sky was tumbling and all order was lost. When the motion had ceased, he found himself confronted by a single segment of the galactic sphere, blown up to occupy the whole of the dome. Directly above him was the image of a fiery ring, dark at the core, rimmed by an irregular halo of luminous gas. A point of light glimmered at the nucleus of the ring.

...‘This is the planetary nebula NGC 7293 in Aquarius...’ ‘It is the source of our signal.’”

SCENARIO 2.

In this scenario all of you will see a little of yourself... a person who loves his job, a dedicated employee working to the best of your ability, always learning and growing, giving 110% and then some. Since you came on staff the attendance at the planetarium increased fivefold, you
established credibility with the community and the local media to the point where anyone with an astronomical question calls the planetarium for an answer, including the media. You always come on under budget and with more revenue than projected.

Now imagine you have reached a point where you have pushed your theatre to the limits of its capabilities and it is time to think about expansion, a new building, a new theatre to meet the future demands of your popularity. A state-wide independent survey was conducted to see if fund-raising for capital expansion was feasible: the answer was a resounding Yes. Architects were hired, plans were drawn, and after some modifications to the existing building, your new planetarium, designed to your specifications, would be Phase II. But your boss was fired and a new person was hired ...

Now imagine you are working on a new promotional plan to attract visitors to the museum. The event is V'ger I's fly-by of the planet Saturn. The museum begs and borrows three large screen projection TV's, you go down to JPL as a media representative and at JPL you spend your day with a phone glued to your ear. You call every newspaper, radio and TV station back home to report that at Saturn, "the bizarre has become commonplace". You slip in the plug that you can see the pictures "live" at the museum ... in a three-day period over 7,000 people show up, and you establish an attendance record. One of the by-products of your trip to JPL is the collection of incredible photographs that were distributed to the media. You make arrangements with a local film processor to make 16 X 20 prints for display, he donates two sets of prints, one set is currently circulating the country courtesy of ASTEC.

Now imagine that it is two days from the premiere of a new planetarium production, Saturn and Beyond, and your new boss calls you into his office. You think he is going to thank you for the success of Project Saturn. Instead, you hear the impossible: "You're fired!" Since your firing no new director has been hired, three staff have been laid off. The planetarium that was to be is but a dream: the planetarium that is, is but a ghost of its former self. Your ex-boss believes that the concept of a planetarium is a dead end, he would rather build an I-Max Theatre!

Obviously the image of planetaria needs a little polishing to survive. We, as a community, need to establish a "Standard of Excellence". We are going to have to improve our programming, administrative work and global image. As a result I would like to share with you some things I have learned through experience.

HOW TO MAKE YOUR PLANETARIUM A COMMUNITY CULTURAL ASSET:

There are two administrative documents that are vital to the growth and survival of any planetarium: they are the BUDGET and the ANNUAL REPORT. Even if you have absolutely no control over your budget you must, and should, prepare a report that will at least aid the next person up the totem pole. Your budget is a document that tells everyone where you are now and where you'd like to be in the future. Remember, as you will have to defend every statement in the budget, stick to the facts!

BUDGET PREPARATION. Do your homework, develop flow or pert charts that show all aspects of planetarium operations. Include show production, theatre maintenance, show installation, practice sessions, administrative work, number of performances, etc., showing all job
responsibilities. Pert charts will show your strengths and weaknesses, you may find a shift in job responsibilities and duties! You should always divide your budget into at least three categories: salaries, recurring expenses and non-recurring expenses. The category "non-recurring expenses" contains your capital expenses for the year and are items that can be amortized according to the latest tax laws.

In your budget document you should outline and indicate your goals during the fiscal year. You should always plan to add new equipment to replace the old, including the Star Projector! You should always be thinking of new equipment that will improve your overall operation and presentations. If you haven’t done it, make a “wish list” and include everyone involved in your operation. You might consider the current state of your planetarium as a “Standard” and build your wish list from that Standard. Then put the “stuff” on your wish list in the budget as part of your five- and 20-year goals, in order of your priority. Remember, you’re the director... go for it!

THE ANNUAL REPORT. This document is important as it is designed to make everyone involved in the operation feel good! It is designed to show that the goals you established were at least met. Always use positive language and this is your chance to write flashy material! You will want to highlight all your shows, star parties, school shows, fund-raising activities, concerts and light shows, making sure that you credit everyone involved in the production, preparation, and presentation of all your activities. Of course list expenses, revenue and attendance, and where possible compare with previous years. But most important of all, make sure that everyone involved gets a copy of your version of the annual report!

PLANETARIUM PROGRAMMING. If you don’t have excellent programs in your theatre, you are doomed, you’ll never get out of the rut. No matter what kind of program you are doing in the theatre, be it school show, public show, light show, ask yourself if it meets your Standard of Excellence. As you make that judgment, remember two things: (1) the planetarium is a "theatre of the mind", it is not a classroom and it is not a movie theatre. Leave Star Wars, Star Trek and Omni-Max at the movie theatre where they belong, and concentrate on the things a planetarium does best: (2) you are the planetarium expert, not the science fiction writer, not your boss, you. I tried in vain to get Ursula K. LeGuin to write a planetarium show. She simply replied: “You’re the planetarium expert, you write it!” With those two thoughts in mind, ask yourself what you would like to do in your planetarium theatre. You should plan to buy at least two quality commercial shows per year. They will give you a chance to improve your own productions and as standards of production improve, the quality of the shows will improve. In a “theatre of the mind”, anything is possible.

THE PLANETARIUM SHOW AND SCRIPT. If you can, arrange a show to coincide with a natural phenomenon, be it space probe fly-by, planetary conjunction, or eclipse, so that you can get a double play from the media. The media love to do stories on natural events (including partial lunar eclipses) and you can throw a star party! The basic problem I see with most planetarium scripts and shows is that they are too long and they desperately need to be edited (and edited, and edited!) Give the script to your spouse, or best friend or colleague, swallow your pride and rewrite, rewrite, rewrite. The end result will amaze even you. The correct
length for a canned production should be about 30 minutes. If you have a policy of doing one-hour shows, do 30 minutes live (yes, live!) on the current night sky.

HOST 2-3 ANNUAL STAR PARTIES. Most of us have developed a good working relationship with local amateur societies. If there isn’t one in your area, start one. Star parties are excellent vehicles to promote both the planetarium and astronomy. Most radio stations have portable outdoor P.A. systems: book one for your star party, play “planetarium music”, and host and do an outdoor real sky planetarium show. You might think of holding a star party in conjunction with the summer favorite, The Perseid Meteor Shower.

