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Hubble Heritage: Poetic Pictures

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I am Wendy Ackerman, Producer at the Davis Planetarium in Baltimore, Maryland. I’m coordinating a project called *Hubble Heritage: Poetic Pictures* that will blend science education and planetarium production with creative writing and a bit of performance art.

The goal of the poetry project is to create an awareness of the Heritage collection and the aspect of having some creative fun with some beautiful scientific images.

We are all familiar with the stunning images from the Hubble Space Telescope (HST), and many of us are also familiar with the Hubble Heritage collection of images.

The Hubble Heritage Project sees HST as a tool for extending human vision, a tool capable of building a bridge between the endeavors of scientists and the public. By emphasizing compelling HST images distilled from scientific data, the Heritage team hopes to pique curiosity about our astrophysical understanding of the universe we all inhabit.

The Heritage images are mined from HST archives but the Team is also granted some observing time of its own. One image is released the first Thursday of every month and the collection now has over 50 images including planets, galaxies and nebulas.

The Davis Planetarium resides at the Maryland Science Center in Baltimore, Maryland. Being on the Inner Harbor, a tourist destination, the Maryland Science Center is one of many attractions area visitors can choose from.

The Maryland Science Center collaborating with the Space Telescope Science Institute (also located in Baltimore) will pave a new avenue of space science education at the Davis Planetarium and perhaps other theaters as a result.

The poetry project is grant funded by NASA’s IDEAS grant program. The following statement of purpose from the IDEAS web site provides some background.

The IDEAS Grant Program is administered by STScI on behalf of NASA’s Office of Space Science Education and Public Outreach Strategy. It provides start-up funding for innovative, creative education and public outreach projects that feature active collaboration between astronomers/space scientists and education professionals. The IDEAS objective is to enhance science, math and/or technology education in the U.S. for students, teachers and the general public by promoting partnerships that explore translating astronomy and space science in ways that will educate and stimulate the interest of students, teachers and the general public.
Project activity will focus on sixteen students from Baltimore City College High School, who will be coordinated by an English teacher.

The High School’s building looks of classic gothic architecture and is a Baltimore landmark. Founded in 1839, it’s the 3rd oldest public high school in the country and the student population is considered under-served.

Over the course of six months or so, student visits to the Maryland Science Center and the Space Telescope Science Institute along with Principal Investigator’s visits to the school, students will get a thorough introduction to the Heritage collection including what the images are and how they came to be.

Hubble Heritage Principal Investigator, Keith Knoll, will provide science interpretation for the images.

Once students choose their favorite image from the Heritage collection to compose a poem about, further instruction on the science behind it will be provided.

Student’s original work will be the basis of a live performance including the image treated visually on the dome. The same poems will also be incorporated into an automated planetarium program that will play for general museum audiences, school groups and teachers.

In addition to the student component of the project, a teacher workshop will be held for first year teachers. Along with a full day’s activities, the teacher participants will be expected to create a bulletin board in their classrooms to highlight the Hubble Heritage collection, it’s monthly releases and encourage students to compose original poems on an ongoing basis.

In brief — start up funding for innovative ways that enhance understanding of space science is worth pursuing!! Check out the web site and submit your ideas to IDEAS.

Project related web sites:

- IDEAS http://ideas.stsci.edu/
- Hubble Heritage http://heritage.stsci.edu/
- Maryland Science Center http://www.mdsci.org
- Baltimore City College High School http://knight.city.ba.k12.md.us/
Digital Planet Scales

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Abstract: In 1980, we modified a Heathkit digital scale to read your weight on the Moon and the other planets. Our motivation to do this came from a SEPA Newsletter article by Fred Carr, Hummel Planetarium Technician at the time.

We have an Anteroom adjoining the University of Wisconsin - La Crosse Planetarium. Two of its walls are lined with posters that we sell. A third wall has glass display cases that contain astronomy, space, and science fiction items. In addition, there is a rack on the floor with t-shirts that we sell. The only interactive exhibit that we have is a digital planet scale.

We bought the scale in kit form from Heathkit after seeing a 1979 article in the SEPA Newsletter by then Hummel Planetarium Technician Fred Carr. Carr gave directions in the article for modifying a Heathkit Model GD-1186 Digital Scale (The Weighing Machine) so that it would show your weight on the Moon and them other planets. The modification required inserting a 10-position rotary switch in the scale’s circuit. It also required removing three electronic components, and using one of them (a 2k variable resistor) in a new sub-circuit consisting of the switch and 9 resistors. (One of the resistors is used for both Mercury and Mars, as your weight would be about the same on these two planets.) Since the maximum Earth weight the scale can read is about 425 pounds, the weights are not accurate for Jupiter for Earth weights over about 150 pounds. This is a minor inconvenience, and we have never had any complaints about it! Most people wouldn’t notice anyway! People love to weigh themselves on Pluto, but they avoid Jupiter like the plague. When lines form with school groups, we usually ask the kids to weigh themselves on Earth and one other planet.

Originally, the scale was powered by 6 C cells. Replacing them fairly often was putting a drain on our supplies budget. So, we switched to a DC Lab Volt supply that was donated to us by our Physics Department. The only other problem we have had is that the pins at the tips of the lever arms occasionally cause an arm to fall off, and it has to be set back up when it does. This only happens once every couple of months.

The scale is not available today, but a similar modification could possibly be made to other digital scales. I would be willing to send anyone who’s interested copies of the circuitry modifications by snail mail if they contact me.

Bob Bonadurer of the Minneapolis Planetarium had a custom digital scale built for them in 1993 by Berne Scale Company, 2206 Edgewood Ave. S., St. Louis Park, MN 55426 (612-544-2422). The cost was about $3,000. It is very durable, and, in spite of heavy usage, they have had no problems with it in nine years of use. They call it their “Way Out Weigh Scale”. It also can weigh you on the Sun, in addition to the Moon and other planets!
Figure 1 - Bob Allen in the University of Wisconsin - La Crosse Planetarium Anteroom

Figure 2 - Digital planet scale

Figure 3 - Switch for selecting a planet

Figure 4 - Scale with cover plate off

Figure 5 - Close-up of scale reading
Working on Digital All-Skies and Panoramas

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Abstract:

The A/V team at the Planetarium of Pamplona has been working on the development of digital scenes for the shows since mid 90s. Our main aim has been getting the most of commercial software available at the time and, parallel, creating specific proprietary software to perform all duties required: manipulation of photographic originals, creation of synthetic scenes, both 2D and 3D, getting a panorama strip or an all-sky “pie” which would be distorted with software for dome projection.

Recent work done tries to control the quality of the projected images: getting [improved] resolutions, filtering to improve contrast and colour, and distorting to correct the dome projection issues.

Besides, we are engaged in several projects of cooperation with the University of Zaragoza Computer Science Department and State University of Navarra Computer and Mathematics Department in order to achieve mechanisms that can ease some parts of the processes and -in a future- generalize them to include All-Sky video projection.

Introduction

The use of computers to work with photographic images has changed, it is known, the way we work and the visual skills of our planetarium shows. Those who love classical photography (we included) feel some nostalgic feelings for those which have been our workmate during long long ours: the dark room, the “truca”, the revealing baths, the spirals and all that magic that goes with the creation of the image on the wet photographic strip after taking it off the revealing tray. Nevertheless, things have changed. Nowadays, with a computer and a slide printer adjusted sufficiently, we can perform many things that we couldn’t even imagine before, with much less time and money. This implies that with the same eagerness and workers that some years ago, now we can make more shows, we can put in our dome more ideas and with a level of excellency much higher.

Besides, the images obtained with these new techniques can be easily shared among planetariums with different dome size, type, arrays of projectors, etc.

The conclusion is that here is a new way of working, so different from the “ancient” one, with new specificities, needs and perspectives.

There are, however, some remnants from before. We currently use classical cameras and photographic film to shot the originals and classical projectors and slides to put the final images on the dome. Of course, this will change into digital devices in the next years.

The Panorama Strip

One of the most successful achievements we have made these years is to standardize the panorama strip. In Spain, we currently interchange these scenes among planetaria. The panorama strip includes the 360 degrees of a landscape assuring the continuity between the beginning and the end of the file.
The All Sky Pie

The All Sky Pie is a generalization to the entire dome of the panorama strip. It is a circular image that represents a projection to a plane of the entire dome.

We make All Sky pies using 3D rendering software and photographic retouching software. The process varies with the type of scene we are representing, but we can define these steps for a typical photographic all sky:

1. **Scanning of the six originals.** We use the higher resolution that allows our slide scanner, 2700 ppi.
2. **Cylindrical distortion.** We pass every image into a cylindrical distortion module because the images include a part of the scene that is below the horizon line. This module vertically compresses the image.
3. **Mapping on a sixth of the dome.** Every of these predistorted images are planar mapped on a part of the virtual dome which take in sixty degrees width and ninety high.
4. **Mapping edition.** We move, rotate and magnify every mapped image in order to find good transitions between adjacent images.
5. **Final image.** Once the transitions between images are good, we shot the entire dome from a camera placed at some point in the vertical line of the dome. The exact position of this camera (which can see all de dome) depends on the final aspect wanted for the scene. This image is rendered to 7200x7200 pixels. The aspect of this image is a circle inscribed in a square, inside the circle is the entire scene.

However, we are developing a new software specifically designed to generate them starting with six images obtained with a 16 mm lens (the standard photographic lens used to obtain the originals). This specific software is based on the projection of every of the original images on the circular area representing the dome. Some tools of magnifying, rotating, moving and spherize will be added in order to allow a correct adjustment between adjacent images.
The usual All Sky pie has 7200x7200 pixels, i.e. in RGB mode and eight bits per pixel leads to an image of 148.4 Mb. Again, this is a reasonable compromise between the quality of the final images and the capability of our computers to process big images.

The final images are 2550 pixels width and 3835 pixels high (28 Mb)

Once the All Sky pie is generated, we filter it in order to stick borders up, to emphasize colour saturation and to focus the entire scene. We use unsharp mask filter and other ones that draw contours. Like in the panorama strip, there is no a fixed rule to perform this filtering due that it strongly depends on the scene itself. The main goal is to get a scene with much strength, contrast and colour masses. This has to be quite exaggerated in the screen because on the dome this scenes trend to appear low contrasted and poor coloured.

**Overlapped video**

As a collaboration with the University of Zaragoza Computer Science Department and State University of Navarra Computer and Mathematics Department, we recently started a project to create a program to work with overlapped video.

The general idea consists on defining a program to edit and generate video scenes that are going to be projected for several video projectors. There will appear a working area on the computer screen that will correspond to the area to be projected on the dome. The software will generate as many video sequences as video projectors are involved. We are not interested in interactivity so our goal is to generate as many video files as video projectors are defined. Every video projector will have its own video source.

This system will be able to compose partial or full video panorama scenes and may be in the future also Video All Sky.

Next IPS (Spain 2004) we’ll see how this works.

**ANNEXE 1: Our little history**

It is said that the best way to learn walking is to walk. So that is the way we’ve been updating our production techniques while we were producing new planetarium programs through years of work.

We opened in 93 with a classical planetarium program called “Vía Láctea” which included lots of photographic panoramas and allskies. We had too, our first contact with video animation and editing (a travel starting in the Earth up to the entire vision of our galaxy the Milky Way)

Next year (94) we introduced our first digital photographs in a planetarium program for children called “El Circo de las Estrellas” (The Circus of the stars). There were some drawings of the protagonist and a digital panorama which was a version of what’s left after a meteorite falls into a photographic landscape. We composed the panorama strip adding one by one a picture after the other working with a Mac II vx (at 25 MHz) with 8 Mb RAM and a hard disk of 80 Mb (Goods, I don’t know how we could do that!)

“Crónicas Marcianas” (Martian Chronicles - 1996) had all the master images in digital format but all of them had to be passed through the truca to be fitted on the dome. There were more than 10 panoramas, half a dozen allskies and dozens of middle dome slides. An important fact of this show was the creation of panoramas based on the paintings of some famous painters: Van Gogh, Goya or El Greco, which illustrated some of the historical hints of the program.
El Universo de Lorca (1998) was the first program in which we put scenes without using the truca. The scenes were composed, edited, distorted and masked in the computer and then printed in our slide printer. Those slides were put in the projector trays of our star theatre. The use of panorama strips were generalized by that time.

Abuela Tierra (Grandma Earth) some months later included our first attempts of an All Sky Pie. This new image format showed its natural way to be used in conjunction with commercial software for planetarium domes. We started with computer generated animations of characters: a hammer fish swimming underwater (a virtual A/S with ripple effect) and a drawing of the Earth speaking.

January 2000, the first “tecnoplanetario” meeting was held in Pamplona. Producers of all the planetaria in Spain came here to share our new digital techniques for creating scenes for planetarium. From then on, all of us can share panoramas and allskies just in digital format: panorama strips and All Sky pies.

Christmas 2000, Dibujos en el Cielo (Drawings in the Sky) includes several animations of a Sun and a Moon speaking with the mouth synchronized with the audio tape. Our truca is almost resting in peace.

For a quick reference of our planetarium programs see:

http://www.ucm.es/info/Astrof/pamplona/pp-plane.html
or the main page: http://www.pamplonetario.org

Now were checking out new ways to create All Sky pies, new techniques for computed generated video and new filters to improve the aspect of the scenes in the dome.

ANNEXE 2: Some Examples

1.- Process to create a panorama scene

1.1.- Scanning of the originals.

1.2.- Creating the panorama strip
1.3.- Editing the panorama strip. Cleansing, masking the sky and filtering

1.4.- Getting the individual images that go to the projector trays

2.- Process to create an All Sky scene

2.1.- Scanning of the originals

2.2.- Getting the All Sky pie
2.3.- Getting the individual images that go to the projector trays

![Individual images](image1.jpg)

2.4.- The result

![Result](image2.jpg)
Astronomy Brain Bowl

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Florida’s Indian River Community College participates in a statewide competition every year. This “Brain Bowl” pits teams of students against each other, testing them on their knowledge of science, math, geography, history, literature, art and music. Quite a few astronomy questions are asked during the competitions. Here are some of the best astronomy questions, culled from the past few years’ competitions. These questions may seem simple or easy to you, but they have proven to be a real challenge to some of the best student teams - an indictment perhaps of the lack of good astronomy education in our secondary schools, colleges and universities.

QUESTION ANSWER

In Astronomy, distances in space are measured by units of great length. What is the name for the astronomical unit of measure as defined by the average earth-sun distance? Astronomical Unit or A.U.

In the moon’s orbit of the earth, there are several noteworthy positions. What is the astronomical term for the position occupied by the moon when it is directly between the sun and earth? Conjunction or New Moon or Syzygy

What is the astronomical term for the position occupied by the moon where it is 180 degrees away from the sun’s position? Opposition or Full Moon or Syzygy

What is the astronomical term for the position occupied by the moon where it is 90 degrees from the sun’s position? Quadrature or Quarter Moon or Half Moon

What celestial phenomenon is the basis for the 29.5 day synodic month? One full cycle of moon phases

At what phase of the moon do solar eclipses occur? New Moon

At what phase of the moon do lunar eclipses occur? Full Moon

What earth motion is responsible for the solar day being 4 minutes longer than the sidereal day? revolution
What is the name of the 18 year, 11 day cycle of solar and lunar eclipses? Saros
This Seventeenth Century Italian astronomer was first to see and report on the discovery of Jupiter’s moons: Galileo Galilei or Galileo
This Seventeenth Century Dutch astronomer was first to resolve Saturn’s rings: Christian Huygens
This English astronomer, who discovered the planet Uranus in 1781, also found evidence for the disk-shape of the Milky Way Galaxy: William Herschel
This German astronomer discovered the eighth planet Neptune in 1846: Johanne Gottfried Galle
This American astronomer discovered the ninth planet Pluto in 1930: Clyde Tombaugh
This Italian astronomer discovered the first asteroid, Ceres, in 1801: Fr. Giuseppe Piazzi
This American astronomer discovered a connection between the absolute magnitudes of Cepheid variable stars and their light curves, providing a useful way to measure great galactic distances. Henrietta Leavitt

This American astronomer found evidence for a much larger Milky Way Galaxy, and that the Earth and Solar System were not at the center of it. Harlow Shapley
We live in the Milky Way Galaxy. Two small satellite galaxies orbit the Milky Way. Name them. The Magellanic Clouds, or the Clouds of Magellan, or the Large Magellanic Cloud and the Small Magellanic Cloud
This rare astronomical phenomenon occurred in the Large Magellanic Cloud: supernova
This is the nearest known large galaxy to ours, roughly 2.3 million light years away: M31, Andromeda Galaxy
What is the name given to the two or three dozen nearest galaxies to our Milky Way? The Local Group
what galactic supercluster does the Local Group belong to? Virgo Supercluster
what is the name given to the object or group of objects drawing our Local Group of galaxies toward the constellation Centaurus? The Great Attractor

Name the largest planet in our solar system. Jupiter
Name the smallest planet in our solar system. Pluto
Name the terrestrial planet with the hottest surface in our solar system. Venus
This planet has been visited by the robotic probes Viking and Pathfinder. Mars
Two stars have the same absolute magnitude, but Star A appears to be 4 times brighter in our sky than Star B. What factor accounts for this difference? Star A is closer to earth than Star B (and therefore appears brighter).
If Star A has the same absolute magnitude as Star B, but appears 4 times brighter, how much closer to earth is Star A than Star B? Twice as close (or half the distance of Star B)
If Saturn is 1 billion miles from the sun and Pluto is 3 billion miles from the sun, how much less sunlight does Pluto get than Saturn? 9 times less (or 1/9 the sunlight received by Saturn)

Name the 20th century Astronomer who used Cepheid variable stars to determine that the spiral nebula in Andromeda was another galaxy beyond our Milky Way. Edwin Hubble
Hubble’s use of V.M. Slipher’s red shift measurements of galaxies indicated what overall condition of the Universe? The galaxies were receding and the Universe was expanding.
If the Hubble constant is 70 km/sec/mpc (70 kilometers per second per mega-parsecs), how far away is a galaxy with a recessional velocity of 140 km/sec? 2 megaparsecs
The best writers are typically avid readers. Reading helps you absorb other folks’ methods and writing styles, so that you’ve got something to model your work on when you actually start writing yourself. A strong influence on my own writing style was James Thurber, and he himself reported that he was influenced by Henry James. Don’t copy their words or phrases verbatim, but imagine for instance how they might write a script about the Hertzsprung-Russell diagram.

As you write, go ahead and write whatever comes into your mind. It isn’t even a question of paper being cheap anymore, now you can just highlight what doesn’t work and cut it out of the word processing document (but don’t delete it – paste it into a null document maybe for later – never throw anything away!)

Decide what it is about the topic that’s worth telling. Then talk about it. To other people, to a tape recorder, just talk about it until you’ve got in your head how you want to say it in the script.

And keep in practice. This is the best solution to writer’s block. For the past several years I have been writing five different sky-watching spots every week that air on the local public radio station. Each spot is about 45 seconds in length, and consists of about 150 words. This keeps me in practice, and even provides material that I can incorporate into my show scripts. And it also helps me to condense my writing so that I can get a lot across with the fewest words. Here for instance is a first draft of a portion of a SkyWatch document:

If you go outside tonight, and the skies are clear, and you face off to the east, look about halfway up in the eastern sky and you can find a bright star, named Arcturus. This star was known to many of the eastern woodlands tribes of Native Americans as Waupee, which means the White Hawk.

And here’s the revision:

The bright star Arcturus that we now see in the eastern evening sky was known to the Shawnee tribe of Virginia as Waupee, or the White Hawk.
2. Great Script, Wrong Audience

If there’s a story worth telling, then theoretically it can be presented to almost any audience and they’ll come away from the experience a little more knowledgeable and a bit more enthused about the subject matter. But often a great script is wrong simply because the audience isn’t yet ready for the topic. Vocabulary and concepts play an important part here, as when a program dealing with the minutiae of stellar evolution is presented to 1st and 2nd graders, or when an elementary program on the planets is given to adults (actually, you can do that if you tell them that the program was written for elementary students and just to bear with the simple vocabulary; often the adults learn a lot of things they didn’t know even by such a basic show.)

Then you have some shows that don’t work as well because the audience simply won’t play along. A couple of years ago I co-wrote “Boldly Go!” with Erich Landstrom of the Aldrin Planetarium. The show looked at the science of Star Trek, and we were both pretty well pleased with the script. The audience members however, fit in to two basic categories: the first group also loved the show because they were Star Trek or science fiction fans, or at least willing to entertain the concept. The second group wanted to see the Big Dipper. We showed the Big Dipper, actually, from every angle as a space-faring Star Trekker might see it. But they just wanted a basic star and constellation program, and they left a little confused and disappointed.

3. Great script, no visuals

I have written a terrific “Death of the Dinosaurs” script where a fireball first appears near the zenith as a faint point of light, then slowly descends, brightening and elongating as it progress at an ever-quickening pace, and toward the end it swooshes across the dome and explodes in an incredible localized flash of light; then a great mushroom cloud builds and grows, eventually encompassing the dome and dimming the sun, while a great wind blows across the dome and small bits of particulate matter fall down gently upon the upraised faces of the audience.

I have no idea how I can do this effect. Okay, I know at least one way to do it, but I’d need to make a video of the developing fireball, and then I’d need to use a video projector that can be scanned and slewed at variable speeds, along with some of the more basic special effects that I would still need to build in order to make the sequence work as I’ve visualized it.

My facility has some wonderful ancillaries, including a triptych of mid-dome slide projectors; individual or group cross fading panoramas, a static video projector with videodisc and VCR sources, and a basic all-sky system. But my collection of special effects includes: one strobe; one aurora; one revealer; one ripple wheel; one grain of wheat lamp; one meteor shower; one warp drive projector; and one simple fireball. That’s it. So when I write a script, I either have to budget in money and time for the purchase or construction of special effects, or I have to write a real basic show which will fully utilize what I’ve got.

It’s best to storyboard your script before you record it. This task helps you to visualize what the dome looks like at any time during the show, and keeps you from getting into trouble later on. It’s also a good idea to avoid taking on a script that’s been written by a committee, particularly one made up of folks who don’t know your projection capabilities.

Always follow the KISS principle (Keep It Simple, Stupid!) If you’ve got more time or energy, then you can move beyond and incorporate more ambitious visuals, but always have a basic fallback storyboard.
4. Watch your grammar (and gramper.)

With the advent of computer tools, spell check and grammar/usage tools can prove very helpful. But keep in mind that these tools can’t think, and are sometimes unable to catch many of the nuances of the written word, as in, “I have a spelling checker; it came with my PC. It plainly Marx four my revue mistakes I cannot see. I’ve run this pome threw it, I’m shore your pleas to no. Its letter prefect in it’s weigh – my checker toll me sew.”

Probably somewhere out there is a computer tool that can also tell you when you overuse a particular adjective. I once edited a soundtrack where the word “enormous” was used a grand total of 26 times. Jupiter was enormous. The Great Red Spot was enormous. The galaxy was enormous. The distances between stars were enormous. And so on. This is an easy mistake to make. As you’re writing, an appropriate adjective comes to mind and you use it. Later on, when you need another adjective, the first one you think of is the one you’d already used. Proofreading helps here, especially by someone else. And it helps to read the script aloud, to get the overall sound and tempo of the thing.

Also, look out for run-on sentences that go on and on and don’t seem to stop and then go on some more and there’s no stopping them; still they keep going and going and hey is this enough words for the script yet and -

5. Just the Facts

I have been trying to get the straight story on Miranda’s ice cliff for some time now. When I first read up on it from the initial Voyager 2 fact sheets, the thing was 10 miles high. Then I found out later it was only 10 kilometers high. Last year I was told it was 5 miles high. And yesterday I read that it was only 5 kilometers high. Are these cliffs shrinking, or what?

And Jupiter has 16 moons. No 17. No 18. 21. 28. 30. Okay, how do I write about the number of Jovian moons if the number keeps changing? Descriptive general phrases such as “Jupiter has over two dozen moons,” may lack the exactness of a specific number, but they do save you the necessity of either doing a new soundtrack or living with a stale fact.

When you do use facts, be sure to check and double check them. And once again, get someone else, preferably someone knowledgeable about the subject, to proofread your work. And wherever possible, try to anticipate future discoveries that may contradict your facts.

6. Eschew Anthropomorphological Connotations

Somewhere out there are some clever scripts that feature talking stars, talking planets, talking rockets, talking cats, talking waffle irons, etc., but I’ve never been comfortable writing that kind of show. If I can’t make myself believe in the personification of an inanimate object, then I don’t think my dialogue will convince my audience either.

This is a completely arbitrary, personal choice on my part, and I only mention it because at some point you may feel compelled to write just such a script simply because everyone else has. You don’t have to.

When I was a kid one of the things I always liked about the televised science learning show “Watch Mr. Wizard,” was that Don Herbert, who created the show and was indeed Mr. Wizard, never resorted to cutesy gimmicks or shtick. He just set up the demonstrations and experiments, explained things to kids in easy-to-understand ways, and let nature and science take center stage.

7. “And Let Me Tell You Another Interesting Thing About the Photopolarimeter…”

You have to know who your audience is. Are they a group of JPL employees who will be building a working model of the Voyager 2 spacecraft in their garages? Or are they a family with a couple of kids who are just trying to find out where Voyager 2 went and what it found out? Don’t get too technical when describing for instance, the functions of a spacecraft. If they want all those
details, well there are books about that kind of thing you know. Hit the high points, provide the color and the excitement and the meaning, and let the details come out in the classroom or the library.

8. “Gosh, Ain’t Space Grand?”

On the other hand, there has to be some meat to the program. The information must mean something. The cognitive facts are your seasoning, your spice, in preparing the dish. In the course of writing a show script we give out a lot of information – it’s our stock in trade. People want to know, “what’s that bright star I saw in the west last night?” “How come the moon’s out in the daytime?” “Is this rock I found a meteorite?” “The TV weather guy said there was going to be an eclipse of the moon, how can I see it?” or “I can’t find anything with the telescope I got, can you help?”

Is it possible to write a dull, information-laden show? Of course! The information is important because it helps us to understand what’s out there; it’s not the be-all, end-all of the process. The show has to use the facts to “build a fire,” so they go out, eager to learn more. Walt Whitman’s “Learned Astronomer” doesn’t have to be a bore, you know.

We want to work in the affective as well as the cognitive domain, and get our audiences excited about astronomy. But that doesn’t mean we have to produce some kind of fact-sparse, touchy-feely pabulum experience, expecting that everybody will “just get it.” Use the facts to nail down all your spicy descriptive passages, and your shows will have gravitas as well as gee-whiz.

9. Thanks for the Dance

There’s an old country saying, “When you go to the barn dance, you dance with the one that brung you.” For planetarium operators and lecturers, the one that brought us to the dance was the incredible effect of the replicated star field projected onto the domed ceiling. If you are writing a script for a star theater, and that theater contains a planetarium instrument that cost hundreds of thousands or millions of dollars, and you don’t use it for anything other than some kind of cosmic backdrop, then shame on you.

Some of the first shows I wrote didn’t even contain a star ID. I was in college, and wanted to write “theater.” I didn’t fully understand the special nature of the planetarium medium.

As the years went by, and audiences came and went, I sometimes resented their criticisms of particular shows. Do they expect me to point out the Big Dipper and Orion every single time? I would argue. We talked about Orion in the last show. This show is about the solar system, there’s no time to point out stars! Yes, but how many times a year do we expect somebody to visit our little theater? Are they going to see all four shows that season? Well, we hope so, but this may not be the case. There may be just one time, one chance, to show someone what you’ve got.

Since the mid-80s I’ve put a star ID in all of my shows. I try to feature at least some of the stars and constellations and other deep-sky objects that are visible in the current evening sky. Because the most important thing we can do is to get people to go outside and look at the real sky and find some of those things for themselves. And in so doing, we can hope that they will, “from time to time, look up in perfect silence at the stars.”

10. Is It Necessary to Include Some Kind of Astronomy Song in My Script?

No, that’s just me.

Jon Bell is the 3rd place winner of the 1998 IPS/Eugenides Script Writing Competition. He has written dozens of planetarium show scripts since his first, “A Tale of Stonehenge,” in 1976.
Major French planetarium manufacturer, R.S.Automation Cosmos designs and sales planetarium equipment for a wide range of end users (astronomy associations and clubs, schools, colleges, universities, museums and entertainment parks). The high quality of our systems has been acknowledged by our clients and the sales policy, in keeping with the market demands, ensures very competitive prices. R.S.Automation Cosmos products simulate a very realistic sky associated with powerful electronic and data processing systems. This innovative technique results in a high quality simulation and the management of multimedia systems. Over the last three years, R.S.Automation Cosmos has developed a new generation of graphical and digital planetariums. The technique that was chosen is a top of the range digital architecture unique of its kind. It has been designed for planetariums and is made up of a graphical 3D sky with the simulation of the solar system together with an all-dome high definition video projection system. Two functionalities are thus united in a single system composed of several graphical pipes (up to 10 depending on the theatre configuration). This system uses image generators made of a PC cluster, with BARCO CRT projectors able to project 3200 x 2560 pixels images.

On the 9th of May 2002, during the APLF (French Speaking Planetarium Association) symposium, R.S.Automation Cosmos presented for the first time its new solution for digital planetariums in collaboration with BARCO company. This presentation, made in the 23 m dome of Brussels planetarium, will show a partial dome projection (180° x 60°) with three high-resolution pipes. This demonstration, that was very appreciated by the planetarium community, showed the technical and technological lead of R.S.Automation Cosmos in terms of design and development of solutions for graphical and digital planetariums.

On the 11th of May 2002, R.S.Automation Cosmos presented the NovaMax software. This software, the first to be dedicated to the computer graphic modelling for the planetarium market, will revolutionise the production and post-production process for planetarium shows. Build up around the most used software for computer graphic modelling (3ds Max®), NovaMax enables show designers the automation of the “celestial universe” depending on two parameters which are date and location. Today, voted by plebiscite by the planetarium community, NovaMax is also a software intended for production companies and directors who took the data-processing step towards computer generated images.
Thanks to its technical and technological lead, R.S.Automation Cosmos serenely views the future of its top of the range digital system and can already announce the development of intermediary graphical and digital solutions for smaller planetariums (less than 10m-diameter dome).

R.S.Automation Cosmos is a department of the company R.S.Automation Industrie, head office of a French industrial group located in Saint Etienne in the Rhône-Alpes region. R.S.Automation Industrie is the leading company in the field of concrete manufacturing automation, and bitumen manufacturing and spreading automation. R.S.Automation Industrie built its success upon the control of specific process, and upon customised solution for major industrial company and high technology company (CEA – EDF – CNR – MATRA – SAGEM – THOMSON – …). Our knowhow and competencies are design and development of electronic cards as well as software development for client applications.
Astronomy Concepts Appropriate for Different Ages (Workshop)

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Too often we think that if we can just explain something right, using great teaching methods such as student modeling and planetarium observations, students are sure to “get it.” Unfortunately, this is not the case.

Although I have done my own research on spatial astronomical concept learning by students of different ages, I have been strongly guided in both my teaching and my research by the developmental learning theories of the Swiss psychologist, Jean Piaget. For over half a century this Piaget conscientiously designed experiments to see how children from preschool through adolescence think, how their thinking changes with maturation, and processes that occur as individuals pass from one mental stage in thinking about the world to the next.

Piaget’s conclusions are powerful. They guided physicist Robert Karplus of the Lawrence Hall of Science when he designed the Learning Cycle and incorporated it into the elementary Science Curriculum Improvement Study in the 1960s. The Learning Cycle still is regarded highly by the educational establishment. By knowing the Learning Cycle, what children of different ages can comprehend, and the normal sequencing of mental abilities, educators and parents can be effective in helping children learn astronomy concepts. Thick books by Piaget and his colleagues (The Growth of Logical Thinking from Childhood to Adolescence, The Child’s Conception of Space, The Child’s Conception of Geometry, and The Child’s Conception of Time) give painstaking details of his research with individual subjects and the theories he built upon this data. Piaget’s ideas, as restated by Karplus, have found expression in the current educational trend of Constructivism. And brain research supports Piagetian developmental theory—There are brain growth spurts which are close to the transitional times in thinking abilities found by Piaget: 2 to 4, 6 to 8, 10 to 12, and about 14.

Preschool children were called “preoperational thinkers” by Piaget. The preoperational child is developing language skills. Thinking is often intuitive. Perception and symbolism are developing.

For the preschool child, there are many abilities that can be promoted through exploration or interaction with the world, and many activities can be done in the planetarium. Children between the ages of 3 and 5 can should do all of these: observe, accurately tell what was observed, make and check predictions, correctly differentiate right from left in a variety of situations, be alert to the relativity of motion, tell how size varies with distance, and realize that time moves forward at a constant rate. Observations of the sky—the stars, bright planets, the moon—are great activities for a young child as soon as he/she can perceive them. Astronomical names are learned easily, and the sounds are fascinating to young children. My son at age 2 was delighted by the appearance of the moon in both the day and night sky. At age 3, he could name many lunar craters. I do not think these abilities were unusual, when encouragement is given.

In the planetarium I suggest the following activities for very young children. A portable planetarium is a great situation for young children, who feel comfortable sitting on the floor and stretching in different directions.
Ask students questions; then give them time to observe and offer answers to each: Do the stars all have the same brightness? Are the stars all the same distances apart—Can you find a place where stars are very close? Very far apart? Where are these places? As the day or night with sun or moon motion occurs, have children follow with their fingers. Point to the sun when you see it is highest. Which way is the sun moving? Where do you think it will go down? Watch the sun until it goes down. Where did it go down? Were you right?

Piaget discovered that prior to age 7, or about second grade, children engage in “transductive reasoning.” That is, one fact explains another. An average-ability six-year old, when asked “Why does the sun stay up?” replies, “Because it’s bright,” or, “Because it’s daytime.” If given an explanation, complete with models, of how the earth turns around on an axis (rotates) to face the sun sometimes and away from the sun sometimes, the words become data to be stored in the brain with other sun-earth information bits, as in a parallel electrical circuit. There is little or no logical connection of the model and explanation with the reason that the sun is in the sky at certain times. If the child repeats the explanation (unless the child is bright and has moved ahead of normal development in thinking ability), it is simply parroting.

There are further, more difficult problems with a young child comprehending the view of the model of earth and sun as if in space. Until early adolescence, most children have trouble relating the space-view to the view of the sky from the earth, even with the simple explanation of day-and-night. I have heard children beyond the transductive stage, to whom a fine lesson has been given (with an earth model and stick person), repeat the explanations and then give completely wrong answers in response to pointed questions. For example, to “Where is the sun after sunset here?” typical answers of young children are, “Behind a mountain” and “In a cave.” Until third grade or later for most, the ability to unite the view of the earth in space with the person’s view is absent, and even then, probing questions usually are answered wrong. Switches in thinking between earth and space views for more difficult concepts (like lunar phases) come much later.

Constellation study, an opportunity for everyone to become familiar with astronomy without instruments, can be guided by Piaget’s spatial development findings. Before age 3, most children cannot distinguish closed shapes such as triangle, circles, and squares from one another. At age 5-6 a child can tell circles from rectangular shapes, can distinguish among straight and curved lines, tell that angles are of different relative sizes, and explain relationships between sides of a figure. The words “shorter” and “longer” become a part of his/her vocabulary. At about age 7, the child differentiates a six-pointed star from a hexagon and uses a fixed point of reference necessary for recognition and presentation of a geometrical figure.

So prior to age 5 for most children, it is meaningless to try to teach a constellation shape. The child will not see it differently from other constellation shapes. By about first grade, the child can learn different simple shapes; learning can be assisted by figures with line drawings between the stars to indicate difference in side length and angle size. By about third grade, the child can be more discerning in picking out different constellations (and asterisms and sky patterns). The ability to recognize a complex pattern in a radically different orientation is evidently an advanced ability. As an adult visitor in Australia, I had difficulty recognizing some of the same constellations I had viewed frequently from Ohio. It is therefore appropriate to concentrate on planetarium observations of how the sun and moon seem to move. Supplement the planetarium observations with a demonstration of Earth rotation using a globe and a small stick
figure facing different directions. (Make sure to turn the globe accurately, from west to east.) Although most children will not coordinate the sky view and the “from space” view that the globe represents, knowing how each appears separately will encourage the full understanding in later years when they have developed their spatial abilities.

I present a program for first grade students about changes with the Seasons. I do not try to relate the Earth going around the sun to the view of the sun’s path in the sky. However, the students learn the changing sun path with the beginning of each season pretty well. I have a little song with stretches I call “This is the Way the Sun Goes” which the students sing and act out for the beginning of each season. (I do not call these dates the equinoxes and solstices for first graders.) We discuss seasons and I show photographs of what is happening to the weather, vegetation, and what people can do at each time. We shine a flashlight on sheets of white cardboard to find when (straight down, tipped a little, or tipped a lot) the flashlight spot is brightest and giving most energy to a place (not to be confused with the largest spot). The children then tell me why we have the warm weather with the high sun path and the cold weather with the low sun path.

By third grade a planetarium program featuring a group of constellations is appropriate, as long as the constellations are pointed out slowly. Have children “trace” the figures shown with the pointer. And then return to previous constellations for a review. For children younger than about 8, point out and concentrate on one or two constellations which have easy shapes and stars that are reasonably bright. For the Northern Hemisphere, I recommend the Big Dipper asterism and for both hemispheres, Orion. The more ways the patterns can be reviewed, the better. Longtime planetarian Ken Perkins’ idea of Orion as sewed buttons on a piece of cloth is a wonderful idea for students in kindergarten and first grade.

At about age 7-8, children move into a “concrete operational” state of thinking, which lasts until about age 12-13. Children can define, order, and classify. But these thinkers need reference to familiar objects and actions and help in formulating detailed plans.

Students in the concrete operational thinking stage, starting in about second grade, are capable in categorizing observations. Elementary children find facts absorbing. As they sort and classify them, building a web of interrelated ideas, they are moving closer to the time they can manipulate the ideas in an abstract manner. The ideas of “planet,” “star,” “galaxy,” as groups and as subgroups become possible and worth pursuing in a variety of activities. Sequences of observations such as lunar phases, sunset positions, and shadows can be made and recorded.

The planetarium is a wonderful place for making the observations, and students of about 8 and older are capable of recording them in a pencil-paper activity. Building up observational knowledge, which can be put together in more advanced ways when the thinking mechanisms are ready, is a good use of time. Students can draw and label each moon phase, list different seasonal sunset positions, and use a Big Dipper clock through an earth rotation. Observing the accepted Constructionist theory of education, students should make hypotheses about what they think will occur and then check to see if they are correct.

To understand many things about astronomy, a concept of time is necessary. Piaget found that until most students reach an age of about 11-12, the concept of infinite space and time does not develop. An average five-year old can imagine to a certain size and then no larger. Third and fourth graders love facts and accept “It is 93,000,000 miles from Earth to sun” and “The earth formed between 4 and 5 billion years ago.” But to these children, the idea of
time going on “forever” or that there are “infinite number” of anything is just words. I can remember of hearing of the Steady-State model of cosmology while in elementary school. At about age 9 my father tried to explain it to me, but I could not imagine that time would never start.

A planetarium program which includes the presentation of many facts is appropriate and motivational. A program about the solar system with lots of data about planets and other bodies is exciting and also is a stepping-stone to making connections both now at later times. By age 11, when most students still enjoy facts, the brain can make connections which bring deeper understanding.

In the planetarium, children of all ages ask me questions about many astronomical ideas, ones which are very important to the children who ask them: What makes the stars shine?, What is a black hole?, How was the solar system formed?, and How old is the universe? I think that it is possible for a teacher or a parent to give accurate, meaningful answers to children of any age by knowing some of the features and limitations (as soon through adult eyes) of their thinking. For example, to a 5-year old, I can say, A star shines because one kind of hot gas inside is turning into another kind of hot gas. When the change takes place, this gives off energy. The child may not really understand “gas” or even the sequential reason for the change, but the explanation is correct, it satisfies him/her that someone knows an answer, and he/she files away one or more retrievable facts—important to the child because he/she asked it.

To an 8-year old, I can say the same thing, but add, The temperature of the center of the sun is over ten million degrees. Small particles of hydrogen bump into each other with great force and sometimes stick. They change into a different gas called helium and give off a lot of energy. (This is helped if I act it, gesture, and emphasize some words. If students act it out, it is even better. I call this “dynamic modeling” and I use it a lot for all age levels.)

The 11-year old who is interested enough to ask the same question is ready for more details, such as, The sun’s center is about 20 million degrees F and because of that high temperature 600 million tons of hydrogen are converted to helium each second, while four million tons of hydrogen is changed into energy. The 11-year-old is hungry for answers to more complex questions and considers me to be a good teacher that will have credibility in other lessons if I can give him analogies with numbers. Another example is: If the sun were wrapped in a shell of ice that was 40 feet thick, the sun would melt all of the ice in a minute. I do not think it appropriate to tell 11-year-olds that the sun is in dynamic equilibrium because nuclear energy production produces radiation pressure, which balances gravitational force. This discussion with its attendant terminology, the proton-proton cycle, the carbon cycle, and details in the outward movement of energy from the center should wait until high school and even later, unless the students are precocious (as in a gifted class).