HOW TO MAKE A PRESS RELEASE WORK. Establish a mailing and telephone list of all the local media. The day after you mail the release, glue the phone to your ear and ask if they would like more information. They want to do a “phoner” or send someone out to do an interview. As you establish credibility with the media they will call you when they get the release or a story on the wire. Instead of calling, you might want to pay each media representative a personal visit to discuss what you’re doing, and learn what format that person likes the material to take in the release. On the day of the event, be it star party or premiere, call again. Promote, promote.

PROBLEM SOLVING, USE BAKSHEESH. So you have a technical problem you can’t solve and you have no dollars to hire the help. Locate the expert, call him up or pay him a visit. Tell him you have a problem only he can solve ... he will itch to know what it is. When he learns that you work at a planetarium, he’ll be really impressed. Give him some passes, take him on a personally guided tour ... remind him of the insoluble problem ... with luck the problem will get solved and you’ll have a friend for life and a future source of future solutions to future problems.

GOT A POLITICAL PROBLEM? FORM AN ADVISORY COMMITTEE. If you need some political clout, establish a “friends of the planetarium advisory committee”. On that committee include a board member, and folks from all walks of life in the community ... doctors, lawyers, teachers, students, etc. Let them recommend to the board of directors solutions to your problems.

HIRE A VOLUNTEER. Overworked and understaffed? Hire a volunteer! Look for retired persons, high school students. You might be able to set up an arrangement with local high schools whereby students can get credit for volunteering. It takes time to train a volunteer, but the results are worth it.

BURN OUT. If you are spinning your wheels, get depressed, get angry easily or are alienating people, take a month’s vacation. Do not pack a telescope, do not visit a planetarium. You’ll be surprised how much better you feel when you get back to work.

TAKE A SHOW ON THE ROAD. Beg, borrow or buy a two-projector set-up and produce a 20-minute slide show on a “crowd pleaser”, a show that you feel comfortable presenting. Let your local Rotary, Lions, Kiwanis, Toastmistresses and Masters, Optimists, etc., know you have a slide show about astronomy. These “service” clubs are made up of local small business men. Promote your cause. Most of these organizations have foundations for the expressed purpose of helping worthy causes, like planetaria. Promote.
We all have our own personal convictions about the cultural worth of a planetarium. For myself, the planetarium is the cathedral of our technical era, a theatre that unites the past with the future, now ... for it represents where man has been and where he will go. Perhaps the most important thing a planetarium can do is to instil an inspiration in the people that visit it. Consider the following story.

Ben Bova, editor of *Omni* magazine, came to town to promote the Viking Fund. He was asked to give his impression of science museums. He replied with the following:

"Did you ever see the movie *Rocky*? Well, the slums of Bova's Philadelphia were worse! By chance, he and his classmates went on a field trip to the Franklin Institute and the FELS Planetarium. His experience at the Planetarium woke him up to the realization that there was a whole universe beyond the slums of Philadelphia. From that point on, his life was profoundly changed."

As long as we planetarians develop and maintain a "Standard of Excellence", only if planetarians continue to grow will planetaria survive and not die. *It's entirely up to you!*
Retrofitting the Spitz Heliocentric Orrery for Geocentric Operation

by Theodore Stalec and David Hill, Kansas State University

PREFACE: While attending the Great Plains Planetarium Association Conference in the fall of 1981, I had the pleasure of seeing Ken Mosley demonstrate the Conic TC-101 from Conic Instrument Company. Had I had the price of the unit, I would have purchased it on the spot. Its performance and accuracy are nothing short of amazing. I watched in awe as the unit, along with its support grid projectors, demonstrated how the single motions of the planets become the complex motions we observe from earth.

Upon returning to our small planetarium and presenting a show on the solar system, I realized even more how much we were missing by not having a geocentric projector but, like many planetariums, our budget just could not afford such a fine unit as the Conic.

JUST A TWINKLE IN THE EYE. After considerable thought, doodling, and several discussions, we came to the conclusion that all that was necessary for our orrery to show the appropriate motions was to simply change the frame of reference from the sun to the earth (transfer the earth's motion to the sun). Very simply, we built a Tychonic model. The sun revolves around the earth and the other planets revolve around the sun, all while the earth remains stationary.

The solution in theory was to build a platform for our existing Spitz projection that would compensate for the rotation of the earth image mirror, giving the rest of the images the combined motion of the orrery and the platform. The results should then be a perfect Tychonic model.

TIMING AND TORQUE. The idea was simple enough, but making it work was not. Since the timing of the earth mirror and the platform is critical, we used a single drive shaft for both. The cam at the bottom gave the platform the appropriate tilt to match that of the mirror, and the unit was finished. By turning the earth projector, the platform tilted nicely, compensating perfectly for the mirror's motion. All excited, we took it up to the planetarium and plugged it in. Mercury turned, Venus turned, and the earth and the platform just sat there. The Spitz projector uses belt drives, and after going through two belts, we concluded that there just wasn't enough torque to run the platform.

After much re-thinking and discussion, we finally went to ball bearings and counterweights on the projector to balance the system. We plugged it in and away it went. With only minor adjustments on the weights and the positioning of the cam, the system performed perfectly.

OPERATION. The platform tips at exactly the same level opposite the mirror on the earth projector. While the platform itself is kept from rotating by a set pin on the support arm (H on the drawing), as the platform tilts the previously stationary sun projector picks up the platform motion and gives its image a rotation about the earth, while the remaining planets have the combined motion of both their normal rotation about the sun image and that of the platform motion.
Photo A shows the motions of the planets and the sun over the period of just under one year. Photo B shows the same time sequence, excluding the sun (for clarity).

Both photos were started with the planets in the above alignment to give a frame of reference. The pictures were taken at 15 sec exposures, then advanced as little as possible and re-exposed. Jupiter and Saturn were brought in close only to show on the same exposure. During normal operation, their distances from the sun will be much greater, giving a much smaller change in position relative to the earth. You might notice that the earth image holds its position nicely, though slightly off-centre. This displacement is due to the displacement of the sun projector from the centre of the earth projector. Spacing of the concurrent images is due to their relative speeds. As they increase in speed, the images appear farther apart.

By physically loosening the set screw on the platform drive shaft, the unit can then be used in its normal mode as a heliocentric projector.

SUPPORT PROJECTOR. The overlays used with the Conic do their jobs nicely, but for us a similar overlay system can be produced by using a clear dome masked off at 15-degree intervals and painted several times. After removing the tape and placing it over a small point light source, it projects an acceptable grid system. If concentric circles are also used, they can be spaced to match astronomical units for distance.

When the orrery is shifted in modes, the projector dome need be only realigned slightly to be used for heliocentric as well.
LIMITATIONS. The unit does in fact perform well and should outlive several Orreries, but there are some limitations. The platform must be used in the upright position. Large table top mirrors available in most demonstration facilities can be used to project the image on a screen.

The earth image is slightly off-centre, though once the overlay is in place this position shift is not noticeable. Since it is due to the physical positions of the projectors, it is inherent.

Probably the greatest disadvantage to the system is during mode shifts. This must be done manually by loosening the set screw on the drive shaft. Because the shaft is flattened on one side, it is easy to realign the projector for heliocentric operation, but, because it must be done by hand, a slight interruption of the program results.

THE BOTTOM LINE. Two things make the platform a welcome addition to the small planetarium. Its performance is more than acceptable as an educational tool. It shows the apparent motions of the planets both in position relative to the earth, and their relative speeds through the sky. But most of all, the price is nice. Using the Spitz projector (which a large number of us already have) and modifying it with the platform, the cost is minimal. The platform can be made by any good machine shop in less than 20 hours with less than $50 in parts, giving it a price tag of around $300 - which is well within the budgets of most planetariums.

FINALLY ... For us, the platform fills a gap in our educational tools. Though it has some limitations and disadvantages in operation, it gives us a capability we had only dreamed of six months ago. Should we by some chance acquire considerable funds, I might still purchase that beautiful Conic projector that first gave me the idea for the platform.
APPENDIX A : CONSTRUCTION. The apparatus consists of a platform mounted on a hollow 5/16 shaft (F) and supported by a spherical bearing (G). Through the centre of the hollow shaft is a 3/16 drive shaft supported from the hollow shaft at each end with a ball bearing (B). On the end of the 3/16 drive shaft is a 5/16 ball (D) with a 1/16 pin extending 1/16 in from each side. This fits into a 5/16 hole in a dovetail slide (E) which is adjustable for regular angular displacement. The dovetail slide assembly rotates around a fixed shaft on ball bearings (B). It is held in place by a set pin (C). All moving parts are supported by ball bearings to reduce friction.

A. Fiber Washer  
B. Ball Bearing  
C. Set Collar  
D. 5/16 Ball  
E. Dovetail Slide  
F. 5/16 X 050 Tube  
G. Spherical Bearing  
H. Anti-rotation Pin  
I. Universal Joint  
J. Extended Earth Shaft  
K. Fixed Shaft  
L. Counter Balances, 2 at 45 degrees of main axis

Mechanical Drawing of Platform
APPENDIX B : PROJECTOR MODIFICATIONS. The main shaft of earth must be lengthened until it extends through the base. This is a press fit and can be pulled out when earth is removed. The replacement shaft should be 5" long. A hole must be drilled in the base below earth. The resistor and capacitor for the motor must be moved, making room for the hole. The leg opposite earth should be rotated 180 degrees.
Platform with Spitz Orrery,

Cover Removed to show Extended Earth Shaft
Galaxy and Black Hole Projectors

by Robert Stoller, Fiske Planetarium, Boulder, Colorado 80309


Artwork is ink / opaque
by Brian P. Sullivan, Production Designer, Grace H. Flandrau Planetarium, University of Arizona, Tucson, Arizona

ABSTRACT : A presentation showing how to assemble models of large space structures for a planetarium show, with a small budget and short time space. Some models in demonstration were published last year in *Time* and *Discover Magazine*.

The presentation is divided into three modes ranging from simple visual methods to complicated ones. Included in the presentation are several tips on tricks of the trade.

Building models for planetarium shows is very popular with a star theatre audience. A model can bring the reality of a show to the public very convincingly. However, there are a few problems - one important aspect is talent, and the others (as always) are time and money.

During the summer of 1981, I was contracted by Kodak to construct a Mothership, take it to Kodak Film Studios in Rochester, N.Y., then film the model using a special close-up lens system. The model was three feet in diameter. I had a budget of $600 to work with and a generous month of construction time. To planetarium production teams, this amount of time and money we can only dream about.

About the same time, I started a small company called the Farside Project. The whole objective of Farside is to have 3D models in 35mm slide form at a very low price, available to planetariums world-wide. As of now, Farside is very successful, but I learned a few tricks of the trade I want to share with you.

Since the coming of Space Shuttles, we have observed over the years the planning of large space structures. These structures can never hold up well in a gravity environment, so models are very hard to make. Take, for instance, a Solar Power Platform - a space structure 10 miles long and 4 miles wide. The panels are easy to make in model form, but the support construction is a little hard to complete on a planetarium budget and time scale. So this is what you do : first you need to have knowledge of, and the materials for, black and white photography. Other tools of the trade can be found in any art studio, i.e. an airbrush, ruler, ruling pen, colour pens, pen and ink, paint, and various model kits. With these tools, you can complete any large space structure desired.

For solar panels, I took a large sheet of brown cardboard and with a rapidograph pen and ruler, laid out a complete solar panel structure. Next, in the middle of the panels, I constructed out of model kits (mostly truck models) the main support centre where work crews would live and the solar energy from the panels would be converted to microwave beams to transmit the energy to Earth. That completed, I then photographed the solar panels on an angle with Plus-X film. Using Polycontrast F Double Weight paper, 11” X 14”, I printed up the visual. When the print was mounted, I took a ruling pen with red animation paint and drew out the complete support structure to the platform. Once this was completed, I used an airbrush for the shiny surface look to the panels. I then re-photographed the print with Ektachrome 50 film (polarized) and the end result was a convincing Solar Panel Platform model that took
only a day to make.

I'll now break up the presentation into three models, ranging from simple visual methods to complicated ones.

MODE 1. Ruling Pen. Using a ruling pen on a black and white visual requires a little practice, but, once mastered, you can really get inventive with this tool. For example: a visual of a large space telescope constructed out of model kits. After it was printed up on black and white paper, I then drew a few lines for support cables, solar panel outlines and antennas, for the finished product.

For a complicated communications platform, I took three dishes with a few model parts, and printed it up on black and white paper. The rest was a simple case of connecting dots, and there was a sophisticated-looking communications platform.

MODE 2. Airbrush/Rapidograph Pen. Last year in May, I was contracted by Discover Magazine to do visuals of the various operations of the new Space Shuttle. One visual was a large Space Ear. This is how you can make such a visual. First, buy a large fruit salad bowl from any five-and-dime store. Remove the lid and drill various patterns of holes for the support beams. Tap the holes and screw in hex screws. The more screws, the better the detail of the visual. Next, spray the dish flat black and allow it to dry. Then spray battleship gray (also flat). Now you have the finished product. After shooting the visual with Plus-X film and printing on black and white Polycontrast F print paper, simply take your rapidograph pen and ruler and once again connect the dots.