Until about age 13, most students are continuously developing a sense of direction. The concepts of horizontal and vertical based on the Earth’s surface and gravity seem to appear at about age 9; the correct relationship between left and right in different situations comes a few years later. A child then advances to a stage of spatial thinking ability Piaget called “projective representation.” Projective representation, so important in astronomy, means an ability to visualize what an object or event will look like from different points of view. In my research, sixth graders (about age 11) in the planetarium had difficulty with the projective representation concept of lunar phases. They were unable to switch back and forth between a view of lunar phases seen from Earth and one seen from a position above the Earth’s orbit in an authentic testing situation of the projective concept.
Therefore we should continue to add details to each perspective of the basic astronomy phenomena of lunar phases, seasons, and planet motions for children in upper elementary and intermediate school (ages 9-12). There is nothing wrong now with trying to unite the perspective from Earth with the one from space, although most students will not fully match the perspectives. If students have been to the planetarium for a moon or seasons program earlier, the presentation methods need to be changed so the students will not think the lesson is boring. For example, a seasons program for 6th grade students could incorporate the Zodiac constellations, the Midnight Sun, and the Tropics of Cancer and Capricorn/Arctic and Antarctic Circles.

Children between second and eighth grade learn mainly by inference rather than deductive logic. Not until adolescence, do most students become able to think abstractly. Piaget refers to thinking at this highest level as “formal operational.” A person with formal operational ability is capable of reversible mental operations, which Piaget terms “transformations.” A formal thinker can consider different hypotheses and figure out the implications, can use symbols to express ideas, and is aware of his/her own thinking. The formal thinker can think about thinking. The formal thinker does not easily confuse related concepts. For example, he or she can simultaneously consider time and distance so that the concept of a “light-year” is correctly understood and applied.

Piaget found that people with formal operations abilities also have reached the spatial stage he called “Euclidean abilities.” Advanced spatial thinkers conserve (that is, they demonstrate understanding that a value like volume does not change when it is represented in a different form). These individuals can measure distance, length, area, volume, and angle. Piaget found that such abilities become integrated with projective representation in the teen years. Concepts of the H-R diagram and the mass-luminosity relationship require integrated projective representation and Euclidean abilities and so are inappropriate for most before high school.

There is widespread practice in the United States of teaching Earth/space science at the eighth or ninth grade level. In fact, exposure to astronomy, geology, meteorology, and oceanography may end at this level in pre-college years. Many of the students taking these survey classes may not understand basic concepts because they have not reached the needed developmental thinking level.

When I talk with adults who were unsuccessful in earth science in high school, I sometimes hear, Astronomy! I am so interested in it now. We had an earth science course in ninth grade, but I didn’t understand it very well. Now I’m reading astronomy books, and the ideas don’t seem very difficult. I don’t know what was wrong with me in high school.

I believe these adults had slowly-developing formal and spatial thinking systems. It is unfortunate that we assume and expect advanced thinking ability of everyone in many high school courses. Although astronomy cannot be fully understood without these advanced abilities, high school educators can maintain interest by expanding and improving the quality of concrete experiences. These experiences will assist complete understanding of astronomical topics at a future time.

Piaget found that a student may reach a thinking level in one area, with which he/she is familiar, sooner than for a topic with which he is unfamiliar. For example, a student might think in abstract terms about baseball or have projective representation abilities in building model airplanes, but not be able to apply the same type of critical thinking to astronomical positions and motions, with which there has been little experience. It seems that if students have more concrete experiences with astronomy, real and planetarium observations and models, they will reach higher level thinking about astronomy at a
younger age. In my own research, I discovered that sixth-grade concrete thinkers who had model experiences and planetarium observations for the topic of lunar phases (statistically) more likely to demonstrate projective understanding of lunar phases two years later when studying this topic.

The Learning Cycle, based on Piaget’s work, assumes that experience with the physical environment is important, that ideas are transmitted by social processes, and that there is self-regulation or construction of the ideas one holds. Robert Karplus named the three Learning Cycle steps 1) Exploration, in which students in groups explore cause-and-effect relationships with materials in a situation where minimum guidance is offered and they are likely to discover relationships. 2) Concept Introduction, formal discussion of the idea through teacher discussion or other source. The student needs to see the relationship between the exploration and this step. 3) Concept Application, in which students apply the idea to similar but new situations.

The U.S. educational reform project of the American Association for the Advancement of Science, Project 2061, which has produced the books Science for All Americans and Benchmarks for Science Literacy, emphasizes the importance of student experience in learning science. I think Jean Piaget and Robert Karplus, if they could return to read the recommendations in these important documents, would be delighted to see the emphasis on inquiry-based learning.

I thought that if I could use the Learning Cycle and other interactive methods shown by research to work well, I would be able to get 13-year-olds in 8th grade, at the Piagetian-found turning point in thinking ability, to understand projective astronomy concepts of the celestial sphere and earth rotation, seasons, lunar phases, and planet positions and motions. I hoped that students in my suburban middle school would be capable of coordinating earth and space views of these topics. In addition to the Learning Cycle, I incorporated planetarium observations, models that the students manipulated themselves, and drawing of both planetarium (view from earth) and modeled (from space) observations.

I designed units, one in the planetarium and one in the classroom, based on detailed analysis of the concepts, used the Learning Cycle. Then I tested all the students both in the planetarium and in the classroom. Sad to say, although there were some important gains with the Learning Cycle, the majority of students in this group of 13-year-olds were unable to answer 75% of the questions on any posttest. I conclude that the kids were not generally capable of understanding the topics as projective concepts. And performance became worse as the astronomy concepts in my study became more complex. (Planet motions and lunar phases were more difficult than earth rotation and seasons).

Some researchers testing general developmental abilities US children, found one-year-or-more delays in maturation of thinking abilities as compared with the European children that Piaget examined. (This difference may be a function of those students tested, with greater abilities among Piaget’s children.) Thus it was not surprising to me that the projective-concept capability in astronomy had not developed in my 13-year-olds, although I had hoped my superior methods would make a difference. I find that a few 18-year-olds in my high school astronomy class also have trouble interchanging the earth and space views.

Each thinking level can gain from use of the Learning Cycle, to teach other subjects as well as astronomy. Even though my 8th graders could not learn the projective concepts, they had concrete, motivational experiences that were bound to be useful for better understanding at a both this and a later time. Probably it is useless to spend much time with the introduction and application steps until a child is near or beyond a thinking level needed for understanding of a particular concept. But let preschool and early
elementary-school children explore with age-appropriate materials. The more kinesthetic action and senses used the better, as internal webs of meaning and knowledge are developed. Discuss what young children are doing and listen for any wrong ideas they hold, their misconceptions. If a 7-year-old tells you that the sun goes behind a mountain or into a cave after sunset. Probe with Why do you think that happens? If a 14-year-old says that the cold weather of winter is caused by our being farther from the sun, ask, What shows that answer is right? Let the child try different things with the model materials. An important process in learning, one that Piaget called “accommodation,” will occur if a child is ready to learn an idea. If not, the experiences (but rarely, just lecture, unless it was especially important to the child) will be stored away to help learning the concept at a later time.

Accommodation is hard work and often not pleasant; the individual must throw off an old way of viewing something and the old mental system, such as the sun going behind a mountain for a 2nd grader or the earth’s distance to the sun not causing seasons for a teenager.

I have found that in teenagers, accommodation can take a form in which the student appears moody or even surly as he/she defends his old thinking or is so lost in thought that he/she is not paying attention to the activities of the class. When a teenager is grappling with new ways of seeing things, the teacher and parent need to be patient. An adult that becomes exasperated with the teenager’s methods of accommodation—continuous questions, arguing about the incorrect nature of the student’s concept, or an apparent withdrawal for the purpose of wrestling with the attack upon a previous mental construct—is defeating the result desired. I think that it is very exciting to identify, observe, and assist teenagers in accommodation. For a planetarium teacher to understand what is occurring in the student’s mind is a major step forward in the teaching process. The adult will relax and be more receptive and nicer to the teenager. The teenager feels freer to do what he thinks he must to learn. Learning takes place.

In high school it becomes worthwhile to try to teach concepts that require projective spatial abilities and abstract or formal thinking. Basic projective concepts, proofs of earth rotation and revolution, the history of ideas about the solar system, the changes of the sun or another star on the H-R diagram during its evolution, stellar magnitude, double-star motions, cosmological ideas, and the basic projective concepts of lunar phases and seasons become understandable to most students, given adequate time and careful instruction. Mathematical relationships, with formulas shown by symbols are comprehensible, such as $F = \frac{Gm_1m_2}{d^2}$.

I begin my high school study of the seasons with a planetarium program in which students plot the diurnal path of the sun for about the 23rd day of each month. Then in the classroom I provide small student groups with lamps and pencil-sharpener globes to determine the reasons for the sun paths they observed and recorded. I begin the classroom exercise by showing students a scale drawing of the Earth and Earth’s orbit, asking if distance to the Earth can be a reason for the seasonal observations. The knowledge quickly eliminates the otherwise-frequent hypothesis that distance is a cause of seasons.

Sometimes I teach high school students in the planetarium who have severely restricted thinking abilities, students with a combination of preoperational and operational abilities but with the emotional needs of teenagers. I try to learn these students’ interests, get them to generate some questions, and explore answers to their questions that will have meaning to them. A planetarium program for such a group can take different directions, with the direction determined by the students themselves.

Planetarium activities, and related activities that complement them, should be designed with the abilities of students in mind. If we understand what students of different ages can and cannot do, the lessons will be most effective.
Some Appropriate Astronomy/Planetarium Activities for Most Students at Different Ages

Ages 3-7:

make more involved with older children:

- Observe the moon and sun in different positions (In the planetarium, the sun is a good object. Outdoors, very special care is needed for the sun.) Have children point or clap or say something when it rises, is highest, or sets. Keep in mind that children have difficulty telling right from left through first grade. Observe the moon in relation to different earth-based objects, as well as direction and height.

- Hold out a small hat and see if the hat “stays on” the moon.

- Then ask how can the hat seem to just fit on the moon and ask if there is a way to make the hat have a poor fit. (Children move arms so hat is further or closer.)

- Predict where the sun will go in the next hour. Predict where the moon will go in the next hour.

- Observe the moon with different shapes (phases). Students should describe what they see. Analogies for this age (e.g., “moon is a cookie with bite out of right side), as well as for older students are good.

- Learn the names of some sky objects with ways of remembering where they are in the sky based on the children’s discussions (planets, moon maria, bright stars).

- Under the night sky ask children if the stars are all the same distances apart. Ask them to find a big gap, very close stars.

- Relate things in the children’s daily lives to where the sun is at times of day and in different seasons.

- Show one or two patterns with easy shapes and stars that are bright. Tell a story that will help children remember the shapes and names. In the Northern Hemisphere, The Big Dipper and Orion are good. Physical references also are very helpful.

Constructionist learning theory suggests that students be given opportunities to say what they think will happen or why something happens prior to activities in which they learn what really happens. For young students, concentrate on saying what they think “will happen” (what they will observe next).

Age 8-10:

- Show constellations. Have students trace the figures shown along with the pointer and then without the pointer.

- Teach names of astronomical things. Children continue to learn language easily.

- Do activities that allow students to order and classify, such as order of planet distance, size, and number of moons; categorize planets as those with and without atmosphere and categorize groups of constellations that can be seen in different seasons.

- Offer opportunities for children in groups to ask questions and give correct, simple answers with a demeanor that shows children that you think the questions are important. and that he/she can understand the answers. If you do this often and are aware or common questions, have a “bag of tricks” ready for response— analogies, physical models, gestures.
• Teach each of the two perspectives of a basic projective astronomy concept well: lunar phases as observed in the sky or planetarium, seasonal paths of the sun, changing planet positions, the position of the Milky Way. Teach the out-in-space view of how the moon revolves about the Earth, eclipses, how the Earth with its tilted axis revolves about the sun, how the planets move, the shape of the Milky Way Galaxy. (Few will be able to coordinate (flip-flop the two in their minds) so they see why one explains the other. But this helps them do this later.

Ages 11-13:
• Use numbers in explanations that explain the extent of time, space, and energy.
• Keep adding new details to perspectives of phases and seasons. If students see the same program on moon motions and phases they did earlier, they will be bored. For a 6th grade (age 11-12) group that has studied seasons, now in the planetarium include and concentrate on the view from different latitudes or the Zodiac constellations as backdrops for monthly sun motion.
• Since students are becoming good with language, have them explain their ideas (which are sometimes misconceptions) at the beginning of study. For example, ask, What causes an eclipse of the sun?
• Use the Learning Cycle in teaching: Exploration (good in a group, since this level is very social), Concept Introduction, Concept Application. For example, Use a light and a ping pong ball to work out how we get known sequence of phases, teacher demonstrates and discusses the correct sequence, student tries to say what someone on moon would see Earth do. These activities attempt to get the student at least partway to understanding the projective concept of phases, although most cannot yet coordinate the Earth-based with the space-based views.

Ages 14-18:
Work hard on getting students to understand correct projective concepts such as seasons and lunar motions. Discuss student ideas of reasons for different things, determine misconceptions, and then use the Learning Cycle.
• AN EXAMPLE FOR TEACHING A PROJECTIVE CONCEPT: Watch the yearly eastward motion of the sun against the Zodiac in the planetarium. Discuss student ideas of why we observe this. Set up a dynamic model of an “Earth,” a “sun,” and 12 Zodiac constellations in an outer circle with signs or stuffed animals. Ask students how “Earth” might be able to see “sun” move eastward against the Zodiac. Try what is suggested. If students do not suggest, finally have “Earth” move Eastward around “sun” and watch the Zodiac. “Earth” should describe what he/she sees. Others should also take part of Earth to confirm this. Ask group what “sun” sees and have sun say if answers are correct.
THERE ARE MANY POSSIBILITIES FOR USING DYNAMIC MODELS, INCLUDING: PHASES, ECLIPSES, LONGITUDINAL LIBRATION, DOUBLE STAR MOTIONS, DYNAMIC EQUILIBRIUM IN A STABLE STAR, STAGES OF STELLAR EVOLUTION FOR DIFFERENT MASS STARS, GALAXY MOTIONS, THE BIG BANG.

- Combine planet observations in the planetarium or outdoors with a dynamic model for an inferior planet and for a superior planet. Determine from data and the model how the different configurations are possible.

- With different materials (the Project Star has a good activity) discover the inverse square law for light. Find and learn a formula and apply this to gravity, magnetism, and other electromagnetic waves.

- Learn points, circles, and coordinate systems of the celestial sphere in the planetarium and on a globe. Answer questions that relate the two views.

- Find stars outdoors/in the planetarium and learn their color/temperature and brightness (luminosity) characteristics. Plot them on a temperature/spectral class-luminosity diagram. Obtain data for more stars add them to the graph, and discover the main sequence and branches of the H-R Diagram.

Do you see why the activities listed for ages 14-up are not appropriate for most younger students?
Science Olympiad Astronomy Events

Preparation and Testing

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Abstract

Science Olympiad is a school-based competition whose popularity is growing in the United States. The astronomy event should involve use of the planetarium, both for preparation and testing. The portable planetarium is ideal for both. In this workshop Science Olympiad and the astronomy events will be described, and methods for preparation and testing will be demonstrated.

Science Olympiad is a US competition with grade levels for 5-6, 7-8, and 9-12. They are called, respectively, Level A, Level B, and Level C. At each level there are 23 different academic and construction events. A total team at each level consists of 15 students, and each student typically is in 2-4 events. Often the events have clever names, such as “Reach for the Stars” and “Polymer Detectives.” Students compete in small groups of 2 or 3. All astronomy events have specified “up to two students.” Usually two students take the astronomy event tests together. About one-third of the events for each level change each year, with coaches learning of the change in the fall.

Science Olympiad allows students who enjoy science and engineering to be challenged beyond the science taught in their schools. Students with similar interests are brought together in preparation sessions and competition. Science Olympiad is the US extracurricular outlet for students who enjoy science, like the sports, music, drama, and writing events are for students with other talents and interests.

For the past four years an astronomy event has been included at each grade level, and every year the astronomy event for each level has changed a little or a lot. It is likely that there will be an astronomy event for each level next year and also it is likely that there will be some changes in each.

I am an overall high school (C level) coach, in charge of coordinating preparation for all events at my high school. But also I help prepare students at the lower levels, and I have served as an area event supervisor for the B and C level astronomy events. I have found the planetarium indispensable in both preparation and testing. Usually I train 4-6 students at the same level at one time in the planetarium, and I test 30 at a time in a STARLAB.

The A level astronomy event is called “Starry, Starry Night.” Fifth and sixth grade students must know the constellations, bright stars, and some other special stars of each of four seasonal skies. They also much know some general solar system information. The star and constellation testing takes place in a STARLAB, while the solar system information is on a separate test.

The B level astronomy event for seventh and eighth grade students is called “Reach for the Stars B.” Like the A level astronomy test, students must know a list of constellations, bright stars, and special objects. Testing usually takes place in a STARLAB. The list is somewhat different from the A test list. And the objects may be tested with the sky at any sidereal time. The
non-planetarium test also is more difficult than the test taken by the A level students. The B non-planetarium test includes descriptive information about the H-R diagram, seasons, moon phases, tides, earth rotation and solar system information.

Up until the 2001-02 school year, the high school C level event, called “Reach for the Stars C” also had a significant part of the test requiring identification of constellations, stars and special objects. Until this past year a STARLAB or other planetarium also usually was used for testing the C level astronomy test. The considerable number of special objects, Messier and NGC’s, made the identification more difficult than the A and B astronomy events. In 2001-02 the only C sky location requirement was the positions of a long list of deep sky objects imaged by the HST and Chandra. The planetarium is useful in finding these positions, but testing in 2001-02 normally was not done in a planetarium. (A constellation map was used instead.)

The focus of the C test in 2001-02 was the nature of stars and star lives, with photograph identification and understanding of many Chandra and Hubble photographs, including the part of the electromagnetic spectrum in which they were taken. Many laws and formulas must be learned to do problems. Use of resources has been allowed for this C testing.

Preparation in the planetarium requires students to have and use their maps and lists. Students use light pens (now available for $5 US or less) or flashlights covered with red cellophane to see their materials. At practices I move through one of more sets of seasonal constellations and stars. At subsequent practices, I review all the constellations, stars, and special objects covered previously as well. I jump from student to student in asking questions and everyone stays alert. I permit the students to use maps at first, but then they must be laid aside.

For C level last year, I had the students plot the positions of the Chandra or Hubble objects on SC1 maps. Using the maps and knowledge of the constellations, students memorized the positions on the sky and in the planetarium used my pointer to show the positions. In previous years, the students learned all listed deep sky objects this way.

I find that students remember constellations, stars, and positions of deep sky objects best if they have memorized star hopping methods and interesting myths or other details about some of the sky objects. In the workshop I go through such procedures.

The test rules for a particular year may or may not allow resources in the planetarium. Regardless of whether the students have resources, there is not much time to consult them. A flashlight covered with red cellophane is needed for each student team in planetarium testing. Students may talk quietly with their partners to determine test answers. I have found that students work in the planetarium with courtesy and concentration. I have found a wide range of knowledge—some student pairs getting almost all questions correct (which is difficult) and other student pairs getting very few questions correct. I ask some students from different schools how they prepared. The top scorers always are those who prepared in a STARLAB or other planetarium.

I urge those who work with planetariums to learn more about Science Olympiad and encourage participation by more local schools in this wonderful competition. I also urge those with portable planetariums to promote their use in preparation of students in the many schools in the US where students will participate in regional, state, and national Science Olympiad competitions.
Astronomical Interactive Exhibits

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Abstract

It has been shown (Franck Pettersen, Master thesis 1995) that a planetarium show has a much larger educational impact if it is accompanied by hands-on experimenting. In the present paper, a number of interactive exhibits that we have used together with Stella Nova Planetarium at Falun Science Center and at Teknoland are presented.

1. Astronomia and Falun Science Center

Our earliest experience of a Science Circus type activity was in the fall of 1989, when Broman Planetarium inaugurated its traveling exhibition Astronomia at Vastra Frolunda Cultural House in Goteborg. Astronomia consisted of a Starlab Planetarium, exhibits, and some interactive astronomical models. These included a Rotating Earth with tiny sundials, lit from one side, a Quatro Stagioni exhibit with four turnable earth globes lit from a central sun, a sunlit Orbiting Moon that made one full circle around the visitor’s head in one minute, and a scale model solar system, built in the scale 1:10 billion and stretching far outside the Cultural House. This model even included a tomato-sized Proxima Centauri, situated at National Institute of Silicon Technology in Islamabad, Pakistan. Astronomia was set up at a couple of Swedish museums until it in 1992 finally broke up: the Starlab continued as Broman Planetarium’s traveling planetarium and the exhibits and models became the new Falun Science Center’s base exhibition.

In 1992, we opened Falun Science Center with the 6.5 m dia. Stella Nova Planetarium and two exhibition spaces. One of these was devoted to Astronomia. It now included also the exhibit Recognize the Constellations; a 1 m dia. star chart with LED stars, whose color can be changed from red to green, one constellation at the time.

2. Teknoland

In 1999, we decided to try to construct a new outdoor Science Center, Teknoland, in Falun. It opened for its first season in May 2000 at the Lugnet National Ski Stadium in Falun. We were able to keep it open for two seasons, but in September 2001, we had to close down for good. It gave us anyway a great experience of building a number of really large exhibits, and several of them belonged to the astronomical theme which we named Cosmos. The theme consisted of a Giant Starlab 6.5 m dia. dome inside a huge 10.5 m dia. and 8 m high lap teepee, equipped with a Spitz A3P star ball (furnished by ASH Enterprises), a Starlab projector, and a computer with projector, plus several interactive exhibits. These were of the kind whole-body-on rather than just hands-on.

Our favorite exhibit was originally probably the Astronaut Scales. Here the visitor could sit on a seat, hanging in 2, 3 or 4 springs (all with the same spring constant). By swinging up and
down, and measuring the time for ten complete swings, the visitor could then use a diagram to find out her mass. If the measurement was done properly, the mass was determined within about 1/2 kg. The name? Well, also astronauts have to determine their mass by swinging in a similar way - the time of a full swing is the same even if the weight of the body is zero. The exhibit however didn't function well without assistance, and the springs we used broke after some 1000 stretches (with the risk to hurt the visitor), so it wasn't used during our second season.

Kepler's Dance is a dance floor, 9 m (30 ft) long and 5 m (17 ft) wide. Painted on the floor are the orbits of planet Earth, planet Mars, and comet Encke, all in the scale of 1:100 billion and with correctly directed orbit major axes. Along the orbits are footsteps painted, and the lengths of the steps correspond to how far the planets and the comet travel in 14 days. The Swedish Walking Tune from Appelbo is constantly heard from a pair of loudspeakers, so if three persons walk the three orbits at the pace of the tune, they will follow all three Kepler's laws. Astonishingly, it took a few years of thinking and calculating to find the correct design of Kepler's Dance. The exhibit is now at Klockargarden in Leksand, not too far from Falun.

Walking on the Moon consists of a 2.5 m (8 ft) dia. glass fiber sphere, from which rises a 10 m high tower. Dressed in a dinghy sailor's west, connected to a rope from the top of the tower, and hanging horizontally, you can walk on the moon. The resultant of the gravitational force and the pull of the rope is (approximately) directed towards the moon and has the (approximate) magnitude 1/6 of the gravity on the surface of the earth. The user of the exhibit can therefore experience how it is to walk on the real moon, how she with ease can jump much higher than on earth, etc. Again an exhibit where the visitors need assistance, but it was Teknoland's most popular exhibit. It is now at a new (so far unnamed) science center in Jonkoping in southern Sweden. It was inspired by a similar exhibit which we saw at Clore Garden of Science in
Rehovot, Israel in 1999.

*Yourself a Sundial* was the result of two years’ discussion about how to construct a good hands-on sundial, and when we finally found the solution, it was a very simple one. Nine concrete squares, numbered 10, 11, ..., 18 were put in an approx. 5 m (17 ft) dia. semicircle on the ground with a white square in the center of the circle. A sunny day, the sundial was calibrated on the hour from 10 (AM) and on. All the squares were placed so if you stood e. g. on the square labeled 13 at 13 hours (1 o’clock PM), your shadow was directed exactly towards the white square.

It is a perfect whole-body-on sundial with just one drawback: since the path of the sun varies with its declination, and due to the equation of time and the human invention daylight savings time, the sundial has to be recalibrated regularly. It is now at the Solar Yard belonging to the Solar Energy Research Center in nearby Borlange.

*Teknoland’s Solar System*; gives the visitors a chance to find all the planets within walking distance, since the sun, the planets, and the planetary distances are all in the scale 1:10 billion. Instead of spheres, we had a two-dimensional picture of each body on a sign, which also gave some information about it. While e. g. the distance between sun and earth is a mere 15 m in this scale, Pluto is about 600 m from the sun. Planets out to Jupiter fit inside Teknoland, so the planets from Saturn and on were placed at strategic places outside Teknoland. This exhibition doesn’t exist any more.

3. Literature list

Over the years, we have published a number of articles and books on interactive astronomical experiments and exhibits, and we have here listed the most important ones:

Lars Broman
A model of the solar system improved by means of pinhole optics
*The Physics Teacher* 11(1973)489

Lars Broman and Bertil Eriksson
101 Experiments
Lärarhögskolan i Falun (1975; in Swedish)

Lars Broman
27 Steps to the Universe
International Planetarium Society, USA (1986)
(originally published in Sweden by University of Goteborg 1980)
Lars Broman and Mariana Back
Framtidsmuseet - The Futures’ Museum

Lars Broman
Teaching astronomy through observations and experiments

Lars Broman, Robert Estalella, and Rosa M Ros
Experimentos de Astronomía

Lars Broman
The world’s largest scale model

Lars Broman, Per Broman, and Aadu Ott
Didactic aspects on how to teach science by exhibitions and planetaria
Proc 10th IPS Conference The Boundless Planetarium, Borlange, Sweden (1990), pp 197-198

Per Broman, Lars Broman, and Kjell Engstrom
Exhibition techniques
Proc10th IPS Conference The Boundless Planetarium, Borlange, Sweden (1990), p 230

Lars Broman, Per Broman, and Eva Sjostrom
Scale models in the planetarium

Lars Broman and Ivar Nakken
Science circus activities in Norway and Sweden

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Communicating Science—New Course at Dalarna University

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Abstract
Following six years of courses in science center education a new one-semester full-time course in Communicating Science started at Dalarna University in the fall 2001. The new course consists of four parts: Science and informal learning, Interactive exhibition, Planetarium program. Individual project study. Languages of instruction are Swedish and English. A continuation course was planned to start for the first time in coming fall.

1. History of the course
Some seven years ago we started a course at Dalarna University called Science Center Didactics. That course was very much a part time course with people working with science centers or planetaria as target group. Due to the fact that the students came from all over Scandinavia, we had meetings just four times per year. We had these meetings over weekends, and at different locations in Scandinavia.

A year ago we changed this course into a one semester full time course at the university, which we call Communicating Science. This course is an eligible course in the teacher training programs. This change was much inspired by a Master Program on the subject at University of Glamorgan in collaboration with Techniquest in Cardiff, Wales.

The course is divided into four parts, which are running two and two in parallel over two ten week periods; Science and Informal Learning, Interactive Exhibition, Planetarium Program, and Individual Project Study.

The aim of the course is:

• in-depth knowledge of two scientific disciplines (with special emphasis on natural sciences and technology),
• a comprehensive understanding of the range of institutions involved in informal learning (including science centres and planetariums),
• the practical expertise to apply their understanding to develop and present informal-learning activities (specifically exhibits and audio-visual programs) for school groups, and
• training for work at informal-education institutions, and for building collaborations between those institutions and schools.

2. Science and Informal Learning
This course is very much a literature course, where students read books about museum theory, science center theory etc. The books are discussed in a seminar form.

Within this course we make a one week field trip, when we visit different science centers and planetaria. The field trips we have made so far have been to Oslo and the Swedish west coast. We plan a trip to the Stockholm area and to Helsinki for the next semester. Each student makes diary notes during the trip. After the trip each student writes a report about what she/he has seen and experienced. During this course, the students also get a "hands-on" experience of how it is to work at a science center or a planetarium for a week spent at such an institution.
3. Interactive Exhibition

In this course the students build exhibitions. A group of typically two or three students choose a theme, and makes a number of exhibits on that theme. This last semester we restricted the exhibitions to be table top exhibits, that can be stored on 60 × 40 cm boards, which can easily be stored and transported in special wagons. This way we get exhibitions suitable for in-service and outreach programs.

Examples of exhibitions:

Optical illusions, including a 3D shadow. The shadow of a turning object will appear in three dimensions when you use a filter to darken one eye. A pair of sun glasses with one glass removed works fine.

Geology. Here a spherical puzzle using the tectonic plates as pieces is the major exhibit.

Mathematical puzzles of different kinds. Here you will find magical squares, different pyramid puzzles, rubber bands forming curves, etc.

One group of students constructed their own 1.5 meter cloth planetarium, using a Starlab-like star cylinder with a MagLite bulb as the light source.

4. Planetarium Program Production

Today computers easily handle huge files, and a high resolution computer projector is something you soon will buy at your local gas station. There is—at least in the near future—really no need for slide projectors and tape recorders any more in a small planetarium.

Our students make computerized planetarium programs typically 10 to 15 minutes long. The work includes research on the subject, script writing, image processing, sound processing, and putting the whole thing together in PowerPoint®.

The students use Microsoft Image Composer® as image processing program. There they can easily make for example Lego astronauts of their own children, travelling in a Lego space craft.

We use Goldwave™ for sound processing. The program is inexpensive and easy to use. It will allow the student to mix a narration file in voice quality with a music file in CD quality.

One of us (PB) has written a 50-page compendium covering the process from first idea to the final product, which will be translated into
English in a reasonably near future. This is because we also have foreign students. The compendium covers use of the mentioned programs, and also Photoshop® and Macromedia Director® as far as needed for production of narrated computer audio-visual shows.

5. Individual Project Study

Each student writes a report on a minor study of some sort. It may be studies about how visits at a planetarium or a science center may have affected interest in science, or what school groups actually do when they visit a science center.

One example of a study:

What do younger school children want from a planetarium program? The study indicated that they rather want facts than fiction. Girls tend to appreciate facts about stars and astronomy, while boys want to know more about space journeys.

6. Communicating Science Continuation Course

The course we are planning will include ten weeks of practice work at a science center or a planetarium. The other part of the course is a literature part, well suited for distance learning. The aim of the course is to prepare the students for work primarily pedagogical in this growing sector.
Instructional Support Services for Space Science Education

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Abstract

The Onondaga-Cortland-Madison Boards of Cooperative Education Services (OCM BOCES) has an instructional support division called the Math, Science and Technology Center. This center provides services that enhance the teaching of mathematics, science and the use of technology in our component school districts. One focus of our services includes training teachers in Space Science Education. Through our kit program, we also provide a comprehensive teacher guide and the materials necessary to present each lesson to students. Then a specialist can bring a Starlab to each school at a time they request. The kit program prepares teachers and students so that their planetarium experience is an integral part of the curriculum in each school. Our center maintains contact with classrooms through the year and facilitates teacher-to-teacher interaction through an Astronomy site on the Internet.

The planetarium instructor’s job at OCM BOCES is tightly woven into a matrix of services provided to schools in Central New York. The following background information will help you to understand the complexity of this relationship, and then specifics of our Astronomy support program will be outlined.

Background Information

What are BOCES?

Boards of Cooperative Education Services (BOCES) are cooperative associations of school districts in a geographic area, component districts, which have banded together to provide educational or business services (shared services) more economically than each district could offer by itself. BOCES was created by the New York State (NYS) Legislature in 1948 under Section 1950 of the NYS Education Law.

There are 38 BOCES in New York State. All but thirteen of the 710 operating school districts in New York are members of a BOCES. Of the thirteen, eight are eligible to become members of BOCES. BOCES membership is not available to the “Big Five” large city school districts (New York City, Buffalo, Rochester, Syracuse, Yonkers). The governing body of BOCES is called a BOCES Board. BOCES board members are elected by resolution of component school district Boards of Education, on a ballot prepared by the BOCES clerk. BOCES board members are elected to 3-year terms of office. Candidates must reside within the boundaries of a component school district but not be an employee of the district.

OCM BOCES

(http://www.ocmboces.org/)

OCM BOCES operates much like a typical school district. The CEO is the BOCES District Superintendent and OCM BOCES employs school administrators to manage its programs, teachers and instructional support staff to provide instruction and non-instructional staff to support programs.
OCM BOCES serves 23 component districts located in three counties of Central New York State. Some special programs are also provided to Syracuse City Schools, Syracuse Diocese Schools and select school districts located in neighboring counties. The 750 employees, located in five major OCM BOCES campus centers, serve an area of 1,433 miles and over 64,000 students.

OCM BOCES Divisions include: Administrative/Management Services, Adult Education, Alternative Education, Educational Communications, Employer/Employee Relations, Support Services, Occupational Education, Operations and Maintenance, School Quality Services, Regional Information Center and Special Education.

What is the MST Center?

The Math, Science and Technology Center is one part of the OCM BOCES Instructional Support Services division. This center provides services that enhance the teaching of mathematics, science and the use of technology in our component school districts. We offer programs and support for K - 8 Science and Health Education and some special programs are designed for older students. For more detailed information visit our site at [http://www.ocmboces.org/iss/mstsite/](http://www.ocmboces.org/iss/mstsite/)

We support the following by providing curriculum guides, kit supplies, kit delivery and pick up, and teacher training. All kits are designed for teachers and students to explore and learn science content through hands-on experiences.

Full Service Science Kit Program,
Grades K - 6, which provides a classroom with up to 42 weeks of science education.

“Light” Science Kit Program,
Grades K-4, for schools with strong science programs that wish to supplement their program.

“A la carte” Science Kit Program,
Grades 5 - 8, which provides a selection of Intermediate Kits available on an individual basis to districts.

New York Health Central Curriculum Project Kits,
Grades K - 5, which provides all the curriculum materials needed for a classroom teacher to meet the educational mandates in health, safety, child abduction, HIV/AIDS, fire safety and child abuse. (These kits stay in the classroom for about 15 weeks)

In addition the MST Center provides for special programs, such as:

Fish Hatching Program
allows participating schools to raise fish (salmon, trout) from eggs and release them in area streams.

Planetarium Program
for Grades K - 12 that provides an instructor and a portable planetarium.

Environmental Science Special Programs
(Adirondack - Marine)
for Grades 10 - 12
**Cost for Services (2002-2003)**

<table>
<thead>
<tr>
<th>Program</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary Science Kits (Gr. K-6)</td>
<td>$595/classroom</td>
</tr>
<tr>
<td>Science Kit “Light” (Gr. K-4)</td>
<td>$300/classroom</td>
</tr>
<tr>
<td>Ala Carte Science Kits (Gr. 5-8)</td>
<td>Varies per Kit</td>
</tr>
<tr>
<td>Health: NY Health Central (Gr. K-5)</td>
<td>$285/classroom</td>
</tr>
<tr>
<td>Health: Growing Healthy (Gr. 6)</td>
<td>$550/teacher</td>
</tr>
<tr>
<td>Technical Support (if using Science Kits)</td>
<td>$562.50/day</td>
</tr>
<tr>
<td>Technical Support (if not using Science Kits)</td>
<td>$750/day</td>
</tr>
<tr>
<td>Fish Project: Salmon Hatching Project (Initial Set-Up)</td>
<td>$500/set-up</td>
</tr>
<tr>
<td>Fish Project: Salmon Hatching Project (Replenishment)</td>
<td>$125/set-up</td>
</tr>
<tr>
<td>Planetarium (Susan Button)</td>
<td>$490/day</td>
</tr>
<tr>
<td>Adirondack/Marine Studies</td>
<td>$630/student</td>
</tr>
<tr>
<td>Environmental Studies (Jack Gramlich)</td>
<td>$410/day</td>
</tr>
</tbody>
</table>

**State Aid**

Although districts are charged the above prices for services, each year the government of New York State reimburses a percentage of the cost back to districts. The percentage of reimbursement is determined by the district’s tax base. If the tax base is low the reimbursement rate is high. In other words, poor districts pay much less for services than rich districts. This process was created to help “level the playing field” or create equal opportunity for all students across the state regardless of the tax income of each district.

**How do we Support Space Science Education?**

The MST Center provides services that enhance the teaching of Space Science and the use of technology in our component school districts.

**Teacher Training**

A very important part of our services includes training teachers in Astronomy. Since our Elementary School teachers are educated in all disciplines, with an emphasis on teaching methods, their understanding of science content is limited, unless they have a specific interest in science. We attempt to remedy this by providing teacher training in science content and in methods for teaching science.

**Astronomy Kits**

Through our kit program, we provide a comprehensive teacher guide and the materials necessary to present each lesson to students. A specialist can bring a Starlab to each school, at a time they request, and can be used as a pre or post kit activity or during the unit of study.
Currently we are in the process of revising our teacher guides for each astronomy kit.

Copies of our teachers’ guides will be posted on our Astronomy Project website: http://www.ocmboces.org/iss/mstsite/ (Click on the MTelementoring button and then on Astronomy Project.) Our goal is to provide information and activities that address specific standards mandated by New York State. These activities can compliment the Starlab planetarium lessons and can be enhanced by planetarium lessons.

The concepts addressed at the lowest grade level (K-1) are revisited as a review and expanded on in succeeding grade levels. Each unit of study includes activities that involve the use of mathematics. Activities involving reading for science content will be included at the third grade level and above. Elementary level students are asked to describe characteristics, cycles and patterns and at the Intermediate level they are asked to explain daily, monthly and seasonal changes on Earth.

The Elementary Core Curriculum

The concepts we will cover in Grades K-4 Astronomy guides follow below. By the end of Grade 4 students are expected to have mastered these concepts.

Each concept is approached through having students make direct observations in the natural world, collect and record data, describe their findings in a journal and then relate their findings to real life experiences. (For example, for two consecutive days students will be asked to list events and times. Then they will be asked count the hours between events and note the patterns.) Students are asked to create models that describe what they observe during this unit of study.

K-1 (5-7 Years)

Concept: The sun and other stars appear to move in a recognizable pattern.

Concept: Stars can form patterns in the sky.

Concept: The stars are always present in the sky but cannot be seen in the daytime because the sun is so bright.

Grade 2 (7-9 Years)

Concept: Natural cycles and patterns occur in the world around us.

Concept: Natural cycles and patterns include: Earth spinning around once a day (rotation), resulting in daytime and nighttime.

Concept: The earth spins around once every 24 hours (rotation), resulting in daytime and nighttime. Humans organize time into units based on natural motions of Earth.

Concept: The earth spins around once every 24 hours (rotation), resulting in circular movement of the North Sky.

Grades 3-4 (9-11 years)

Concept(s): The Sun appears to move in a recognizable pattern. The rotation of the Earth causes a pattern of day and night. Science Inquiry includes: asking "Why" questions, developing relationships between observations, the testing of proposed explanations.

Concept(s): One Earth Day is 24 hours. Humans organize time into units based on natural motions of the Earth (hours)

Concept(s): Natural cycles and patterns include: the Earth moving in a path around the Sun (revolution) resulting in one Earth year, the length of daylight and darkness varying with the seasons.

Concept: Patterns of light and dark on a sphere can be applied to natural objects.
The Intermediate Core Curriculum

The concepts we will cover in Grades 5-6 Astronomy guides follow below, and these concepts will be revisited in Grade 7-8. By the end of the year, Grade 8 students are expected to have mastered these concepts.

Again, each concept is approached through having students make direct observations in the natural world, collect and record data, describe their findings in a journal and then relate their findings to real life experiences. Students are asked to create models of what they observed and models to explain what they observed. Students are then given information about other stars, planets and moons and ask to model what cycles and patterns they would see from a different perspective. (For example, students are asked what day/night, celestial motions, seasons or moon phases would be observed on another planet.)

**Grades 5-6 (11-13 years)**

Concept: Earth’s sun is an average-sized star. The Sun is more than a million times greater in volume than Earth. Other stars are like the Sun but are so far away that they look like points of light. Distances between stars are vast compared to distances within our solar system.

Concept: The Sun and the planets that revolve around it are the major bodies in the Solar System. Other members include comets, moons, and asteroids. Earth’s orbit is nearly circular.

Concept: Gravity is the force that keeps planets in orbit around the Sun and the Moon in orbit around the Earth.

Concept: Most objects in the solar system have a regular and predictable motion. These motions explain such phenomena as a day, a year, phases of the Moon, eclipses, tides, meteor showers, and comets.

Concept: The latitude/longitude coordinate system and our system of time are based on celestial observations.

Concept: Moons are seen by reflected light. Our Moon orbits Earth, while Earth orbits the Sun. The Moon’s phases as observed from Earth are the result of seeing different portions of the lighted areas of the Moon’s surface. The phases repeat in a cyclic pattern in about one month.

Concept: The apparent motions of the Sun, Moon, planets, and stars across the sky can be explained by Earth’s rotation and revolution. Earth’s rotation causes the length of one day to be approximately 24 hours. This rotation also causes the Sun and Moon to appear to rise along the eastern horizon and to set along the western horizon. Earth’s revolution around the Sun defines the length of the year as 365° days.

Concept: The tilt of the Earth’s axis of rotation and the revolution of Earth around the Sun cause seasons on Earth. The length of daylight varies depending on latitude and season.

Concept: The shape of Earth, the other planets, and stars is nearly spherical.