Finally, the cover design. With the same model of the Space Ear, I took another picture angle of the model and printed it on print paper. Then I took a blue gel and taped it over the print. With this done, I took the airbrush and painted lights and shadow areas on top of the blue gel. This method isn't new. The originator is the renowned production designer Vic Costanzo of the Strasenburgh Planetarium. I worked with Vic from 1972 to 1977 on various projects while I was in college, and he is responsible for my start in three-dimensional visuals.

MODE 3. Mixed Media. Lights on spacecraft visuals are always an attraction to a planetarium audience. The Farside Project built a model of a large Space Colony (called Colony 2) for the Davis Planetarium in Baltimore, Maryland. It was built mainly out of plastic sprinkler system parts and PCE piping. The main support structure was four steel metal screw rods. Assembly was done by myself and a new assistant, Lisa Peterson. Because of the time element, I could only construct this giant colony. Lights had to be put on in a different way. Now, in Hollywood, lights on models are put on with fiberoptics. The Mothership in Close Encounters had thousands of fiberoptics, but the time and crew it took to do it would be prohibitive at a planetarium.

So, with a ruling pen (as in Mode 1) I put lights on the visuals the same way. After Colony 2 was printed up on black and white print paper, I began to put on a "light complex". This same principle was used with many other models. With a little airbrush work, I was able to differentiate the lights.
To reinforce some of the points I have covered in this material, I will offer a few tips:

1. Always polarize your lighting when shooting visuals.

2. Use Ektachrome 50 professional film - for total colour saturation.

3. Learn to plan out models by a few rough sketches, and when you are designing, keep in mind a good light complex design.

4. Get used to using a ruling pen, and have patience while you are learning, as it takes a time to master.

5. Be aware of the many kinds of plastic items that would help in model-making.

6. Obtain a good reference book on Spacecraft design. One is McCall’s book *Our Worlds in Space*. Another is Rick Steinbach’s *Spaceflight Chronology*.

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**Polarize Light**

Use Ektachrome 50

Sketch model first

Plastic parts work best

Idea: "Star Trek Spaceflight Chronology"

"Space Technology"

**Comic Books**

**Star Field**: Toothbrush dipped in white paint & spray on.

Light 3200 K + little bounceback. Remember only 1 light source.
Seamless Matching of Panorama Slides

by Larry Toy and Billy Smith, Chabot College Planetarium, 25555 Hesperian Blvd., Hayward, California 94545

We have modified a technique learned by one of us at the Strasenburgh Planetarium production techniques seminar to produce seamless multislide panoramas with no additional masking required. It involves photographing using a soft masking technique on the sides and top of the panorama scenes. The method is very effective and reduces the photography time and mounting time to about 10 minutes each for a 12-slide panorama. In addition, no modification to artwork is made. The final panoramas are quite tolerant of slight misalignments of slide projectors caused by vibrations or bumps.

The technique involves placing two black metal "knife edges" (fabricated from sheet steel or aluminum) about four inches in front of the camera used to photograph the artwork. The camera and knife edges are both secured to the same platform made of plywood. The camera lens is opened to f/4 and because of the lack of depth of field, the knife edges are out of focus, creating a soft edge to the sides of panorama. There is a similar knife-edge bordering the lower portion of the photographic field, although its placement is not as critical. Much experimentation is necessary to produce the proper combination of F stop and distance of knife edges both from each other and from the camera. The top edge of the panorama can be similarly masked by using a wire form maker and using it to approximate the contours of the panorama scene. This latter step is not as critical as it might appear, since the form maker is placed at the same distance as the other knife edges and is equally out of focus.

Precise registration of slides is accomplished very quickly by use of pin registered slide mounts (we use Wess Mount SM35 2). The only other requirement is artwork which covers slightly more area than that actually photographed, since the soft edge overlaps two adjacent scenes. We have found that almost all existing artwork can be used. Kodalith slides taken of the panorama scenes aid alignment of projectors for proper coverage.
Planetary Gatherings: 1982-1984

by Robert C. Victor, Abrams Planetarium, Michigan State University

A planetarium demonstration of the most noteworthy planetary events as seen from Earth in the two years until the 1984 I.P.S. Conference. The events include:

- The compact gathering of Mars, Jupiter, and Saturn in Virgo, in July-August 1982. All three planets, together with Spica, will fit into a 15 degree arc from July 5 through August 7. Not until March-April of the year 2000 will the three bright planets assemble into a more compact group.

- The gathering of the Sun and all eight planets into an arc of 63 degrees on October 31-November 1, 1982. The group will extend from Mercury and Saturn in Virgo to Mars in Sagittarius. Unfortunately, because of the proximity of the Sun, only Mars will be easily seen with the unaided eye.

- Several triple conjunctions involving planets and bright stars in 1983: Venus-Mars, Venus-Regulus, Jupiter-Antares, Jupiter-Uranus, and Uranus-Antares. In addition, Jupiter will pass closely south of Beta Scorpii three times that year: on January 10, June 22, and September 2.

- Two fine apparitions of Venus:

EVENING SKY (from December 1982 to August 1983). From mid-northern latitudes, Venus will set as much as 3½ hours after sunset in May 1983. In this apparition, Venus will pass Mercury on January 6, 1983, Mars in Pisces on February 18, the Pleiades on April 12, Aldebaran on April 20, Pollux on May 29, Regulus on July 8, and Mercury on August 6.

EVENING SKY (from September 1983 to March 1984). From mid-northern latitudes, Venus will rise nearly four hours before sun-up in November 1983. Venus will pass Regulus on October 6, 1983, Mars in Leo on October 28, Spica on December 1, Saturn in Libra on December 17 (a very close conjunction, only 9 arc minutes separation, observable from North America), Antares on January 8, 1984, and Jupiter in Sagittarius on January 26.

- A visible conclave of all eight planets within 60 degrees of celestial longitude on the mornings of January 12-15, 1984. The group will extend from Mercury, Jupiter, and Neptune in a compact group just 3.2 degrees across in Sagittarius to Mars and Pluto in Virgo. Saturn will be in Libra, while Venus and Uranus will reside in Ophiuchus. As seen from Earth, this will be the narrowest span of the eight other planets in this century!