**Planetarium Program**

OCM BOCES has been providing high level and intensive planetarium lessons since 1986. Ideally the MST Center kit program prepares teachers and students so that their planetarium experience is an integral part of the curriculum in each school. However, Starlab lessons are also designed to be effective as a “stand alone” experience.
Standard Four of the New York State Learning Standards for Mathematics, Science and Technology states: “The Earth and celestial phenomena can be described by principles of relative motion and perspective.” Elementary students need to be able to “describe patterns of daily, monthly, and seasonal changes in their environment.” Intermediate students must be able to “explain daily, monthly, and seasonal changes on Earth.” At the Commencement level (when students graduate from High School) students are expected to be able to: “explain complex phenomena such as tides, variations in day length, solar insolation, apparent motion of the planets and annual traverse of the constellations” and to “describe current theories about the origin of the universe and the solar system.”

To help students truly understand and be able to fulfill these requirements, the Starlab Portable Planetarium travels to schools and is used as a hands-on laboratory for discovery. It is the most cost and time effective means for helping students to understand concepts that cannot be experienced by reading textbooks. Since Astronomy objectives are built into National and State Science Standards, we believe that it is imperative that students have the advantage of using the planetarium as a laboratory to examine and confirm space science concepts explored in the classroom.

OCM BOCES MST Blackboard Telementoring Project

Many times teachers feel isolated in their classrooms and find it difficult to consult with colleagues in their field. Another part of the support system provided by our center includes the use of technology as a tool to benefit teachers and students. The goal of our MSTelementoring project is to facilitate teacher-to-teacher interaction within the fields of Science, Math and Technology. Through the use of specific websites, teachers are able to share resources, share information, address questions encountered in their classrooms related to both content and pedagogy in these subject areas. The ultimate goal is to create experiences that enrich student learning. An Astronomy Project site has been established with the mission to provide a forum for teachers to mentor each other and share resources related to Astronomy. Our new teacher guides and related materials will be posted on this site. You can access this site at http://www.ocmboces.org/iss/mstsite/ (Click on the MSTelementoring button and then on Astronomy Project.) When you are asked to login you may do so as a “guest” by clicking on the “Preview” button. This will give you access to most of the site with the exception of communication/interaction tools.

Conclusion

MST Center teacher guides, kits and planetarium lessons are designed to promote direct observations and collection of data. These kinds of activities can encourage further student directed investigations and help students feel comfortable using the scientific method and the tools of science. Getting students to relate what they are learning to the experiences they have in their everyday lives also enhances their ability to understand concepts and transfer new learning to other situations.

By facilitating teacher-to-teacher interaction, through the use of the Internet, we are helping teachers to get support from each other. They are sharing methods and activities that really work with students and they are searching together for solutions to common problems.
The OCM BOCES M-S-T center provides services that support teachers’ work in the classroom and students’ learning. Our services include teacher-to-teacher telementoring, materials and comprehensive teacher guides, teacher-training and specialists who provide subject specific programs to each school. In these ways we hope to enhance math and science education and the use of technology as a tool in our component schools.

The intent of this paper is to illustrate how a planetarium program can be strengthened and sustained through utilizing many avenues of support within an organization. Space Science Education and our Starlab program are an integral part of the MST Center’s mission. Planetarium lessons reflect the goals of the MST Center and visa versa; it is a symbiotic relationship. This helps everyone concerned with their goal of providing quality education services to our schools.
Chinese Sky and Starlore

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Abstract
In a traditional Chinese star map, you can find 306 asterisms, of which 283 were developed in or before the Han Dynasty more than 2000 years ago. The remaining 23 asterisms were created by Royal Astronomer Xu Guang-qi (1562-1633) et. al. with reference to the Western constellations near the Celestial South Pole. Unlike the West, where constellations are often associated with myths and legends, the Chinese sky is by large an extension of the terrestrial world. In this paper, I would like to give a more in-depth discussion on the development, lore and meaning of Chinese asterisms.

History of Chinese Asterisms
As Chinese astronomy was developed independently from its Western counterparts, its star classification system is in many ways unique.

The Chinese divisions of the sky began with the Northern Dipper and the 28 lunar mansions. Images of the Azure Dragon, the White Tiger and the Northern Dipper formed by clamshells and bones were uncovered in the early 1980s in an ancient tomb excavated at Si Zhui Po in Po Yang, Henan. The tomb was estimated to belong to the Neolithic Age, about 6,000 years ago. Meanwhile, some star names relating to the 28 lunar mansions have appeared on oracle bones dating back to the Wuding Period, about 3,200 years ago. The names of the 28 lunar mansions found on the cover of a lacquer chest excavated from the tomb of Zeng Hou Yi in Suixian, Hubei attest to the use of this classification system before 433 BC.

Aside from lunar mansions, other Chinese constellations were based on the works of Shi Shen-fu, Gan De and Wuxian. Shi and Gan were believed to belong to the Warring States Period (476-221 BC), while Wuxian, to whom the Star Manual of Master Wuxian was attributed, was a legendary minister of the Shang Dynasty (~1,600 BC). However, the authorship of the Star Manual of Master Wuxian is still very much in dispute, since the names of 12 states mentioned in it did not exist in the Shang Dynasty. To make matters worse, it was customary in the past for the Chinese to forge works of notable scholars. Nevertheless, the majority of scholars today agree that the naming of most of the Chinese constellations originated from the works of Shi, Gan and Wuxian and developed to their present form during the period from the Warring States to the Han Dynasty (206 BC – 220 AD). Chen Zhuo of the Period of the Three Kingdoms (220-280 AD) combined the work of his predecessors to form a star catalogue containing 283 asterisms and 1,464 stars.

Wang Xi-ming of the Tang Dynasty (618-907 AD), in his poem “Pacing the Heavens”, was the first to divide the sky he saw into 31 regions, the so-called three enclosures and 28 lunar mansions. The three enclosures, which mean three walled regions, are the Purple Palace Enclosure, the Supreme Palace Enclosure and the Heavenly Market Enclosure. The 28 lunar mansions, meanwhile, are similar to the 12 signs of the zodiac in the West. They are regions near the ecliptic and the celestial equator, where the
Sun, the Moon and the planets pass by. Astronomers believe that lunar mansions are related to the 27 1/3-day revolution period of the Moon, which is the time it takes for the Moon to complete one revolution in its circular path on the celestial sphere. In ancient Chinese astronomy, the origin of the lunar mansions was a much-debated topic.

The Purple Palace Enclosure is where the emperor and members of the imperial household - the empress, crown prince and the concubines live. The ancient Chinese believed in a mystical relationship between the Earth and the heavens. As the emperor was divinely appointed, the heavens echoed his rule. Should his administration become unjust or defective in other ways, comets, new stars and a host of unpredictable phenomena would appear in the sky. On Earth, Chinese emperors believed that they received their mandate from heaven, and so they called themselves the sons of heaven. In the sky, the noblest god was the Great Emperor of Heaven.

The star Beta Ursae Minoris represents the emperor, and is called the Emperor Star. This star, though dim and inconspicuous, was the Pole Star 3,000 years ago. Because of the Earth’s precession, the Pole Star changes with time. The following stars have all assumed the role of the Pole Star at some time in the past:

<table>
<thead>
<tr>
<th>Name of Star</th>
<th>Time Nearest to the North Pole</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Pivot (右樞)</td>
<td>2824 BC</td>
</tr>
<tr>
<td>Heavenly First One (天乙)</td>
<td>2608 BC</td>
</tr>
<tr>
<td>Great First One (太乙)</td>
<td>2263 BC</td>
</tr>
<tr>
<td>Second Chief Judge (少尉)</td>
<td>1357 BC</td>
</tr>
<tr>
<td>Emperor (帝)</td>
<td>1097 BC</td>
</tr>
<tr>
<td>Celestial Pivot (天樞)</td>
<td>807 AD</td>
</tr>
<tr>
<td>The first star of Curved Array (勾陳一, the present Pole Star)</td>
<td>2105 AD</td>
</tr>
</tbody>
</table>

Source: References 1 and 2

The 28 lunar mansions can be grouped into the Four Images - the Azure Dragon to the East, the Vermilion Bird to the South, the White Tiger to the West, and the Murky Warrior, which is a tortoise entangled by a snake, to the North. The colours of these four images are closely connected with the theory of five elements prevalent in ancient China. East belongs to the element Wood, and is endowed with the colour green; West belongs to Metal, white; South belongs to Fire, red; and North belongs to Water, black.

Each of the four images contains seven lunar mansions: Horn, Neck, Root, Room, Heart, Tail and Winnowing Basket are found in the Azure Dragon in the East; Well, Ghosts, Willow, Star, Extended Net, Wings and Chariot are located in Vermilion Bird in the South; Legs, Bond, Stomach, Hairy Head, Net, Turtle Beak and Three Stars are
located in White Tiger in the West; and Dipper, Ox, Girl, Emptiness, Rooftop, Encampment and Wall are found in the Murky Warrior in the North.

At the end of the Ming Dynasty (1368-1644 AD), in his new book *The Encyclopedia of the Chongzhen Reign*, Xu Guang-qi introduced 23 new asterisms near the Celestial South Pole based on Western star catalogues. Ignatius Kogler and Liu Song-ling of the Qing Dynasty (1644-1911 AD) revised the number and position of stars in the book *Imperial Astronomical Instruments*, which has now become one of the most important references for compiling traditional Chinese star maps.

**Chinese Starlore**

Unlike the West, where constellations are often associated with myths and legends, the Chinese treat the heavens as a miniature of their earthly world, a reflection of their feudal society. A rough counts of things represented by the Chinese asterisms can clearly illustrate the point (table 2). However, there are still some interesting stories related to the stars or asterisms. In order not to make the paper exceedingly long, I would not discuss Chinese mythologies related to the Creation, Sun, Moon and five planets. Only legends directly related to stars or asterisms will be listed below.

<table>
<thead>
<tr>
<th>Type</th>
<th>Example</th>
<th>No. of asterisms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Officials</td>
<td>Celestial Premier, Royal Secretary</td>
<td>50</td>
</tr>
<tr>
<td>Weapons or military facilities</td>
<td>Celestial Spear, Celestial Ramparts</td>
<td>27</td>
</tr>
<tr>
<td>Building or facilities</td>
<td>Celestial Pillar, Inner Kitchen, Guest House</td>
<td>60</td>
</tr>
<tr>
<td>Daily utilities</td>
<td>Northern Dipper, Whetstone</td>
<td>45</td>
</tr>
<tr>
<td>Natural phenomenon or objects</td>
<td>Cloud and Rain, Thunderbolt, Celestial River, Sun</td>
<td>13</td>
</tr>
<tr>
<td>Gods, legendary characters or mythological animals</td>
<td>Celestial First One, Xuanyuan, Flying Serpent</td>
<td>18</td>
</tr>
<tr>
<td>Animals</td>
<td>Dog, River Turtle</td>
<td>20</td>
</tr>
<tr>
<td>Common people</td>
<td>Peasant, Grandfather, Son</td>
<td>7</td>
</tr>
<tr>
<td>Others</td>
<td>Eight Kinds of Crops, Establishment,</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Total</strong> 306</td>
</tr>
</tbody>
</table>

Note: Since scholars are still divided over the true meanings of many Chinese asterisms, the numbers given in the table are for reference only.
Northern Dipper (*Beidou*) 7 stars; in Ursa Major

This Chinese asterism is more commonly known as Big Dipper. In Taoism, the seven stars of the Northern Dipper are regarded as seven gods. In addition, ancient Chinese believed that “Southern Dipper (in Sagittarius) is responsible for the registration of birth, while Northern Dipper is responsible for the registration of death.” (See “Dipper” below)

Dipper (*Dou*) 6 stars; in Sagittarius

This asterism is also called Southern Dipper. It was said that, in the Period of Three Kingdoms (220-280), there was a famous Taoist priest named Guan Lu. Once day he met a young man named Yan Chao. As an expert in physiognomy, he found the young man would die soon and told the man his ill fortune. At the time, Yan Chao was only nineteen and was really upset by the bad news. He begged the priest to help him. Guan Lu instructed, “You should go home fast and prepare a bottle of good wine and a plate of deer meat. Then go to the south of the wheat fields. Under a giant mulberry tree, you will find two old men playing chess. Serve them well and don’t say a word. They may help you.” Following the instruction, Yan Chao finally found the old men as described. He stood beside still and served them with wine and meat silently. Being too concentrated on the game, they enjoyed the feast subconsciously. After some time, the old men to the North suddenly noticed the present of Yan Chao and annoyingly said, “What are you doing here?” Without saying a word, Yan Chao fell on his knees and kowtowed. Didn’t know how to deal with the young man, the old man finally said, “we’ve enjoyed his offerings. Let’s do something to reward him.” The old man to the South said, “Give me your record of death.” When he found that Yan Chao was destined to live only nineteen years, he crossed the record out and changed it into ninety. Delighted with unexpected good result, Yan Chao thanked the old men and went home. Afterwards, Guan Lu explained, “the old man sitting to the North is Northern Dipper, the one to the South is Southern Dipper. Southern Dipper is responsible for the birth and Northern Dipper is responsible for the death.”

Administrative Centre (*Wenchang*) 6 stars; in Ursa Major

The sixth star of this asterism is called Silu, an officer responsible for promotion and salary. Silu is worshiped as the god of honor in ancient China. This star was personified and connected to a fabricated character named Zhang Xian. One version said that Zhang Xian was a Taoist priest who attained the Taoist wisdom and became immortal in the Five Dynasties (907-960 AD). Another version is more interesting. It was said that the previous incarnation of Zhang Xian was Meng Chang, a king of a small nation in Sichuan during the Five Dynasties. He was famous for his immoral and extravagant way of living. Even his chamber pot was made of gold and decorated with pearls and precious stones. Later on, He was defeated by Zhao Kuang-yin, the first emperor of the Song Dynasty (960-1279 AD). When Emperor Zhao saw the luxurious chamber pot, he was amazed and said, “A king indulging in pleasure like that should doom.” After the defeat, Meng Chang and his most beloved concubine, Lady Pistil, was kept captive in the capital of the Song Dynasty, Kaifeng. It was not long before Meng Chang was killed. In memory of her husband, Lady Pistil painted a portrait of
Meng Chang in secret. One day, emperor Zhao visited her and discovered the painting. He unhappily asked who the man was. Desperately in search of an excuse, she lied that it was only a painting of a Taoist immortal named Zhang Xian, a popular god worshipped in Sichuan. Whoever offering sacrifice to the god would be granted a son. As such, Meng Chang was turned into a god for no reason. Because of this legend, the god of honor was always depicted to be a Chinese senior official holding a little child.

The asterism Wenchang is also worshiped by Taoist priests as god of official honor and promotion. It was said that, during the Jin Dynasty (265-420), Zhang Ya-zi, an official who was famous for his filial piety deeds, died in a battle. In honor of his virtue, people build a temple and gave offerings to him. In the Song (960-1279 AD) and Yuan (1280-1368 AD) dynasties, Taoist priests began to fabricate a whole series of previous incarnation stories to him. It was also said that he was appointed by the Jade Emperor of Heaven to hold the celestial administrative office and govern the official honor and promotion on Earth. In a typical Wenchang temple, you will find the god served by two boy attendances, namely Tianlong (which means born deaf) and Diya (which means born mute). Since the god Wenchang governs the official honor and promotion, it is utmost important to keep the decree of god in secret. He intentionally uses two handicapped boys so that the one can hear the secret cannot speak, while the one can speak cannot hear.

**Emperor’s Seat (Dizuo)** 1 star; in Hercules

Dizuo is the seat for Shennong [which literally means “deified farmer”]. Shennong is the famous Emperor Yan, the legendary inventor of agriculture and medicine.

**Fuyue (Fuyue)** 1 star; in Scorpius

Fuyue was a high minister of Emperor Wuding of the Shang Dynasty. It was said that Fuyue was a slave who helped to construct a city in Fuyan. He was discovered by Emperor Wuding and was appointed high minister. Another version of the story portrayed Fuyue as a hermit in the mountains. One night, Emperor Wuding dreamt of a wise and good man. When he woke up, he drew a picture of the man in the dream. With the picture, a search was conducted. Fuyue was found and was appointed high minister.

**Heart (Xin)** 3 stars; in Scorpius

The second star of Xin (Antares, ± Scorpii) is a red giant that represents the heart of Scorpius. The Heart mansion is also called the Shang star. For more information about the story of these stars, see “Three Stars” below.

**Three Stars (Shen)** 7 stars; in Orion

Shen is also called Shichen. In Chinese legend, Shichen was the younger son of an emperor named Gaoxinshi. He was always fighting with his elder brother Ebo. The situation was so desperate that his father had no choice but to separate them. Ebo was moved to Shangqiu and was responsible for sacrifices to the Shang star (Heart mansion), while Shichen was moved to Daxia and was responsible for the sacrifices to Shen. These two lunar mansions were just like the brothers, who lived far away from each other and never met.
Winnowing Basket (Ji) 4 stars; in Sagittarius

Ji is the wind god named Fengshi [Master of Wind]. As early as the Zhou Dynasty, ceremonies were conducted to worship the wind god (Ji) and the rain god (Net mansion).

Celestial Cock (Tianji) 2 stars; in Sagittarius

Tianji is the sacred cock living on a mountain called Taodu. The sacred cock crows at the break of dawn and causes all cocks to crow.

Territory of Dogs (Gouguo) 4 stars; in Sagittarius

Gouguo may be a fabled nation in Chinese mythology. In Emperor Gaoxin’s time, a powerful tribe called Quanrong was mounting frequent attacks on the frontier areas. Worried about the situation, the emperor appealed to the whole country, saying that he would reward anyone who could bring him the head of the tribe’s chieftain with his own daughter and a fief with 300 households. The emperor’s dog Panhu left without a sign. After three months, it ran into the palace, holding the head of the tribe’s chieftain. To keep his promise, the emperor married his daughter to the dog and granted an island in the southeast as the feudal land of Panhu. The new nation was called Nation of Dogs. In this fabled nation, all men are dogs and all women are beautiful girls.

Drum at the River (Hegu) 3 stars; in Aquila

The second star of Hegu (± Aquilae, Atair) is the star Cowherd. The two dimmer stars on each side are the sons of Cowherd carried by a pole on his shoulder. According to legend, Cowherd’s wife, Weaving Girl, was the granddaughter of the celestial emperor. She worked hard year in year out, weaving colourful brocade for the gods and goddesses. However, she stopped weaving after she married Cowherd. Outraged, the celestial emperor ordered the couple to be separated by the celestial river and only allowed them to meet once a year. On the seventh day of the seventh lunar month, the magpies would spread their wings together to form a bridge, enabling the tragic lovers in heaven to meet that night. In the Chinese sky, Hegu can mean a drum at the river.

Weaving Girl (Zhinu) 3 stars; in Lyra

The first star of Zhinu (± Lyrae, Vega) is the famous star Weaving Girl. The asterism is also called Celestial Granddaughter since, according to legend, Weaving Girl was the granddaughter of the celestial emperor (see “Drum at the River” above).

Legs (Kui) 16 stars; in Andromeda and Pisces

Kui is the first lunar mansion of the Western White Tiger. In the Eastern Han Dynasty (25-220 AD), famous Confucius scholar Song Jun said that the star arrangement of this asterism was similar to the strokes of Chinese character. Hence, it was long believed that Kui was the god of literature.
Net (Bi) 8 stars; in Taurus

The fifth star of Bi is the red giant ± Tauri, generally described by stargazers as the red eye of the angered bull. From time immemorial, Bi was worshipped as the lord of rain, named Yushi.

Pool of Harmony (Xianchi) 3 stars; in Auriga

Xianchi is the pool where the Sun bathes every day. The astronomical chapter of the Book of the Prince of Huai Nan says: “The Sun rises from the Yang valley [which means “Sun-rising Valley”] and bathes in Xianchi.”

Old Man (Laoren) 1 star; in Carina

The second brightest star in the sky, Laoren is known as Canopus in the Western constellation. For the ancient Chinese, this star was so close to the southern horizon that it could only be seen for a short period of time. Since its appearance would bring peace and prosperity, there were temples specially dedicated to this star. In many Chinese families, you can find a statue of the God of Longevity, the humanized figure of the Laoren star.

Xuanyuan (Xuanyuan) 17 stars; in Leo and Lynx

The star A Leonis is also known as Maids-in-waiting, and in some documents it was regarded as a subordinate asterism of Xuanyuan. Xuanyuan is the name of the Yellow Emperor, who, according to folklore, was elected to be the common leader of the tribes after the defeat of Emperor Yan and the killing of the rival chief Chiyou. This united tribe finally developed into the Chinese nation. Chinese people call themselves the descendants of Yellow Emperor, in memory of Xuanyuan.

Interested readers can get more information about the topic in the Hong Kong Space Museum homepage (http://www.lcsd.gov.hk/hkspm/) or the book “Ancient Chinese Star Map” published by the Museum. In our homepage, a full list of Chinese asterisms and star names with English translation can be found in:

http://www.lcsd.gov.hk/CE/Museum/Space/Research/e_research_chinengstarzone.htm

A conversion table of Western and Chinese star names can be found in:

http://www.lcsd.gov.hk/CE/Museum/Space/Research/c_research_chinengstars.htm

You can also download simplified Chinese seasonal star maps from:


Selected ancient Chinese astronomical documents (only in Chinese) can be found in:

http://www.lcsd.gov.hk/CE/Museum/Space/Research/Literature/c_research_literature.htm

References

1. 陳遵妫, 中國天文學史, 上海人民出版社, 1982
2. 潘鼐, 中國恒星觀測史, 學林出版社, 1989
3. 伊世同, 中西對照恒星圖表, 科學出版社, 1981
4. K.H. Chan, Chinese Ancient Star Map, Hong Kong Space Museum, 2002
5. Sun Xiaochun & Jacob Kistemaker, The Chinese Sky during the Han, Brill, 1997
7. 陳美端, 中國古星圖, 遼寧教育出版社, 1996
8. 江曉原, 天學真原, 遼寧教育出版社, 1997
9. 任繼愈主编, 中國科學技術典籍通俗演義, 天文卷, 河南教育出版社, 1994
Simplified Chinese Seasonal Star Map
(Latitude: 22.5° N)
Simplified Chinese Seasonal Star Map
(Latitude : 22.5° N)
夜空星
月初 晚上十時
月中 晚上九時
月底 晚上八時

Night Sky of August
10pm First of month
9pm Middle of month
8pm Last of month

Simplified Chinese Seasonal Star Map
(Latitude: 22.5° N)
Simplified Chinese Seasonal Star Map
(Latitude: 22.5° N)
10,000… And Counting!

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Abstract
Since opening the new Sky Pavilion at Adler Planetarium … Astronomy Museum in January 1999, four difference shows have been presented in the new StarRider™ Theater. Since we give at least 9 shows per day, by the end of 2001, we passed the 10,000 show mark. Three of those shows were produced by Adler staff as part of year long museum-wide themes. How did we integrate video and Digistar with full-dome real-time models and interactivity? What problems might you encounter in operating a full-dome digital theater? This paper will outline some of the experiences we had building 3-D models and creating animations for those shows, while keeping the theater running.

Background
On January 8, 1999, the Adler Planetarium & Astronomy Museum opened a new addition to our 1930 building. The new Sky Pavilion is a sloping glass and metal structure surrounding the eastern half of the existing historic landmark building. Inside the 60,000 sq. ft. addition are two floors containing over 20,000 sq. ft. of exhibits, a restaurant, two classrooms, and a new theater. The theater is known as the StarRider™ Theater, after the technology produced by Evans & Sutherland.

Originally intended to be a Digistar theater similar to those in Pittsburgh and Phoenix, just a few months before signing equipment contracts, E&S invited Adler President, Dr. Paul Knappenberger, to Salt Lake City to view their new product—the StarRider™. Jeri Panek used a well-known sales technique — she handed him the joystick and let him fly through the Grand Canyon, as if he were hang-gliding. That “test drive” sold him on the concept of interactivity by giving him the power to choose his own path through the canyon model. (Note: while it was still in the prototype stage, the very first Digistar was purchased by Dr. Knappenberger for the Science Museum of Virginia — so he has a track record for early adoption of technology.)

Although I was somewhat skeptical about being the first to adopt the StarRider™ technology (I was burned before when Adler was only the second planetarium on record to install an Intelligent Lighting System (ILS) automation system driven by a Data General Nova 4 computer), I believe that we made the correct choice in this case. The StarRider™ has proven to be very popular with our wide range of audiences — preferred about 2 to 1 over the Zeiss Theater. (Note: since we had the luxury of retaining our Zeiss Theater, we continue to run hourly shows in the older theater with the same ticket price as those in the StarRider™ Theater. Planetarium Members are free to the museum and Zeiss Theater shows.)

The Technology
Since this meeting is being held at the only other existing StarRider™ Theater, I will only briefly describe Adler’s theater and hardware. Our StarRider™ Theater dome is 55 feet in diameter, has a 15-degree tilt, and 191 seats—each with a 5-button keypad. The backbone of the theater is a Digistar II and an Evans … Sutherland Image Generator (ESIG 5530). The
image generator sends model information 60 times per second to six video projectors (modified Barco 1209s) which are blended into a full-dome image by a device from SEOS known as a DigiBlend 200. Each of these systems requires at least one computer. The show operator starts the show by clicking a button on the Host computer (a PC), which sends information to the image generator describing the order of the computer models, when to place them on screen, and the model and camera paths. The system clock and all regular program audio originate from another PC using SAWPRO software, while yet another PC produces interactive sounds running GIGASAMPLER software. (Note: we have other sound sources available: a DA-88, a CD player, and a cassette deck, but these are seldom used except for the CD player, which is used for pre-show and post-show music.) In addition, we have a seventh video projector which allows us to superimpose various other video sources on the dome together with those produced by the image generator, as well as a few slide projectors for credit slides, lectures, etc. The video sources, cove lighting, audio levels, and slide projectors are controlled by another PC running SPICE software from Sky-Skan. And, of course, the Digistar II system interface is a Sun workstation.

**Shows and Show Schedule**

E&S supplied our first show, “Journey to Infinity,” which is still running as one of our offerings after more than 3-and-a-half years — although we made a number of visual improvements earlier this year. During the first 9 months of operation, “Journey” played every 30 minutes throughout the day. Maintaining such a schedule was exceedingly difficult, since the show runtime is approximately 24 minutes. On busy days, we fell somewhat behind schedule during peak hours and any technical difficulties were a dis-aster (no pun intended!) However, we felt we needed such an aggressive schedule since our older theater was being remodeled at the time. At present, we run shows every 45 minutes, which (together with the Zeiss Theater) enables us to accommodate all our visitors and absorb minor delays without major complaints. As the title of this paper implies, we run so many shows that we reached the 10,000 show milestone sometime in the past year.

Sometime in the winter of 1999, only about a month after our grand opening, the First Lady, Hillary Clinton, proposed a new educational program that many of you might recall — the “Mars Millennium Project.” What a fund-raising opportunity! So, what we thought would be a producer’s dream—a short show production hiatus—became a nightmare. We had to learn several new technologies with their associated software packages to be able to produce and install an interactive StarRider™ show in just a few months. With the help of two new modelers (hired in June) and interactive programming by Lynn Buchanan of E...S, we pulled it off.

†“Blueprint for the Red Planet” opened on October 1, 1999. Since then, we have produced one StarRider™ show per year, while continuing to produce new shows for our Zeiss Theater.

StarRider™ shows are not limited to the output of the image generator. Each technology—Digistar, special effects, and video add other visual layers to the production. However, none of these work seamlessly with the others. Just as in a show in a conventional theater, you must design the show to prevent overlapping stars with images, for example, unless you intend such as effect. Because the human eye easily distinguishes imaging differences, we choose to mix only similarly projected visuals — i.e., since Digistar projections resemble video technology, the images work best when used alone or when combined with video. Obviously, our 7th video projector works well with the 6 others used by the image generator. Projected slides, on the other hand, seem to match less well. Surprisingly, the technique of using multiple visual layers actually hastens the ability of any planetarium producer.
to create StarRider™ shows. StarRider™ show production techniques are somewhat similar to those used to create conventional planetarium shows. Most of us create shows mixing video, slides, and special effects along with the star projector. That’s what StarRider™ does, unlike full-dome playback systems, which may lead some to eliminate their star projector and special effects.

**Maintenance**

As you might imagine, the various systems combined into a StarRider system can become a headache when troubleshooting problems. The most important issue is electrical power. Even though your power company will inevitably claim it will provide your theater with clean uninterrupted power, buy and install as many UPS units as your construction budget can afford. Our power company ignores any power interruption less than one second! Adler now has a UPS for the image generator, the DigiBlend 200, for Digistar II, and for all of the other computers in the theater. When we did not have so many computers on UPS units, we had a number of show crashes caused by brownouts.

Since most of the theater systems are exceedingly reliable, the most frequent calls for a technician to fix something in the theater result from operator errors. The most problematic device in our experience seems to be the DigiBlend 200, which is used for videoprojector blending, alignment, convergence, and color balance. However, now we put our videoprojectors into standby mode just once, at the end of the last show each day, so we can run shows all day without ever realizing that the DB200 has malfunctioned. Recently, we had an evening event together with a StarRider™ show — during the routine pre-show system tests, the operator could not bring the videoprojectors out of standby mode. The show operator on the day shift had turned off the videoprojectors. Fortunately, the evening operator performed the pre-show system check early enough to call a technician at home, and was able to reboot the DB200 and ultimately save the show.

You might be surprised to learn that, of all the complex systems running in our theater, the most expensive to maintain are the videoprojectors. Last year, we decided to enter a service agreement with E&S which, among other things, allows us to have a certified videoprojector technician from E&S visit us twice per year to tune projectors. The 5-year agreement also includes two complete tube replacements scheduled at our discretion. 18 months after we opened, we replaced all our videoprojectors with brighter models, so we have about 2 years on the current set. In my opinion videoprojector maintenance and tube replacements probably will be prohibitively expensive for many planetariums. Unfortunately, most budgets for new planetariums do not contain sufficient money for hiring staff to produce and perform shows, much less enough money for equipment maintenance. Some managers of existing full-dome facilities may find a poignant reminder in the phrase “too little, too late.” Imagine this scenario which may actually be occurring in various cities around the world today: a planetarium with a full-dome playback system opens in the same museum as an IMAX theater showing “Cosmic Voyage” or some other astronomy-based program. How can the public distinguish between the two venues? How can the planetarium achieve ticket sales comparable to the IMAX? Which will survive when budget cuts loom? How will videoprojector maintenance effect these decisions? These are the tough realities facing our profession in the near future.
The Planetarium: Astronomy and Modern Culture

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ABSTRACT

What would have been of the human mind without the challenge of the clear night sky? Here I deal with Astronomy along human history and the relevance that the understanding of the Universe has to the evolution of human endeavours such as art, philosophy and religion. I discuss some ideas about how the teaching of Astronomy becomes more successful by the use of cross-curricular links at all levels of education, so all the way from the classroom to the public environment, society benefits from a richer and wider cosmic awareness as part of our modern culture. A sense of scale and perspective, both in time and space, then a sense of belonging, a sense of common origin, by knowing the nature and evolution of everything, including ourselves. Deep humility yes, but also pride of being able to understand the Universe. Could the wonders of Nature inspire humankind to fill the spiritual gaps that modern science seems to have created?

THE CHALLENGE

A clear view of the night sky has always been one of the most challenging natural displays to humankind, perhaps specially to the first ape-like creatures that started to walk on the plains of our planet around two million years ago.

To their eyes, the entire sky, populated by thousands of tiny points of light, all slightly different from each other. To their eyes, the daily appearance of the blinding golden disc, illuminating the land and keeping it warm, the changeable Moon, everything following eternal, mysterious cycles…. What thoughts then? What questions? What emotions and fears would eventually trigger the need to find ways of understanding inside those incipient minds, deprived from any previous knowledge?

The need to find ways of understanding…. Curiosity has been one of the main drivers along human history. However, in facing the challenge offered by Nature, humankind had to cope with her limitations in perceiving and interpreting the reality of the environment, limitations perhaps also imposed by a desperate need for immediate answers to every mystery…, the birth of superstition, mythology and religion.

The planetarium works here both as a virtual reality environment and as a time machine, taking audiences there and then, to share those feelings and to ask those questions, in silent contemplation of the clear night sky.
AGAINST COMMON SENSE

‘Sit down before fact like a little child and be prepared to give up every preconceived notion. Follow humbly wherever and to whatever abyss Nature leads, or you shall learn nothing’ (T H Huxley)

But to ‘follow humbly’ the roads of Nature is difficult, because usually Nature is extremely deceptive. Our senses tell us that we are at the centre of the Universe. We still say ‘the Sun rises, or the Moon sets’. For centuries, this deception was enhanced by the arrogant attitude of humankind that found herself as a dominant power conveniently placed by a supernatural entity at the centre of creation.

In the end, the influence of Astronomy in society had a major milestone in the decades around 1600, with the discovery that humankind is not at the centre of the Universe. Key players in this process were Nicholas Copernicus, Giordano Bruno and Galileo Galilei. After careful observation, Copernicus provided the model, Bruno publicized it and Galileo used a telescope for the first time to produce indisputable evidence. Those were the times of the Inquisition, established by the Catholic Church to keep society under control. Teaching that the Earth was just another planet and that the planets were like the Earth, all in orbit around the Sun is against sacred scriptures and was considered heresy. Copernicus refused to publish during his life time, Bruno was tortured and burned alive, murdered by the Catholic Church in a public place in Italy and Galileo nearly suffered the same fate.

This painful revolution was fundamental to the birth of modern science, that is, a way, a method to explore, to discover and to understand Nature. A process involving careful observation, then the production of a model, a theory, trying to explain what has been observed and even to make predictions.

The planetarium can be used here to compress time by moving the planets in the sky and also emulating a heliocentric solar system in motion. There is plenty of room for story telling and dramatisation of those real historical events and to make analogies with radical attitudes about our natural world that we still find around today.

ACROSS THE CURRICULUM:
THE POWERFUL MESSAGE OF ASTRONOMY

What follows contains what I consider fundamental topics about our natural environment. Topics that should play a major role in the syllabi of primary and secondary schools. There is a strong cross-curricular component and an underlying theme that, in my view, is one of the main driving forces behind human curiosity, something in the mind of every child that needs to be addressed as frequently as possible: ORIGINS. I am aware that nothing of what follows may be new to the IPS community, perhaps only a different approach, a different order of priorities.

A) THE NAKED EYE SKY (Main cross-curricular links: history, literature, art, religion, philosophy, psychology, mathematics, geography).

This is one of the simplest, richest and most attractive aspects of Astronomy, where we find patterns in the sky, geometrical figures, motions of stars, planets, the Sun and the Moon, light and shadow so clearly seen in the phases of the Moon. We learn about old myths and legends that named the stars, placed heroes and gods in the sky and gave ‘magical powers’ to the heavens over human destiny. A great opportunity to experience the physical and emotional
influence of stars in our lives and to admire, for example, the eloquent hymn to the Sun by Akhenaten (‘beautiful is your rising in the horizon of heaven...’)*.

The planetarium brings alive the myths, the poetry, the wonderful stories, all different, but fundamentally similar despite the isolation in time and space between the minds that produced them. Describe the practical use of the sky, which provided markers and defined paths, so by land and sea we could explore and discover. Even further, let the audiences imagine how the regularity of celestial cycles allowed humans to settle and to develop agriculture and large cities.

B) OTHER WORLDS (Main cross-curricular links: philosophy, religion, psychology, history, literature, art, geography, technology...)

In the early 1960s, Galileo pointed a primitive telescope to the sky. He explored and he discovered what nobody had seen until then. But most important: he interpreted and made links. He saw landscapes on the Moon and compared them with the landscapes on Earth. Absolute evidence that the Moon is another world, similar to ours. That was the beginning. Since then, technology produced better means to observe and explore many more landscapes in the sky, from powerful telescopes to space probes. A major event was the direct exploration of the Moon, from where the astronauts were able to look back to the Earth and to see it isolated, floating, now as another world, between the stars. Once again, the planetarium takes us with the Apollo astronauts to the middle of the lunar landscapes and makes us wonder what Copernicus, Bruno and Galileo would have felt in our place.

C) ORIGINS I.- WHAT ARE THINGS MADE OF? (Main cross-curricular links: chemistry, mathematics, history, technology, literature, art, ...) Here we are at the starting point of a fascinating process of discovery in which Astronomy provides a wonderful, almost magical conclusion about origins. The first step involves materials and their properties. The modern concept that all matter in Nature is made out of ninety two chemical elements, all placed in order in Mendeleev’s periodic table. The crucial and amazing fact that every chemical element is made out of a kind of tiny little bricks that we call atoms and that all atoms are made out of only three types of, even tinier, fundamental blocks or particles (protons, neutrons and electrons). That atoms of different chemical elements are different from each other only because they have different numbers of protons, from hydrogen with one proton, or carbon with six protons, to uranium with 92 protons and that the particles forming the atoms are held together by mysterious forces that include electricity and magnetism. Play with magnets. Refer to Mendeleev’s table and use marbles or beads of 3 different colours to assemble models of atoms of several chemical elements. Compare all this knowledge with the ideas of ancient Greeks, for example, who had decided that there were only four fundamental substances: water, earth, air and fire. Examine samples of chemical elements like carbon, aluminium, iron and gold, think about our atmosphere made our of nitrogen and oxygen, then ask what are the stars made of?

* FOOTNOTE: (I am not afraid to deal with Astrology. In fact, I think it is essential to address the issue, to acknowledge the wide public interest in the subject and to make the connection to Astrophysics, which so vividly provides the most magical, beautiful and intimate link between us and the stars, as I explain later on).
D) ORIGINS II.- WHAT ARE THE STARS MADE OF? (Main cross curricular links: chemistry, biology, technology, history, philosophy, religion, literature, art, …)

Stars are so far away, that we could think that we would never know what they are made of (actually, a philosophical remark by Auguste Comte). Today, we find the answer in…. the rainbow! As it happens, the electric and magnetic forces within the atoms produce all the light that we see, from atoms in light bulbs, in fluorescent lamps, on TV screens, from atoms in the Sun…. and in the stars. Each type of atom produces a unique, exclusive ‘rainbow’, or set of specific colours. Looking at the stars with special ‘rainbow machines’ called spectrosopes, astronomers have discovered that the chemistry of the Universe is one and the same everywhere, including our own planet and our own bodies. The beautiful rainbow. The colours of painting and poetry. The stars, including the Sun, made out of hydrogen and helium, with traces of virtually all the other 90 natural chemical elements in Mendeleev’s table. But where did the atoms come from?

E) ORIGINS III.- ATOMS FOR LIFE IN THE UNIVERSE (Main cross curricular links: chemistry, mathematics, biology, geology, history, philosophy, religion, literature, art, …)

For thousands of years, Astrology has linked the stars to human destiny. Even today, Astrological ideas are very popular despite the lack of any evidence to support them. I suppose that, apart from all this, we always feel something special when we look at the clear night sky. Somehow, we almost feel linked to the stars. Stars have lives. They have birth, middle age and death. Stars and planets are born from giant clouds of mainly hydrogen gas floating in space. Stars shine because deep inside, they are burning their hydrogen in fierce nuclear reactions that put together protons, nuclear fusion. The result is the light that makes them shine. So, only deep inside each star and no where else in the Universe, the building blocks of chemical elements are assembled. As stars die, the chemical elements they have produced are spread as clouds of gas out of which further generations of stars and planets like our Solar System would eventually form. Cosmic recycling. The fact that all the atoms around us were assembled inside stars that lived and died long ago, gives limitless material for thought and reflection. Now look again at the stars and you will see the light produced by those ovens where more atoms are being put together, to make more stars, more solar systems, the chemistry of the Universe, which is the chemistry of life. Have another look at Mendeleev’s table and think: the link between us and the stars could not be more evident and wonderful, a sense of belonging to the Universe well beyond any Astrological claims, because without the stars there would be no chemical elements, no planets, no life. And certainly without a particular star, the Sun, we would not be around at all. Think about the meaning of all this, now that more than 100 planets have been detected orbiting nearby stars. I like the idea at the Hayden Planetarium in NY, where those stars with identified planets around them appear in the sky surrounded by a little blue ring... Rainbows, atoms, stars and human feelings, material for so many engaging planetarium shows.
F) ORIGINS IV.- THE ORIGIN FOR EVERYTHING (Main cross curricular links: chemistry, mathematics, biology, geology, history, philosophy, religion, literature, art, …)

As for the very first generation of stars, we go back to the origin of the Universe itself, where there is evidence of a colossal expansion called ‘the big bang’, out of which ‘somehow’ came a primordial cloud not of atoms, but of fundamental particles mainly protons, neutrons and electrons. As the cloud cooled down, atoms of hydrogen, helium and lithium were able to form, and nothing else. For a very long time that was the chemistry of the entire Universe. Then the cloud collapsed in many places and stars were formed. Inside those first stars, hydrogen started to be converted into heavier chemical elements, initiating the cosmic recycling. Compare this picture with ideas about the Universe from other cultures past and present. Once again, plenty of material for thought, reflection and communication.

G) HOW MANY STARS? (Main cross curricular links: mathematics, philosophy, religion, literature, art, …)

Modern Astronomy has discovered that stars appear only in large groups called galaxies. Our star, the Sun, belongs to a galaxy, our galaxy, the Milky Way. All the stars that we see with the naked eye are part of our galaxy and most of them form the cloudy band of light across the sky, only visible from places with very clear and dark skies, away from the cities. There are about 150 thousand million stars in our galaxy alone. In order to give a meaning to this large number, I have this analogy: a heavy bag of 30 kg of rice would contain around one and a half million grains. Imagine a large football stadium with 100,000 spectators, each of them carrying one of those bags. There will be in the stadium as many grains of rice as stars are in the Milky Way.

And the Milky Way is only one of many galaxies that populate the Universe. To have an idea of how many galaxies may be out there, refer to the historical picture by the Hubble Space Telescope of an apparently empty area of the sky towards the constellation of the Plough. With one or two exceptions, every single object in that picture, even the very tiny ones, is an entire galaxy, made out of as many stars as our own Milky Way. Nothing special about the Plough, everywhere in the sky we would find a similar picture, telling us, for example, that behind a full Moon we would find half a million galaxies! The ultimate challenge to our minds. The expression of our feelings facing this immensity goes all the way from science to art, philosophy and religion.
H) THE FUTURE, A PERSPECTIVE FROM THE PALE BLUE DOT  (Main cross curricular links: biology, geology, philosophy, religion, literature, art, …)

(The Voyager view of the pale blue dot) This is a real picture. From the edges of the solar system the Voyager spacecraft, now on its way to the stars, turns its eyes of glass to the Earth, for a final view of the home planet. The picture was described by the late astronomer Carl Sagan: ‘A pale blue dot …..that is us. That is home. That is where we are. On it, everybody you loved, everybody you know, everybody you heard of lived out their days…..’

The enormous power of this image triggers all kinds of feelings. Our physical insignificance, yes, but at the same time, our eternal need to know and to explore, our human eyes, looking back at the Universe that created them, the eyes, the mind of the Universe, for some reason trying to understand it.

There are still plenty of challenges out there, many discoveries to come. We do not know yet the nature of the fundamental components of the Universe, including gravity, electricity and magnetism. The very origin and final fate of the Universe are still a mystery, as are the details about the formation of galaxies, stars and planets, the origin of life itself. This is part of the fascinating landscape waiting to be explored by today’s children, and they need to know this now.

CULTURAL SHIFT

Astronomy uncovers the overwhelming reality of Nature, a reality that is there for us to face and to deal with. We are part of it, there is no escape. Hopefully, humankind would be able to find and develop elements within this reality to satisfy spiritual needs, a new philosophy, ethics, sense of belonging, cosmic awareness, critical and lateral thinking to confront and replace the distorted ‘answers’ and complicated explanations coming from beliefs based on superstition and fear, or in a single word, from ignorance, the source of all human misery. The ignorance that is taking away the stars from the sky. The ignorance that is taking the stars out of the human mind.

Let us encourage, by all means of education at all levels, the pursuit of knowledge for its own sake, a fundamental tool for every single mind to contribute to the development of a much needed cultural shift in our modern society.
I have done many projects in the planetarium in collaboration with other museums and even our local zoo. I have found that these collaborations usually generate new audiences for the planetarium and provide for new ways to cross promote more than one institution. About two years ago our sister institution The Fernbank Museum of Natural History successfully negotiated with the country of Syria and the government of Canada to bring a large exhibit of significant ancient objects to Atlanta called “Ancient Empires: Syria Land of Civilization”. I thought that this exhibit would generate enough local interest that if we produced a show to go along with the museum events we might be able to attract even more visitors to both sites. I had never written a show on this subject before, so it was quite an interesting learning experience for me. I concentrated on the period between 800 AD and 1500 AD. During this pre-telescope time I found a rich treasure trove of astronomical activity happening throughout the Islamic World. I wrote and produced a planetarium show called “Ancient Islamic Astronomy.”

My colleague April Whitt wrote and produced a children’s planetarium show called “Flying Carpets and Shooting Stars.” While the adult show featured Islamic Astronomy from calendars to determining the time of the five daily prayers, the Flying Carpets show featured stories from the Middle East with a genie and of course a flying carpet. We choose narrators from the local Islamic community for the production of Ancient Islamic Astronomy. In this way we got free word of mouth about the show into the local mosques. During my research into Islamic astronomy I ran across a web site of company that sells brass replicas of astrolabes. After ordering one and learning how to use it I wanted to share this new found knowledge with others. So I have been doing gallery talks in the Syrian exhibit at the natural history museum. I station myself next to the display of ancient scientific instruments at preannounced times and conduct brief demonstrations to the public. I have always found visitors very appreciative of any personal contact with the academic staff. It also is a novelty to get to handle a real, well a real replica astrolabe The marketing departments of the Science Center and the Museum of Natural History got together put out joint press releases, we also offered discounts at both institutions on admission if someone brought a ticket stub from the other site. Both institutions hung show posters in each other’s galleries to promote the exhibit and the planetarium show. We even featured one of the Syrian artifacts on the cover of our annual planetarium brochure.

When the events of September 11 happened both the planetarium shows and the exhibition were in the final stages of production. By September 12 there was some pressure to cancel both projects, in the fear it would upset our visitors. But I and others felt in post September 11 it was even more important to feature the many positive things that have come from the Islamic world. It turns out that the public interest because of world events in the Middle East has been heightened.
Music of the Stars

(A live concert in the Planetarium)

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(This program was a Power Point presentation. I have paraphrased much of what I will discuss along with the pictures and provided a few images).

Most people know music in our planetarium from the popular Laser Light Shows which we have done for many years. Or they’ve enjoyed the music in the soundtracks of Astronomy Shows. However, when the opportunity presents itself, we can always find new ways to engage the public with musical events. A few years ago, Jonn Serrie brought his concerts to the planetarium. A number of larger planetaria have held concerts in their theaters, including one I have heard accommodated a full symphony orchestra in Germany. But being a more conventional-sized facility, and with a minimum of space in the front of the theater, how could we accommodate more than one musician (as in the Serrie concert). When the opportunity was presented to us, true to the British heritage of some of this music, just like Dr. Who’s Tardis - we were able to create a space bigger on the inside than it was on the outside. Or maybe we folded time and space?

Fig. 1. Benjamin Carlisle, School of music doctoral student.

You be the judge.

Benjamin Carlisle (fig. 1), a doctoral student in the UNL School of music working on his degree with conducting as his specialty, first approached me in the fall of 2001 with the idea of bringing over some students to play classical music composed by astronomers. UNL’s own Dr. Martin Gaskell (fig. 2—a quasar researcher in the Department of Physics and Astronomy) is a classical composer with a number of published works. He first introduced me to Ben and has been a big supporter of the Planetarium. It was also his harpsichord which he loaned to us for the concert.

Fig. 2. Dr. Martin Gaskell, a quasar researcher in the Department of Physics and Astronomy.
Astronomers have been associated with music in many ways. Johannes Kepler theorized about the “music of the spheres.” And Sir William Herschel (fig. 3) was a classical composer of prodigious output. The first performance of the concert would take place on the anniversary of the discovery of Uranus by Herschel. And thus, Herschel’s music took a prime spot in the performance.

From our discussions, Ben decided to put together a chamber orchestra to play classical music composed by astronomers. The concept of doing this in the planetarium theater was something we wanted to pursue - but realized it was a daunting proposal. Mueller has a 31 1/2 foot diameter dome and the seats go far towards the front (too far in my opinion). We knew we would have to take out seats to accommodate the orchestra as there is not a huge amount of room in the front of the theater. It turned out we took out the entire front row and also blocked the middle portion of the second row to have room for the orchestra. These seats have been bolted to the floor for many years. Age, rust and dust, made removing them very difficult - certain more difficult than some would have imagined. (Namely our musical and astronomical colleagues in this project). My grad student volunteer Elizabeth Klimek and two other students Chad and Zach helped me fight the chairs. But it worked. There were still bolts from the chairs of the front row sticking up from the floor. We weren’t about to try and remove them. So we marked the floor with yellow electrical tape to keep people from stepping on them. It looked much like the outline of a crime scene.

Plans and work all came together in March 2002 with two concerts performed in the planetarium theater. Of course, there were a number of rehearsals in the theater beforehand. So the “crime scene” tape remained on the planetarium floor for several weeks.

We were borrowing music stands and some equipment from the music department, but it had to go back after each rehearsal. One weekend we had a fine snowstorm and even the University closed. But the next day, I had the pleasure of pushing a big cart of music stands across icy sidewalks across the campus. We also struggled with lighting. Each music stand had a light. We had to create red filters for each light to mask the light leaks which might throw abundant unwanted light on the dome. Our intention of course was to create a “concert under the stars.” As I began talking with Martin about the concert he became quite excited (he does tend to be enthusiastic). As someone who was born in Britain, he is quite taken with Herschel and thought we needed to flesh out the audience’s knowledge of Sir William and his sister Caroline. Two UNL students from Germany (Marco Seine and Evelyn Allgeier) portrayed the Herschels (who were born in Germany) in some introductions for the performances of two of Herschel’s symphonies (the Second Symphony in D Major and the Fifth Symphony in F Minor).

Gaskell’s “Romance” (written while observing at Lick Observatory) and “Song of the Night” made the program.

Current Russian astronomer Dr. Valentina Doroshenko (fig. 4) also contributed a work: “Summer Rain.” Funding for science in the post-Soviet Russian economy is in a precarious
position. Many times the power has been cut off temporarily to the observatory where Valya (the name she prefers) does her research (the Crimean Station of the Sternberg Astronomical Institute). During one of these periods, Valya composed “Summer Rain” by candlelight to words by her husband Yuri Efimov, who is also an astronomer.

Martin Gaskell and I started looking for visuals of Herschel’s period and the lives of William and Caroline. We received pictures taken at the Observatory where Valya does her research (the Crimean Station of the Sternberg Astronomical Institute) and I started putting these together in images to show during the concert. In fact, I received an e-mail from Martin at 1 a.m. the night before the first performance with more images that were labeled: “Look at These!” Fortunately, I was able to persuade him we had to stop somewhere and the show was ready to go.

Both concerts were sold out almost a week in advance. And both performances were recorded digitally. I have produced a CD of the best performances representing all the works performed. I’ve distributed them to the players and to some fellow astronomy enthusiasts who enjoy Herschel’s music. This is no commercial, but I have brought a few with me to give away at this conference. And we’ve had many inquiries about when we might do this again. The difficulty in attempting such an event is in matching the very busy schedules of all the players in the orchestra (figure 5). It was certainly a unique experience. And the harpsichord sounds wonderful in a dome!
The French-speaking *Planetariums* Magazine

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**Abstract**

Since 1995, the french speaking Planetariums magazine is growing up, becoming this year the first planetarium review fully in colour, exchanging abstracts with IPS Planetarian since 1998.

This annual magazine was founded in 1995 by the French-speaking Planetariums Association APLF, with papers in the planetarium field (technology, pedagogy, planetariums activities), astronomy news, and rubrics upon books, CD, Planetarium directory and Planetarium shows for the french speaking countries concerned: France, Belgium, Switzerland, Quebec, Louisiana, Algeria, Tunisia, Morocco, …

The greatest astrophysicians bring their contribution: Agnès Acker, Jean-Claude Pecker, Hubert Reeves, Antoine Labeyrie, James Lequeux, Jean-Pierre Luminet, Marc Lachieze-Rey, Serge Koutchmy, …

After eight years, it contains 156 articles and 51 *comptes rendus* of meetings and other editorial papers written by 114 authors. With 728 pages today, it is the most important data base upon french speaking planetariums activities at the turn of year 2000.

The magazine was stand up with 24 advertisers from six countries and the help of french Ministry of Science and Education, and this year, it becomes the first Planetarium magazine fully in colour.

At international level, the magazine is exchanged with these of other planetaria societies, like *Twilight* for Japan, and an exchange of abstracts with IPS *Planetarian* was stand up by Dale W. Smith and John Mosley and runs on since 1998.

Like for APLF, the magazine contains echoes of IPS activities and conferences. It is opening its columns to European Planetariums: Great Britain, Germany and Italy were presented by articles and maps from Undine Concannon, Andreas Scholl and Loris Ramponi.

The small and portable planetariums are also presented like for the international meeting stand up in Strasbourg with Susan Button.

The Tables for the period (1995-2000) are edited and will continue every 5 or 10 years periods to give the research more easier.
All Sky Projectors – Beyond the Naked Eye

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Abstract

The night sky visible to the naked eye, whether seen from a dark site or inside a planetarium, is unfortunately a very shallow view of the universe. One can barely make out our Galaxy. There is a great need to reveal to our audiences the nature of our Galaxy and how galaxies such as ours are sprinkled throughout the visible universe, within a world bounded by the shell formed by the Cosmic Microwave Background. Unfortunately not many of us have the resources and funding of New York’s Hayden Planetarium in resorting to full dome video to do the task. Nevertheless all-sky images, projected in register with the star field can show us what the eye cannot see. We can look progressively deeper into space, or alternatively view the sky at other wavelengths such as radio or infrared.

We humans have evolved as creatures of daylight. Our eyes, our main sense organs, work well in a daytime environment. Daylight is so abundant that the entrance aperture to our eye is usually only a millimeter or two across. We can adapt to nighttime, but only to a limited extent. The aperture can increase to 6 or 7 millimeters and in the same time span as normal twilight, the production of rhodopsin switches vision from cones to rods. Rods are the more abundant and more sensitive of the photoreceptors in the retina of the eye. We can see fainter light levels with them, but only in black and white and with limited resolution. Suffice to say that if we were to walk the countryside at night, we would frequently stumble over tree stumps and rocks that we could not clearly see. In modern times, we would be lost without artificial lighting.

Yet at night, we use our eyes to look up and examine the universe that surrounds us. Not surprisingly, we do not see that much. Of the seven other major planets in the solar system, the naked eye can make out five. Of a trillion stars in the galaxy, the eye sees at best only about nine thousand, none of them particularly distant. It has no way to discern the true shape of the galaxy, which it sees as a vague luminous blur. Of all the billions of other galaxies in the observable universe, it can just manage to see only three.

It is a very shallow view of the universe! No wonder so few people realise what is out there, or even know where they are.

It is the same shallow view that we attempt to reproduce on our planetarium domes for the benefit of the public. And the problem is the same. Most members of the public cannot interpret what they are seeing. Of course, it is the planetarian’s job to provide that interpretation. But if all they have to show is the normal star field that planetarium projectors provide, then a lot of explanation and vivid description is necessary.

Why then can a planetarium not show the audience where they are? It seems the most fundamental need that ought to be addressed. In fact, it was exactly what the opening production of the new Hayden Planetarium in New York sought to do. But few of us have all-dome video
and the budget that lavish production required. However, many planetariums possess six-projector ‘all-sky’ systems and such systems can be employed to do the job.

We simply need to show the Galaxy in which we live. Once the audience can understand the nature of our Galaxy, they can extrapolate that knowledge to other galaxies. So we need to enhance the sensitivity of the human eye, such that it could see the sort of details recorded by astrophotography, so that it could clearly see the nature of the Milky Way. If the planetarium projector cannot do it, the all-sky projectors can.

At the planetarium in Cape Town, we have, since 1989, been trying to show our audiences what the Milky Way is like. The idea has been to produce artwork, based on astrophotography, that could be put up by the all-sky projectors in place of the diffuse Milky Way projected from the star projector. In other words, the artwork would work in register with the stars from the star projector, and be projected at an appropriate intensity level. Our first version (painted by Anina Botha) was in color, but had the disadvantage that the ‘black’ of the color emulsion in the slides was not completely black (so that a diffuse light was put over the whole dome). To improve on this, our next version was black and white on Kodalith film (which has a true opaque black); it was painted by our artist Margie Walter and based on the black and white panorama then put out by the European Southern Observatory. By 1996, we again resorted to color artwork (yellowish bulge, bluish spiral structure with red emission nebulae) painted by Margie, based on considerable research using the southern sky surveys. To overcome the problem of the not-completely-opaque black, we sandwiched specially prepared masks. We also employed a second bank of all-sky projectors with thousands of additional faint ‘Kodalith’ stars, concentrated towards the galactic plane.

This artwork has however been completely ‘eclipsed’ by the release of a color photographic panorama of the Milky Way prepared by one of us (Mellinger) between 1997 and 2000. Using a Minolta 28-mm wide angle lens and 35-mm format film (Kodak PJM2 and PJ400), 51 color photographs of the night sky were taken from various dark-sky locations in California (USA), South Africa and Germany. The limiting magnitude of each photograph is approx. 9m. After digitizing the negatives with a film scanner (Polaroid SprintScan 35 Plus), vignetting was eliminated with a digital unsharp mask. To create a seamless mosaic, the individual frames (each of which represents a tangent projection of the celestial sphere onto the film plane) were then transformed to an equidistant cylindrical projection in galactic coordinates. The transformation parameters were determined by fitting the (x,y) positions of selected reference stars to the PPM catalogue. Fig.1 (next page) shows the final image in an equidistant azimuthal projection.

Even though the panorama image has a nominal resolution of approx. 2 arcminutes, individual stars appear as disks with a diameter of up to 35 arcminutes, due to light diffusion in the gelatin emulsion layer of the photographic film. In a planetarium, the traditional star projector thus has a clear advantage in displaying pinpoint star images, while the photographic panorama offers a unique view of the Milky Way’s star clouds and nebulae. Therefore software was developed that removes all bright stars (<6m) from the panorama image by replacing the star images with median-filtered pixels from the surrounding area. A small amount of noise was artificially introduced to mimic film graininess. The resulting image was converted to six pre-distorted all-sky slides using SkyScan’s DigiDome software.

The Milky Way all-sky is clearly the most crucial visual for demonstrating where we are in the universe; it can also be used as a staging point to the extragalactic universe. One of us
(Fairall) is a researcher in galaxies, and has, in previous years, developed an extragalactic sky, which shows the positions of several thousand nearby galaxies, rather than stars, via the all-sky projectors.

An complementary approach is to show what the eye cannot see because it is outside the visual portion of the electromagnetic spectrum. Again in the past, all-sky projectors have been used to put up a false-color radio sky (more specifically that at 2300 MHz from Rhodes University). Such a scene is dominated by the Milky Way, but includes numerous extragalactic sources. We are currently working on 2MASS data to show the sky and the galaxy in the infrared.

One can also show the ultimate horizon – the surface of “last scattering” of the early opaque universe – the Cosmic Microwave Background. That surface encloses the observable universe in a spherical shell, so it is very appropriate to depict it on the hemispherical screen of the planetarium. In the past, we have used the well-known COBE data, but its resolution has now been far exceeded by the BOOMERANG data. The latter does not however cover an entire hemisphere, so some license has to be taken. Future years will see data from the MAP spacecraft.

In summary, all-sky projectors – unlike planetarium star projectors - are not limited to a shallow view of the universe. They allow us to carry our audiences out to the galaxy and far beyond!

I can remember a time, in my youth, when I gazed upon the starry night, ablaze with brilliant stars against a deep black sky, nightly. Looking back upon this time with fondness, I can only visualize in my mind something that was truly high definition. Sadly, due to poor lighting practices our entire planet is losing or has lost our heritage of the starry night. It was this heritage that instilled a passion for the night sky in my sole and thrust me into a planetarium career. It is a passion that I have tried to share with every visitor or student that I have encountered in my 21-years as a professional Planetarian and even longer as an amateur astronomer.

To me the most important thing in education is reinforcement and enrichment. What we teach under the dome is only as good as the student remembers and/or reinforces in their daily lives. Hopefully, we all inspire visitors to embrace the night and make them eager to explore for themselves the wonders of the universe firsthand. However, the skies have become extremely challenging for identifying all but the brightest of stars, making it difficult for novices to make the true connection with the cosmos. All is not lost. Through the efforts of IDA and other caring individuals, including many planetariums, society is learning better techniques of lighting that reduces glare, light trespass and wasteful practices.

Many Planetarians start presentations showing the effects of light pollution and I applaud each of you for doing so. But how many Planetarians continue for a few more sentences offering solutions for the problem that they had just spoke of? Its true, it is much easier to complain about a problem rather than fixing it. However, once you have an audience’s attention and they realize what they have missed due to light pollution follow through with some solutions of how they can help change the situation, practicing better lighting at home. Keep it short and simple. No one, including myself, wants to be preached to for a long period of time. Brevity and the offering of solutions help create a more positive learning experience.

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Planetariums and the International Dark Sky Association

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Abstract

A look at how Planetariums and the International Dark Sky Association can work together to help promote public awareness in the efforts to reduce light pollution while stimulating interest in, and the education of, the night sky. A glimpse at the successful campaign led by the Bishop Planetarium in Bradenton, Florida will offer ideas on how to promote proper lighting and generate positive press and promotion for your facility.

Who and what is the International Dark Sky Association? Hopefully, everyone, at least in our arena, has heard of them. If not, then I hope that I can acquaint you with them and instill upon you the need of your participation in helping achieve their goals. After all, their goals and what we do and teach go hand in hand. The International Dark Sky Association, or IDA, is a not-for-profit organization composed of over 8000 members whose goal is to preserve and protect the nighttime environment and our heritage of dark skies through quality outdoor lighting.

I can remember a time, in my youth, when I gazed upon the starry night, ablaze with brilliant stars against a deep black sky, nightly. Looking back upon this time with fondness, I can only visualize in my mind something that was truly high definition. Sadly, due to poor lighting practices our entire planet is losing or has lost our heritage of the starry night. It was this heritage that instilled a passion for the night sky in my sole and thrust me into a planetarium career. It is a passion that I have tried to share with every visitor or student that I have encountered in my 21-years as a professional Planetarian and even longer as an amateur astronomer.

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Additional stimulates and reinforcements can come through lobby displays, brief videos, hands-on activities and handouts. The International Dark Sky Association has an abundant supply of printed material free for your use that address just about every type of situation you or a visitor might encounter. Visiting their web site is free and is as simple as http://www.darksky.org Here you can find just about everything you can imagine and I guarantee you will learn something new each time you visit the site. Also available, for a modest fee, are slide sets that represent good and bad lighting, T-shirts, bumper stickers, Power point presentations and much more. There are also copies of the Southeastern Planetarium Association’s Saving the Night QuickTime movie, IDA’s recently released Protecting the Night Sky and the City of Los Angeles’ Looking to the Stars video tapes. SEPA’s Saving the Night and IDA’s Protecting the Night Sky are brief programs, under 15 minutes in length, that are ideal for use in lobbies, classrooms, astronomy clubs, civic organizations, government meetings or anywhere else an audience might be gathered.

Continual reinforcement does work. While Director of the Bishop Planetarium in Bradenton, Florida, I had a unique opportunity to educate the public on the effects of light pollution. Although I was considering making the first move, I was forced into early participation via the news media. Fortunately, I was well aware of the IDA, had visited their web site, and was looking for ideas on how to remedy a very bad situation.

The City of Bradenton decided to build a new City Center complex directly across the street from the South Florida Museum - Bishop Planetarium and its observatory. Naturally, the night-skies from the rooftop observatory nestled in the downtown of a small city were not the best to begin with. However, it could always get worse and it did! I thought I had this potential problem addressed since the Mayor had chosen me to be on a blue ribbon task force for the redevelopment of downtown. I thought that I had done a pretty good job educating them on proper and improper lighting techniques and how it would affect our observatory program. Obviously, I was living in a fantasy universe because this was not the case. What was their answer to my educational efforts? Glare bombs! Over 100 glaring lights and more scheduled to be erected just a few hundred feet away from our doorstep.

Upon their first light, I was puzzled on how I would approach the city government and remedy the situation. A few days later, while vacationing back home in Tennessee, the Florida media tracked me down. They wanted to know if the recently added lighting affected us in any way. The media realized how brilliant these lights were and how they would surely doom our observatory program if not corrected. My answer of course was yes! Unfortunately, to the media and community, the whole issue was more than just bad lights. The city residents did not want the City Center development in the first place and everyone was upset at the local Mayor for building it anyway. The museum and planetarium were considered a treasure to the community and the destruction of any of its programming, when it could have been avoided, was not excusable.

I am sure that the whole lighting ordeal was an accident but I had to use every opportunity to correct the situation. Accidents usually don’t fix themselves, especially when money is involved. The city was tired of hearing about the problem, especially after continual bombardment in the media, and they wanted solutions. With the help of IDA, its web site and employees, I discussed the appropriate steps to take on what would be a successful journey. The key was and still is education. Educating the city as well as the general public was crucial in this success. Allies
in the media didn’t hurt either! Of course, like any other city or town the controlling factor is money and how much is it going to cost usually dictates how fast a project is accomplished. Fortunately the City’s electrical department was quick to come up with a solution that only cost a couple of dollars for material to fix each light. Each light was fitted with an aluminum band that shields the lamp source and forces all of the light downward where it was needed.

Once the city electrical department was educated on proper lighting they were eager to implement better lighting throughout the city, starting nearest the planetarium and working outward. Dusk to dawn lights were shielded with Hubbell skycaps and all drop lens cobra headed fixtures were replaced with flat lens fixtures. Even the Florida Department of Transportation participated in replacing 44-drop lens cobra fixtures with flat lenses on an adjacent bridge that reduced sky glare significantly. The combination of the City and State agencies working together to help reduce the light pollution around the observatory increase our ability to see stars a full magnitude and half.

The whole lighting issue presented a unique opportunity for additional public education. The planetarium ran the Saving the Night planetarium program on a regular basis, in addition to providing printed material from IDA readily available for the taking. Photographs of before and after were strategically placed in the lobby area providing proof that better lighting does work. Additionally, source material for the local government access and county school system television stations was provided. Both of these stations were eager for new material to use on their stations. The stations ran the Los Angles production of Looking to the Stars with a tag line for more information to contact the Bishop Planetarium followed by our phone number. Each member of City Council, the Mayor, county and city utility departments and County Commissioners all received their own personal copies of the program as well. The entire borage of material was distributed and aired in the same month guaranteeing exposure to as many people as possible. The follow up step is to created ordinances that will help control future lighting. Already agencies are pursuing such issues since the community became aware of the problem and how easy it can be solved. It is not necessarily the night sky that the community wants back it’s their own darkened bedrooms, homes or yards that have been lost due to unwanted or unwarranted trespassing light.

As you can see, informal education does work. To further assist science centers and planetariums, IDA formed a working group dedicated for working closely with these venues. Known as the Informal Education in Science Centers and Planetariums working group the ISCP will work closely with other working groups such as the Formal Education and Student working group, interfacing ideas and products. Through these groups we hope to provide better communication, educational materials and solutions. It is essential that we have your input. By visiting the IDA web site and selecting “quick links” and then “IDA Special Interest Working Groups” you can supply valuable input to many areas.

Currently, the ISCP is working on several projects, some of which will take some time to complete. Once completed we feel that these products will help you better educate your visitors and audiences. The first thing we are trying to do is work closely with SEPA in further distributing the Saving the Night planetarium program. Over 216 planetariums in 11 different countries have purchased this program. This is a good start but we hope to put the show into more facilities.

The ISCP is also working on traveling exhibit ideas. The first of which is a small-scale exhibit that introduces people to IDA and its
goals. This display will feature a floor standing Nomadic display that can be easily assembled, disassembled and shipped. The magnetic panels will allow continual updates to be added or selected source material for a targeted audience. Each of these units will have at least two hands-on activities that will help reinforce ideas and solutions. The first of these exhibits should be on display at the October 2002 meeting of the IDA at the Boston Museum of Science and the Harvard University Observatory.

The ISCP is also working on a large-scale exhibit that encompasses the history of lighting. Needless to say, this exhibit will be very large and we are looking into healthy grants to help in its research, design and production. The goal for this exhibit is to travel with quarter year stays in each location. There is no definite date for its completion since all of the ideas are still on the drawing board. Funding will play an important role in its completion.

Also planned is an updated version of the SEPA QuickTime version of Saving the Night. The program currently utilizes all of the slides from the planetarium version but is in need of additional material that planetariums were to supply in their own productions. Hopefully, the new QuickTime version will give more examples of good and bad lighting with out losing the overall flow of the program.

On line discussions have suggested posters, exhibit design sheets, computer programs and Power Point presentations that can spin-off from some of the exhibits and ideas that are currently in progress. The bottom line is we need your input. You know your audiences. You know what works best for you. We need your ideas to help steer us in the directions that work best for you and your facility. Please share them with us. Together with IDA we can better the conditions of our nighttime environment and save our heritage. Small steps lead to large ones and we need your help. The educational efforts of IDA take funding. If you’re not a member of IDA please join and urge your regions to join also. Remember, IDA is only a mouse click away. Book mark: http://www.darksky.org I promise you will find solutions, great materials and friendly advice if needed. We look forward to hearing from you. May you have - Clear DARK Skies.
A Flight Through the Universe

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The Swinburne Centre for Astrophysics and Supercomputing has developed a range of visualisation tools and techniques to help explain fundamental astronomical concepts to school groups and the general public. One recent project was the visualisation of the 2dF Galaxy Redshift Survey (2dFGRS), which provides a three dimensional map of nearly 250,000 galaxies in the nearby Universe.

The 2dFGRS was performed by an international team of astronomers over a period of five years from 1997 to 2002. In May 2000, the survey became the first to map the three dimensional locations of 100,000 galaxies, so a promotional tool was needed. By working closely with members of the 2dFGRS team, Swinburne was able to produce a digital sequence showing what it would look like to fly through the Universe. Galaxy images were supplied by David Malin (Anglo-Australian Observatory).

Since the initial release of the “Flight Through the Universe” sequence, Swinburne has continued to create versions that have appeared in news reports, television shows (e.g. “Space”, BBC 2002), fulldome planetarium shows (“Infinity Express”, Sky-Skan Inc./National Air and Space Museum), exhibitions (“To Mars and Beyond”, National Museum of Australia, Canberra), and in Swinburne’s Internet-based Astronomy Online program and Virtual Reality theatres.

For more information, visit:
http://astronomy.swin.edu.au
http://vr.swin.edu.au
How to Build An L.E.D. Arrow Pointer

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If you would like to see the poster paper as a PowerPoint presentation, download it at http://www.pa.msu.edu/people/frenchj

Web page version is at http://www.pa.msu.edu/people/frenchj/pointer/

For more information, precise measurements, and more photos, visit Tom Ferguson’s pointer web site at http://www.egr.msu.edu/~fergus52/pointer. Or e-mail fergus52@msu.edu.

Happy pointing!

1

How To Make An Arrow Pointer

Are you tired of pointing to stars with just a little red dot?

Do you remember the days before laser pointers?

Have you seen the new super bright “Light Emitting Diodes”?

If your answer is YES to any of these questions, then this poster paper is for you!

2

The first thing you will need is an L.E.D. flashlight.

This Brinkmann L.E.D. Flashlight is available at WAL-MART for about $12.00

It features a long-life Light Emitting Diode (LED) Bulb, a momentary on/off switch on the bottom, and a barrel shaped body that fits easily into a plastic plumbing extension tube.

3

Next, get some plumbing parts and a lens.

A six inch long 1 1/2 inch extension tube will be used to hold the lens in place over the flashlight.

A plastic PVC tube will allow focusing.

I scavenged the lens from an old single slide projector.

The lens is a Cabin 75 mm focal length lens.

4

Make an arrow using your favorite graphics program...

and turn it into a slide.

Or download some of these arrows we made at our web site.

5

When you have all the parts, it’s time to put it all together.

Parts List:

✓ LED Flashlight
✓ Lens
✓ Extension tube
✓ Arrow Slide
✓ Black Foil
✓ Black Masking Tape
✓ Dremel Tool
✓ Safety Glasses
Step one:
Cut the arrow slide into a circle and tape it to the flashlight.

Step two:
Determine the distance from the slide to the lens.

Go into the planetarium dome.

Hold the lens over the flashlight and focus the arrow onto the dome.

Measure the distance between the flashlight and lens. This will tell you where to cut the extension tube.

Step three:
Cut the extension tube to the proper length.

Be sure to wear safety glasses when using a Dremel tool.

Step four:
Slice the PVC pipe to make the focus collar. If you have enough plastic left over from the extension tube, you can use that for the focus collar.

Step five:
Rearm the top of the extension tube so the lens will fit in the top.

Step six:
Put the lens in the extension tube and carefully secure it.

Step seven:
Insert some black foil into the extension tube to reduce internal reflections.

A very important step.

Step eight:
Put the lens/extension tube into the focus collar and insert the flashlight.

Step nine:
Slate the lens back and forth until it’s focused.

Step ten:
Point the lens at the stars! You’re done.

The projector was designed by Tom Ferguson, an engineering graduate from Michigan State University and planetarium staff member at the Abrams Planetarium.

The projector could be decorated if you like. Here’s some design ideas.
Northern Lights as PASS Volume 13

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Abstract

In the late 1980s, Franck Pettersen on sabbatical at Lawrence Hall of Science, developed the “Northern Lights” planetarium show in collaboration with LHS staff. The show featured a taped narration depiction of an auroral substorm that played with a series of images, as well as audience activities including discovery of the midnight Sun phenomenon and creating aurora chalk drawings. The show is now released as Planetarium Activities for Student Success (PASS) Volume 13 and thanks to funding from NASA’s Sun-Earth Connection Education Forum, is available for free to planetarians as funds permit. The show is now in memory of Franck—he passed away in August of 2000, and his taped narration has been set as a sound track to aurora movie footage as part of the show kit. Information on the PASS series is at http://www.lawrencehallofscience.org/pass.

Show Conception

Franck Pettersen was Planetarium Director of the Nordlysplanetariat—the Northern Lights Planetarium, in Tromsø, Norway. At 70°N, it is the northernmost planetarium in the world and, lying within the Arctic Circle, is firmly in prime aurora borealis real estate. In the early 1980’s, Franck arranged to have a long sabbatical at Lawrence Hall of Science (LHS) to work with our planetarium staff and learn about our audience participation style of planetarium shows. One of his goals was to create a new show on aurorae, in audience participation style, for his own planetarium. Working with LHS staff, Cary Sneider, John Erickson, Lisa Dettloff, myself and others, Franck developed ideas and key show elements emerged:

a. Seasons Above the Arctic Circle. We set the stage for northern lights in an activity aimed at having the audience understand conditions needed for seeing aurorae. In this activity, the instructor marks sunrise position on the horizon for summer solstice at the home planetarium and the audience is challenged to guess where the sunset position is. This part of the activity is good for dispelling a common misconception that the Sun always sets exactly opposite on the horizon from where it rose. The Sun is then reset for noon and the whole planetarium
“transported” to Tromsø, Norway. The audience is again asked to guess where sunset will be on the horizon. Of course this is a “trick” question, since the Sun never sets on the summer solstice in Tromsø. It is a classic discrepant event—an unexpected and even shocking result, that help teach people about how the apparent movement of the Sun radically changes with latitude, to the extreme of a midnight sun occurrence.

b. Light On The World. This is a modeling activity with a light bulb in the middle of the planetarium representing the Sun, and each person holding a model Earth whose axis they point towards Polaris. Positions of the home planetarium (e.g. Berkeley) and Tromsø are marked on the Earth globe and the visitors rotate the globes to simulate the movement that gives rise to the midnight sun phenomenon.

c. What the Northern Lights Look Like. Franck was an excellent aurora photographer and he brought with him numerous slides of aurorae. He assembled a slide animation of aurorae using our two cross-fading slide projectors. With his excellent theater-trained voice, he also recorded a narration on audiotape that verbally conveyed the beauty and wonder of witnessing an auroral substorm. This tape accompanied the aurora slide animation set.

d. Drawing the Northern Lights. Visitors use red and green fluorescent chalk on black paper to create renditions of aurora based on their observations in the planetarium. When they are finished, we switch on ultraviolet lights that make the drawings glow, a quite dramatic effect.

e. Historical Interpretations of the Northern Lights. This is a brief section on how aurora were explained at different times in history, from Aristotle’s “light torches,” “barrels,” and “jumping goats,” to the Eskimo spirits of the dead feasting and playing football with a walrus skull.

f. Scientific Explanation of Aurorae. In this section we show how solar wind interacts with Earth’s magnetic field and coronal mass ejections give rise to dramatically increased auroral activity.
The NASA Sun-Earth Connection Education Forum

Isabel Hawkins, Co-Director of NASA’s Sun-Earth Connection Education Forum (SECEF) at University of California’s Space Science Laboratory, approached LHS to make a planetarium show for SECEF, and we naturally suggested that the Northern Lights show be revised, field-tested, made a new volume in the PASS series, and distributed to planetariums. We discovered that there have been significant advances in scientific understanding of aurorae. There were also satellite missions operating that specifically studied Earth’s magnetosphere, aurora behavior, and interactions with solar wind. As part of the SECEF work, we added a short section on NASA spacecraft missions as well as major revision of the Scientific Explanation section of the show.

Slide Animation to Video

Over the years, we experimented with substituting aurora movie footage from University of Alaska’s Color Television Project for Franck’s slide animation set. The combination of Franck’s audiotape narration with the movie clips made for an improvement in audience viewing experience. SECEF funding allowed us to purchase rights to use and distribute the aurora movie material as part of our PASS Volume 13 show. Around the same time, Macintosh movie editing software, Imovie, became available and we were able to dub Franck’s narration onto the movie with unbelievable ease.

Field Testing

PASS Volume 13 is the first of the PASS shows to undergo national field testing. For all the others, we relied solely on field tests in our own LHS Holt Planetarium. We put out an invitation on Dome-L to recruit field testers and got several excellent planetarium field test sites, including Seminole Community College Planetarium in Sanford Florida (Laurent Pellerin), Starlight Traveler in Stockton, California (Wayne Narron), Columbia Public Schools Planetarium in Columbia, Missouri (Roy Morris), Muncie Community Schools Planetarium in Muncie, Indiana (Peggy Motes), and Schreder Planetarium in Redding, California (Curt Dodds). In addition, Nathalie Martimbeau, Astronomer at Planetarium de Montreal, reviewed the script and made suggestions for improvement.

The IMAGE spacecraft, one of the new slides in the show.

The field testers returned excellent feedback and great ideas for show improvements. Some of the suggestions were:

a. Have more aurora images. This led us to add many more aurora slide images and movie clips to the show slide set. Duh.

This image by Jan Curtis is one of the many that we added to the final version of the show.
b. Reordering the show. The show ending needed some “punch” and since many visitors/students really enjoyed the Drawing section of the show we implemented suggestions to move that part to be show finale. We added more aurora images here as “drawing inspiration.” Turning on UV lights is a pretty dramatic way to end the show.

c. We’d love to have a slide image for the Eskimo story. This led us to assign an LHS artist to create an original slide image for the Eskimo story. If you look closely at it, it is a little gruesome, since the artist read the script section and noted that “Only the raven and the spirits of those have died violently have been over this pathway” [to the heavens]. Hence, the spears and knives sticking in the backs of the spirits trekking the pathway—you have to look closely to notice them.

**Tragedy Strikes**

In August, 2000, when Franck and his wife Marit was visiting us in California, we decided to have a recording session to get the highest quality audio for creation of the aurora movie with Franck’s narration. We set up a digital camcorder for this purpose, since it would be a straight shot to import that digital data into a latest model Macintosh computer for editing. The recording session went well, and we went out for a celebratory dinner and said our find farewells. Very early the next morning I got a call from Marit. Franck suffered a heart attack and had passed away! Franck’s joyous spirit, his great sense of humor, his dedication and talent in education, gone! We truly miss him and this planetarium show is now dedicated to him.

**Final Production Steps**

All that remained to have a full-fledged PASS volume was to have final scientific review by NASA scientists, create write-ups for follow-up classroom activities, and complete the video editing for creation of VHS and DVD versions. Northern Lights field tester, Roy Morris, come to Berkeley for a couple week internship, during which he did the editing of Franck’s audio narration onto the aurora movie. Roy, in consultation with me, also did preliminary drafts of all the Classroom Activities section of the PASS volume. To create the DVDs, we simply used I-movie with I-DVD software that comes with the newer model Macs.

**How to Get the Show**

Free versions were made available to planetariums as of May 14, 2002, thanks to the NASA SECEF funding. To receive a free show kit, including script book, slide set and video (VHS, DVD, or slide animation set), planetarians applied through the PASS website

http://www.lawrencehallofscience.org/pass/

Learning Technologies, Inc. (LTI) is now the publisher of the entire PASS series. Once all the free copies are gone, LTI is the primary source. Their contact information is

Learning Technologies, Inc. 40 Cameron Ave., Somerville, MA 02144 800-537-8703 starlab@starlab.com

It is also available through Lawrence Hall of Science, via the PASS website listed above.
The Future of PASS

Can a large planetarium do audience participatory shows? This is a question we have explored lately and are convinced that audience participation is a vital and valuable strategy in any planetarium, even the largest. We also know that many planetariums use recorded/automated shows exclusively. However, even in those planetariums, in many cases there is a live person who welcomes the audience at the beginning and makes concluding remarks at the end of the show. We are thinking of designing shows that have

a. an opening audience activity (5-10 minutes)

b. a recorded/automated middle section (10-20 minutes)

c. a concluding audience activity (10-15 minutes)

We think this might be a highly adaptable format and entice many planetariums who are used to recorded shows into exploring the benefits of including audience participation.

Are you interested in this approach?

If so, please let me know!
Ideas and Innovations from Latin American Planetaria

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Abstract

Steady funding for planetaria and astronomy education programs is not always assured in the industrialized world; yet few educators in affluent nations could conceive of working within the unstable economic conditions facing many Latin American countries. However, despite crippling economic, social and political instability, astronomy education in Latin America is not dead.

This paper will highlight some of the great work being carried out by dedicated planetarians in Latin America. Some examples include the “Constelación” project, a successful initiative to create a network of low-cost planetaria in Sonora, Mexico; “Acrux” planetarium’s radio broadcasts in Mar del Plata, Argentina; and Paraguay’s first ever planetarium, which incorporates that country’s indigenous language into its programs.

By increasing awareness among the IPS community, this paper hopes to promote greater collaboration with Latin America’s astronomy educators and planetarians. More importantly, however, we may all learn valuable lessons in resourcefulness and how to keep astronomy education thriving despite limited resources.