- Oppositions of all six superior planets within a 70-day interval in 1984, from Pluto on April 20 to Jupiter on June 29. This surpasses 1982's record of 78 days. The passage of Venus on the far side of the Sun (superior conjunction) on June 15 keeps this from being another notorious "great alignment".
- The 1984 apparition of Mars, Jupiter, and Saturn. These three bright planets can be viewed simultaneously from about January 1, 1984 (at dawn) until mid-October (at dusk). In those 9\(\frac{1}{2}\) months, their angular span remains between 49 degrees and 61 degrees. Throughout that year, Saturn will be in Libra and Jupiter in Sagittarius. Mars opens the year 4 degrees from Spica, then passes 3/4 degrees south of Saturn on February 14. Stopping short of the head of Scorpius on April 5, Mars then commences retrograde and returns to within 4.3 degrees of Saturn on the night of June 10. (Since there is no conjunction in either right ascension or celestial longitude, this event will not be noted in most astronomical ephemerides.) Mars then resumes eastward motion on June 19 and goes 2.2 degrees north of Antares on September 3. Finally, the red planet, while less than 0.1 degree north of Lambda Sagittarii (the top of the Teapot), passes 1.9 degrees south of Jupiter on the evening of October 13. Around that date, Saturn fades into the western twilight glow. After October 1984, the next chance to see all three bright superior planets simultaneously will come in March 1986. They will then span 85 degrees.

Charted in the accompanying diagram is a section of the zodiac, the celestial highway of the "wanderers" in the heavens: the Sun, the Moon, and the planets. For the next several years, this part of the sky will be the scene of many interesting conjunctions involving the outer planets.

The section shown, 120 degrees in length, slides into the eastern evening sky between March and July each year, and departs in the west between August and December. The section includes the zodiacal constellations Virgo, Libra, Scorpius, Ophiuchus, and Sagittarius. To avoid crowding, lines connecting stars within constellations have been omitted. The familiar patterns can be recognized by comparing this chart to the detailed monthly maps in the center pages of Sky and Telescope.

*Mars* will remain in this region until late November 1982, then will pass through it again from November 1983 through October 1984.

*Jupiter* remains in the region charted here until December 1984. *Saturn*, taking nearly 30 years to orbit the Sun, crawls through the zodiac at a snail's pace: it won't reach the left edge of this chart until 1990.

*Uranus* and *Neptune*, even slower, will leave this chart together in 1993.

In addition to the events mentioned in the foregoing text, there will be triple conjunctions between Saturn-Antares in 1986, Saturn-Uranus in 1988, Saturn-Neptune in 1989, and Uranus-Neptune in 1993.

Special thanks are due to Robert D. Miller, who prepared the computer-plotted ecliptic star chart for Abrams Planetarium.
Watch the Planets Move!

SYMBOLS USED ON THIS CHART:
- Alpha Vir Virgo
- Beta Lib Libra
- Gamma Sco Scorpius
- Delta Oph Ophiuchus
- Eta Sgr Sagittarius
- Theta Vir Virgo
- Lambda Oph Ophiuchus
- Omega Sgr Sagittarius
- Iota Vir Virgo
- Lambda Lib Libra

Scale: 10°
Creating Photographic Effects

by Ray Villard, Producer, Davis Planetarium, Maryland Academy of Sciences, 601 Light St., Baltimore, Maryland 21230

Abstract

A number of photographic techniques can be used to significantly enhance the visual quality of a planetarium show. They provide an economical and creative alternative to contracting additional artwork to achieve such visuals. Most special photographic effects can be accomplished with a modest amount of equipment and time. Special effects discussed are all accomplished in-camera, in the process of slide duplication. Specific techniques include: multiple exposures, color enhancing, posterization effects.

Description

The increasing use of multi-media automation systems in major planetarium theatres puts more demand on the producer to create sophisticated visual sequences. A program's appearance can be greatly enhanced (while minimizing increases in production time and cost) if the producer has a repertory of creative photographic techniques. One of the biggest advantages of in-camera effects is that they free the staff (or freelance) artist to focus his/her time on the more demanding illustrations in a show. Special photographic techniques do not necessarily require elaborate and expensive equipment, but rather a working knowledge of photographic film processes, and creativity.

Most special effects techniques require re-filtering, multiple exposing, or otherwise manipulating a color slide in recopying.

Professional "slide copiers" complete with bellows, camera mounting, and lamp source can range from $500 to $1,000. At the heart of most of these devices is a dichroic lamphouse. It consists of a steady color temperature quartz halogen lamp and three variable density fade-proof dichroic filters (cyan, magenta, yellow). A dichroic lamphouse alone (sold for color enlargers) can be purchased for under $200. Since most planetariums already have a copystand and camera with macro lens for photographing reflection art, a lamphouse alone is all that is needed for starting creative slide copying. A dichroic copier is the photographic equivalent of an artist's color palette. Since the device's three subtractive filters are continuously variable, virtually limitless color range is available.

FILM SELECTION. Ektachrome 5071 slide duplicating film will minimize contrast build-up, and is tungsten balanced. Ektachrome EPY-50 is higher in contrast, but offers the advantage of copying slides and reflection art all on one batch of film.

Kodak Vericolor Slide Film 5072 complements EPY-50 in that it produces a negative image, and hence reverses the colors of an original. Though not very practical for normal slide copying this film provides added flexibility and production shortcuts in creating graphic effects. Since the film's base comes out clear when unexposed, custom color gels that filter selected areas of a kodalith slide can be photographically created. The film is also handy for turning color negatives into transparencies, or B & W negative into color-tinted slides.
SIMPLE OPTICAL ENHANCEMENT. The dichroic copier’s ability to make both subtle and/or dramatic color changes allows images to be “recycled” and used in a different context in the show. For example, a grey partial moon pan can be transformed into a glowing primordial moon through dialling up a deep orange-red filtration. A “glow” is added through the use of a haze filter. In another example, a kodalith lightning bolt can be improved by copying it on to color film and adding a blue-white or orange-yellow tint. Adding a “glow” filter and over-exposing by two F-stops dramatically enhances the image.

COMPOSITES. A dichroic copier allows you to optically combine color and kodalith images on a single piece of film (through multiple exposures) and even change color filtration between exposures. Color can be added to a kodalith chart or graph by recopying it on to EPY-50 with a selected color dialled in. The film is next re-exposed to the dichroic’s blank stage with a different color selected. This “washes” the film with a background color that gives added depth. As a rule of thumb, background colors should be one of the primary additive colors (red, green or blue) and underexposed by one or two F-stops. This assures that a chart won’t be washed out by a background color. This technique is also useful for adding labels to color visuals. Kodalith lettering can be “burned” into a color slide through double exposing. The lettering can be kept white or lightly filtered, depending on the color and density of the pictorial slide.

POSTERIZATION. Eye-catching graphics can be created purely in-camera. The first step involves copying a color slide on to litho film to get a high-contrast image. Degree of contrast can be controlled through selection of film developed. Kodalith developer offers highest contrast and density, while lower contrast will result from Kodak HC-110. The kodalith separation is then re-exposed on to color film with a selected dichroic filtration. The kodalith slide is removed and the film re-exposed to a background color “wash”. Depending on the color combination selected in the double exposure this can provide subtle to dramatic effects.

Another approach involves sandwiching a positive and negative litho separation. If the two frames are mounted slightly out of register a clear, white “fringe” will result. It will outline details of the original picture, resembling line-copy which would normally be generated by an illustrator. The sandwich is then exposed on to EPY-50 with color filtration.

Though more involved and time-consuming, an even more unique and striking effect can be produced by sandwiching positive and negative color separations of an original. First, copy a color original on to kodalith film. The kodalith copy is next double-exposed on to EPY-50, producing a high-contrast color graphic. A second high-contrast color image possessing shadows and highlights opposite to that of the EPY-50 separation, is next produced by copying the kodalith on to Vericolor Slide Film. Since this is a negative film, it will also produce colors opposite to those dialled up on the dichroic.

In the last step, the EPY-50 and Vericolor copies are sandwiched together. Depending on the filtration selected, this produces a unique image containing several different colors and tones.

In summary, a wide range of unique photographic effects can be produced through the use of a dichroic slide copier. A show’s visual appearance can be greatly enhanced through such effects, while minimizing added production time.
This photograph illustrates one of the uses of a dichroic slide copier. The different visual elements (earth, comet and spacecraft) were separately exposed on to a single piece of film. Such compositions are quick and easy to produce with an adequate slide copier.
A $75 Synthesizer For Your Dome

by Dee M. Wharton, Band Director, Yukon (Oklahoma) Public Schools Instrumental Music Department: Music Consultant, Kirkpatrick Planetarium

The Casio VL-1 portable synthesizer is more than just a hand-held musical toy - it can be put to great use in creating or reinforcing planetarium soundtracks. This paper will review the capabilities of the VL-1 and demonstrate its possible planetarium production uses. Included will be taped excerpts of musical pieces produced with basic audio studio equipment and the VL-1.
Effective Media Manipulation

by John G. Wharton, Director, Kirkpatrick Planetarium, Omniplex, 2100 N.E. 52, Oklahoma City, OK 73111

The Jupiter Effect caught many of us off-guard in dealing with the intensity of the public and media interest. Some planetarians came away from the Jupiter Effect hype feeling manipulated by the media. This paper will show you how you can get even with the media, beat them at their own game, and make the most of your least expensive form of promotion in the process. Topics included will be “Press Releases Your Local Paper Can’t Avoid Printing”, “How NOT To Do A Radio Interview” and “Making The Most Of TV Exposure”.

Where Is That Darned Moon?

by Elizabeth C. Whitehouse, Planetarium Director, Sayville Public Schools, N.Y. 11782

For thirteen years I have been directing, maintaining, and been “your-my-everything” for a middle-size planetarium in Sayville, Long Island. Along with running the installation for ten different participating school systems, I have found the time to do a little wondering. The question was, and is, “How can I make the programs so exciting that people will be knocking down the doors to see the productions?”

Our programs were well received, but I noticed that the audience never participated. The planetarium was viewed as a movie production. The answer to my question seemed to come in two parts: Use the spectacular dome of stars to better advantage; initiate an observation competition. I made ditto’s of a map of the skies over Long Island and I ordered pens with the planetarium name printed on them. The cost was very little and it was a form of advertising. At the beginning of each program we spent five minutes observing the evening skies. The lights were put up and the challenge was made. It is this competition that will be demonstrated along with the “prizes”.

Two variations of Where Is That Darned Moon? will illustrate the technique used for a general audience and a very young group. The doors to our planetarium are still standing, but we have had more reservations than we can accept. This has been exciting.

An observation is more than a look,  
Just as reading is more than a book,  
So, if you look but do not see,  
Overcome this oversight immediately.

The greatest asset that any planetarium has is the fact that it accurately portrays the skies. The audience does not always appreciate this. Most of the time we, the Planetarium Directors, ignore this fact when we should capitalize on the remarkable domed screen that we use. I will suggest a remedy that will complement and enhance the newest and best of any of our programs. Begin with a five-minute lesson in observation that will change the average passive “looker” into an active participant. It is a competition. Just as running faster is achieved by pitting one’s abilities against others, so accurate observations may be made into a skill that rewards the audience as well as the planetarium.
A Survey of Planetarium Non-Automation Microcomputer Use

by Kenneth Wilson, Morrison Planetarium, California Academy of Sciences, Golden Gate Park, San Francisco, California 94118

ABSTRACT: "Our Mikey is the best Microvac in the whole world!" - Jerrodette I, from the Strasenburgh Planetarium version of Isaac Asimov's The Last Question.

This paper presents the results of a recent survey on the use of microcomputers by planetariums for non-automation related purposes. Data on what sorts of hardware and software are in use, and what tasks they are being used for, was collected. The feasibility of software-sharing and a possible planetarium microcomputer newsletter were also explored.

It seems that microcomputers are everywhere these days - an intelligent, silicon-based life form which has recently found our planet a fertile breeding ground. Planetariums have not been immune to this invasion. Not only are microprocessors increasingly controlling our special effects, but astonishingly powerful and versatile microcomputers are increasingly found in the planetarian's office.

The usefulness of microcomputers in doing complex and repetitive astronomical calculations is obvious. But these machines are also very handy for word processing of scripts, budget making, reservation taking, income and attendance statistics, and more.

For the past year or so, the staff of the Morrison Planetarium have discussed adding a microcomputer to our staff. But which one? There are so many on the market these days. It seemed logical that whichever machine we chose, it should not only be able to do the many tasks we had in mind, but it should also be compatible (as much as possible) with the microcomputers that other planetariums had. This would allow a ready exchange of the often specialized software that might evolve or that already exists. This led me to devise a survey.

The primary goal of this survey was to determine which, if any, microcomputers were in use at other planetaria. At the same time, however, it seemed prudent to find out: what planetaria were using their microcomputers for: what sorts of software they were using, and whether or not they were willing to share any of it. I also wanted to know if there was any interest in starting an I.P.S.-sponsored newsletter for planetarium microcomputer users. So, questions on these topics were also included. The survey was mailed out to 54 planetaria, the selection of which was somewhat arbitrary. Not having the time or resources to send the survey to every planetarium, I selected those with 50' or larger diameter domes, who were likely to have similar needs to our planetarium. Surveys were also sent to any planetarium, regardless of size, which had, to my knowledge, used microcomputers in a non-automation context. I would like to broaden the base of this survey, so additional copies of this survey will be distributed at the I.P.S. meeting in Vancouver this summer. I would welcome letters from others regarding their experiences with microcomputers for non-automation planetarium uses, even after the I.P.S. meeting.