Introduction

If the words “passion” and “resourcefulness” stand out in this paper, it is because they are central to our field. Most of us in education know what I’m talking about: the passion of teaching what we love, and the clever and unique ways that we find to do this, often in the face of obstacles. These traits are without a doubt essential for effective education, whatever the subject matter. The aim of the present paper is to share with you some of the projects on which planetarians in Latin America are working. My hope is to generate a greater awareness and appreciation for what our counterparts are accomplishing in the face of economic obstacles. Such projects exemplify these traits by showing how one person’s dedication and resourcefulness can overcome, or at least work within, economic constraints.

Why Latin America?

The focus on Latin America is due primarily to a personal connection. As a child growing up in Buenos Aires, annual visits to the Galileo Galilei Municipal Planetarium were eagerly anticipated school field trips. With wonderful images of the 1967 Zeiss projector and Saturnian/UFO looking planetarium still etched in my memory, I have been fascinated by the stars and have gravitated into this line of work.

Although my connection to Argentina remains active it has more recently extended to other countries in Latin America. As I learn more about what is happening in the continent, I realize how important it is to support a field that is inherently small and generally only grows where economic conditions allow for it. As a child, I was very fortunate to be able to experience the magic environment of a full-sized planetarium because
Argentina, like Mexico and Brazil, have historically had the strongest economies in the region, the highest literacy rates and a strong public education system (albeit sadly now eroding rapidly). Most other Latin America countries are less fortunate. It is no surprise that planetaria in Latin America are found in those relatively wealthier nations. Consequently, IPS membership is also very low. Planetaria may be toys for the richer countries, but the interest that astronomy generates is universal and is found in every nation, rich and poor.

The planetaria that I have chosen to highlight in the present paper are found in Argentina, Mexico, Paraguay and Bolivia. These countries are both some of the wealthiest and some of the poorest in Latin America; some already count on permanent installations, others barely have one portable system for the whole country. All projects involve small, 5-7 meter domes, with portable systems turned into permanent facilities. Some are stand-alone, and some work within the context of a larger institution like a university, science museum or observatory. What they all have in common, however, is that the talented individuals (in most cases one person) who make it happen rely more on ingenuity than on prohibitively expensive technology to bring astronomy to their communities. As the examples below will illustrate, Latin America may be short of cash but is rich in human resources. Great ideas are brewing and positive things are happening to bring the planetarium experience to more people.

**Acrux**: Mar del Plata, Argentina

This little planetarium and astronomy center in Argentina’s seaside vacation city has had a short yet successful existence working alongside a natural history museum. In 1999-2000, their first year of operation, the “astronomy annex” was visited by over 10,600 people. *Acrux*’s main audience comes from the city’s area schools which enjoyed over 230 planetarium programs in that year. For its educational programs, *Acrux* counts on a GOTO EX-3 projector, along with an archive of over 700 slides, as well as digital images, astronomy software, posters, photographs and an array of publications. As well as planetarium programs, which the general public can enjoy every Sunday, *Acrux* has offered astronomy workshops for young and old. The educators in charge, both amateur astronomers, organized a children’s program titled “La Aventura Espacial” (“Space Adventures”) in which kids built paper space ships, learned about rocket propulsion, and planned their own imaginary space voyages. *Acrux*’s official name is Mirador Astronómico *Acrux*, essentially an observatory and as such, it offers regular public observation sessions throughout the year. The January 20, 2000 lunar eclipse, for example, attracted over 400 people who were able to observe the event through the Center’s telescopes and binoculars. Another unique service to the community is the Center’s weekly radio program, “Brillando en la Noche” (“Shining by Night”) which broadcasts astronomy-related news to a much wider audience.

**Proyecto Constelación**: Sonora, Mexico

Like the combined light of hundreds or thousands of stars that make up a star cluster, the state of Sonora in northern Mexico has recently embarked on an ambitious project to bring the planetarium experience to a larger audience by combining the “light” of many. The *Proyecto Constelación* “Constellation Project” is the work of Antonio Sánchez-Ibarra, Saúl Grijalva-Varillas and Carlos Mendez-Peón, from the astronomy program of the University of Sonora’s physics department. This program has been promoting astronomy for twelve years by offering courses, lectures, press releases, producing television programs, and since 1996
has counted on its observatory Carl Sagan to provide public viewing and, more recently, regularly broadcasted live solar webcasts.

As the authors declare, Mexico badly needs more spaces to generate interest in the sciences. Just like there are libraries, theaters, and cultural centers in most communities, there need to be places specifically geared for science education. Declaring that in the community “astronomy is possibly the most attractive of the sciences” a planetarium is the ideal place to make astronomy and science accessible to people. Unfortunately, the cost of building a traditional planetarium is extremely high and beyond the reach of most cities ($2 million). In this regard, the Proyecto Constelación provides an extraordinary alternative by coordinating the construction of small planetaria at a fraction of the cost of traditional planetaria ($80,000). The goal is that a planetarium will be as common as a library in every city.

In order to achieve this goal, Grijalva-Varillas, a systems engineer, has designed a small (7 meter) dome and planetarium projector that can show stars down to magnitude 5.4, as well as planets, deep sky objects, celestial coordinates and constellation outlines. The technology might seem small and modest to those in large dome establishments, but it must be remembered that the goal here is to provide a low cost solution to planetaria within the context and reality of a developing country. The cliché “small is beautiful” is apt in this situation, as is the idea that there is strength in numbers. All of the planetaria will form part of a network organized and moderated by the University of Sonora astronomers. Local talent, to be recruited and trained for the staffing and operation of these planetaria, will be in charge of programming and will have a say in how to best serve that community.

Ground breaking for the first planetarium in the network took place on November 26th, 2001 in the city of Magdalena de Kino, in the state of Sonora. Other cities planned for the network are San Luis Rio Colorado, Puerto Peñasco, Caborca, Nogales, Cananea, Baviacora, Sahuaripa, Navojoa, Guaymas, and Ciudad Obregón; approval for construction in these last two cities has already been approved. The project begins in the state of Sonora, but, as Sánchez-Ibarra and Grijalva-Varillas say, the idea is easily exported to the rest of the country and, because of the low cost, it is an attractive proposition for developing countries with “much more difficult conditions than ours”.

In fact, in late April of this year, the University of Sonora group presented their initiative at the Congreso Nacional de Divulgación de la Ciencia (National Conference on Science Education). The project was received enthusiastically by educators from other states interested in establishing something similar. The national paper Reforma carried the news item on the front page of its cultural section stirring even more curiosity. Mexicali, La Paz, Chihuahua, Tampico, Los Mochis, Morelos, Mérida, Jalapa, Veracruz and Quintana Roo are the other Mexican regions that have shown interest so far. As the authors of this exciting and innovative project declared: “we have jumped the borders of our state and we hope to go further.”

**Planetario Buenaventura Suárez: Asunción, Paraguay**

Last year I mentioned in the *Planetarian* that this landlocked South American country had proudly joined the ranks of the planetarium community with its first ever planetarium. The GOTO EX-3 with its 5 meter dome has been a dream come true for educator and amateur astronomer Blas Servín, who purchased it with a combination of his private funds and a donation from the Japanese Embassy. Servín, who is also president of the Asociación de Aficionados a la Astronomía del Paraguay (Amateur Astronomer’s Association of Paraguay) is a well-known astronomy educator who offers astronomy classes, runs two school astronomy clubs, organizes star parties and has published on Paraguay’s history of astronomy. Recent news from Asunción is that the country’s indigenous language, Guaraní, is being incorporated in the new planetarium’s programs.
Paraguayan children are today learning about astronomy, including Guaraní astronomical myths and legends under the canopy of the planetarium named after an 18th century Jesuit priest and astronomer. It is worth noting that the Jesuits are credited with having protected the Guaraní people, their language and culture from Portuguese colonialists.

**Planetario de la Universidad Mayor de San Andrés, La Paz, Bolivia**

Manuel de la Torre, director of Bolivia’s planetarium, writes that the planetarium has been in operation since 1976 and is dependent on the university’s Faculty of Sciences. The planetarium uses a Spitz Nova III projector, a 6 meter dome and can seat 40 people. All programs have been written by local planetarium personnel including one on Andean Constellations written by de la Torre and later adopted by the Madrid Planetarium.

Today, the planetarium is almost exclusively dedicated to enriching La Paz area schools’ science and astronomy curriculum. The planetarium’s small size only permits one class at a time; however, the planetarium offers 2 to 3 different programs for each grade level. This allows teachers to visit the planetarium many times a year with the same group of students.

**Conclusion**

Argentina’s economy collapsed late last year, and a few months later so did the **Mirador Astronómico Acrux**. Economic necessity forced one of its two operators to abandon ship in search of a more economically viable line of work. The other educator wrote to me and told me that she was sad to close down after having devoted so much energy and enthusiasm. Nevertheless, she has found the energy to start anew and plans on developing an astronomy workshop for children. The only resources at her disposal: “my hands, experience and ingenuity, just like I used to do it before” (mis manos, experiencia y mucho ingenio, tal como lo hacía antes).

Latin America is an immense continent with over 300 million people, 20 nations, and a rich and diverse ethnic and cultural heritage. Economically, politically and socially there has been progress as well as regression. And while there are many problems common to the developing world, there are incredibly creative and passionate individuals doing fabulous things for astronomy and education. There are many hands, and plenty of experience and ingenuity creating a positive movement forward in the field. The projects that I have briefly highlighted above are but a tiny fraction of what is out there. Still, the work of many individuals is confined to their own regions and is conducted in relative isolation from each other. Except for Brazil, the only Latin American country with an established planetarium association, most other planetarians work alone.

However, there is reason to think that it will not always be this way. In recent years, technology, particularly the internet, has enabled better communication and organization among the continent’s amateur and professional astronomers, a great number of which include science educators and planetarians. The **Liga Iberoamericana de Astronomía** or LIADA (Iberoamerican Astronomical League) is one association that promotes astronomy by organizing conferences, star parties, maintaining regular on-line discussion groups and editing publications. Even if the communication and organization hurdle can be overcome, economics remain the biggest obstacle for progress. But if Sonora’s low-cost planetarium network idea catches on, and we as an international planetarium society continue to show our support for such valuable projects, we have reason to hope that one day more Latin American communities will have their school, library, cultural center and planetarium.

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Following the very successful release of “Where in the Universe is Carmen Sandiego?™”, a live theatrical, educational program now licensed to planetariums across the US, Canada, and Japan, “Where in the Universe is Carmen Sandiego? - II™” has been created with over 30 minutes of original 3-D character and astronomical special effects animation. As with “Carmen I”, “Where in the Universe is Carmen Sandiego? - II™” was written, produced, and directed by the author under license from Broderbund Software, Inc.™ and in cooperation with PBS Television.

Both programs utilize a model previously found very successful by the author in the creation of both “Wonderful Sky with the Sesame Street Muppets™” (produced in conjunction with The Children’s Television Workshop) and “Robots in Space featuring Star Wars’ R2D2 and 3-CP0™” (created in conjunction with Lucasfilms.) This model utilized the interfacing of a live teacher / presenter and the audience with famous characters recognized by children in a highly interactive setting. In the case of the “Carmen” programs, however, the goal was to create even higher end products by utilizing large amounts of 3-D color computer animation yet, at the same time, make the shows affordable to as many planetariums as possible.

The first “Carmen “ planetarium program (“Carmen I”) was modeled quite closely after the very successful television programs, “Where in the World is Carmen Sandiego?™” and “Where in Time is Carmen Sandiego?™” seen for seven consecutive years on PBS Television in the US and Canada. In other words, the planetarium program was consciously designed as a fast paced “quiz show in outer space” but fashioned to foster and hone listening and math skills rather than requiring the audience to quickly recall pre-learned trivia. Furthermore, unlike the television shows, the planetarium program allowed everyone in the theater to play an active role, answering questions to score points. The goals, very simply, were to focus on good science and achieve good pedagogy while allowing audiences to have fun.

To amass the necessary funding to create the program, a consortium of eight planetariums in the US and Canada was assembled by the author with each institution contributing $7200 to the production budget for the first Carmen show.

Animation was provided by a variety of sources including Broderbund Software, Inc., Sky-Skan, Inc., and Evan & Sutherland. Video of talent in costume and make up was recorded on a large Ultimat sound stage in New Jersey with backgrounds and special effects added in post production. Five-part harmonies by Rockapella (also featured in the Carmen television series) were recorded at a sound studio in New York, mixed down from 14 tracks on ADAT to stereo on DAT and lip synced on the sound stage. Final video and audio elements
were created and assembled on D1 and Betacam SP and converted, after final mix, to a pair of laser discs. To help create and preserve visual realism, panorama and all-sky environments for the show were created by Brian Sullivan as 3-D models which were then lit and photographed by individual planetariums to achieve best fit for their particular projection systems.

The end result was a program which utilized highly recognized, franchised characters linked to television, computer games, and other merchandise, on-camera talent who had Tony, Oscar, Emmy, and Grammy Awards to their credit, and featured state-of-the-art 3-D color computer animation for a fraction of the cost to each institution that the show cost to produce as a whole. In addition, the program, which has appeared in over two dozen planetariums in the US, Canada, and Japan, has been highly praised by teachers and parents alike, has beaten attendance for IMAX movies in the same theaters during the same periods of time, succeeded in increasing overall annual attendance in individual planetariums by as much as 97%, and trounced all competing educational planetarium programs in the same theaters by as much as 800%. Through the cooperation of the consortium institutions, a full color show poster and a Teacher’s Guide containing pre- and post visit activities were also produced to complement the show at no additional cost.

As a result of the success of “Carmen I”, enough money was generated to create the sequel, “Carmen II”. “Carmen I” has the solar system as its backdrop covering all the planets, the sun and moon, the major satellites of Jupiter, asteroids, and comets. “Carmen II” moves on to cover stars, multiple stars, star clusters, stellar evolution (including: why stars have different sizes and colors, diffuse nebulae, planetary nebulae, novae, supernovae, neutron stars, and black holes), and the general size and structure of the Milky Way Galaxy.

Since sequels typically are expected to demonstrate even higher production values than the original product, “Carmen II” was consciously created using all the same production and education devices that made “Carmen I” such a success while, at the same time, increasing both the amount and quality of the computer animation employed. To accomplish this, many of the affiliated institutions not only contributed funds for the creation of “Carmen II” but also provided much of the animation. Thus the show was infused with the considerable talents of such animators as Salt Lake’s Aaron McEuen, Houston’s Tony Butterfield, Dickson’s Weiherng Lee and Kevin Scott, and Vancouver’s Erik Koelemeyer. (Additional, character and black hole animation was produced by a team of California animators with credits that include products for Lucasfilms” and again, Steve Savage also kindly allowed the use of some of
Sky-Skan’s animation material.) Video post production time and facilities were provided by The Renaissance Center in Dickson, Tennessee. Again, cooperative efforts also produced a show poster and a second, even more extensive Teacher’s Guide.

The result was another highly successful program which cost each consortium participant, and subsequent purchaser, only $6200. To put this in perspective, at very conservative commercial rates, the animation in “Carmen II” alone would have cost over $200,000. And added to this would have to be other costs for script, sound track, talent, production, post production, laser disc and CD-ROM creation, and more.

Thus, via “Carmen I” and “Carmen II”, it has been demonstrated that very successful production and fiscal models have been developed for the creation of high end educational planetarium programming.

A consortium production model was also employed a few years ago when the author was asked to write and help produce the opening program for the recently renovated H.R. MacMillan Space Centre in Vancouver. In this instance, the production was to be an interactive, live stage play designed for the planetarium. The general subject was our long fascination with the question of life on Mars. “The Night of the Martians” was created as a multi-act play with scenes involving live actors and sets interspersed with prerecorded scenes to allow for costume, make up, and set changes. Animation was created by Vancouver’s Erik Koelemeyer and spacecraft models by Brian Sullivan

were photographed as stills or recorded on tape against a Chroma-key back drop with crushed blacks added in post production. Slide, film, video, laser, and other projection devices were integrated throughout the production and theatrical props allowed the actors to perform hands-on demonstrations or interact directly with the audience. For users with limited budgets, the production was designed to be staged with as little as a single actor.

As originally written, the play proceeded as follows:

Act 1, Scene 1  As the program opens, we are near Milan. It is the summer of 1877 and we briefly hear the Italian astronomer Giovanni Schiaparelli recording with amazement his discovery of a mysterious system of fine lines, or “canali”, on the surface of Mars.

Act 1, Scene 2  In moments, we are transported inside the Lowell Observatory near Flagstaff, Arizona. It is 1896 and the institution’s founder and benefactor, Percival Lowell, enters for his nightly observations. Excitedly, he describes the exotic, distant world called Mars which fascinates him almost to the point of obsession and tells of his sincere belief that the canali are nothing short of vegetation.
lined waterways constructed by an intelligent race of Martians. On the dome above, we see Lowell’s visions come to life in the form of stream of consciousness animation. As the scene ends, Lowell ponders the Martians as he wonders aloud, “What would it be like to meet them?”

Act 2, Scene 1 As the lighting fades (and our actor exits to change costume), we see and hear of early fanciful schemes to contact would be Martians from setting large signal fires in the Sahara to using thousands of hand held mirrors to flash friendly greetings across the ocean of space.

Act 2, Scene 2 Suddenly, the theater is bathed in a thousand swirling reflections. Mirror balls spin slowly as the music of Ramon Raquello and his orchestra fills the air. Courtesy of Orson Welles, the Martians are about to call. It is Halloween Eve, 1938 as we reenact scenes from the famous radio broadcast of H.G. Wells’, The War of the Worlds. Moments later, amid flashing police lights, smoke machines, and laser beams, the audience is transported to a farmer’s field outside Grovers Mill, New Jersey as the first Martian invader slithers from his spacecraft and sprays fire from a deadly “heat ray” in all directions. Another setting shift and we are perched atop the CBS Broadcast Building in New York. Martian war machines wade the Hudson River and poisonous black smoke begins to eclipse the lighted skyline as the theater fades to black.

Act 3, Scene 1 The silence is broken by a countdown. A rocket’s light splits the night and thunders skyward. The Space Age has begun. Fiction gives way to reality as earth invades Mars with a host of spacecraft that reveal an awesome world of giant volcanoes and mighty canyons but no apparent Martians.

Act 3, Scene 2 It is the present and our audience members have become visitors at the Jet Propulsion Laboratory in Pasadena as results from the latest Mars probe arrive at earth. An actor, portraying a NASA planetary scientist, welcomes the audience and illustrates how news of the latest discoveries and even animated journeys across the Martian landscape are now at everyone’s command via the Internet. But even as discoveries pour in, one tantalizing question still waits for a definitive answer. Could there be life on Mars today, at least primitive life, somewhere in the soil or hibernating in vast underground ice reserves? A video-telephone call from a leading exobiologist gives rise to some lively conversation and speculation.

Act 4, Scene 1 Future Mars missions briefly come to life on the theater’s domed screen culminating with the audience being taken aboard the first manned mission to Mars. It is 2038. Through narration, animation and special effects, we travel with the first humans to set foot on another planet.

Act 5 Scene 1, A final transition and our actor(s) return one last time. It is the year 2350 and we are within the “Holo-deck” of a monitoring station in orbit around a new Mars. Dressed in futuristic garb including data gloves that glow brilliantly, our engineer-host gestures toward the Holo-deck’s dome. As he talks, random swirls and flashes of light transform as if by magic into scenes that illustrate the terraforming of Mars into a second earth - a world with rivers, gardens and breathable air. As he beams with excitement, his wife and children call out to him from a view screen above. They are just completing the long journey from “Old Earth” and are about to dock with the station. Soon, the family will be reunited and travel down to the surface of the planet together to begin their new lives … as the Martians.

The program was funded via a consortium of Canadian planetariums in Vancouver, Calgary, and Edmonton and provided a moderately priced yet very special and highly successful type of
presentation for public audiences. Furthermore, like the Carmen Sandiego programs, “The Night of the Martians” can be presented on a daily basis yet may be expected to generate more audience appeal and higher attendance than conventional, prerecorded or “lecture format” programming. In addition, it serves as an excellent complementary experience for a planetarium or museum planning to host a traveling Mars exhibit. Information on staging special, opening day / evening activities is also available from the author.

Finally, the same production and fiscal model was also recently applied to “The Greatest Wonders of the Universe narrated by StarTrek’s® Jeri Ryan” which was produced for the Coca Cola Space Science Center in Columbus, Georgia, The Renaissance Center in Dickson, Tennessee, and Discovery Place in Charlotte, North Carolina and has since been licensed to other theaters. In this case, financial funding was provided by the various institutions as well as Digistar, Omniscan, and 3-D color computer animation. A non-Digistar version was also produced for planetariums with mechanical-optical star projectors, alternate narrations were recorded in both metric and English units, and a variety of PSAs were also narrated by Ms. Ryan for use on radio or TV.

Again, the result of this model is a program which, for reasonable cost to consortium participants and purchasers, provides a high end, flexible product with an extensive amount of animation and a name narrator associated with a major television franchise and considerable spin-off merchandising (for additional planetarium / museum income).

In closing, it is hoped that the funding and production devices outlined in this paper will prove of value to other producers and institutions in the creation of future high end products at relatively low unit cost.
How Tycho Brahe Really Died—New Evidence

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Abstract

Tycho Brahe died in Prague on the 24th of October 1601 after attending a banquet. A burst bladder was the course of death - so the story usually goes. But is this the real story behind the death of this famous Danish astronomer? Scientific analysis has provided new insight into the circumstances surrounding his death. The director of Ole Rømer Museet in Copenhagen, Claus Thykier and the leader of Institute of Forensic Medicine at Copenhagen University, Bent Kæmpe found high concentration of Mercury in beard remains and hair from Tycho Brahe. Besides being an astronomer, Tycho Brahe also had a strong interest in chemistry and medical drugs and potions. Strong evidence suggests that Tycho Brahe died from using his own Mercury-rich medicaments and not from a burst bladder.

Modern scientific analysis provided new insight into the circumstances surrounding death of Tycho Brahe. The first medicolegal investigation was made possible in 1991 on beard remnants of Tycho's that was handed over to the Danish ambassador as a gift to the Danish government by the Director of the Czech National museum.

When the beard remnants arrived in Denmark the director of Ole Rømer Museet in Copenhagen, Claus Thykier, took initiative for the items to be transferred to the Institute of Forensic Medicine at Copenhagen University for a possible clarification of the rumours of poisoning. The leader of the institute, Bent Kæmpe, consented to such an investigation concentrating on arsenic, lead and mercury by using an atomic absorption spectrometer.

In Tycho Brahe's beard a relatively high amount of lead compared to recent people was found, so it can not be excluded that Tycho died from lead-poisoning. But more likely, the lead content could be caused by the historical facts, that lead frequently was used in kitchenware, water pipes and as a winesweetener. Also environmental influences such as lead in the coffin may have given a high concentration of lead in the beard.

The concentration of arsenic was not found to be high enough to have caused the death of Tycho Brahe. However, the beard contained a much higher concentration of mercury than normal. In addition, the description of his illness uremia shortly before his death, this correspond with symptoms of a poisoning by mercury.

In 1996 it was possible to do another analysis using the PIXE-method, and this time on hair from Tycho with the root preserved. The result was that the mercury was not from an outside source but actually had been digested. Using the growth rate of hair it was concluded that Tycho was poisoned by mercury one day before his death.

So even though it can not be excluded, it is not likely that Tycho was murdered by a mercury poisoning. Besides being an astronomer, Tycho Brahe also had a strong interest in chemistry and medical drugs and potions. These recent forensic investigations (conducted by Claus Thykier and Bent Kæmpe) shows strong evidence that Tycho Brahe did not die from a burst bladder but most likely caused his own death by using his own mercury-rich medicaments the day before his death.

References:

Video Standards for Planetariums - A Primer

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Abstract  
This paper discusses the various video standards and compression techniques used in planetarium video systems. Numerous terms and acronyms such as JPEG, M-JPEG, MPEG-2, wavelet, 4:2:2, 480p, 1080i, are defined. This paper discusses the various video formats and compression schemes used by leading vendors, and compares and contrasts the various compression techniques.

Video Standards  
The video standards that planetarians have become increasingly reliant on were established by various national bodies during the mid-20th century. The three most prevalent standards are NTSC (National Television Standard Committee), PAL (Phase Alternating Lines), and SECAM (Séquence de Couleur À Mémôire) [1]. Each video transmission standard was developed based on the prevailing power transmission system. NTSC was developed in the United States and is based on a power line frequency of 60Hz. PAL and SECAM were both developed in Europe, where the power transmission systems operate at 50Hz.

The human vision system relies on complex electrochemical responses and communication between the eye and the brain. Our perception of color is as much a psychological phenomenon as it is physical. Light entering the eye is focused onto the retina which contains individual receptors for color (cones) and specially adapted receptors (rods) for low light conditions. Each cone is sensitive to different wavelength bands. Chemicals are released by each of the cones in proportion to the amount of light that strikes it. A certain amount of time is necessary for the individual cones in the eye to recharge after being exposed to a particularly bright image. This phenomenon explains why an afterimage of a camera flash is usually visible for several seconds. This response lag in the human vision system is exploited in the various international video transmission standards by using a method known as interlacing. The human vision system, especially the peripheral vision, is sensitive to image flicker at frequencies up to nearly 60 Hz. This sensitivity to flicker is due to the fact that the human vision system is very adept at detecting motion outside of the central field of view.

NTSC defines a video transmission system where approximately thirty (30) frames are transmitted each second. Since the natural flicker frequency of the human visual system is approximately 60 Hz, a method of interlacing two sequential fields to form a single frame was developed. This requires only half of the bandwidth that would be required to transmit 60 full frames per second, but takes advantage of the response lag of the individual receptors in the eye to produce a sufficiently pleasing video image. The frequency of NTSC video is 59.94 Hz, and not 60 Hz. This frequency has been chosen so that interference from other electrical equipment is minimized. The resolution of an
NTSC frame is 720 pixels horizontally by 486 pixels vertically.

PAL and SECAM have a base frequency of 50 Hz. Interlace encoding is used in PAL and SECAM as it is with NTSC. Fifty (50) fields of video data are transmitted every second to form a video stream with 25 individual frames per second. The resolution of the PAL and SECAM standards are higher than that of NTSC since the lower frequency for each field permits more data to be transmitted in each field. The horizontal resolution for PAL and SECAM is the same as that for NTSC, while the vertical resolution for PAL and SECAM is 576 pixels.

The apparent flicker using PAL or SECAM is more noticeable than it is with the NTSC system. The apparent resolutions of the PAL and SECAM systems are significantly higher than that of the NTSC system. The main differences in the PAL and SECAM systems lie in how each system encodes color in the video signal. All three of the transmission systems were designed to be backward compatible with the existing monochrome (black and white) transmission systems that were already in use. The signal in each system is divided into two different types, luminance and chrominance. The luminance signal is designated as Y, and is identical to the preexisting monochromatic television signal that millions of existing televisions already received. The chrominance signal is broken into two color difference signals, C_b and C_r. The chroma information is encoded in the signal as the difference between the blue component and the luminance (B-Y or C_b), and the difference between the red component and the luminance (R-Y or C_r). The green component is the same as the luminance component since the luminance component has been developed to match the photopic response curve of the human observer.

The Video Electronics Standards Association (VESA), founded in 1989, is an international standards organization devoted to developing open standards for displays and display interfaces [3]. VESA is the governing body that sets the standard PC graphic display resolutions and interface requirements. Signal timing, voltage levels and connector definitions are all voted upon and agreed upon by the member organizations of VESA. Table 1 depicts a small portion of some of the numerous video standards approved by VESA [4].

<table>
<thead>
<tr>
<th>Type</th>
<th>Resolution</th>
<th>Number of Colors</th>
<th>Refresh Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>VGA</td>
<td>640x480</td>
<td>16, 256, 64K, 16.7M</td>
<td>60Hz, 70Hz, 72Hz, 85Hz</td>
</tr>
<tr>
<td>SVGA</td>
<td>800x600</td>
<td>16, 256, 64K, 16.7M</td>
<td>56Hz, 60Hz, 70Hz, 72Hz, 85Hz</td>
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<td>16, 256, 64K, 16.7M</td>
<td>56Hz, 60Hz</td>
</tr>
<tr>
<td>XGA Non-Interlaced</td>
<td>1024x768</td>
<td>16, 256, 64K, 16.7M</td>
<td>56Hz, 60Hz, 70Hz, 72Hz, 85Hz</td>
</tr>
<tr>
<td>SXGA</td>
<td>1280x1024</td>
<td>16, 256, 64K, 16.7M</td>
<td>56Hz, 60Hz, 70Hz, 72Hz, 85Hz</td>
</tr>
<tr>
<td>UXGA</td>
<td>1600x1200</td>
<td>16, 256, 64K, 16.7M</td>
<td>56Hz, 60Hz, 70Hz, 72Hz, 85Hz</td>
</tr>
<tr>
<td>QXGA</td>
<td>2048x1536</td>
<td>16, 256, 64K, 16.7M</td>
<td>56Hz, 60Hz, 70Hz, 72Hz, 85Hz</td>
</tr>
</tbody>
</table>

The video standards listed in table 1 are almost exclusively non-interlaced signals, and all utilize pixels with square aspect ratios. These video display standards differ greatly from the NTSC, PAL, and SECAM systems described earlier, where the signals are interlaced to minimize bandwidth and the pixels are taller than they are wide, or rectangular in shape. Non-interlaced video produces less eyestrain for the typical observer, and does not exhibit the scan line patterns normally seen in interlaced video. For large format projection like that used in planetariums, non-interlaced video is preferred.
High Definition Television (HDTV) standards have been issued in the United States, and are being finalized in Europe, Japan, and China. Japan was the first country to start broadcasting HDTV signals. NHK and Sony developed the analog HiVision system in Japan in the early 1980s for terrestrial broadcasts of HDTV content [5]. Europe developed a competing HDTV system called MAC in an effort to ensure European television equipment manufacturers would not be eliminated from the HDTV market by their Japanese counterparts. The MAC system was also analog in nature and was incompatible with the HiVision system from Japan. The MAC system was abandoned by the European governments before it was ever implemented [5].

Several years of proposals and testing for a new HDTV standard in the United States led to numerous competing systems, both analog and digital. Digital transmission systems quickly rose to prominence once it was shown to be feasible. The Grand Alliance was formed by AT&T, General Instrument, North American Philips, MIT, Zenith, Thomson, and the David Sarnoff Research Center in the United States to unify a digital HDTV standard that could be transmitted terrestrially in the 6MHz bandwidth that is allotted to existing NTSC television broadcasts. All acceptance testing of the new HDTV standard has been performed in conjunction with the Advanced Television Systems Committee (ATSC) [6].

Eighteen different image resolutions and coding schemes have been approved for broadcast in the United States. Most HDTV equipment manufacturers support all eighteen of the defined formats. The ATSC defined resolutions are listed in Table 2 [7].

<table>
<thead>
<tr>
<th>Resolution</th>
<th>Display Aspect Ratio</th>
<th>Pixel Aspect Ratio</th>
<th>Frame Rate</th>
<th>Frame Type</th>
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</thead>
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<td>1920x1080</td>
<td>16:9</td>
<td>square</td>
<td>30</td>
<td>progressive</td>
</tr>
<tr>
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<td>16:9</td>
<td>square</td>
<td>30</td>
<td>interlaced</td>
</tr>
<tr>
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<td>16:9</td>
<td>square</td>
<td>24</td>
<td>progressive</td>
</tr>
<tr>
<td>1280x720</td>
<td>16:9</td>
<td>square</td>
<td>60</td>
<td>progressive</td>
</tr>
<tr>
<td>704x480</td>
<td>16:9</td>
<td>4:3</td>
<td>60</td>
<td>progressive</td>
</tr>
<tr>
<td>704x480</td>
<td>16:9</td>
<td>4:3</td>
<td>30</td>
<td>progressive</td>
</tr>
<tr>
<td>704x480</td>
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<td>4:3</td>
<td>30</td>
<td>interlaced</td>
</tr>
<tr>
<td>704x480</td>
<td>16:9</td>
<td>4:3</td>
<td>24</td>
<td>progressive</td>
</tr>
<tr>
<td>704x480</td>
<td>16:9</td>
<td>4:3</td>
<td>60</td>
<td>progressive</td>
</tr>
<tr>
<td>704x480</td>
<td>16:9</td>
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<td>704x480</td>
<td>16:9</td>
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<td>interlaced</td>
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<tr>
<td>704x480</td>
<td>16:9</td>
<td>4:3</td>
<td>24</td>
<td>progressive</td>
</tr>
<tr>
<td>640x480</td>
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<td>progressive</td>
</tr>
<tr>
<td>640x480</td>
<td>16:9</td>
<td>square</td>
<td>30</td>
<td>progressive</td>
</tr>
<tr>
<td>640x480</td>
<td>16:9</td>
<td>square</td>
<td>30</td>
<td>interlaced</td>
</tr>
<tr>
<td>640x480</td>
<td>16:9</td>
<td>square</td>
<td>24</td>
<td>progressive</td>
</tr>
</tbody>
</table>
Data Compression Techniques

Numerous image compression algorithms have been developed to reduce storage and bandwidth requirements for image and video data. The four most common that are used for show production in planetaria are JPEG, MJPEG, MPEG, and wavelet compression. JPEG is used to compress still imagery, while the others are intended for compressing video streams.

JPEG - Joint Photographic Expert Group

JPEG compression uses discrete cosine transform (DCT) algorithms to reduce the required storage space for still images. The image is broken up into 8x8 pixel blocks. The DCT algorithm is a lossy technique that converts the image blocks from the spatial domain to the frequency domain. The amount of image compression is determined by varying the coefficients of the DCT. Entropy encoding is used to further compress the data stream in a lossless manner. Increasing the compression ratio will cause the quality of the resulting image to be degraded. These degradations usually include a loss of spatial resolution and inaccuracies in the color representation of the projected image.

Figure 1 depicts a typical example of how a standard NTSC resolution image is encoded for JPEG compression [8]. An image generated by a video camera, a scanned slide or photo, or other video source is usually represented by three color planes (red, green, and blue or RGB). The RGB image is passed through a conversion matrix to generate the luminance and chrominance image planes. Some scaling of the chrominance image planes is possible since the human visual system is less sensitive to changes in chroma than it is to differences in luminance. Figure 1 illustrates 4:2:2 video since the two chrominance image planes have been scaled to half of the horizontal resolution of the original signals. Full bandwidth chrominance signals, instead of those depicted in figure 1, results in 4:4:4 video. If the resolution of the two chrominance image planes is halved in both the horizontal and vertical directions, the resultant video signal is referred to as 4:2:0 video.

The DCT algorithm is applied to each of the three resultant component image planes (Y, Cb, Cr) of the video image, the data is entropy encoded, and then the three image planes are interleaved together to form the resultant compressed data stream that represents the image.

Figure 1: Typical Example of JPEG Image Compression
M-JPEG - Motion - Joint Photographic Expert Group

The JPEG compression standard has been adapted for use with image sequences and is designated as M-JPEG. Information about every frame and its relation to the previous frame is stored in an M-JPEG file. The software and hardware tools for producing content using M-JPEG are well developed. M-JPEG has been the logical choice for most show content production in the planetarium environment until recently. Affordable tools have become available within the last year to enable creating content based on MPEG-2 compression, which is more robust than M-JPEG.

Images that are projected onto a dome screen with an immersive projection system need to have the highest quality of imagery possible, since the video projectors are typically being operated far beyond their published specifications. On a large dome, pixel sizes can be as large as 20mm square. Compression artifacts are much more noticeable under these conditions than they are in a typical home theater application. The author has developed a method to determine how much compression is acceptable for projection onto a domed screen for a given compression algorithm. Frames from an original uncompressed sequence are compared to those of the compressed image frames using morphological image processing techniques to quantify the amount of image degradation resulting from the compression algorithm. This method has been successfully used to compare different compression techniques and to determine acceptable limits for the amount of compression that can be allowed for projection onto a dome screen. Experimental results, using a high-resolution test pattern, have indicated that virtually no discernible artifacts are visible when using compression ratios up to 2.3:1 with a M-JPEG compressed file.

MPEG - Motion Picture Expert Group

The Motion Picture Expert Group (MPEG) has developed standards for compressing video streams for storage and transmission. Three different generations of MPEG standards have now been approved. These three standards are designated as MPEG 1, MPEG 2, and MPEG 4. Each succeeding standard is fully backward compatible with its predecessors. MPEG 1 has a maximum resolution of 352x240 pixels, and is therefore not too useful for projection in a planetarium. MPEG 2 is the enabling technology behind DVDs and HDTV. The MPEG 4 standard, approved in January 2000, has enhancements that are specific to streaming video content over the Internet. The next iteration of the MPEG standard is known as MPEG 7 and will add provisions for metadata to allow indexing of content.

Similar to JPEG, MPEG uses DCT-based compression algorithms to work on 8x8 pixel regions of the video frame for compression. MPEG 4 now also allows wavelet compression, in addition to DCT-based compression. Unlike M-JPEG, where information is transmitted for every frame, MPEG compression relies on the assumption that only a small portion of the imagery in a video stream changes from frame to frame. MPEG streams are divided into groups of pictures (GOPs), consisting of I, B, and P frames. The Intra frames (I frames) are essentially JPEG encoded frames. The Bidirectional frames (B frames) and Predicted frames (P frames) are based on actual and predicted differences from the original I frame [8]. Broadcast quality video projection can be achieved with half of the storage and bandwidth
as required for M-JPEG. Affordable editing systems for MPEG 2 video have appeared on the market within the last year, and have only recently been introduced to digital video playback systems designed for planetariums.

Wavelet Compression

Wavelet compression techniques have been adapted for both still images and for image sequences. Both Wavelet and DCT methods rely on transforming the image data from the spatial domain to the frequency domain. DCT algorithms assume that Gaussian approximations, in the form of base cosine waveforms, can be applied as probability functions to convert the image data. Wavelet compression relies more on approximation theory [9], using a more complex, multi-frequency waveform to convert the image data. This base waveform can more closely approximate the original content of the image, providing for better compression ratios than can be achieved using simpler cosine waveforms.

Multiple wavelet transforms are typically used to increase the frequency resolution and encoding efficiency. Figure 3 illustrates a multiple pass approach to wavelet transforms [10]. The wavelet transformed information is quantized using the appropriate number of bits to ensure the desired quality level. The data stream is then entropy encoded to maximize compression of the data. The wavelet transform breaks the image into Diagonal, Vertical, Horizontal, and Low Frequency components. Each successive pass with the wavelet transform operates on only the Low Frequency components. The diagram of figure 3 depicts four passes through the wavelet transforms.

![Figure 2: MPEG Group Of Pictures (GOP) Example](image)

![Figure 3: Multiple Pass Wavelet Transform Example](image)
Whereas JPEG, M-JPEG, and MPEG operate with 8x8 pixel arrays, the entire image frame is analyzed at once when using wavelet compression. This eliminates the blocky artifacts that are usually present in the image frames compressed using DCT-based algorithms. Experimental results using the methods described earlier have demonstrated that the quality of the imagery using wavelet compression is maintained with compression ratios as high as 12:1, as compared to the M-JPEG method whose images display visible artifacts with as little as 2.3:1 compression. Wavelet compression is the preferred method of delivering content for the digital cinema market, where image quality is the highest priority, and compression efficiency must be maximized due to the size of the video files being presented. Immersive video on the planetarium dome requires highly efficient image compression to maintain affordability of the playback hardware. Compression artifacts must be minimized due to the extreme magnification of the imagery to cover such a wide field of view. Figure 4 depicts an extreme example of the graceful degradation of wavelet encoded imagery, compared to DCT-based encoding [10]. The appearance of the wavelet compressed image is vastly superior to that of the DCT compressed image.

Figure 4: Comparison of Extreme (165:1) Compression using DCT-based (Top) and Wavelet (Bottom) Algorithms
References


Compressed Data

Out
Cr
360x480
Cb
360x480

Filter and Scale
Interleave

Conversion Matrix

JPEG Encode
JPEG Encode
JPEG Encode
R-Y
720x486
B-Y
720x486
Y
720x486
RED
720x486
BLUE
720x486
GREEN
720x486

B
B
B
B
B
B
B
B
B
B

I
17
16
15
14
13
12
11
10
9

Pictures
Group Of

P
8
7
6
5
4
3
2
1
Planetaryr Graphics for Dummies
Or Celestial Bodies for $5 a Day

Clifford M. Jenkins
Bishop Museum/NASA Explorers Project
cjenkins@bishopmuseum.org

Abstract

Bringing Planetarium graphics painlessly into the 21 Century through the use of computer digital technologies i.e. scanners, software and the Internet. The conversion of 35 mm archive slides to digital files. The techniques of creating, editing, masking, and setup for single, panoramas, and all sky 35 mm slides. Image gathering and remote service bureau slide printing. My professional claim to fame; I taught my mother-in-law Photoshop and she is still my mother-in-law!

Introduction

To quote John Stoke of the Space Telescope Science Institute.

“. . . I’ve always been a “big, museum-based planetarium” guy. Fifty foot and up . . . Hundreds and thousands of automated ques. Carefully choreographed composites of slides, video, optical effects. Stirring music”.

So much for growing up in the Griffith Observatory & Planetarium. I now happily reside at 30 ft dome at the Bishop Museum.

We’ve been known to build a “show” for some special event in less than a couple of weeks, slides, pans, DigiDome ques with music.

All this can be accomplished with a minimal (albeit) experienced staff. A Planetarium Director/Mgr. To keep the project on schedule. A Writer/Producer, And of course, full fledged graphic guru to make the magic happen (and create original unheard of curse words when the computer crashes in the middle of a three hour editing session).