Although the surveys have not yet all been returned, enough have been completed to see some interesting trends. Those wishing a complete copy of the final results should send a self-addressed stamped envelope (business size) to the author: Kenneth Wilson, Morrison Planetarium, Golden Gate Park, San Francisco, CA 94118.
It seems that there are quite a number of microcomputers already in use among planetarians. Nineteen of the 30 respondents so far say they either have a microcomputer or access to one through a related facility. Of the 11 that did not have a microcomputer, six planned to acquire one within the next year. Of those that had a micro, 11 had Apple II+; two had Commodore PETs; and one each HP-9845B, Northstar Horizon, Exidy Sorcerer, IBM System 34, AVL Eagle, and one home-built. One respondent had, in addition to his other computer, a TI 99/4. Of the five respondents who did not have a microcomputer but planned to acquire one within the next year, three said that they planned to get Apple II+'s, one planned to get an AVL Eagle, and one was undecided. Thus, the trend seems to be towards the Apple II+ as the most common machine.

The survey also asked the respondents to rate in order of importance a list of possible uses of a microcomputer. Unfortunately, a number of respondents only checked off items on this list, rather than numerically rating them. This makes it impossible to do a precise numerical rating of each use. By adding up the number of times a particular item was checked or numbered, however, the relative importance of each use, in general, can be seen. Thirteen respondents indicated that they used their microcomputers for astronomical calculations. Twelve used them for word processing (scripts, letters, etc.) Twelve used them for educational purposes (classroom tutorials, lab exercises, demonstrations, etc.) Eight were used for computer graphics. Six were used for financial purposes (budgets, etc.). Three were used for reservations and scheduling. Three were also used for inventory purposes. Two were used for exhibit design, and two more respondents used their micros in actual exhibits.

Listed under the "Other" category were the following uses: mailing lists, software development for future exhibits, video disc control, publications department management, electronics development, and data reduction for research.

There seems to be a growing amount of astronomy-related software. Most planetarians expressed a willingness to share their in-house and public domain software.

Of the 19 respondents that had microcomputers, 16 expressed an interest in seeing an I.P.S.-sponsored newsletter on microcomputers for planetarians. Several excellent articles on computer use have appeared in The Planetarian, but the space limitations for program listings and the sometimes capricious publication schedule of The Planetarian suggest that a separate newsletter on this topic might be more effective. Twelve of the respondents also expressed a willingness to contribute to such a newsletter. And, most amazing of all to me, four were willing to edit such a newsletter. It is hoped that these interested individuals will find time to get together at the I.P.S. meeting to formalize plans for such a publication.

The most important conclusions that can be drawn from this survey so far are: (1) there are a good number of non-automation microcomputers in use by planetariums; (2) by and large, the most popular machine seems to be the Apple II+; (3) predominantly, these machines are being used for astronomical calculations and word processing; and (4) there seems to be substantial interest in sharing information on microcomputers and software via an I.P.S.-sponsored newsletter.
**ABSTRACT : HARD TIMES FOR THE STARS**

During 1980 the Maryland Academy of Sciences was forced to make drastic cuts in its operating budget in order to survive. Staff layoffs, curtailment of production budgets and other forced economies resulted in a rethinking of planetarium priorities and production methods.

This presentation discusses the priorities we placed on various services performed by the planetarium, the use of outside talent on a contract basis to reduce expenses and other means employed to increase the cost effectiveness of our operation and ensure our survival.

Time: 10 minutes

Equipment: Slide projector

**ABSTRACT : THE VOICE TRACK**

Planetariums typically expend the bulk of their show production time and budget on visual hardware and software. The audio portion of most shows, however, especially the voice track, usually carries the bulk of the show's information.

This presentation discusses the selection of a narrator, methods that can be used to get the best possible results during a recording session, equipment and equalization techniques and the importance of the editing process as it applies to the voice track.

Time: 20 minutes

Equipment: Open reel tape recorder (7.5 IPS, half track, ideally with remote stop/go available to the speaker). Slide projector may also be needed.
CASSANDRA, a multi-media audiovision designed exclusively for planetariums, will, in a unique alchemy of sound and image, prove irrefutably that the planetarium is a full-fledged medium in its own right. In so doing it will open a whole new field of possibilities which promise to expand the limits of the planetarium.
It is perhaps easier to view the planetarium as an auditorium with audio-visual facilities than as a separate medium. A definition of terms may dissipate this notion. A medium possesses three major defining characteristics. Firstly, it is a conduit by which information is communicated. Secondly, it must possess characteristics and capabilities that are unique and which differentiate it from other media. Finally, it is not message specific, i.e., it can, within the limits of its technology, transmit any content.

The first two criteria are easily met. To begin with, the planetarium's raison d'être is precisely the communication of information. Secondly, it possesses capabilities which can be found nowhere else. Its unique dome screen surrounds and overwhelms the spectator. It creates, furthermore, a strong illusion of three-dimensionality and depth which can be used to great effect.

The planetarium device is an intricate piece of machinery which can produce effects of incredible realism and magnitude. Finally, the incredible array of audio-visual projectors, some of them designed specifically for planetariums, surpass anything that can be found in other facilities. These three elements combine to permit an audio-visual virtuosity unmatched in kind or magnitude anywhere else.
THE STORY

Somewhere in the immensity of space present and future meet as two races lock in mortal conflict, reliving the universal drama of the Trojan War.

Two people. Two minds. THE ARGOTIANS, a barbaric warrior sect led by the cruel Agamemnon. Technology is at the service of evil as they march under the blood red banner of conquest.

THE TROJANS. Citizens of a universe where wizardry and wisdom flourish, blessed by the Gods Aphrodite, Apollo and Athena. Cassandra, their priestess, warns them of the impending doom, but in vain.

Overwhelmed by the sounds and images of an unknown galaxy we witness the battle that neither can win. The terrible seige begins, and the past echos into the future as Cassandra’s lone voice goes unheeded. Wisdom is naïve. Technology triumphs again as it did in the time of the Trojan horse.

The Planetarium can vehicle any show

T he third criteria is more controversial. Planetariums were devised as instruments of astronomical vulgarization. Traditionally, the only shows presented were those which dealt with astronomy. CASSANDRA’s contention is that this need not be the case. There is no real impediment to the presentation of shows which, while not astronomical, are nonetheless of significant cultural or artistic value. To not do so would be to limit the usefulness of the planetarium as an educational tool.