My task to today is to bring you to the world of Planetarium digital graphics.

Archiving - The Thousand Mile Journey

Does this look familiar? All we need is a couple of slides for the K thru 3 school show next week. I’ll add a few from the “Myths and Stars” show we’ve been showing since the last “NASA Apollo” mission.

Fig1.
Music would be nice but what about rights and licensing. We spend two hours looking for that special Scorpius slide, and after 5 days, some kodalith, and a foot of mylar masking tape, the show is still not ready!

Making the bold assumption that we all have a decent basic computer system, or at least access to one, the first piece of equipment we need is a scanner [Fig. 1]. This input device is used to convert the slide, picture, and in some cases a 3D object into a digital image (a computer picture). This process can be an ongoing one like the journey of a thousand miles beginning with the first step.

Two things need to happen as soon as the image is captured. . . a unique but descriptive file name, and, just as importantly, a key word for lookup and sorting later. Here we use the program PhotoShop [Fig. 2] by Adobe to scan, edit/restore save the file name and keyword as well as later to edit or change the image or background as we like. This key word/words coupled with a hierarchical position in a search path will provide an almost magical retrieval later.

The next and more complex issue is file size. I keep two . . . low resolution @ 96 dpi (prints clearer and cleaner than 72 dpi). High resolution @ 192 - 288 dpi good for printing detail at 8x10.

The key at this point is to database the image so that retrieval can be easy to access through the use of a Boolean search engine (i.e. I need pictures of Jupiter, it’s moons and the great red spot close-ups). [Fig.4] You can use MS Word,
MS Excel, or any good database that will allow the import of graphics as a record to easily find what you are looking for. We use Image AXS. [Fig. 5]

Once you have your slide files digitized and data based, you are ready to develop them into a 35 mm slide, print or web graphic. Here is where the output device comes into play. Printers, monitors, video projectors, and of course the film recorder [Fig. 6]. Basically a 35 mm camera back that records computer images onto film which is then processed into slides or prints. We use a bulk film (100 ft roll) back which can produce close to 800 slides/roll. If you don’t have the $2-4K for a film recorder, a service bureau will do the job somewhere between $5 & $10/ slide. Most can be accessed from the internet and finished slides back to you in-house within 48 hrs.

Creating Masks

The job of slide masking is to show graphics and text that “float” seamlessly on the dome without that slide shadow rectangle. Or to create invisible edges on two or more “joined” slides as in pans & all sky’s.

Masking slides used to be a cumbersome and tedious nerve racking affair.

No more. There are basically two types of masks; a hard edge and a soft edge. From these two basic types, several combinations and varieties may be derived.

Any graphic program that will let you edit and create a layer will do.

1. Open a copy of the original graphic/photo file in the base layer [Fig. 7]
2. Create a new blank layer (make this layer editable or active). If possible save the file as 256 grayscale file. (B&W will save on file size).
3. If necessary change your color palette to black and white. White will create a “clear” window and black will mask out any light. Any gradation will soft edge or gray out an area.

4. From this point there are several directions you can take. Use a white brush to paint clear areas and blacks to mask out others. Soft edge with gray areas transiting the black & white borders of the mask. [Fig. 8]

   For a soft-edge you may select or highlight areas with the selection tool and use a gradation brush to mask areas (recommended).

**Text Mask**

Text is a little more difficult but can be very elegant when done correctly. As with graphics, take a negative copy and reverse the text [Fig. 9], white lettering on a black background. Make the reverse 2 points larger than the original text. Zoom in and using a white brush of one point or smaller remove or paint out the centers of 3, 5, 6, 8, A, B, etc. or you may just simply create an empty text box around each group of text [Fig. 10].

**Panoramas**

A 360° panoramic scene can only still be seen accurately on a planetarium dome.

   It is possible to create a simple 3 slide edge dissolve pan all the way to 12+ pans with intricate dissolve effects.

1. Select the image, make sure you have a repeatable theme.

2. Create one long file with a height to length ratio around 9:2 (half pan). Constrain your selection marquee to a 1:1.5 preparation.

3. Create a 10-25% overlap on each edge
4. To visualize end points use
   PhotoShop menu: Filter >
   Other>Offset > [Fig.11].
5. Edit end overlaps to matching.
   Remove off set.
6. Set marquee select to constrain
   with a 1:1.5.
7. Where the two files overlap use
   a feathered (6-10pt) 50%
   opaque edge, or save yourself a
   lot of time and effort and use
   Digidome or PolyDome type
   programs.

**General digital editing & cleanup**

Try and set your image size close to the final intended use. Clean up
and reuse images as many times as possible, with small changes that
make them appear to be different.

   Learn and practice simple editing techniques like, cutting, masking,
   blurring, scaling, skewing, etc. [Fig.12-13]

   When in doubt. . . read the book! (the manual).

---

**Conclusion**

As this is a 10 minute presentation and I’m
a graphics person and not a writer (or an orator)
I will conclude by offering my email and phone
number.

e-mail: cjenkins@bishopmuseum.org
phone: (808) 848-4150 (this is Hawaii,
so check the time!)

What little I have learned in this field I owe
to a small albeit knowledgeable group of
teachers:

   **Peter Michaud** - Gemini Telescopes,
   **Ken Miller** – GOTO Optical Mfg.,
   **John Stoke** – Space Telescope Science
   Institute, and
   **Mike Shanahan** - My boss.

Mahalo & Aloha
Data Exhibeo: Using a Database Program to Create Public Exhibits

Keith H. Johnson
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Abstract

Database programs now offer such powerful input and display formats that they can be used to run interactive public exhibits. My example is an astronomy quiz program called “Who Wants to Be an Astronomer?” Operating under FileMaker Pro, it allows a visitor to see a multiple-choice question with colorful background graphics, choose an answer and see if he’s right (accompanied by optional explanations and appropriate sound effects), obtain a hint, see how other visitors have answered the question, eliminate two of the four answers, etc. Each question is a record in the database file, so it’s easy to change and add questions. Copies of the program are available from the author: a small shareware fee applies. Note: Regis Philbin does NOT appear in the quiz.

Interaction for everyone

Exhibits at museums (or exploration centers, if you don’t want to use the old-fashioned word “museum”) have changed in recent years. Static displays are no longer acceptable: dry bones with labels are right out. Even animated displays, such as looping laserdiscs, are frowned on by the Interactive Police. The visitor should have, They say, a certain measure of control over the actions taking place in a modern exhibit, which implies some sort of computerization.

Unfortunately, such exhibits can be costly, and difficult to program. A planetarian who is not willing to take an advanced degree in C++++ or Javanese is at a disadvantage.

I submit that a planetarian wishing to create a good interactive exhibit (I’ll use an astronomy quiz program as an example) must have available a programming environment with the following characteristics:

• easy to learn and use, yet versatile and powerful for the expert;
• graphical input and output (e.g., buttons to press, sounds, colorful pictures);
• easy to create a number of graphical layouts (e.g., one for a question, another for an answer);
• easy to add new “pages” (e.g., add new questions) at any future time;
• able to record how visitors respond (e.g., how do they answer a particular question?) so that changes can be made to make the exhibit accomplish its purpose better;
• for a large facility, lets non-programmers make changes (e.g., Luddite staff members can add questions to the list);
• cheap (e.g., runs on some old computer from the back room).

A programming language might satisfy most of these requirements. But I thought of a different solution. Today’s database programs are designed expressly to satisfy many or all of them, and are easier to master than an entire new language. So I decided to try one of my favorites when I was confronted by the need.

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AstroQuiz

Many years ago, so far back that the Apple //e was one of the best computers on the market and the IIGS hadn’t come out yet, staff members at Fleischmann Planetarium created an astronomy quiz program called “The Universe Quiz” that ran on an Apple //e. And ran, and ran, and ran... those old Apples were truly workhorses. It would still be running today, had we not decided that four colors and 280x192 resolution was no longer cutting-edge graphics. So this was an opportunity to try out my idea.

Being more familiar with Macintoshes than Wintel machines, I chose FileMaker Pro for my experiment. This is probably the most widely-used relational database program in the Mac world, though it’s available for Windows as well. The same sort of thing could be done in Access or any other scriptable database, I’m sure.

My version, called “AstroQuiz,” is entitled “Who Wants to Be an Astronomer?” on the screen, and I’ll leave it to you to figure out what it’s modeled after. It includes the following features:

- a layout posing a multiple-choice question (from a list of 60 currently), with an accompanying background graphic and four possible answers;
- an answer layout, including a text block explaining the answer;

- some “lifeline” layouts, including:
  - “50-50,” wherein the computer removes two of the four answers;
  - “Poll the audience”: the program keeps track of how previous visitors have answered each question;
  - “Hint”: I couldn’t easily provide “Call a friend,” so this is the substitute.
  - appropriate sounds when the visitor chooses an answer; for example, if the choice is incorrect, you may hear Homer voice his famous “Doh!”, or Bart his “Aye, Carumba!”
- a little bit of humor.

The results seem to be worth the effort. I often see people of all ages going through the exhibit. They interact with it at different levels. Some young children simply advance through the questions without trying to answer
them, to see what the next picture will be; others do answer the questions, but don’t take the time to read the explanations; adults usually do read the explanations, and they don’t even groan at the humor most of the time. All of these are acceptable responses as far as we’re concerned.

Availability and requirements

I can provide copies of the file on CD-ROM to anyone who wants to try it out. You need to provide your own copy of FileMaker (I can’t make run-time versions at present). If you decide to use it, and are happy with it, I brazenly suggest you send me a shareware fee of $20.

AstroQuiz will run under FileMaker Pro version 4 and greater; any Macintosh computer that can run FileMaker should be adequate, so even pre-PowerPC machines are fine. Ours is running on a Quadra 630; the graphics draw a little slowly, but not objectionably so.

I haven’t run FileMaker under Mac OS X, so can’t tell you if any changes need to be made. I know Bartender (see below) won’t work under System X, being a control panel. But if you’re using an old Mac, you’re not using System X anyway, right?

Your exhibit needs to supply a mouse/trackpad; no keyboard is necessary or desirable as far as visitors are concerned.

Boring technical details

I designed the exhibit to work in 640x480 resolution, so that one can use any old Mac that will run FileMaker. At this resolution, the scroll bars and work areas normally visible are hidden.

However, FileMaker by itself will not let you hide the menu bar at the top of the screen. For this, I resorted to a third-party freeware control panel called “Bartender,” which allows you to control the visibility of the menu bar in various ways. This is included on the CD-ROM. If you use this, I’ll tell you I run Bartender in “proactive” mode (menu bar appears only when you hold down a meta-key).

The file starts up on a random question, then proceeds through the list in order. I tried to mix up questions about the planets with questions about the stars and the universe. The README file will tell you more about adding questions.

Often a visitor will leave the exhibit while it is still showing an answer to her last question. I’d rather it always show a new question when a new visitor walks up to it, so after a suitable amount of time spent in any layout but the question layout, the programming will automatically switch over to the question layout.

The scripts choose sounds randomly from two sets for right and wrong responses. Unfortunately, the container holding a sound must be present on the page in order for it to be activated. In order to keep the visitor from seeing the ugly sound icons, I put them off the visible screen to the right. Since he can’t see any scroll bars anyway (they’re off the screen on the bottom), he can’t scroll over to the right. You may know of a more elegant technique.

Just to retain a bit more of the flavor of the TV series, about 10% of the time when a visitor chooses an answer, a box will pop up asking “Is this your final answer?”

If you need more detail about how the scripts work, please let me know. I might even remember...
Using Live Actors in a Planetarium Theater

Erik Koelemeyer
H.R. MacMillan Planetarium
Vancouver B.C.

Five years ago the H.R. MacMillan Planetarium Theater underwent a renovation that included the addition of a stage. This marked the beginning of a new direction in show production for our star theater in Vancouver. Bringing actors into the star theatre was nothing new: but not on a full time basis. Fortunately, we have found that most actors are both creative and flexible, and the experience of working with them has been successful in a number of ways. We clearly have more to offer the public. Not all our shows contain actors, although three of our current presentations do. Originally the plan was to have at least one show which featured an actor, but the success we have had with this new theater, has lead us to, where today, the majority of our shows utilize the stage.

Starting with a conventional 20-meter dome and 267 concentrically positioned seats, a section of seats was removed and replaced with a 12-foot deep stage, that measures 30 feet across at the back against the dome. Our theater was equipped with hoist, which allows us to lower the Zeiss projector out of sight. This provides a clear line of sight for the seats across the theater from the stage. Theatrical lighting in the form of eight large spotlights was installed against the back of the dome across from the stage. Each is trained on a specific location on the stage. When all are turned on, they fully illuminate the dome and appear as eight extra large suns in the planetarium sky.

Right from the start, we approached the production of shows with actors as a theatrical performance. A designated “Green Room” was established to provide the actors with a backstage change and preparation room. A costume person was needed to both acquire and maintain all of the costume elements over the period of a show’s run. Stage props also require attention, and fortunately some of this kind of work overlaps with the skill set of our planetarium technicians. Although the more demanding productions also required some specialized construction work, such skills can be found within the theatrical community of any large urban center. At least two actors are required for each show, with daily shows and an expanded schedule over the summer months, it is the only way to deal with an unexpected illness and insure that the show will go on. The audio needs for the performer are also very important so we use the highest quality profession FM microphone system and directional microphones have worked very well in our theater. The importance of good sound can not be understated, as performers will need to move throughout the theater, audio coverage needs to be up to the task. Freeing up the actor to move about the theater and throughout the audience is something, which we found very useful for children’s presentations. Lastly, and perhaps most importantly, a director is needed to work with the actors, to provide guidance to work in this new theatrical space that is also a planetarium, which for the actor, is as foreign or alien as the theatrical stage is to the planetarian.
Our initial production in 1997 was called “Night of the Martians”. Written by Bill Gutsch, it was designed to coincide with the Pathfinder landing and the media attention it would focus on the planet Mars. The show featured a single actor playing four major roles, Percival Lowell, the War of the Worlds reporter, a contemporary JPL scientist and a fictional future scientist engaged in terraforming Mars.

The appearances of the four characters in the show were staggered to allow enough time for costume changes. At the show’s opening, Lowell appears on stage with an all-sky backdrop of the interior of the Lowell Observatory. As seen in the video sequence pictured (right), Lowell gestures toward the Clark telescope and describes how he would spend hours observing the planet Mars. He then proceeds to describe his theories based on his observation of canals, which lead him to speculate on a Martian civilization that must exist to support such vast construction projects.

Adding actors to the Multi-media Theater that is a planetarium theater creates a new and unique presentation stage. Marrying these two, very different media, into a successful new theater experience demands the best from both. The actor brings the personal experience, and the Planetarium Theater provides the multi-media spectacle. Since the actor is a partner in the multi-media production, we approach these shows by creating visual environments for the actor on stage. In the next set of images, the second actor for the “Night of the Martians” is seen as a JPL scientist describing the latest results from Mars. The actor’s appearance in the show occurs along with an all-sky projection of the media room at JPL. The illusion is completed with his costume, which is made up of a baseball hat and tee shirt that can be easily acquired at JPL.

This philosophy of incorporating the actor and stage into the scene projected on the dome allows us to create some unique children’s programming. Here, live characters, once
introduced, can voyage onto the dome as prerecorded video to interact with the environment simulation. This works to further combine the live action with the projected material. Working with a local ventriloquist and two of her puppet characters, they first establish themselves on stage and then the story line evolves to allow the characters to make appearances as projected images on the dome. An example, would be a dream sequence where they visit an imaginary world. Or in another example, a character builds a rocket to launch himself into space, only find that he is lost, and in need of guidance and direction from the audience, who then help him find his way through the solar system and back to earth.

The stage also provides a new setting for the traditional astronomical presentation. Like many conventional planetarium theaters, the presenter in our theater was tucked away in a control console, behind a wall of knobs and faders, almost hidden from the view of the audience. We have found that putting the astronomer on a stage, along with the projected imagery on the dome, has given our basic astronomical shows new appeal. The framework for this show, featuring a live astronomer, was developed to present astronomical information to a variety of audiences. Starting with a 12-minute prerecorded segment on the history and growth of astronomical knowledge, the audience is prepared for the arrival, on stage, of a 21st century astronomer.
Developing a Portable Planetarium Curriculum for a Large School System.

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Abstract

The Broken Arrow Oklahoma school systems serves a large suburban area southeast of Tulsa Oklahoma. We have over 13,000 students spread over 20 campuses. I teach astronomy courses at the Senior High campus and as such am considered the local “Astronomy Expert” for the area. When our school system obtained a Learning Technologies Starlab portable planetarium in 1994 our teachers were eager to “bring the universe to their classrooms.” However, their lack of knowledge in astronomy and the sheer size of Starlab made many of them reluctant to try Starlab on their own. We brought together a team of interested teachers to develop self-contained curriculum units with easy to follow instructions and audiotapes for several different grade levels and topics. Starlab captains are trained at each campus to use the planetarium and act as mentors to the other teachers. In this presentation I will share some of our Starlab curriculum units and my personal experiences learned from working with portable planetarium systems since 1982.

Astronomy is one of the most popular topics among school-aged students but few teachers have a practical knowledge of the sky. Almost everyone can name the planets and many can even give lots of scientific facts about the planets, but few can point out a single planet or identify the constellations in the sky. To compound the problem our largest school systems are blanketed by a canopy of light polluted skies where only a few dozen stars can be seen. A trip to the local planetarium would be nice, but that may happen only once a year and takes lots of planning, supervision and fund raising to pull it off. How can the teacher and students get short regular lessons in astronomy on their very own school campus? PORTABLE PLANETARIUM SYSTEMS can come to the rescue! They provide a stimulating environment for presenting a variety of astronomy and other presentations to classroom sized groups of children.

Purchasing a portable planetarium system is a major undertaking for most school systems. The administration and school board need to be convinced that the system will be well utilized and represent a wise investment over a number of years. Often special grant monies are needed to finance such an undertaking and grant committees also need to be persuaded about the education benefits of the project. Our school system chose a Starlab from Learning Technologies because of its rugged construction and system of interchangeable projection cylinders on a variety of topics. I had used other portable systems but the Starlab was superior in its thoughtful design and innovative in its flexibility to reach beyond astronomy to other topics.
Self-contained curriculum units for different grade levels and topics.

Astronomy is a popular area of interest to many people but few have an adequate knowledge of the observable sky. Most can find the Big Dipper but how can I use that to find Regulus in Leo, Arcturus in Bootes and Spica in Virgo. Most know the “signs” of the Zodiac, but have no idea where these constellations are or how they relate to the motions of the sun or the changing seasons. Elementary school teachers must be fountains of knowledge on everything from Dr. Seuss to cell biology. Students start learning about stars and planets as early as first grade and their textbooks are filled with images of planets and spaceships but how do we teach them to follow the motions of the planets among the stars?

Task Number One:

Develop a planetarium program that doesn’t require the teacher to be an “Expert” in astronomy. Early portable planetariums could project an accurate image of the night sky with hundreds of stars but did little to help the students or the teacher to visualize the patterns of the constellations.

Preparing their minds for astronomy.

Before sending out our Starlab I strongly recommend that the teachers use it as the culmination to a unit on astronomy or space-based unit. When we purchased our Starlab in 1994 we brought together a team of teachers during the month of June to brainstorm ideas for Starlab units. Having approached astronomy from a scientific point of view, I was amazed at the variety of approaches they assembled for experiencing astronomy. They came up with poetry, art, songs, plays and a wealth of activities. Frankly, I was a bit unnerved at all this “fluffy” nonscientific stuff. I soon began to appreciate the world of elementary education. The teacher’s role is to stimulate and motivate the mind to explore the world through a variety of senses and activities. By opening the windows of the universe to the child’s mind he becomes the explorer. I strongly recommend that every community planetarium regularly reach out to the schools in their communities to tap these fountains of learning. Set up a summer workshop for ten to twenty elementary or middle school teachers. Set forth a goal for a learning unit, show them what resources you may have, and then marvel at what ideas they bring together.

Great books for teaching the stars.

I recommend that their school libraries have several copies of two great books for learning the constellations. For lower elementary ages, I recommend “Find the Constellations” and for upper elementary through novice adult, the classic book “The Stars, A New Way to see them.” Both books are by H.A. Rey — the author of the popular children’s series “Curious George.” Rey was an astronomy enthusiast who wanted to make the patterns of the sky easily accessible to the minds of children. Many books and maps of the constellations contain either fanciful artistic drawings or strange geometrical “dot to dot” patterns that have little resemblance to the names associated with the constellations. Rey has constructed simple line patterns among the stars that in most cases make stick figures that represent the names of the constellations well. These images are easily transported from paper to the sky. In each of our curriculum units I have included a seasonal star chart of the sky based on H.A. Rey’s figures. Starlab also includes a projection cylinder utilizing most of these stick figures.
Self-contained curriculum kits.

We developed a number of curriculum kits focused on topics covered at different grade levels. Our idea was that Starlab should be experienced several times throughout the child’s education. Starlab is most effective coupled with a focused learning unit rather than as an entertainment attraction. Each of our curriculum kits is contained in a Tupperware file box that can be shipped from school to school. The teacher selects and schedules a unit. The kit is sent out a week or so in advance so that the teacher can begin preparing her classes. Enclosed in the kit is a 3 ring binder containing specific instructions for that program module and all the materials needed for the unit. Samples of star maps, signs, posters, audiotapes and even play scripts are included with the modules. The teacher can use the display materials in her classroom to stimulate the student’s interests. We included a number of the activity ideas from Learning Technologies PASS booklets, plus others that seemed to fit each unit well. The teacher is free to be creative and go beyond the materials included in the kit but at least there are plenty of things to get them started. (See Figures 1, 2, and 3.)

At the end of each booklet is our “Rules of conduct for using Starlab” and general instructions about setting up and using Starlab. I have found it very valuable to let every teacher instruct their classes ahead of time what is expected of them inside Starlab. Younger groups need to know ahead of time that the room will be dark. All the groups need to know that Starlab is an exciting place but it’s not a playground. Our basic rules included no gum or candy, remove shoes before entering Starlab, sit quietly on the floor and don’t lean on the walls. Understanding what’s expected ahead of time can prevent disruptive behaviors that detract from the learning. (Rule copies attached)

Our Curriculum units include:
1st Grade – A Trip Through the Solar System -
This includes a slide show and activities about the planets

3rd Grade – American Indian Legends – A set of delightful Indian tales by storyteller Lynn Moroney

4th Grade – Cepheus and the Sea Monster –
The children act out the tale of Andromeda’s rescue. Also seasonal sky lessons for Fall – Winter and Spring.

5th Grade – Follow the Drinking Gourd – A lesson on how the Big Dipper guided Slaves to freedom.

7th Grade - Where on Earth? - A lesson in geography using the world map cylinder

7th Grade - The Biological Cell - an adventure into a cell magnified 2 million times

8th Grade - The Changing Earth – Earthquakes, Volcanoes and Plate Tectonics.

Fig.1. 1st Grade Curriculum unit “A Trip through the Universe” Includes posters, poems planet images and cut outs for making the scale model Also a slide show and a special 45° projection mirror.
One of the most successful things I have done with Starlab is to make a set of audiotapes specifically designed to carry class through an entire session in Starlab. The biggest difficulty teachers have is knowing how to find the constellations or stars in Starlab. I made a set of tapes with many descriptive clues telling where to look for patterns in Starlab. Ideally the actual presentation should be no more than 30 minutes in length. Younger groups have short attention spans and older students classes run on schedules that are usually no more than 45 minutes in length. When I first started making tapes 18 years ago I tried to load everything I knew about astronomy into one lesson. Now I try to be more focused on a few specific goals.

I made the tapes inside the Starlab LIVE so that I could get a feel for the timing and orientation needed during the presentations. I allowed extra time for the teacher and the students to locate the object of discussion before continuing with the lesson. My tapes sound somewhat amateurish - stopping and starting an old manual tape recorder. Some of the later productions include some background music. I’m sure they would sound better with some booming theatrical voice but when we tried a professional script reader on our cell lessons, he rushed right through the script in half the time it really takes to point out all the features of a cell.

One more tip. NEVER – EVER loan out our original tapes. Use the best quality tapes for the master. Make at least two backups for each presentation. Tapes get lost, tangled or accidentally erased. With a backup tape you can send a copy to the teacher quickly. If the master is damaged that’s the end of that show and you’re back to a long 6 to 8 hour session recreating a new show. Done it once – Never again ! !

Navigating the sky in Starlab.

We ALWAYS set up the projector in the same orientation. The projector sits in the middle, elevated on the main shipping case. The teacher sits with her back to the fan tunnel, which is always North inside Starlab. The entry door is East and opposite side is West. We always start with one of the line patterned projection cylinders. There are two reasons for this. One: The lines are much easier to see and visualize the patterns discussed in the program. Two: When groups enter the Starlab they are not dark-adapted and cannot appreciate the natural night sky projections. I give a little welcoming opener and then help them get oriented in Starlab. Each time I tell them to look for a new object I say: “Look up above the fan tunnel to the North for the Big Dipper” or “See Orion rising above the entry tunnel in the East.” Then I include some dialogue about the shape or name of the constellation. These extra clues let someone not familiar with the constellations feel confident that they can still point out the objects in each lesson. Several of the teachers that use Starlab on a regular basis tell me they often turn off the tape after a few sessions and give lectures on their own.

For the younger groups I usually stick to just one projection cylinder, but for older groups we often finish with the unlined night sky projection. Before switching cylinders I briefly review the groups from the lesson. Then I have them close their eyes and cover them with their hands, telling them I will have a special surprise if they don’t peek. This assures that they will keep their dark adaptation while I, or the teacher, turn up the lights to change the cylinders. If I’m doing a session myself I’ll tell them I have to erase all the lines and I don’t want them getting stardust in their eyes. Then I turn the lights completely off and tell them to open their eyes.
When I first started doing planetarium shows in the earlier 80s, we would borrow a portable planetarium and I would do all the shows. Our school system was small enough that the elementary kids would come on a field trip to enjoy the presentations. Now that we have over 13,000 students on 20 campuses, that is an impossibility. We decided on a system of Starlab Captains. These are teachers who have gone through a training session on the use and care of the Starlab planetarium. The Starlab Captain is responsible for scheduling the Starlab event. While the Starlab is on their campus they are the person responsible for the care and security of the Starlab. This also gives me a contact person at each site if some of the materials don’t get back into the curriculum kits. All our teachers have inter-district e-mail, making communication efficient concerning special needs.

We usually run a two-hour training session twice a year. Teachers from all over the school system are invited to watch and participate in setting up Starlab and running a program. These teachers can then return to their own school campuses to run the Starlab. Each year there is a constant turnover of new teachers coming to the system or changing teaching assignments. Therefore, it is important to repeat training sessions each year. Since many schools do their space units in the Spring I usually have a session in January or February. Occasionally I will visit a specific school to demonstrate the Starlab to several teachers at that site. Often teachers of a certain grade level work on special emphasis units. For example: when the 4th grade does a Space Unit, the Starlab captain at that site would take all the 4th graders through one of the programs chosen by that team.

One other project I have tried is to train 11th and 12th grade students from my classes to go to the schools to assist with the Starlab. We’ve had mixed results with this concept. Some are capable of running the show and

**Other Tips:**

I never use more than two cylinders for a presentation. The main projection case has space to protect two cylinders from clumsy feet in the dark and there isn’t room for extra cases. In addition to the usual set of pointers, our Starlab kit includes a set of cloth mittens to keep handprints off the cylinders. Also I keep the cylinders in the original shipping plastic bags. I learned the hard way that even though the foam liners are soft the scratch they cylinders over long periods of use. We include an electric power strip for plugging in a tape player and the projector. We use a set of night lights with red Christmas lights to light the floor during a session. Sometimes we leave these on with younger children if a child is fearful in the dark. Red and white light flashlights are also included in the kit. Red light, of course, is best a preserving dark adaptation.

Another thing that is important is a small budget line item to purchase batteries bulbs and other minor materials necessary to keep things running smoothly. I haven’t been able to implement that here and always have a problem getting the main office to decide which budget should pay for these things. Most of the time it comes out of my pocket.

**Teacher Training sessions:**

When I first started doing planetarium shows in the earlier 80s, we would borrow a portable planetarium and I would do all the shows. Our school system was small enough that the elementary kids would come on a field trip to enjoy the presentations. Now that we have over 13,000 students on 20 campuses, that is an impossibility. We decided on a system of Starlab Captains. These are teachers who have gone through a training session on the use and care of the Starlab planetarium. The Starlab Captain is responsible for scheduling the Starlab event. While the Starlab is on their campus they are the person responsible for the care and security of the Starlab. This also gives me a contact person at each site if some of the materials don’t get back into the curriculum kits. All our teachers have inter-district e-mail, making communication efficient concerning special needs.

We usually run a two-hour training session twice a year. Teachers from all over the school system are invited to watch and participate in
working well with the students. Others are intimidated by all the children’s enthusiasm. Many of my best students are involved in other extracurricular activities and only have a limited number of activity absences they can use each year.

**Scheduling, Shipping and Maintenance of Starlab**

1982 was my first experience with portable planetariums. The Tulsa school system nearby had purchased a system and contacted the local astronomy club for assistance. As an amateur astronomer and teacher I had a special interest in this project. I offered my services to train their teachers in exchange for the opportunity to borrow the planetarium for use in my school system. Later, Texaco Corporation in Tulsa purchased a Starlab planetarium for loan to schools as a public relations effort. Again, I was invited to help with the training. I learned a lot of lessons about managing and maintaining a system. I was constantly being called on to make repairs. I also had to track down missing parts of the system that had cycled through many schools with no accountability for making sure all the equipment stayed with the system. Individual teachers were responsible for using their own cars to pick up and deliver the large bulky cases. The sheer weight and size of the equipment was a barrier to smaller framed teachers. When Broken Arrow purchased their system in 1994, I was determined to find a better way for maintaining our system.

**Scheduling:**

Teachers submit a request in advance, requesting the use of Starlab and specifying which curriculum units they need. Starlab is always delivered on a Monday and picked up in the afternoon on Friday. This allows consistency in scheduling dates and some flexibility at the individual sites on which dates to make the presentations. A week or so before shipping Starlab, I send out the curriculum unit kit by way of our inter-school mail carrier. It would be wise to have two sets for every unit, but we haven’t done that yet. A short inventory list is needed in each curriculum unit case to help all the materials get returned to the case.

**Shipping:**

Starlab is picked up and delivered by our school system shipping and transportation department. We own two delivery trucks that move equipment from place to place within the system. They have a strong person with the right equipment and vehicle for bulky deliveries. While smaller school systems may not have an actual delivery truck, I am sure they have a pickup truck or van that will serve the purpose. Using the shipping department to move equipment assures its safe delivery to the sites on time. It also eliminates liability issues, which may arise if the equipment were lost or damaged while being delivered in a private vehicle. Teachers only have to arrange a secure place to store Starlab once it reaches their location.

**Maintenance and Accountability:**

Our Starlab is stored in a locked closet near my classroom. It is picked up there and returned there between each delivery cycle. This gives me time to check over the equipment and be sure all the parts have been returned. A numbered sticker on each main item and a checklist would help teachers be sure they have returned everything. If something is missing I know to contact the Starlab captain in charge of the last delivery. It’s not unusual for a poster or extension cord not to come back with the rest of the materials. In my past experiences with other systems, a planetarium could have been cycled through a dozen or more schools with no clear contact person at each site. Parts that didn’t move on to the next site often got shoved into a closet and forgotten. By delivering it to me between cycles, I can keep up with the equipment and make repairs as needed. Our Starlab system is almost 8 years old now and except for a few minor pinhole patches it is still in great shape. My biggest problem has been getting the curriculum units back and moved on to the next school on time.
STARLAB RULES

Following these rules will insure a successful program and protect the STARLAB from damage.

PREPARE YOUR CLASS IN ADVANCE

The STARLAB can be a wonderful experience if used properly. The STARLAB works best as a part of a planned curriculum. Students with prepared minds will gain more from the experience. Tell the students several days in advance and make it an exciting experience. Let them know what is expected of them.

DRESS APPROPRIATELY

Students will be sitting cross-legged on the floor inside the STARLAB after crawling through a tunnel. No shoes should be worn in the STARLAB. Shoes can catch and tear the fabric.

REMOVE ALL PENS, PENCILS, COMBS FROM POCKETS

Teachers should distribute pencils needed for hands-on activities after students are seated inside the STARLAB.

NO GUM OR CANDY

These materials are extremely difficult to clean up. Provide a waste can outside the dome for last minute checks.

ENTER AND EXIT IN SMALL GROUPS

Assign a responsible person to monitor the entrance tunnel. Send five or six students into the dome at a time. Wait for the tunnel to clear before sending more students into the STARLAB. It may be necessary to pause briefly to allow the dome to inflate. The lights should be on inside the STARLAB during entry or exit. When exiting dome do not stand up until completely out of the tunnel.

DO NOT LEAN AGAINST THE SIDES

Students should sit in a circle on the floor not the fabric. This will allow the dome to fully inflate and prevent damage.

BE QUIET AND STILL IN THE STARLAB

The STARLAB is an excellent sound-reflecting dome making sounds louder and appear to come from all directions at once. Students will need to be quiet so they can hear the program. The supervising teacher may want to have a dim red flashlight to get the attention of disruptive students. It may be necessary to screen certain students who have a special problem with close quarters in the dark. If a particular group has shown uncooperative conduct, it may be necessary to provide them with some other sort of learning activity. A class, which is hard to control with the lights on, can be very difficult in the dark!

A POSITIVE ATTITUDE AND POSITIVE PREPARATION IS THE KEY TO A SUCCESSFUL EXPERIENCE.
The Digital Planetarium

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Abstract

Planetarium technology is steadily shifting from opto-mechanical based projection to digital projection. This technology shift allows the consolidation of many individual projection sources into a single full-dome video-based display and image generation system. This shift is having a profound effect on planetarium show production, educational tools, theater automation, system maintenance, equipment life cycle, required staff and overall theater economics. The history of digital planetarium systems is reviewed, digital planetarium options are discussed, and the advantages of digital planetaria are weighed against opto-mechanical planetaria for both large public theaters and smaller teaching facilities.

In The Beginning…

In April 1983, Evans & Sutherland installed the first Digistar in the UNIVERSE Planetarium/Space Theater in Richmond, Virginia. Digistar was the world’s first computer graphics based planetarium projector, providing a calligraphic starfield using 4k x 4k addressable points on a single hyperbrilliant CRT tube, projected full-dome using a fish-eye lens.

Detractors complained that the image was dim, the stars fuzzy and the colors a monotonic greenish-white. Others hailed the Digistar for its ability to project a true 3D database with high astronomical accuracy. One could actually leave the solar system and see constellations deform with proper star motion. In addition, the Digistar provided spherically mapped special effects that provided strong motion cues by stimulating the opto-vestibular response through wide-field imagery. Many of us have seen a “dim, fuzzy, greenish wireframe” asteroid image cause an theater full of children to duck down in their seats and scream as it “collides” with them. E&S has sold nearly 100 Digistar systems since 1983, an impressive feat for this small market.

Back in 1981, after seeing an early Digistar demonstration, Claire and Everett Carr foresaw the next generation full-dome systems that would utilize “…four or more large screen projection TV’s with wide angle lenses covering a planetarium dome,” utilizing CRT projectors and HDTV players [2]. Their dream has been realized, with nearly 30 raster-video based “digital dome” theaters open worldwide.

While edge-blending of video projectors on spherical screens has long been employed for expensive military flight simulators, it took a while for this technology to be simplified and adapted to planetarium applications. A 1995 course at ACM’s SIGGRAPH conference introduced the concept of military simulator technology for planetaria [3], with actual edge-blended systems installed by Spitz and Goto in 1997, followed by systems by SkySkan, E&S and Trimension in subsequent years.

With the exception of Digistar, however, digital dome theaters have not relied on video for primary starfield projection. With the emergence of higher resolution dome video systems and user-friendly night-sky generating software, this is now about to change. Planetarians will soon be declaring “look, Ma, no starball!” IPS 2002 promises to be remembered as the year of the digital planetarium.
Digital Dome Configurations

The last 5 years have been formative for new digital planetarium technologies. Hardware and software have matured, illusions have been dispelled, and many lessons have been learned. Manufacturers naturally choose to specialize in different technologies, resulting in numerous choices. Following is a brief overview of the many choices now available to planetarians, and their relative importance to the digital planetarium.

Image Coverage.

Planetarians have had to choose what portion of their dome shall be covered with video imagery. Multiprojector solutions allow scaling from a single video channel (not really an immersive projection) to panoramic video (3 edge-blended projectors with 200° horizontal by 60° degree vertical coverage) to half-dome video (using 4 projectors – the video pan plus a zenith projector) to full dome coverage (six or seven projectors or single projector fish-eye). Alternate schemes have been implemented as well including a 4-projector full-dome scheme.

The panoramic video format - initially promoted by Spitz - was offered as a cost-effective, entry-level medium for unidirectional theaters that places the image where it is needed the most – in front of the audience. Supplemented by all-sky slides, it remains an effective medium for traditional planetarium show presentation with reduced equipment, maintenance, and show production costs. However, panoramic video, while cost effective, is clearly unsuitable for primary starfield projection. The digital planetarium makes a full-dome video system more economical since an expensive optomechanical star projector is no longer required.

Edge-Blends.

Multiprojector systems require individual “sub-frames” to accurately overlap on the dome screen – requiring precise spherical mapping – and they must be carefully masked to provide seamless edge-blending. A basic choice must be made between pre-rendered mapping/edge-blending and real-time mapping/edge-blending.

Pre-rendered blending is analogous to all-sky slides where a single fish-eye image is split into separate geometrically correct images with applied soft-edge masks. When separately projected onto the dome, the sub-frames stitch back together to recreate the original spherical image.

Real-time blending accepts a source image in one of several multi-frame formats and applies real-time spherical warping and edge blends just prior to video projection. Formats may include multiple view planes (frustums) from a common viewpoint (common with real-time, multi-pipe image generators such as SGI Onyx and E&S ESIG), overlapped flat-plane views (such as a real-time computer desktop), multiple camera views from a live or prerecorded camera cluster, or generic plane views split from a fish-eye “dome master” frame. Real-time blends allow the display of real-time images. Pre-rendered blends do not.

Another approach to real-time edge-blending is the use of optical blend masks placed in the projector light path. Optical blends are inflexible. For instance, an optically blended projector cannot be used in widescreen mode since the blends cannot be removed. However, optical blending is useful with light-valve type projectors where the residual black level cannot be electronically blended.

Real-time image warping may be accomplished either digitally or by using the CRT projector geometry correction circuitry. Digital correction solutions, such as Trimension’s Mercator and Barco’s Warp-6, are more flexible but add to the system cost. They are the only means of real-time image mapping for light-valve type projectors which have a fixed pixel structure.
Recently introduced “fish-eye” video projection systems circumvent edge-blending altogether. Single-lens solutions have numerous advantages over edge-blended systems, including lower maintenance, true “plug-and-play” operation, and easy interfacing to real-time computers. While black level remains an issue with fish-eye video projectors, these systems are expected to find favor with planetaria due to their simplicity and ease of use.

**Projector Choices.**

Nearly all digital dome theaters to date have utilized CRT projectors to attain the ultra-low black levels demanded when overlaying video onto an optomechanical starfield. The Zeiss ADLIP (all-dome laser image projector) laser-based video display can now approach the extreme black levels that were previously the exclusive domain of CRT projectors.

While CRT projectors are ideal for low black levels, they are also notoriously dim. A 9” CRT provides around 270 lumens, while a 12” CRT (only available from Barco) provides 500 lumens. Display brightness can be computed by

\[ \text{Luminance (foot-Lamberts)} = n \times \text{O} \times \text{R} \times \text{B} / \text{A} \]

Where n=number of projectors, O=brightness loss factor due to projector overlap, R=dome reflectivity, B=projector brightness in lumens and A=dome surface area. CRT systems operate at around 0.1-0.2 fl. Contrast this with IMAX® Dome theaters that have around 3.5 fl, or a 35 mm film theater with the SMPTE standard of 12 fl. The low brightness results in a serious loss of color saturation. Furthermore, dome reflectivity cannot be lowered to the ideal 0.3-0.4 level typical of omni film theaters, resulting in significant loss of contrast from cross-dome scatter. Settling on a CRT solution brings with it many compromises. Higher brightness can be achieved by “double-stacking” projectors, resulting in a 12-projector full-dome configuration. The penalty is increased maintenance and cost.

Black level has been such an important issue because, until recently, digital dome systems have had to operate in unison with an optomechanical star projector or Digistar. In one test it was found that a 100,000:1 ratio of full white to full black was required to prevent residual light from a CRT projection system from interfering with a Spitz System 1024 starfield in a 12m diameter dome. Higher light levels caused washout of the Milky Way and other night sky details.

In the digital planetarium, however, the black level is less of an issue - provided that it is a uniform black. Since the stars are digital, a simple gamma adjustment can boost the Milky Way and dimmer stars up over the residual light level for comfortable viewing. Even a 600:1 contrast ratio projector can create an adequate night sky, as the brightest magnitude stars are 600 times brighter than the surrounding background. While the sky will not appear as “velvet black,” this does not hamper most educational goals. Dynamic range compression of star magnitude is essential in video-based starfields. Excessive compression, however, can make the recognition of constellations difficult, as the brightest naked-eye stars will no longer stand out against the background of dimmer magnitude stars.

Creating a uniform black level does present a challenge for edge-blended light-valve type projectors (LCD, DLP, D-ILA, etc.) unless they employ optical edge-blend masks in the projector light path. Single-lens fish-eye projectors naturally produce a nearly uniform black field.

**Image Generation.**

The majority of existing digital dome theaters utilize pre-rendered shows streaming from hard-drive based video or graphics players as their primary image source. Graphics players from Spitz now offer 1600x1200 pixel resolution at 60 frames/second. A six-projector full-dome
system with this resolution requires a 4k x 4k fish-eye frame size – nearly the same as large-format film. Production at these resolutions is costly, however, even by Hollywood standards.

The pre-rendered production model is very similar to standard video or film production: write a script, develop the characters, storyboard the scenes, develop shot lists, execute the production of scenes then assemble them in post-production editing. Automated planetarium shows have long used a similar model, except that final editing utilized the dome as a compositing medium rather than a nonlinear video editing suite.

Many have objected to digital dome theaters as just another movie theater. Most optomechanical planetaria allow live interactive shows where the presenter manually dims the lights, starts and stops the star motion and fades up grids, constellation overlays and other effects at will. It is possible to pre-render a large selection of star motions and celestial effects to be randomly accessed upon demand. But a real planetarium needs the ability to create their own night sky for any desired time or place, whether it is pre-rendered or real-time.

Pre-rendered starfield generation utilizes special software that allows rapid (i.e. overnight) rendering of virtually all celestial phenomena and planetarium effects. Applications are now being introduced that simulate traditional planetarium effects: starfield rotations, planetary motions, constellation overlays, clouds, etc. Since the celestial objects are digital, they can be animated, zoomed, rotated and arbitrarily moved about the dome. Custom images can be accurately positioned in the night sky, or the entire starfield itself can be changed as needed. Standard slide projector banks can be simulated, as well as moving projectors. In the virtual planetarium, however, all projectors can be placed at dome center!

Spitz’s digital sky generating software is essentially a spherical compositing tool with timeline-based animation control, so it can be used to edit digital dome movies and clips, map videos onto the dome to create a virtual flat-screen theater, and more. Show editing is identical to planetarium show scripting, except that shows can be created and previewed in real-time on the desktop without the need for a dome. After the preview animations are completed, the final rendered frames are created for the specific theater configuration and loaded onto the graphics playback system. Alternate theater configurations can be rendered at any time using the edit file.

For those that demand the utmost in random access, real-time starfield generation provides the closest approximation to the operation of an optomechanical planetarium. However, star databases are far more extensive and are three-dimensional. Popular catalogs include the Hipparcos database with about 100,000 stars, and the Tycho star catalog with about a million, and are available online from the European Space Agency [5]. Deep sky objects can be properly oriented in the night sky. A real-time 3D database allows the audience to leave the solar system and cruise through the galaxy and beyond. These systems turn the planetarium console into a spaceship cockpit. Operators can command real-time annotation of constellations, celestial objects, star data and more. Audience interactivity is possible as well.

While real-time systems have been very expensive in the past, the latest generation of graphics accelerator cards, such as those based on the NVIDIA GeForce4, have revolutionized real-time graphics. It is now possible to achieve realistic starfield simulation at a fraction of the cost. New software for digital planetaria will be more powerful and extensive than ever before, while running on a single high-speed PC or PC cluster for multiprojector systems.

Many have complained that real-time systems cannot match the image quality of pre-rendered images that include particle effects, ray tracing, rich compositing and other techniques that can increase render time to minutes or even
hours per rendered frame. Real-time systems must always render in $1/30$th of a second or more per frame. With the price drops in both graphics playback and real-time planetarium systems, most planetaria will soon be able to afford both as a seamlessly integrated planetarium system.

**Optomechanical vs. Digital**

Ultimately, the optomechanical planetarium cannot compete with the digital planetarium as a teaching tool. While accurate planetary motions can be simulated mechanically, the planets cannot be zoomed up to reveal surface detail and orbiting moons, and other celestial objects such as comets and asteroids cannot be accurately simulated. Likewise, deep-sky objects cannot be zoomed up for closer inspection. While time can be speeded up to display annual motion of the planets, sun and moon, with the digital planetarium one can watch two galaxies collide over a billion year duration, or simulate the formation of the universe using the latest supercomputer models.

The digital planetarium is empowering to educators. The narrator need no longer be a discarnate voice – their live image can be projected for all to see. Hubble images can be downloaded daily and dropped onto the celestial sphere. Students can draw their own planet images and the planetarium operator can move them accurately in the night sky. Planets, moons and deep-sky images produced by the local observatory or astronomy club can be proudly displayed in the sky as well. The sky tonight will include a faithful rendition of the latest comet or a breathtaking simulation of a coming eclipse. Hometown skylines will be added with ease. And the entire known universe will be available at the click of a mouse.

Regarding visual accuracy, video cannot yet compete with optomechanical star projectors. But this issue is most often one of aesthetics more than educational value. Digital planetaria can be said to illustrate the night sky instead of accurately reproducing it. Illustrations are certainly a powerful educational tool. Digital planetaria create illustrations that are close enough to reality to create a “willing suspension of disbelief,” which means that if I point out Orion it can be recognized as such - and there the fun begins. We can then leave the solar system and observe proper motion, fly through the Orion Nebula, or employ any number of teaching devices that are impossible with an optomechanical instrument.

The last 5 years have seen many pioneering digital dome projects. Lessons have been learned and technologies have matured. The path has now been cleared for digital planetarium systems with advanced features to better realize the promise of the digital dome and to replace optomechanical systems entirely. Greater involvement from planetarium educators is essential in the development of software applications, educational modules and digital star shows if the full promise of this emerging medium is to be realized.

The Hundred Year Hunt for the Red Sprite: An Affordable Planetarium Program

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ABSTRACT
For over 100 years, anecdotal reports have appeared in the scientific literature describing brief luminous glows high above thunderstorms. They were given little more credence than UFO sightings until 1989, when university researchers serendipitously captured a “red sprite” on low-light video. Sprites are now known to flicker like transient, phantasmagoric auroras in the mesosphere, at the very edge of space, whenever powerful lightning flashes within storms far below. The National Science Foundation has funded the development of a video production (with companion educational website) for presentation in select planetariums. The goal is to promote informal scientific education by illustrating the excitement of discovery, the scientific method at work, and the interconnectedness of energy flows in the Sun-Earth system. Also discussed are the criteria for obtaining the program for presentation during 2003.

INTRODUCTION
For the earthbound, to view the wonders of the universe we first must look through the atmosphere. Normally, for astronomers, the atmosphere is a source of frustration, with clouds, haze, reflected city lights and refractive index gradients all degrading seeing on all too many nights. But where does the atmosphere end and space begin? There is a region at the edge of space, between 30 and 100 km above the ground, which aeronomers have only half jokingly called the “ignorosphere,” due to our profound lack of knowledge of the phenomena occurring there. At this interface between air and space, recent discoveries have revealed a virtual “zoo” of bizarrely-shaped, albeit tenuous, electrical phenomena appearing like will’o’the wisps above some thunderstorms. These aurora-like flashes, collectively termed transient luminous events (TLEs), exist mostly at the lower level of human visual acuity, even against the darkest night sky. But startled eyewitnesses who have caught them, out of the corner of their eye have been reporting them in the scientific literature for over a century. Even a report by a Nobel Laureate in Physics, C.T.R. Wilson, who first predicted them theoretically in 1925 and actually reported his own sighting in 1956, went largely ignored. The few such reports that made it into science text books were often in the same chapters as “strange but true” tales of living turtles encased in hailstones or half meter wide snowflakes falling in Montana. Barely escaping being lumped in with UFO sightings and other paranormal gibberish, the mainstream scientific
establishment steadfastly paid the reports little attention, until the night of 6 July 1989. Then serendipity struck, as the late Prof. John R. Winckler, an auroral physicist at the University of Minnesota, was testing a low light television (LLTV) camera for an upcoming rocket launch. On the tape appeared a mere two frames of video showing bright columns of light towering high above distant thunderheads over northern Minnesota. This was the first documented proof of what was at first called “cloud-to-space lightning,” but has since become known as the red sprite. The sprite sightings were soon followed by blue jets, elves, trolls, gnomes and pixies... fanciful names all chosen to avoid implying that we knew more about the physics of the phenomena than was warranted. The tale of the hundred year hunt for the red sprite is a story of how science works. It is story illustrating that science, rather than knowing all there is to know, stands barely on the threshold of discovery of complex and fascinating universe. It is a story that the National Science Foundation, through its informal science education program, believes can foster science education for citizens of all ages.

SCIENTIFIC BACKGROUND

Since 1989, thousands of sprites have been imaged, many at the Yucca Ridge Field Station near Ft. Collins, CO, where the first intentional hunt for sprites using LLTVs yielded a haul of 248 events in the very first night of monitoring in 1993. Mesospheric sprites, at 40 to 90 km altitude, are induced by lightning discharges with highly unusual characteristics. During the summer of 2000, a meteorological field campaign called STEPS (Severe Thunderstorm Electrification and Precipitation Study) focused on discovering just what is different about the small percentage of lightning flashes which trigger the ghostly sprites near the base of the ionosphere. Using video, 3-D lightning mappers and extremely low frequency (ELF) radio receivers deployed around the globe, we are gradually unraveling the nature of the giant lightning discharges which spawn sprites. In the process we have found other unusual electrical discharges atop thunderstorms. Evidence is mounting that sprites affect the electrodynamics and chemistry of the middle and upper atmosphere in a variety of ways. Figure 1 illustrates some of the TLEs which dance above thunderstorms at the edge of space.

![Figure 1](image-url)
SUMMARY OF PLANNED ACTIVITY

Under NSF auspices, Sky Fire Productions, Inc. (also housed at the Yucca Ridge Field Station) will produce and distribute a DVD-based planetarium show for the general public 200° minutes length) entitled, “The Hundred Year Hunt for the Red Sprite.” It will document the application of the scientific method to unraveling the century old mystery surrounding strange lights in the night sky. The observations were so unexpected that one scientist noted it was as if “biologists had suddenly discovered a new human body part.” We will also contrast this story of discovery to the pseudo-science prevalent today in topics such as UFOs. A companion educational website will allow students, teachers and adults wishing to supplement their planetarium experience to further investigate sprites and related basic science topics. The interactive website will encourage visitors to test their knowledge. The public will also be encouraged to actively search the sky for these fleeting phenomena, and to photograph rare events recently brought to the attention of science by amateurs.

EDUCATIONAL GOALS

This Informal Science Education proposal (a supplement to an active NSF Research Award) is designed to increase scientific literacy among Americans. The planetarium show will chronicle a scientific detective story that leads to the discovery of an entirely new class of atmospheric optical events above storms. Entitled “The Hundred Year Hunt for the Red Sprite,” the show will motivate the planetarium visitors to engage in self-directed learning through the companion interactive website [www.Sky-Fire.TV]. Site visitors will furthermore be encouraged to report via the web their visual observations of sprites and also contribute photographs and video of newly discovered phenomena (Figure 2) which would also greatly assist ongoing research programs. The concepts addressed will by nature cover many of the topics covered in general and Earth science courses, giving them life and meaning in a pleasing learning environment.

The planetarium show and website will be aimed at the general public, from middle school up. The intent is to produce the planetarium show at a level that is to some degree accessible to even younger audiences. The venue will be smaller and midsize planetaria as typified by the US Air Force Academy facility in Colorado Springs. The basic “take home” messages of the planetarium show and
Companion website include:

**The excitement of scientific discovery.** Sprites were something unexpected. Science has not come remotely close to discovering all the facets of the natural world about us. Science can actually be fun!

**How the scientific method works.** Showing how scientists patiently documented, verified and began explaining these “strange lights in the night sky” will be contrasted to UFO “research,” aiming to instill healthy skepticism.

**Demonstrate the interconnectedness of energy flows within the earth system.** One recent finding: a cigarette tossed from a truck starts a massive wildfire in drought ravaged Mexico in the spring of 1998. A vast smoke pall soon covered the south-central U.S. for the next two months. That same smoke altered the electrical characteristics of High Plains thunderstorms, producing record numbers of intense lightning bolts - and sprites. This possibly influenced the chemistry of the mesosphere in unknown ways. (Lyons et al., Science, 2 Oct. 1998, pp. 77-80).

**Motivate to learn more on your own.** Attendees will be directed to the interactive website for a variety of science vignettes, tutorials and quizzes. Visitors can apply basic trigonometry skills to compute the height of a sprite, etc.

**Participate in the scientific enterprise.** Interested amateurs will be shown how to “hunt” for sprites and contribute their own observations (recent photographs from amateurs have helped document new phenomena above storms).

We note the published vision statement of the National Science Foundation comments on the need to “integrate research with education, infuse education with the joy of discovery, and an awareness of its connections to explorations through directed inquiry, careful observations and analytical thinking for students of all ages.” This project aims to advance this vision.

**PRODUCTION**

The show kit and website will be produced in-house by Sky Fire Productions with input from the U.S. Air Force Planetarium. Sky Fire Productions has launched a facility called CECIL (Collaborations for Educational Computing and Interactive Learning). The CECIL facility includes a state-of-the-art digital image acquisition, production, editing, authoring and web-based distribution system (Figure 3). The underlying motivation behind CECIL is to facilitate working scientists becoming personally involved in public science education. Dr. Lyons will serve as chief producer, script developer and narrator. Dr. Lyons, aside from his 30-year research career, has extensive background in media production and public science education. In addition to six years
undergraduate teaching (Associate Professor, Univ. of Wisconsin-Milwaukee) he has 18 years major market broadcast television experience, as both talent and producer (Chicago, Twin Cities, ABC network reporter). CECIL resources include a Media 100i/xs digital non-linear editing system running on a Macintosh G4, dual Mac G4 1 GHz processors, Final Cut Pro, DVD Studio Pro, and one terabyte of online video RAID disk access. Outputs include DVDs, plus several common tape formats (VHS, S-VHS, miniDV, DVCAM). Web authoring tools include DreamWeaver 4, Fireworks 4 and Flash 4. An extensive in-house video library of sprite, lightning and thunderstorm images will be utilized.

The chief collaborator for this project is Mr. Mickey Schmidt, Director, US Air Force Academy Planetarium, Colorado Springs, CO (and also Director of the Pikes Peak Observatory). The USAFA Planetarium is a public facility on the grounds of the Academy. With seating for 100, it offers over 500 shows yearly, serving 40,000 citizens. Mr. Schmidt will play a key oversight role in the design and distribution of the show kit and the Presenter’s Guide. He will oversee script development based on his experience creating and presenting public all-age programs. He will provide guidance to the formatting and content development of the written planetarium Presenters Guide manual and the integration of planetarium astronomy projection features into the sprite show.

**DISSEMINATION / DISTRIBUTION**

The initial draft of the production will be premiered as a “sneak preview” presentation at the USAF Planetarium at the end of Summer, 2002. Audience reactions and educational evaluations will be used to craft the final version. We expect production copies to become available toward the end of 2002. The NSF funding will allow us to make up to 25 show kits available at a subsidized price to selected institutions. Announcements of availability will be made via email and the trade press. In selecting awardees, in addition to potential audience size, diversity factors will be considered (urban areas with strong minority populations and rural regions serving Hispanic and Native Americans). Each planetarium awarded the program will be required to commit to a minimum number of shows and to conduct its own advertising and public relations for the show at a level commensurate with similar programs.

Distribution to each of the 25 selected planetaria (upon receipt of a nominal $100 fee) will be as follows:

- Mail the show kit in a suitable format (DVD; VHS, S-VHS; miniDV or DVCAM tape)
- A show Presenter’s Guide in PDF format will be available for download
- Master reproduction copies of the double-sided student and teacher’s fact and resource guides (it will be the local center’s responsibility to make copies for distribution to their attendees)
- A pre-addressed envelope for submitting monthly attendance summary forms will be provided.

After this initial distribution, Sky Fire Productions will continue to make the show kits available for purchase at a cost covering labor, duplication, distribution and administration. Funds received from this activity will also be applied to the upkeep of the [http://www.Sky-Fire.TV](http://www.Sky-Fire.TV) website.
Lewis & Clark and the High Frontier

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On the 25th of July, 1805—197 years ago nearly to the day of this presentation—Captain William Clark and an advance party reached the headwaters of the great river whose course they had traveled since leaving St. Louis some fourteen months before. Clark wrote in his journal: “A fine morning. We proceeded on a few miles to the three forks of the Missouri. Those forks are nearly of a size, the North fork appears to have the most water and must be considered as the one best calculated for us to ascend.”

Captain Meriwether Lewis, leading the main party of the Corps of Discovery in their canoes, arrived two days later to describe a country that “opens suddenly to extensive and beautifull plains and meadows which appear to be surrounded in every direction with distant and lofty mountains. . . . Believing this to be an essential point in the geography of this western part of the Continent I determined to remain at all events until I obtained the necessary data for fixing its latitude Longitude &c.”

There the Lewis & Clark expedition tarried for several days to rest, hunt, and take the necessary celestial observations with the instruments they carried for this purpose. They camped at the very spot from which their Shoshone guide Sacagawea had been kidnapped five years earlier by the Hidatsa, eventually being delivered to the Mandan of North Dakota, into the path of Lewis & Clark and subsequently into history.

On July 30th, the expedition proceeded on. And the spot from which they resumed this journey to the Pacific almost exactly 197 years ago today, lies just 25 miles from the Museum of the Rockies in Bozeman, Montana, where I work.

A year later, on the return trip, Clark with some of his men passed even closer, traveling east from the headwaters to cross the Gallatin Valley on the 14th of July, 1806—by all accounts passing just north of present-day Bozeman virtually within sight of where my house now stands, on his way to the Yellowstone River and thence to the Missouri and home.

But for the intrusions of the modern age, one could fancy that the land today looks not so different than the day the Corps of Discovery passed by.

Living as we do on the Lewis & Clark trail, with the bicentennial of the celebrated adventure bearing down upon us, the Museum of the Rockies is planning exhibits and programs to interpret the event and its significance for our audience. In this effort, the museum’s Taylor Planetarium has found its role by combining past and future, by linking the wide open spaces around us to the starry spaces above. The Taylor Planetarium has received space grant funding to develop a planetarium program tentatively called “Lewis & Clark and the High Frontier.” The program will key on the Lewis & Clark expedition as a cultural context for considering the modern parallel of exploring the frontier of space for future colonization.

There are striking similarities between the two efforts. The Lewis & Clark expedition was a government-funded project (the first of its kind) charged to explore unknown territories, with
political objectives providing the impetus, but science hitching a ride. The explorers, cut off from the world they knew, had to be self-sufficient, taking what they would need most and could reasonably transport, extracting the rest from the environment they encountered. They employed the most advanced technology of their day, devised their own quarters, provided their own medical care, solved transport problems, and forged partnerships with others to insure their survival. And they had to be scientists as well as explorers, fixing their location by the heavens, creating maps, collecting data on new plants and animals, recording the lands and peoples they encountered. All of these challenges have their modern-day equivalents in human space exploration and colonization. By linking this premier adventure of American history with adventures beyond the Earth, we hope to convey a powerful public message about the value of exploration and development of the modern frontier—the high frontier—of space.

Program development is still in its early stages. Current plans call for the creation of a 35- to 40-minute multidisciplinary program, beginning with a basic account of the expedition (including their “way-finding” efforts) that evolves into a modern-day scenario focusing on the similar challenges of providing technology, transport, safe passage, self-sufficiency, opportunity for discovery, and opening new environments and resources to human exploration and settlement in space. We plan to premier the program in our facility next summer for evaluation and modification, and we hope to make a reasonably-priced packaged version available to interested planetariums beginning in the fall of 2003, in advance of the bicentennial observance. Supporting materials are also under consideration.

If such a program might be of interest to you, we would welcome your input and suggestions on ways to make this effort useful and appealing for other facilities and audiences. I will be eager to listen to your thoughts—and to provide further information as our project progresses over the coming year.

Historian Dayton Duncan has termed the Lewis & Clark expedition the Apollo 11 mission of its era. We hope that in some small way, “Lewis & Clark and the High Frontier” may inspire the same spirit of adventure and discovery for our journeys into space as we find in the journals of Lewis and Clark. For these words written by Meriwether Lewis on a spring day along the Missouri River nearly 200 years ago could translate as well to the journeys of our own age:

“The hills and river Cliffs which we passed today exhibit a most romantic appearance . . . water in the course of time . . . has trickled down the soft sand cliffs and worn it into a thousand . . . figures, which with the help of a little immagination and an oblique view at a distance, are made to represent elegant ranges of lofty freestone buildings . . . parapets well-stocked with statuary . . . collums of various sculpture both grooved and plain . . . long galleries . . . nitches and alcoys of various forms and sizes . . . As we passed on it seemed as if those scenes of visionary enchantment would never have an end . . .”

Today, new scenes of “visionary enchantment” seem also to never have an end. But now, we find them in the sky.
Stretching the Limits of Real-time

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These model studies are taken from the real-time StarRider demo entitled “Eleven.” The Adler Planetarium is in a unique position not only to have a traditional theater (running a Zeiss) but the world’s very first StarRider® theater from E&S. This theater is state-of-the-art because unlike traditional theaters, the StarRider’s shows run in real-time, just like a video game. In addition to this the show can also be interactive, giving the entire audience the ability to participate in the show. For the demo “Eleven,” although not interactive, it is entire shown using real-time models. Presented here are three models from the demo, the VAB, the Apollo 11 Saturn V, and the Apollo 11 LEM.

Unlike rendered, or slow-time models, real-time models have to be built with extreme precision as well as with in a polygon budget. Briefly, a polygon is what makes up a model, they are points in space pieced together to form the object, then textured to make it look real. With the current set up of our StarRider® theater, we are limited to 6000 polygons on screen at once.

Each model provided a different challenge. The VAB consisted of the Florida landscape, buildings, and VAB interior (although only one side of the interior was complete as that was the only area that the audience would see.) The Saturn V was actually made up from a number of different models, as pieces needed to break away after launch. At different distances from the Saturn V polygons were dropped to maintain smooth motion while it was on screen. This technique called LOD’s were used on this model, as well as a majority of the models in the demo.
An LOD, or level of detail, actually changed the way that a model is processed by the image generator or IG. The last model study here is that of the LEM. This model took the longest to build because of a number of reasons: most audience members recognize what the LEM is, it had to be detailed because the virtual camera would be very close to it, and it had to be within polygon limits due to the fact it was going to be on screen with a lunar surface (a very polygon intensive model.)

If you would like additional info on these models, real-time 3d modeling, the demo “Eleven” or the Adler Planetarium’s StarRider® theater please contact me at mmascheri@adlernet.org
Accurately Masking Digitally OutputSlides

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In the digital age, how do you produce a mask that accurately fits a digitally output slide? Of course, you must first start with a few basics. One would have to have some software such as Adobe Photoshop and Illustrator. You would need access to certain hardware components such as a film recorder and slide scanner. If you find yourself not having any of these tools, please feel free to stay and read on. After reading this, you may find justification in pursuing digital production. If you only have access to a few of these tools, certain parts of this presentation will still be applicable.

We begin with a digital image. For standard’s sake, most of my images are at a resolution of 2048 pixels by 1365 pixels, an aspect ratio of 1.5:1. These are called 2K images. Most film recorder software will accept a file that has any dimension. Also, they usually have an option to fit the image as best it can. I find it is best if you specify in your original artwork what dimension, resolution and orientation (portrait or landscape) you wish to use. i.e. always make the slides that you output a 1.5:1 aspect ration and at a 2K resolution. By doing this, you don’t give the film recorder the option to confuse you.

Prior to any masking, use Adobe Photoshop to change the image parameters as follows.

1. Image > Image Size
2. Make sure Resample Image is turned off and that Constrain Proportions is turned on.
3. Change the width to 1.44 inches. If your image is already a 1.5:1 aspect ratio, then the height should have automatically gone to 0.96 inches. The Resolution in not a concern (unless it is REALLY low) If you did start with a 2K image it should be at 1422.222 pixels/inch.
4. Select OK and move on to masking.

Masking can be done many ways. I produce many images via a 3D software package like Lightwave or 3DS Max. With this approach, you can usually render an Alpha Channel, making your masking process much faster. If you are starting from a scanned slide or an image from a book, some masking work will need to be completed by hand.

1. Using the Marquee, Lasso and Magic Wand tools, select the parts of the image you want masked. Once you are done you need to turn the selected area into a Path.
2. Make sure your Paths window is open, select Window > Show Paths.
3. In the upper right side of the Paths window you will find a little triangle. Click on this and select “Make Work Path”.
4. The next option is Work Path Tolerance. The smallest you can go is 0.5 pixels. The smaller the number, the more accurate the path will be. The higher, the more “loose fitting” the Path will be.
5. Knowing that your image is of Slide Resolution (1.44 in x 0.96 in) and you have a Work Path for the mask, save the image in its entirety as a Photoshop Document.
6. Now save it again as a TGA, TIFF or PICT, depending on the film recorder you are using.
7. Next, export the work path to Adobe Illustrator by selecting File > Export > Paths to Illustrator.
While creating all of these slides, keep your naming conventions simple. All three files you have just created should have similar names, with exception to their tagged file extension, for example:

- IPS_Slide.psd – master image
- IPS_Slide.tga – film recorder image
- IPS_SlideM.ai – path mask file

At this time, you can now output the raster file (your TGA, TIF or PICT) to your film recorder.

The changing of the image to 1.44 in. x 0.96 in. now comes into play. Since most film recorders do a pretty accurate job of outputting the image to 35 mm, you should be able to rely on this dimension throughout the development of the film. More on that later. Now, the real problem with creating masks digitally is that Kodalith will not expose accurately in a film recorder. If it did, this paper would be much shorter. We need to get the digital mask to a film medium another way. We will “Image Set” it using an image setting printer. A little more preparation first.

1. Run Adobe Illustrator.
2. Open the path file that was exported to Adobe Illustrator (IPS_SlideM.ai).
3. Select the path that you created. The path may not be visible due to the fact that the path does not have a designated stroke color and weight, however, when it is selected, you should see a number of blue splines highlighted.
4. When you have the path selected, you need to fill it with black. Do not give the path a stroke color or weight. This will change how the mask fits.
5. The printing process usually is done on a film printer at sizes as low as 8.5 in. x 11 in. So, you should do a number of masks, probably about 75 or so per sheet, making this very cost efficient. You will need to arrange them in Illustrator so that they are evenly spaced apart. Give yourself enough room between masks so that you can cut them apart. (Note: It is important that you always keep the masking data as paths. Do not rasterize this data. Your file will become extremely large and will not work.)
6. Save your file. This will be your masks master file that you take to the developer. Double check with your developer as to what file format they prefer. EPS usually works well.

Find a printing house that will do this next step. At Hansen Planetarium, our developer, Replicolor, uses an Agfa Accuset 1000. It works much like a printer. They can print anywhere from 8.5 in. x 11 in. all the way up to 14 in. x 80 in. We usually do 8.5 in. x 11 in. This size of a print costs us $10. The film used is a Standard Litho Film. If when you where building the master masks, you filled the paths with black, this means that when you print, you will need to have them print a negative, thus making the masked areas opaque, and the artwork area transparent. Also, they may ask you for line screen resolution. Don’t worry about this, you are not simulating gray scales and this doesn’t apply to this process.

There are some issues with digital processing that I must address. First, E-6 film shrinks. The amount of shrinkage is not consistent. Because of this, testing is necessary. Second, film recorders all have slight differences in how they do their job, hence forth, further testing will need to be done. My point is you can’t take this process, apply it and expect perfect results the first time.

In reference to my earlier comment, ‘More on this later’, here we go. In a perfect world, a film recorder should output a slide with the exact dimensions of 1.44 in. x 0.96 in. And, the image...
setter has set your masks at exactly the same dimensions. If this is so, mount the Lithofilm over E-6 film and you will have a perfectly masked slide! BUT, E-6 shrinks. Some film recorders have small variations in their mechanics. Some even have the camera back mounted with loose mechanisms. These are reasons why testing will be necessary. At Hansen Planetarium we have determined that by using our film recorder for slides and having Replicolor print our masks, we needed to add one last step to the process. When the path is filled with black in Illustrator, we have to apply a 96% (exact) scale to the path. This solves our E-6 shrinkage and film recorder variation issue. To get this number, we had to test a few different printings and change our process each time. Below is a list of steps that were tested but failed. The reason for this list is to help prevent you from wasting time in trying what already didn’t work.

In Adobe Photoshop we tried:
1. Feathering the selected area
2. Contracting and/or expanding the marquee selection
3. Using a higher resolution image to mask, thus trying to make the path iterations more fine.

In Adobe Illustrator we tried:
1. Giving a weight and stroke to the path
2. Scaling ALL masks when completed with our percentage value (we found that they where more accurate done 1 by 1.
3. We made a number of the same masks on one sheet, all with different Scale values. This is where we found our number of 96%. This is the only place we have modified our procedure from the rest of this paper.

A few last things to think about:
Replicolor will accept a work order via an e-mail attachment or their FTP website. That is how we get all of our stuff to them. They will then ship the completed work back to the customer. Dave McCullough is the guy you want to talk to. He is aware of this presentation I am making. And, of course, he would like to see some more work come through his shop. Plus, he knows what this is all about and is used to this type of job request.

At an earlier stage of this procedure, I had concerns as to the viability of the Lithofilm in the environment of a slide projector. I have now been doing this procedure long enough to notice that the E-6 film is more of a problem. We find ourselves changing the E-6 part of a slide more frequently.

We use a Lasergraphics – Personal LFR Plus. We spent around $4,000 for it. It is not pin registered, but the mechanics in the camera move the film rather consistently. We had to justify the expense of the film recorder. We knew that within a given year, we can easily output over 1000 slides. Our local printing house charged an average of $4 a slide. Hence forth, buying a film recorder was well within reason.

Good luck and give me a shout if you have any questions.

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Birth of a Planetarium Projector – The GOTO CHRONOS

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Abstract

The beautiful skies and dazzling capabilities of multimillion dollar opto-mechanical planetarium projectors for big domes are finally being made affordable for “the little guy.” In an unprecedented process begun at IPS 2000, GOTO OPTICAL MFG. CO. gathered input on what would make the “ideal” projector for the 26-40 foot (8-12 meter) dome. Real-world user gripes about existing systems led to innovative solutions, as hundreds of planetarians helped to design the new GOTO CHRONOS through focus groups at regional planetarium conferences.

Ergonomic user interfaces were developed through use of a “cardboard console.” Styrofoam models led to working prototypes tested at regional conferences, and then to the final production device. Revolutions and evolutions in real-time computing power, CAD engineering, robotics hardware, LED and fiber optic light guide technology have made an affordable, compact, digital, opto-mechanical planetarium projector for small and medium sized domes. And it’s about time…CHRONOS.

In recent months, and especially at this IPS conference, there has been much debate about the future of the planetarium with respect to introduction of various all-dome video systems. Many IPS members will recall the demonstration of GOTO’s interactive, color, all-dome VIRTUARIUM™ system in the IPS 1996 post-conference tour. As the world’s first producer of such a system, we feel qualified to make a few statements about the exciting future possibilities of such technologies, but also to mention some of the definite limitations of such systems.

In the past 6 years, almost no visible changes have come to all-dome video from the original Virtuarium system… except price. The plummeting price of computational power, the development of chip-based video handling, and the speed of data transfer have all made the “digital” part of digital all-dome video more and more affordable. However the “video” part of digital all-dome video is virtually identical in its capabilities AND ITS LIMITATIONS as the systems of 1996.

Typical systems follow the VIRTUARIUM model of using 6 or 7 video projectors around the room, blended together to make a mosaic image on the dome. Of course each projector must be precisely matched with its neighbors. Keeping 18 or more individual red, green, and blue cathode ray tubes (CRTs) aligned and balanced in brightness is a constant challenge. Replacing burned out, blurry CRTs is a very expensive proposition. But all that could be forgiven, remembering that the buyer has already committed to the costs of original purchase and the cost and difficulty of program production, IF these CRT concerns could be the least of your worries.

However, the weakest point of current video projectors (CRT, LCD, DILA, DLP and laser projectors included) is RESOLUTION. In 1996, the limiting factor in resolution, brightness, and contrast, was not the computer and the video signal they sent out, but the final “weakest link” in the digital chain; the video projector. Then, as
now, CRT type video projectors offer the greatest contrast and only true blacks in the video projection industry. Then, as now, they offer only a bit over 1,000 lines of resolution in their vertical dimension. While most systems use as many as three projectors to cover a line from north, to zenith, to south, that means that only about 3,000 lines/pixels are available to display images reaching from horizon to horizon.

That number by itself may not mean much. However consider that slide projectors or typical movie projectors have resolutions equivalent to more than TWICE the number of lines in the very BEST video projectors. Even pinhole star projectors are better than film. And finally, at the very top of the resolution scale in dome projection, are the opto-mechanical star projectors. Depending upon how you try to compare star dots with pixel sizes and the multiple pixels required to display a video star, the difference between video projectors and opto-mechanical star projectors can be as much as 15 times the resolution. Or put another way, star diameters on the dome of a video theater would be as much as 15 times larger than opto-mechanical stars!

That fact, and the many other disadvantages of video star fields, have led those within the GOTO OPTICAL MFG. CO. to firmly believe that today, and for many, many years to come, planetarians who want to display a convincing, realistic, accurate sky will do so with opto-mechanical planetarium projectors.

But, in GOTO’s tradition of customer service and support, as we set out to develop our next projector for 8-12 meter domes, we did not simply talk to ourselves to make the decision to stay opto-mechanical for this system. Instead, we came to YOU, to the users of planetarium. GOTO sent representatives to every U.S. and Japan planetarium conference since the last IPS meeting. At each of those regional and national meetings, we conducted focus and discussion groups (OK, in hospitality suites) to ask hundreds of planetarians what THEY wanted in a planetarium projector.

The number one request was for, “A sky made of tiny, sharp, colorful, bright, beautiful stars.” So our opto-mechanical choice was confirmed, and we set about trying to turn the rest of their dreams to reality, in the machine which we now call the CHRONOS.
Hundreds of interviews and conversations became a design parameters list. Those parameters were taken back to Japan, where GOTO designers and engineers began to assemble the CHRONOS. Each expressed need was met with a hardware solution. Some of the top requests were:

1. “Inexpensive star lamps, and long general lamp lifetimes!”
   - The CHRONOS uses commonly available commercial track lighting bulbs, less than $10 each. The lamps for constellation outlines, coordinate lines, cardinal points and other markers have all been replaced with super long lifetime LED illumination.

2. “Stars that have a convincing range of brightness — not all stars of 2 or 3 magnitudes.”
   - The CHRONOS uses a new technology star plate and fiber optic light guides to bring maximum illumination to each of 32 star plates. Condenser lenses, star plates, and projection lenses on each section of the sky maximizes performance. 8,500 stars, down to mag 6.5 are shown to create a gorgeous sky.

3. “Give me lots of individually controlled constellation outlines which move with motions of machine.”
   - The CHRONOS has 24 (!) individually controlled constellation outlines on the machine. They are arranged in optional groups such as “Zodiac” and can be controlled then one by one, or as the whole group.

4. “I want digital planets/sun/moon, just like the “big boys.”
   - In the past decade, we have seen the major planetarium producers adopt the single starball and outboard planet/sun/moon design for their large opto-mechanical projectors. The GOTO HELIOS was a leader in this movement, and the subsequent URANUS and SUPERHELIOS designs have continued in that mode. Modern computing power has allowed the manipulation of the sun, moon, and planets to be individually controlled on X-Y slewing systems. Those independent motions can then represent the classic annual motions and retrograde loops of the planets as seen from earth, but can also be directed to demonstrate other motions, such as an orrery. For the first time in a projector for this size dome, the CHRONOS has digitally controlled sun, moon, and planets.

5. “Give me SPEED!”
   - All axes of the CHRONOS can rotate at speeds up to 3 rpm. In annual motion, a full year can be shown, complete with rapidly moving moon, in one minute. And because of the CHRONOS digital planets, you can also choose to “jump” to any date and time you choose, in 2 seconds or less. The time to adjust your projector’s planets and precession from “today” to the settings for that Star of Bethlehem show is 20 seconds.

6. “I want to produce my own constellation outlines.”
   - The cool temperature of the LED constellation projectors allows you to make simple Kodalith or even laser printed acetate transparencies. Have students draw their own, scan them, shrink them, print them out on clear film, and install in any of the 24 projectors!

7. “Give me clear, easy to handle manual controls. No touch screens or mandatory computer keyboards or mice.”
   - The CHRONOS has a console ergonomically designed with YOUR input. All of the classical controls exist, with a few improvements. These include a safety lockout cover over the precession-enable control to avoid accidental movement by student operators, a different shape and feel to the motion control knobs so you can tell...
them apart in the dark just by touch, panel lights which dim by section or all together, white and RGB room light controls for those who have them in their domes, with both individual and ganged control.

8. "I want analog position readout dials, not digital mini-numbers."

- Since nearly all celestial motions go in circles, we agree that a standard clock-dial type display is most intuitive. (We also include digital readouts if you prefer.) Each of the diurnal, annual, precession, latitude, heading, and real-time clock dials can be minimized (shrunk) or totally eliminated from the display screen, to customize that screen to your liking.

9. "I don’t like being so dependent upon a crashable computer. Give me some fail-safe mode to be able to do at least a minimal show when the next yellow school bus pulls up in front of the planetarium."

- The CHRONOS has totally manual capability for stars and house light control, as well as diurnal, latitude, and azimuth motions. The show must go on!

10. "Make it cost $153.95!"

- Well…, we can’t do EVERYTHING the focus groups asked. But we have incorporated some very interesting off-the-shelf products from the worlds of robotics and computerized process control to make production of the CHRONOS as economical as possible. Even with its advanced technology, the CHRONOS is now available at a price which is very, very competitive with the other 26-40 foot projectors on the market.

We invite all IPS 2002 attendees to visit room #208 to see the GOTO CHRONOS demonstrated within a square room. Even with the limitations of that room, we think you will be amazed at the projector’s capabilities. If you are unable to see the demonstration at IPS, or would like to see the CHRONOS in a dome environment, please visit Young Harris College in northern Georgia. There, in the 40 foot Rollins Planetarium dome, Dr. Kent Montgomery will be happy to show you the world’s first CHRONOS, which was installed there in May, 2002. Please contact me or GOTO’s headquarters in Japan to help arrange your visit soon.
No-Stress Slide Masking with LPD-4 (Workshop)

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Abstract

Using the LPD-4 method for slide masking is an inexpensive and painless way of giving show slides a professional look on the planetarium dome. Kodak LPD-4 is a high contrast, precision line process film used primarily in the old graphic arts and print shop applications. LPD-4 is not a negative, but rather a positive that produces two tones, clear and black. This means that a perfect mask of the most difficult detailing can be achieved in one simple step, saving lots of valuable time.

There are several methods of generating slide masks to block out those distracting gray windows that surround an image on the planetarium dome when using slide films. The folks at Loch Ness Productions refer to these gray windows as “GRIS” - “gray rectangles in space”. These methods include:

- Kodak Film Opaque Red or Black
- Opaquing Pens
- Double-duping

- Kodalith
- LPD-4
- Computer rendering with appropriate software

Most of you are probably familiar with some or all of the techniques mentioned above and are no doubt aware of how time consuming or expensive some of the methods can be.

This workshop is intended to demonstrate that excellent, effective slide masking can be inexpensive and nonhazardous to your mental health, i.e. NO STRESS!

Of the methods outlined on page 1, only three, in my opinion, give satisfactory results. They are the very expensive computer processing method, the Kodalith method and the LPD-4 method. Of these, the LPD-4 is the least expensive, especially when you factor in the time investment.

The Kodalith method is good for making title slides and is relatively simple to do because for this purpose, it is a single step process. However, if Kodalith is to be used for masking black and white images such as galaxies, star fields, globular clusters, etc., it requires a second “reversal” step and doubles your time investment. An insert entitled “Masking Impossible Slides” explains in detail how that process is accomplished.

If you want to Kodalith slides of color images such as panoramas, planets, people, spacecraft, etc., the task is nearly impossible to do in terms of time investment.

The computer method is very good and is a great tool for those who already have the equipment and software. However, to purchase a computer and software for slide masking is extremely expensive.

The LPD-4 method is a much easier and much faster method of masking slides of most images. LPD-4 is a single step process that takes less than 5 minutes to produce an excellent slide mask.

LPD-4 is a high-contrast, precision line process film. It is not a negative like Kodalith, however, it is a positive that produces two tones, clear and black (not opaque). However, the black is dense enough to completely block out any unwanted projector light from passing through the film and onto the dome.
LPD-4 is the reverse of Kodalith. With Kodalith, black becomes clear and white becomes black. With LPD-4, dark areas become black and light areas become transparent, thus saving you the extra step that is required when using Kodalith. Below is a list of items that you will need to make LPD-4 slide masks.

- Kodak Precision Line Process Film, LPD-4 (This product comes in a 50-foot bulk roll). **IMPORTANT!** Make sure that you specify number 663. This product can be ordered through full service photography stores, camera shops and graphic arts suppliers. The cost is approximately $50.00.
- Wess peg registration AAA002 glass slide mounts. These can be ordered from: Wess Plastics, 70 Commerce Drive, Hauppauge, NY 11788. Or, you can call in an order at (516) 231-6300. These mounts come in boxes of 50 and cost approximately $24.00 per box.
- Inexpensive red safe light
- Low wattage light source
- Black cloth or construction paper
- Kodak Dektol Developer
- Kodak Kodafix
- Pair of white cotton gloves to avoid fingerprints
- Inexpensive plastic utensils for handling film in solutions

**Chemical Preparation & Processing Times**

Mix Kodak Dektol Developer according to the instructions on the package. Use full strength and develop LPD-4 for **ONE MINUTE**.