The laser shows have demonstrated that planetariums can successfully present non-scientific shows. They have pioneered an evolution in attitudes which is essential for a fuller exploitation of the audio-visual capacities of the planetariums. Yet the laser shows do not recognize that the planetarium is a self-sufficient, full-fledged medium. They bring in their own equipment and utilize only the planetarium screen. Furthermore, their show is pure entertainment, with no cultural or educational value.

CASSANDRA will expand the limits of the planetarium

CASSANDRA goes much further. Its dramatic story unfolds through the projection of drawn settings and characters. It blends a variety of elements in the crucible of the planetarium to create an exciting swirl of sight and sound which will draw the viewer into the ageless tragedy of Troy. But it will do so using only the facilities inherent to the planetariums in order to prove that they are a self-sufficient medium capable of presenting a spectacular mass entertainment.

CASSANDRA will not bring any of its own equipment. Rather, as it tours from city to city it will adapt itself to the technical particularities of each planetarium. The intent is to exploit to the utmost the potential of each individual planetarium.

In addition to its unique utilization of planetarium facilities, CASSANDRA will also be the first show to fully integrate holography within a dramatic context, thereby elevating this exciting new medium above its present use as a show piece. Several holograms will represent the gods of Troy and will animate whenever the gods are called into action. These holograms will integrate beautifully with the three-dimensional illusion of the dome-screen to further enhance the spectacular nature of the story.

Though CASSANDRA is a spectacular epic designed to be a mass-appeal entertainment, the spectacle is not gratuitous. CASSANDRA expresses, above all, the conviction that cultural value and entertainment need not be mutually exclusive. The story, based on the classical myth of Troy, draws its plot and characters from Greek mythology but updates it and recasts it in the immensity of space. It is a fresh look at an ancient tale that harks back to the most hallowed traditions of Western literature. Its educational value should not be minimized.

Further than any other planetarium show

CASSANDRA, then, is a spectacular epic which goes much further than anything previously seen in planetariums. Its determination to utilize the planetariums’ capacities to their fullest and to adapt to each planetarium’s individual characteristics combined with its cultural, educational nature make it a much more ambitious, appealing enterprise than the laser shows.

CASSANDRA, nonetheless, seeks to draw a large audience in order to fulfill its objective of popularizing the planetarium as an exciting medium capable of competing for the entertainment dollar. To this end a complete marketing plan has been devised to generate interest in and publicize both the show and the planetarium. Included in the marketing mix is a $40,000. advertising budget to be spent in each city which presents CASSANDRA. This substantial expenditure combined with the exciting and spectacular nature of CASSANDRA permits a conservative expectation of 60% attendance.
The Planetarium will be popularized like never before. This considerable occupancy rate will have two results. For one, it will popularize the planetariums to an extent never before seen, and will do so with a high quality cultural show. Secondly, CASSANDRA will allow the planetariums to substantially increase their revenues during the run of the show. Both these consequences will further the planetariums' efforts to educate and entertain its clientele.

Ultimately, CASSANDRA seeks to blaze the trail, to create a new type of planetarium show. CASSANDRA is a grand-scale epic spectacle that will engulf the spectator in a welter of sounds and images to transport him to a distant galaxy. And, in so doing, it will expand the limits of the planetarium opening to the world the full potential of this exciting medium.

Holography

The ultimate in total visual representation, holography is on the threshold of revolutionizing, even more radically than photography, our mode of seeing and perceiving. It transcends all barriers of age and sex because it is reality in its full dimensionality.

Recent developments have brought holography to the threshold of the mass distribution necessary for the full realization of its immense potential. Originally laser produced, its three-dimensional image can now be reconstituted by simple white light. Furthermore, various types of holograms have been developed for different uses and scopes.

The integral hologram is one of the many kinds of holograms. This type shows a 360 degree image reconstituted in a clear plastic cylinder through the projection of a white light mounted on a rotating base. The dramatic effect is further enhanced since, by this method, the three-dimensional image can be animated.

Integral holograms of at least one metre will be used in CASSANDRA to represent the Trojan gods.

CASSANDRA is produced by Rudy Barichello, André Lauzon and Vincent Robert of ARMADA PRODUCTIONS, Inc., 7265 Sagard, Montreal, Canada H2E 2S6. These gentlemen will lecture at the International Conference in Vancouver.
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Contributions to the Society are tax deductible and are especially important to support the initiation of exploratory programs and the Search for Extraterrestrial Intelligence (SETI).

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As part of its comprehensive program supporting astronomical research and disseminating astronomical information, the Society:

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  Mercury, first published in 1972, is an illustrated magazine featuring non-technical articles on new developments in astronomy. It is written by astronomers actively engaged in the research they are describing, but edited to be accessible to the interested layperson.

- Issues regional directories of astronomy activities, listing all observatories, planetaria, amateur clubs, science museums, astronomy courses, and telescope stores in each area of the country.

- Distributes a monthly sky calendar and star chart describing the appearance of the night skies from week to week.

- Makes available a full catalog of educational materials in astronomy, including books, slides, prints, posters, tapes, and observing aids. (For example, the best images from all...
the recent planetary probes are available from the Society in sets of prints and slides accompanied by detailed captions and mission summaries.)

• Produces a series of introductory information packets on astronomical topics, such as black holes, the alignment of the planets, viewing eclipses, and getting started in astronomy.

• Compiles and distributes a variety of bibliographic materials, including introductory reading lists, indices to astronomy articles in popular magazines, and references on distinguishing science from pseudo-science (such as astrology). Thousands of copies of these materials have been sent to schools, libraries, observatories and individuals requesting them.

• Sponsors a number of annual public lectures by prominent astronomers, offered in cooperation with amateur astronomy groups and educational institutions.

• Holds a major astronomical symposium on a topic of current research interest as part of its yearly scientific meeting. (Recent topics have included "Quasars and Active Galaxies," "New Designs for Telescopes," and "Late Stages in the Evolution of the Stars.")

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• Acts as a clearinghouse for reliable, up-to-date astronomy information for the media, providing news items on recent developments and the names of astronomers who can do longer interviews.

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  - Small portable systems.

* Heliostat

* Coelostat & Solar Spectro Projector
  Major installation model as well as portable science room unit.

* Telescopes
  Refractor & reflector types.

* Pyrheliometer
  Simplified pyrheliometer to measure solar constant, for daily experiment.

* 70mm Multi-Screen Slide Projector
  For multi-media shows, 70mm slides projected on multi-screens up to 12m x 12m.

* Sky Graph
  Precision equatorial camera mount for astro photography. (Crystal oscillator accuracy: \( \pm 5 \times 10^{-6} \).)

* 35mm All-Sky Movie Projector
  Up to 15m/\( \phi \) dome screen.