Dilute Kodak Kodafix solution with three parts water. Fix LPD-4 for **THREE MINUTES**.

Wash LPD-4 for **SIX MINUTES** and hang to dry.

**Directions for Making LPD-4 Masks**

Under safelight conditions, precut several LPD-4 “chips” (8 perforations) and place in a light-tight container. Place original slide in the glass slide mount and then place an LPD-4 chip on top of the original with the **emulsion side down**. Make sure that both pieces of film are properly positioned on the two pegs on the slide mount. Securely close the glass mount (you will hear a snapping sound when the mount closes properly).

Place slide mount on top of a piece of black cloth or construction paper so that no light will reflect back up through the slide. **Make sure that the LPD-4 chip is on the bottom.** Expose the film to the light source for the desired time. This can be anywhere from 8 seconds to two minutes, depending on the image. If the original slide has no reds, oranges, or browns in it, the exposure time is usually 8 to 14 seconds. If the original has oranges and browns, you will need to do a couple of test runs to determine the proper exposure length. **Remember, LPD-4 is not sensitive to red.** If you have an original with a lot of red in it, then you will have to do that slide by hand, using an opaquing pen or red opaquing fluid.

Remove the LPD-4 chip from the slide mount and process according to the developing instructions on the previous page.

When dry, remount LPD-4 chip with the original slide and you will have a perfect mask in a minimum amount of time.

**Other LPD-4 Resources**


The Boeing / International Planetarium Society Partnership

Margaretha (Peggy) Motes
Muncie Community Schools' Planetarium
801 North Walnut Street, Muncie, IN 47305
pmotes@muncie.k12.in.us or pmotes@comcast.net

Abstract

Learn about the new Boeing / International Planetarium Society Partnership

How often in a lifetime do fantastic projects start from ordinary circumstances? Boeing's partnership with the members of the International Planetarium Society will result in each member receiving a free DVD to use in the planetarium as a stand-alone program, or adding the images along with an existing program, or in a program a member may create in the future. The possibilities are limitless.

Christine Shupla asked Peggy Motes to attend the Division of Planetary Sciences Meeting in New Orleans, Louisiana during November, 2001 and meet with other representatives attending the meeting to develop new partnerships with the members of the International Planetarium Society.

Watching the DVD of the Mars Odyssey Launch on Joseph Palsulich’s laptop, both coasts of Florida were clearly visible as the Delta rocket soared to the planned trajectory lifting 2001 Odyssey on its six-month journey toward the planet, Mars. If only IPS members could have access to such fabulous graphics! Just think of how using these graphics could enhance a planetarium program! Over the next several days, Joe and Peggy developed a plan that would evolve into a new partnership between Boeing and the International Planetarium Society members.

With Lynne Van Trieste at Boeing working on the project along with Joe and may others, the development of a the DVD moved forward with the debut of the first DVD during the International Planetarium Society conference in July, 2002 in Kansas. The Boeing partnership will include additional DVD projects in the future for International Planetarium Society members.

Join us now as we sample the graphics on the DVD.
Spanish Resources

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pmotes@muncie.k12.in.us or pmotes@comcast.net

Abstract

Spanish classroom teachers attending programs at the Muncie Community Schools’ Planetarium found these resources useful in the classroom.

Students enrolled in Spanish classes from two high schools attend programs at the Muncie Community Schools’ Planetarium. Initially the students learn the names of the constellations and planets in English and in Spanish. Some of the Spanish classroom teachers with limited background in astronomy were interested in locating resources easily available.

From the McDonald Observatory in Austin, Texas teachers ordered Universo. For additional information about classroom materials from McDonald Observatory, check this website, http://universo.utexas.edu/


More classroom activities especially for Younger children are found at the Space Place Spanish Webpage at http://spaceplace.jpl.nasa.gov.espanol.

**El Telescopio Infrarrojo Espacial**


**Fundación CIENTEC**

Fundacion Cientec is located in Costa Rica. Constellation maps are included in the astronomy information found at http://www.cientec.or.cr.

**El gran libro de la astronomía**

El gran libro de la astronomía is available from Scholastic Book Services and EDC Publishing. Check under this ISBN 97460 36485.

**The Star Date Ancient Horizons planetarium Program** explains the beginning of the Egyptian New Year, the building of the pyramids, and the Egyptian Zodiac.

Students learned more information about the Zodiac we use today and why the zodiac sign is associated with the specific constellation.

**El universo a sus pies**

The Astronomical Society of the Pacific now has the Spanish Version of The Universe At Your Fingertips. You can order El universo a sus pies from the Astronomical Society of the Pacific.

The PowerPoint version of this paper can be found IPS 2002 Proceedings CD-ROM, in the “Supplemental Materials” Folder.
APLF Show production for French and European Planetariums: a unique experience

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m.moutin@cite-espace.com, acker@astro.u-strasbg.fr

Abstract

In 2001, the French Speaking Planetarium Association (APLF) launched, in association with the French Space Agency (CNES), a very unique experience in developing and producing a show for the whole group of French Planetariums, with the audiovisual elements adapted for three different levels of Planetarium technical configurations, giving a very original show about the earth seen from space and satellites, proposed in four language and with a huge success in 37 planetariums since April 2001.

The experience has been renewed in 2002 at a European level in association with the European Southern Observatory, to present in October 2002, in a new original Planetarium show, the power of the Very Large ground based Telescopes (VLT) in Chile and the mysteries of the southern skies.

The presentation will resume the method and the different steps of these original productions, and the typical documents developed to take in account the technical variety of the theatres: a unique experience that could, and should be reached to an international level, at the heart of the IPS missions.

Since 2000/2001, the Association des Planetariums de Langue Française (APLF) is working in relation with public research institutions, who gave funds to the APLF in order to present their scientific results to the large public of the Planetariums via a specific show. This show must be ready for a fixed deadline, must emerge from the usual productions thanks to an exceptional quality and brightness, and must be universal, satisfying all visitors of the involved Planetariums.

These constraints need the participation of audiovisual production professionals. More often grouped in a production company carefully selected, writer, director, graphists, music composers and video specialists add their know-how to the elaboration of an original work generally family oriented and adapted to the Planetarium where the show will be presented. If the show conception process and the audiovisual elements integration are done in a narrow collaboration with the Planetarium team, the production company finally delivers a “ready to project” program, perfectly adapted to the technical constraints of the theatre.
In 2001, the APLF launched, in association with the French Space Agency (Centre National d’Etudes Spatiales, CNES), a very unique experience in developing and producing a show not for only one Planetarium but for the whole group of French Planetariums, trying to get the audiovisual elements adapted to all Planetariums technical configurations. This project was a real challenge and required to build a special process quickly described in this paper, in order to give to the IPS regional or national organizations an example of a successful experience that lead to a very original show about the earth seen from space and satellites, proposed in four language and programmed in 37 Planetariums.

Following are the different steps which authorized this original and collective production:

1. The writing of a **partnership agreement** between the CNES, who gave the funds for this production, and the APLF, who was the distributor of the show for the members Planetariums assuring the CNES of a very large diffusion.

2. The constitution of a **production committee**, including people from the CNES, bringing the scientific expertise on spatial sciences, and people from the APLF for the Planetarium constraints and the astronomical expertise.

3. The creation by the APLF of a **specific job** devoted to the coordination of the APLF Planetariums in this context.

4. **The survey of the precise technical configuration** of the APLF Planetariums, including all the technical aspects (sound, slides, video, stars projection, automation or not) but also the theater configuration: seats configuration, flat or tilted dome etc. The analysis and synthesis of the survey allowed to define different technical levels, from which each theater should be able to adapt the show. That analysis lead us to define 3 visual levels, considering that the soundtrack and the sky effects would be the same for all Planetariums: level 1 with simple slides, level 2: + video, level 3: + immersive projection systems (panoramas, allsky video or Digistar all dome effects).

5. The writing, for the production company call for proposal, of a very **precise technical book**, describing the 3 technical levels for the storyboard conception and defining extensively, for the audiovisual systems, all the physical supports needed to build the audiovisual kits to be duplicated.
Pour le son :

- 1 version Protools ou équivalent contenant les éléments musique, textes, bruitages, séparés, calés, livrée sur CDRom...s, permettant aux planétariums de réaliser eux même leur mixage multipistes.

- 1 Master 8 pistes numériques «0dB» reprenant les différents éléments son, non mixés mais montés calés au TC, séparés les uns des autres, (musique, textes, bruitages) répartis individuellement sur les 8 pistes, pour PCM800 Sony ou DA88 Tascam, livrée sur K7.

- 1 Master 8 pistes numériques «mixé», idem 0dB mais avec le mixage des entrées sorties, niveaux des effets, des musiques et des voix intégrés.

Description d’un planétarium type

I. Qu’est-ce qu’un Planétarium?

Sous une coupole figurant la voûte céleste immergant le spectateur et l’incitant au rêve, sont projetés et animés les astres visibles à l’œil nu et composant notre

- niveau 1: voûte céleste + diapositives
- niveau 2: voûte céleste + diapositives + vidéo
- niveau 3: voûte céleste + diapositives + vidéo + dispositif immersif (panorama, image hémisphérique, effets spéciaux 3D, etc....).
6. The selection of a production company and the constitution of a precise production calendar, fixing the inauguration date for all the Planetariums and including periods for visual elements testing, kits duplication and sending and Planetariums integration, programming and testing.

7. The writing of the scenario and storyboard, specifying precisely, for each level, the visual effects on the dome, and the building of the different audiovisual elements under the control of the production committee, including an intense communication with the engaged Planetariums and taking into account, as far as possible, their critics, remarks and suggestions.

La planète aux miroirs / Le monde des Terriens / Planète avec vue...

<table>
<thead>
<tr>
<th>1</th>
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<tbody>
<tr>
<td></td>
<td>Musique.</td>
</tr>
<tr>
<td></td>
<td>La voûte céleste apparaît.</td>
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<tr>
<td></td>
<td>Titre (dia): IL Y A 5 MILLIARDS D'ANNÉES...</td>
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<th>2</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Digistar ou vidéo ou diapos sur fond d'étoiles:</td>
</tr>
<tr>
<td></td>
<td>formation du système solaire.</td>
</tr>
</tbody>
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<tr>
<th>3</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Voix off homme:</td>
<td>Ciel étoilé.</td>
</tr>
<tr>
<td>Il était une fois une planète qui se connaissait elle-même. Cela ne lui était pas venu tout de suite.</td>
<td>On s'approche de la Terre, qui se matérialise sur l'écran vidéo comme une masse rouge sombre qui grossit jusqu'à prendre tout l'écran.</td>
</tr>
<tr>
<td>D'abord, elle avait été trop occupée à mettre de l'ordre dans les matériaux dispersés dont elle était faite. Et puis la jeunesse, ce n'est jamais de tout repos.</td>
<td>Refroidissement de la Terre.</td>
</tr>
<tr>
<td>Finalement, les choses s'étaient un peu calmiées. Et plutôt que de se nicher dans la torpeur de l'âge mûr, cette planète s'était mise...</td>
<td>Atmosphère puis océans apparaissent sur une Terre primitive (pas bleue, mais rose).</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>4</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>... à vivre...</td>
<td>Ouverture sur un All Sky: une jungle, la nuit. Au clair de lune, une minuscule musaraigne traverse la fenêtre vidéo. Fondu au noir.</td>
</tr>
</tbody>
</table>

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<tr>
<th>5</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>À vivre... et à mourir...</td>
<td>Fondu enchaîné All Sky: le jour se lève. Ce que, la nuit, on prenait pour des montagnes</td>
</tr>
</tbody>
</table>
vaste réservoir d'eau chaude. Cette année-là, cette masse chaude a été repoussée vers l'Est.
Ce n'était rien. Juste un déplacement de quelques milliers de kilomètres de phénomènes parfaitement normaux : évaporation et pressions atmosphériques, nuages et vents.
Voix off :
Ce phénomène, appelé El Niño, s'était déjà produit des dizaines de fois depuis des siècles. Mais voilà que les mesures prises depuis l'espace et à la surface des mers pouvaient être mises en équations dans de puissants modèles numériques.

<table>
<thead>
<tr>
<th>Niveau 1</th>
<th>Niveau 2</th>
<th>Niveau 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ciel + 6 dias tirées des panoramas</td>
<td>6 fichiers panorama</td>
<td>6 images vue de nuit</td>
</tr>
</tbody>
</table>

**SEQUENCE 11**

Il suffisait de prendre un peu de recul. Retour à la nuit de la jungle (clair de lune, cris d'oiseaux nocturnes).
Décollage d'Ariane de nuit.

<table>
<thead>
<tr>
<th>Niveau 1</th>
<th>Niveau 2</th>
<th>Niveau 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 dia décollage Ariane nuit.</td>
<td>Vidéo Ariane masquée</td>
<td>Vidéo Ariane masquée + vue de nuit</td>
</tr>
</tbody>
</table>

Cadre du rang : Ariane en synthèse pour un lever image jusqu'à la sortie de champ.
8. A pilot planetarium (whose leader is member of the production committee) performed the testing, on computer or/and on the Planetarium dome, of all the visual elements for each scene and each level, as soon as the elements were produced by the production company. The presentation, in the pilot planetarium, of a preview of the show for the first and the third levels, will helped all the invited participants to integrate quickly the show in their theaters.

9. The writing of manuals with the detailed storyboard, including synchronization files, and the furniture of a video tape of the show filmed during the preview,
10. **The kits duplication and sending**, through the specific APLF-job, for the 37 Planetariums following the media choices defined by each theater.

11. The creation of the show **communication elements** (posters, flyers, press kits...) and their diffusion via the APLF-job in the different theaters following the needs defined by each Planetarium.

This experience couldn’t have been a success without a very strong involvement of a few people, including Gérard Azoulay, Director of the “Observatoire de l’espace” at the CNES, Pascal Prieur working in the Pilot Planetarium in Cité de l’espace of Toulouse, Philippe Simonnet, the APLF treasurer, Bastien Leget, the APLF full time young employment, and the authors of this paper.

Launched in May 2000 at the annual APLF meeting, the show “La planète aux mille regards” opened in more than 30 Planetariums the 18th of April 2001.

The experience is renewed in 2002 at a European level, with the partnership of the European Southern Observatory (ESO), in order to celebrate in October 2002 the 40th Anniversary of ESO through a new original Planetarium show devoted to the secrets of the southern sky. Thanks to the power of the Very Large Telescopes (VLT) ground based in Chile, remarkable astrophysical results are obtained in particular concerning the stellar formation in dusty clouds, and the discovery of galaxies at the edge of space and time, implying mysterious dark matter and energy in a cosmological context. About 40 Planetariums are involved or interested, including German Planetariums and some important IPS Planetariums.
All Sky Program

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The All Sky program is a network of meteor-tracking cameras that offers students the opportunity to participate in real-world meteoritic research, the results of which can be used by scientists and researchers working in the field. The concept for the program was born from Curator of Geology Jack Murphy’s passion for finding meteorites. Jack has spent over three decades in the field searching for meteorites and interviewing eyewitnesses. Finally in 1995 a fireball went soaring over Colorado Springs and was caught on a security videotape. This gave Jack and research associate Frank Sanders the idea that there was a way to collect more accurate data in order to narrow the search area for potential meteorites. In 2001 Gianna Sullivan in the DMNS Community Science department molded this idea into a teacher-driven program for Colorado students.

The goal of the All Sky program is for youth to have access to and awareness of the everyday science around them and in so doing become comfortable with the scientific process, to encourage geology and space science careers, and to bridge the technology gap in rural areas. To meet these objectives a team of educators from across the state came together for a year with DMNS professionals to develop the program and its curriculum. The resulting materials support the Colorado Content Standards for reading, writing, math, science, and history.

By fall of 2002 the All Sky program will install and support a dozen camera sites across the state. Each site will have two teachers and a student team collecting, analyzing, and using meteoritic data in classroom activities. Participating 6-12th grade students will put together a specialized camera and mount kit that will link to detection software on a workstation within the school. The network of rooftop cameras create a triangle of sky coverage within the state, making it possible to record the same meteor event from multiple perspectives. With this correlated data, students will be able to track a meteor's trajectory to where a meteorite might have landed. It will also be possible to use that same trajectory to trace the meteors entry into Earth’s atmosphere and recreate the original orbit of the meteoroid allowing researchers insight into the little-known habits of near Earth objects.

Students will share data from the camera network to conduct an inquiry-based investigation of meteors, fireballs and other solar system objects. This accurate data will inevitably lead to ground searches for potential meteorites lead by Jack Murphy and the meteorite recovery team. Participants will work on a variety of projects which include: creating histograms to discover day and seasonal meteor patterns, triangulating meteor paths to map accurate trajectories, interviewing eyewitnesses, producing news-breaking press releases, and participating in field searches for meteorites.

All Sky is the only program of its kind that uses a network of cameras to gather data about the night sky for both research and educational purposes. The program is teacher-driven, and builds middle-to-high school collaborations which will provide opportunities for student-to-student mentoring. With momentum for the project gaining, the Museum anticipates that All Sky will grow well beyond these initial efforts.
Honoring the Sky, from Lakota to Hevelius

Dan Neafus
Cosmic Atlas development team, Space Odyssey project, Denver Museum of Nature & Science

Abstract

A captivating series of constellation illustrations will be utilized in the new Gates Planetarium. The Scientific Visualization team is collecting classical and historical artwork from around the world. Each image is modified to be available as a permanent teaching tool in our “Digital Starball” Included in this ongoing work are depictions from European and Lakota culture. The “traditional” constellations were adapted from the glorious printing “Firmamentum Sobiescianum sive Uranographia” by Johannis Hevelius, 1690.

As Planetarium professionals we strive to help our audiences make personal connections with space. During the development of our Space Odyssey project we took two very different approaches to help visitors make their own connections with the sky. Our two initial projects share a similar goal but each utilizes very different presentation techniques.

Both projects start with a digital version of stars from our database called Cosmic Atlas. This Atlas can create accurate digital maps of star locations and magnitudes. Digital overlays were then created that aligned to these star groups.

Honoring the Sky featured stories and images from Lakota Sioux elders. Their words and drawings are featured in a popular portable planetarium show offered by Denver Museum of Nature & Science outreach. Symbolic images of “Animal, Snake, Turtle, Racetrack, and the popular Dipper accompany authentic recordings of the elders stories.

Snake constellation from Honoring the Sky, Copyright 2001, DMNS
To create the images the *Cosmic Atlas* stars were matched with digital renditions of the Lakota drawings. The outlines were then etched into brass templates and secured to the front of “Bruteforce” flashlight projectors. Students attending the show are then encouraged to match the projected images with the Starlab stars. The authentic recordings of the Lakota storytellers combined with the simple constellation projectors has made *Honoring the Sky* very popular with Colorado schoolchildren.

The creation of constellation images for the new Gates Planetarium has been much more difficult. Our new Planetarium will feature a one-of-a-kind all-dome projection system. All images and show content will be digitally generated in real-time with our *Cosmic Atlas* software.

Realizing that the digital capabilities of *Cosmic Atlas* go far beyond the mechanical limitations of traditional star machines, we have designed new ways to present constellations. We began by creating digital maps of the 88 constellation boundaries. Stick figure constellation outlines were then plotted into the database. The resulting sequence of lines is designed to help viewers make their own connections with the stars as the images appear.

Many Planetarium visitors recall the mythic constellation figures projected in traditional star shows. Our Scientific Visualization team utilized the powerful *Cosmic Atlas* tools to develop truly spectacular constellation figures.

After researching a number of sources we arranged with the Linda Hall Library in Kansas City to provide original digital scans from their large collection of etchings. Sixty six glorious constellations were adapted from the printing “Firmamentum Sobiescianum sive Uranographia” by Johannis Hevelius, 1690.

Composite image of the Cosmic atlas stars and the original Hevelius scan of Taurus. Copyright D.M.N.S. 2002

Each has been painstakingly modified to align precisely with the *Cosmic Atlas* starfield. The labor intensive process utilized a variety of digital editing techniques to reveal his majestic original artwork. Once loaded into the *Cosmic Atlas* database these constellation figures can be combined with the line drawings in any color or intensity to enhance planetarium presentations.
There is virtually no limit to the range of artwork and cultural variety that can be held in the *Cosmic Atlas* archive. As a cultural institution the Denver Museum of Nature & Science will continue to collect and process works of art from humanities efforts to honor the sky. Perhaps this is the ultimate personal connection with the heavens.

*Cosmic Atlas* constellations, Copyright D.M.N.S. 2002

*Notes and additions;*

The Denver Museum of Nature & Science, *Space Odyssey* featuring the new Gates Planetarium and the *Cosmic Atlas* will open in summer 2003

Linda Hall Library has an excellent web exhibition entitled; *Out of This World - The Golden Age of the Celestial Atlas - An Exhibition of Rare Books from the Collection of the Linda Hall Library*
Honoring The Sky
from Lakota to Hevelius

The New Gates Planetarium

redesigned from the ground up
Practical Use of the Leonids C.G. and Movies for Astronomy Education

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and
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Abstract
Since 1993, we have particularly focused on astronomical phenomena to produce C.G. animation based on scientific or observational data for astronomy education. By collaborations with specialists of several fields such as calculating of orbit of solar-system’s body, making computer-graphics, and astronomy education on planetarium, we could produce scientific visualization animation.

For recent years, the Leonids is the most attractive astronomical phenomena. We produced the Leonids C.G. movie and took the Leonids meteor shower at 2001 by video with image intensifier. They were effectively used for live style explanations on planetarium and exhibition of Nagoya City Science Museum, web site of us, and TV news or science programs in Japan.

1. INTRODUCTION
Plain visualization and explanation of astronomical phenomena interest people in astronomy and looking up the sky. In Nagoya City Science Museum, we explain various astronomical phenomena by live planetarium shows. We have about 300,000 visitors per year and want them to watch the phenomena in real nature as much as possible. But it is not easy to show the mechanism of the astronomical phenomena (like 3-dimensional orbits of celestial bodies) not only plainly but also scientifically. To produce attractive and high level contents, we try to make 3-dimensional computer graphics with cross field collaborations. Because of different points of view of other field’s specialists, we think collaborations have potential to develop new methods.

Figure 1. Nagoya City Science Museum Planetarium
Since 1993, we produced 4 collaborative works as follows.

- The comet Shoemaker-Levy 9 collision with the Jupiter C.G.
- The Saturn ring crossing C.G.
- The comet Hale-Bopp C.G.
- The Leonids C.G.

In this paper, we describe the latest work; the Leonids C.G., and the live video of the Leonids meteor shower which we took at November 19, 2001 in Japan.

2. COLLABORATIONS

In our collaborative works, we have 3 groups. All members are specialists from each field; solar system orbits calculation, computer graphics and astronomy education in planetarium. Our relationship is similar to the group of making movie films. The original worker is specialist of calculating. He also investigates final works on scientific view points. The camera operator and effect maker are specialists of computer graphics. The scenario writer and the director are education specialists. If one person tries to make movie films, he has to study all about it and do all roles by himself. So it is hard to make high quality movie film.

For scientific accuracy, orbital data of our solar system was calculated based on NASA's ephemeris and considered all planet's and the Sun's gravity. For scientific visualization, we use OpenGL and C language for programming. We don't use applications for 3-D animation. If we want only beautiful computer graphics, it should be better to use these applications that are on the market. For easy understanding and impressive expression, planetarium stuffs checked trial C.G.s and used them in the live planetarium shows. If someone wants to study all about our skills and techniques, it seems to be impossible. Therefore the cross field collaborations are valid and efficient to produce what we want.

Figure 2. The Leonids C.G. WEB page (http://www.ncsm.city.nagoya.jp/astro/leoCG_e.html)
3. THE LEONIDS C.G.

In the past, the Leonids caused meteor shower in a 33 year cycle. The meteor shower’s mechanism is interesting and easy for understanding by using 3-D view points through our computer graphics. On march 1998, the comet Tempel-Tuttle returned and passed descending node. So we hoped the meteor shower from 1998 to 2001. The Nagoya City Science Museum changes it's planetarium shows every month. Until now, we used the C.G. in 4 planetarium shows.

1998. 8 “The shooting star to the Earth”
1998.11 “Looking forward the meteor shower”
1999.10 “The Leonids meteor shower again”
2001.11 “Meteor shower coming”

As a result, more than 100,000 visitors heard our live explanation using the C.G. In classroom on universities and high schools, our C.G. was used for education. About 300 sets of the Leonids C.G. were used in Japan and the other countries. Mass media also paid much attention to our work. Our C.G. was used in more than 50 TV program. All key stations in Japan include NHK asked to rent and use our C.G. on their program. In November 1999, our Leonids web pages had more than 800,000 hits during 20 days. We displayed these C.G. movie’s files on mpeg and Quicktime format to download.

3.1 The Leonids from space

In the Leonids C.G., we have 3 scenes: the Leonids from space, simulation of meteor particles diffusion and simulation of the Leonids as shooting stars.

Figure 3 is distant view of solar system and orbit of comet Tempel-Tuttle (an elliptical orbit). The CG’s view point goes to the descending node. Figure 4 is the scene of comet Tempel-Tuttle crossing the descending node on March 1998. Figure 5 shows the positions of the comet on the orbit every year. Only one year later from crossing the descending node, comet Tempel-Tuttle was far away from the Earth orbit.

Figure 6 is the close up view near the Earth at November 17,1999 4:00 am (JST). The Earth is crossing dust tube of comet Tempel-Tuttle. The particles from right side of the screen flow about 42 km/sec. The Earth moves about 30 km/sec. from left to right on the screen. Eastern Asia looks to the upper stream of meteor particle. Figure 7 shows the Leonids radiant and the Earth from space. We can see the meteor particle spread from the radiant. Because the Earth moves about 30 km/sec. around the Sun, the radiant is different position to be see from the Sun. This is “The Space Leonids”.

Figure 3. Distant view of solar system
3.2 Simulation of meteor particles diffusion

Comets are made by ice and particles of rock material. When comets come close to the Sun, ice melt and particles are discharged. If those particles flow into the Earth’s atmosphere, they become meteor. The particle’s discharge speed is thought one thousandth of the comet’s orbital speed. On this simulation, we set the particle’s speed 12m per second. When the comet gets close to the Sun (inner Mars orbit), the comet discharges particles to all directions. The faster particles that are discharged forward have outer and longer orbits than the comet. In this way, the particles come to descending node after the comet. The slower particles that are discharged backward have inner and shorter orbits. So the particles come to descending node before the comet. Figure 8 shows a snapshot of the simulation of meteor particles diffusion. The disk on right center is the Sun, the other disk moving around the Sun is the comet Tempel-Tuttle and white dots are meteor particles discharged from comet nucleus. The Number is years from start.
### 3.3 Simulation of the Leonids as shooting stars

In this simulation, the particles that were discharged from the comet scattered as some spatial density. The particle comes into the Earth’s atmosphere, flashes, and disappears and counted by program. The parameters are as follows.

- **Flash altitude**
  - 120 km–80 km (-3,-2,-1 mag.)
  - 110 km-80 km (0 mag.)
  - 100 km-80 km (1,2,3,4 mag.)

- **Flash time**
  - 0.75 second, Typical flash pattern of meteor.

- **Brightness**
  - Luminous function is 1.5 from -3 mag. to 4 mag.
  - We consider the distance from observer to the meteor to know the real brightness.

- **Density of particles** are given as shown in Figure 10.

<table>
<thead>
<tr>
<th>particles per 100km cube</th>
<th>0.05</th>
<th>0.97</th>
<th>9.6</th>
</tr>
</thead>
<tbody>
<tr>
<td>H.R. under ideal condition (stars=6th,meteors=4th)</td>
<td>500</td>
<td>10000</td>
<td>100000</td>
</tr>
<tr>
<td>H.R. under urban condition (stars=3th,meteors=2nd)</td>
<td>150</td>
<td>3000</td>
<td>30000</td>
</tr>
</tbody>
</table>

Under urban condition, the H.R. (Hourly Rate) decreases 1/3, but only darker meteors cannot be seen. So in the case of great shower, the urban condition is not so bad.

![Figure 9. The Leonids meteor in comparison with ideal and urban condition of the night sky](image)

![Figure 10. The table of density of particles and results (H.R.)](image)
4. THE LEONIDS LIVE VIDEO

Fortunately, we encountered the Leonids meteor shower at November 19, 2001 in Japan. From November 17 to 19, one of our teams went to Mt. Ontake where is located the middle of Japan and took the Leonids by video with image intensifier under the dark sky. Another team stayed in Nagoya and took the Leonids under city light pollution.

People who watched the Leonids were surprised and want to know “why so many shooting star appeared?”, “my experience at that night is very precious or not” and so on. People who did not watch the Leonids regretted it and asked us, “can I see the record of the Leonids in your planetarium?” So, we think education after the astronomical phenomenon is also very important. The next day of the Leonids, we edited these tapes to the short-time video and used it in our live planetarium show. After that, we edited long version and played it in our exhibition room. In this long version, various scenes such as radiant point, long meteors in the western sky, meteor shower under the light pollution and bright meteor at the dawn can be seen. People can also try meteor counting in the video. For recording these images, we used high speed video system almost the same sensitivity as naked eye. And we also use wide field lens to cover wide area like naked eye. These points of view are important for education.

Figure 11. Big fireball (-8 mag)  
Figure 12. Show radiant point  

Figure 13. Long meteor with famous winter constellations in the western sky  
Figure 14. Meteors under light pollution
5. SUMMARY

We produced the Leonids C.G. movie with cross field collaborations and the live video of the Leonids meteor shower at 2001. More than 100,000 visitors in Nagoya Science Museum heard our live planetarium using our works. About 300 sets of the Leonids C.G. were shared to other planetaria, public observatories, classrooms, mass media and on the WEB. We are pleased with large-scale spread of our works for attractive education tool.

6. ACKNOWLEDGMENT

The authors would like to thank all members concerning this project. We also wish to thank Mr. Takashi Yamada for useful guidance and advice and Mr. Toshinori Ohkouchi for wonderful music.

7. REFERENCES


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Abstract

Today, I would like to demonstrate the exciting new products designed to deliver Minolta’s proven optical and digital technology.

MEDIAGLOBE is a new generation, full color, all-sky CG projection system.

The MEDIAGLOBE is the world’s first full-color, full-dome projection digital planetarium for the small dome. The MEDIAGLOBE combines digital planetarium functions and multimedia projections in one compact unit, and can replace all other projectors found in traditional small-dome planetarium.

The MEDIAGLOBE is designed for smaller domes that like to think big and can be customized to fit existing planetariums or classroom or exhibit hall.

The MEDIAGLOBE combines traditional planetarium motion with a digital projection system.

1) Programmed sequences can be played back.

2) Built-in database includes information about Bright stars, Nebulae and Clusters.

3) Manual operation is available. Operation is easy by Graphical User Interface.

The MEDIAGLOBE accurately and realistically immerses audience in 6,000 stars down to 6.0 magnitude. Data setting is available from the range of BC 30,000 to AD 30,000. Traditional and basic functions as planetarium are, Diurnal, Annual, Latitude Adjustment, Azimuth Adjustment, Precession Motion. On top of it, Celestial track, 88 Constellation Figures, All-sky Grid, can be projected accurately. These are the sample images. The adoption of a Graphical User Interface for the man-machine interface also makes it possible to control traditional planetarium functions with ease. It instantly projects these images with ease. Learning has never been more exciting by the MEDIAGLOBE. A dome size classroom, or a genuine entertainment, or a relaxation room. A shuttle launch! Or, simulated flight through an asteroid field!

In addition to fundamental planetarium data contents, the MEDIAGLOBE can also be used with a variety of image sources, including user-created images.

At 48 inches in height, the MEDIAGLOBE is designed with these primary specifications.

1) Full-dome diffraction-limited Minolta Fish Eye Lens.

2) Resolution: SXGA (1,280 x 1,024 pixels), full-color (16.77 million colors)

3) Dimensions: H 48 (inch), We 25.2 (inch), D 27.6 (inch).

4) Weight: less than 265 lbs.
We have started our sales activities in the United States from this spring for MEDIAGLOBE, with MEGAsystems, as our exclusive U.S. distributor. The first US installation of the MEDIAGLOBE will take place this autumn at the Louisiana Arts & Science Center in Baton Rouge, LA.

Next of all, GEMINISTAR II is a new generation integrated planetarium combining pin-point stars with full-dome computer graphics. Three major features are:

1) Conformity – by using same blue coloring.
2) Economic use of space – combined into a single round space to minimize size of foot print.
3) Open architectural design – User-friendly console.

By adding the new Infinium to the Evans & Sutherland’s Digistar II, we named it a GEMINISTAR II. We have come up with a total new single-ball type Infinium for the GEMINISTAR II. It has an accurate and realistic star field by using Metal halide lamp. Up to 21 optical fiber bright stars are presented with as many as 250,000 Milky Way. As for the Digistar II by E&S is itself explanatory for the majority of today’s audience. Needless to say, it is all sky Computer Graphic projection system featuring 3D wire frame images on the dome. This is all about something new from Minolta. These exciting products are only from the mind of Minolta.
More than just a planetarium

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Abstract

As a midsize planetarium functioning as a stand-alone facility in a rural district we are constantly facing the task of keeping finance in balance, increasing revenue and attracting new audience. While not being a science centre there is still a lot of activities that can be held outside the dome, and I will here present some of the events that take place during the year at our facility.

Many larger and midsize planetaria play a natural role as part of a larger science centre or museum complex and many smaller planetaria are placed as part of a school or on a college or university campus. But what about those midsize planetaria, that function as stand-alone facilities? How can activities taking place outside the dome help to increase revenue and stimulate higher attendance? In the following I’ll share some of our experiences with special events and side-activities that are restricted to the area beyond the dome.

Like most places the Orion Planetarium are stuck with an odd-shaped entrance hall, basically what is left when you build something round in something square. We have decided not to use this as a permanent exhibit area on astronomy, but rather as a flexible area used for special exhibition, interchangeable hands-on experiments and demonstrations. We do not restrict ourselves to astrophysical themes in these activities but take up various topics within science history, physics, chemistry, geology, biology etc. When possible the adjacent lecture room is opened up to the entrance hall and the two areas merged, providing a much larger area for the activity in question.

One of our great successes is chemistry and physics “shows” performed by teams of students from the University of Aarhus. They comprise demonstrations of some of the most spectacular and instructive experiments all carried out with a lot of colours, smoke and noise but always keeping the main educational objective in mind.

Together with the Steno Museum at the University of Aarhus campus we have also developed thematic weekends focused on families with children. This concept consists of 30-40 smaller hands-on activities and some demonstration experiments carried out by our staff at intervals. As of now we have developed the following themes: Fun-with-Water, Fun-with-Air, On-Visit-to-the-Micro-World and we intend to develop more themes in the coming years, the next one possibly on electromagnetic radiation. Each theme is scheduled at maximum twice a year in each institution. As for many of our side-activities the workload of such events are too large, with our limited staff, for a general opening. But it can be put up for a long weekend, winter break or a short period in the summer season giving the audience some extra experiences for that special time.

There are also things to do outside. A small observatory is placed right next the to planetarium and a planet trail makes its start from our parking lot. The observatory houses an 8” Schmidt-Cassegrain telescope and is opened (weather permitting) in conjunction with the planetarium dome every Wednesday night at 7-10 p.m. It’s a huge benefit to be able to show some of the objects, that has been mentioned in
The audience also often finds it neat to refer the current sky talk as heard in the dome to their own experience of the night sky, which of cause puts more pressure on the live interpreter, when his/hers explanations can be checked immediately afterwards. Located in a rural district we suffer little light pollution and the most popular Messier-objects are observed quite easily. The observatory will also be opened at any time for special astronomical events like planet conjunctions, lunar and solar eclipses or meteor showers. We have seen 350 people for the 1999 solar eclipse and once had 150 visitors for a lunar eclipse in the middle of the night! This shows that you can actually attract a lot of visitor if you get the right media coverage.

The scale model of the Solar system has the Sun located on the edge of the drive way to the parking lot and Mercury and Venus are also placed on our grounds. The path then continues into the woods and down to the nearby lake and follows the shore all the way to Pluto 3 km away. Visiting school groups are offered a 15-minute introduction leading them to Mars and can then continue on there own as far as the teacher sees fit (some actually make it Pluto!). Public guided tours along the entire trail are offered at intervals, too.

With the previously described activities and special events the Orion Planetarium has been known as a location, where interesting things take place, and therefore we have for instance been able to attract some of the major events during the biennial Danish Science Festival. It has also proven to be a lot easier to get through to the media, both local and nation wide, with our special events than with the ordinary show programme and we have over the last four years been in the TV-news on national programmes 2 or 3 times a year.

Does these side-activities deflect the focus from the main purpose of the planetarium, the shows? I think not. Seen over the entire year, the activities supplementing the planetarium shows do not comprise more than 10-20% of the business, both time-wise and money-wise. But they are often those that stimulate new visitors to come and thereby promote an increased use of our main product.
Human Connections of Cultures to the Cosmos (Poster)

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Abstract

Human connections of cultures to astronomy can be incorporated in planetariums in a variety of ways. Ideas presented in this poster session have been a part of the offerings at Adler Planetarium. These ways have been through shows, exhibits, courses, members' tours and outdoor sculpture.

Often the field of astronomy appears to be so unrelated to the lives of our audiences that it seems to them to be an irrelevant subject. Yet they are amazed when they become acquainted with the ways cultures all over the world and through time have incorporated the cosmos into their lives. Astronomy through cultures makes the subject much more approachable to our visitors and is a way to cover the basics with them without saying so. Finally, this becomes an inspiration for our audiences to seek out dark skies and become personally acquainted with the half of nature that extends overhead. This is the ultimate human connection. There are five different ways in which the staff at Adler Planetarium & Astronomy Museum has made that connection with our visitors. These are ideas that our colleagues may wish to incorporate.

Sky shows are an impressive way to present cultural astronomy by using horizon panoramas and all-skies to create the you-are-there immersed environment. Sound tracks supply the cultural music and ambient sounds. The star projector accurately recreates the skies of long ago and far away to see what they were seeing and recording. Over the years, the Adler has written and produced a number of shows that cover what, how and why people of different cultures observe the sky. Some of the shows have been: “Sky Gods of the Ancient Americas” (Hopi, Puebloan Ancestors, Northwest Coastal Indians, Pawnee, Maya, Aztec, Inca and Papago), “Secrets of the Ancient Skywatchers” (Aztecs, Mayas, megalithic people, Egyptians, Mesopotamians and Chinese), “Beneath Southern Skies” (Polynesian Navigators), “Discovering New Worlds” (Christopher Columbus and other explorers, Aztecs, Incas, Cahokia Mound Builders, and Polynesians), “African Skies” (Egyptians, Dogon, Taureg, Namoratunga, San, and Yoruba tribes) and “Spirits from the Sky, Thunder on the Land” (the NSF funded and available show about the Pawnee Indian incorporation of the night into the cycles of their lives). The Pawnee show and the opening events will be featured in the poster session.

A brand new permanent exhibit gallery “Bringing the Heavens to Earth” opened at Adler Planetarium on the spring equinox this year.

The elements are an approach through one of the Stonehenge trilithon arches to a huge panorama image. Then the visitors can step into a cavern with a zenith hole where a cycled sun passes through. From there visitors enter into a “starry realm” with an introductory show about human connections to the sky. Afterwards,
visitors enter a sweeping area with a backdrop of images, videos and artifacts. The heart of this area is the 4 interactives - one is on Polynesian navigation where the visitor steps aboard a sailing canoe to attempt to successfully steer until the “red star” is overhead. The exit area consists of three different computer interactives. Floor demonstrations are included with this exhibit. The main message is why people look at the sky: survival, orientation and beliefs. The poster will show photographs of this exhibit.

Public courses have included “Ancient Astronomy” taught by this presenter for some twenty-five years now at the Adler. The course covers: Egyptian Astronomy, Mesopotamian Astronomy, Chinese and Indian Astronomy, Greek and Arabic Astronomy, Stonehenge Astronomy, North American Indian and Polynesian Astronomy, Mayan and Aztec Astronomy, Nascan and Incan Astronomy. The first 45 minutes are in the sky theater using the Zeiss projector set for the proper date and latitude to recreate the celestial events important to a particular culture. The final 45 minutes are spent looking at and analyzing the records that we have that are as lore, or written and/or monumental architecture. Examples will be shown.

Members’ trips have been taken to the Southwestern United States, Peru, Mayan sites, Easter Island and Ireland. An itinerary will be part of this poster display.

A spiral-shaped 60-foot diameter sculpture of 60 stones on the Adler’s south lawn works like a spiral Stonehenge. Four pathways lead from the center of the sculpture to the places on the horizon where the Sun reaches its northernmost and southernmost risings and settings on the solstices. Any clear morning or evening during the year, park visitors may check the progress of the seasons by seeing where the Sun rises or sets between these two extremes. At its center, the thin spaces between the four stones align with the north-south and east-west compass points. Appropriate for its location adjacent to the Adler Planetarium & Astronomy Museum, this sculpture embodies the spiral shape of galaxies, while being reminiscent of ancient observatories. Images of this sculpture will be a part of the poster display.

Human connections of cultures to astronomy can be incorporated in planetariums in a variety of ways. Ideas presented here have been a part of the offerings at Adler Planetarium. These ways have been through shows, exhibits, courses, members’ tours and outdoor sculpture.
New 3-channel immersive digital video system in Tampere Planetarium

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Abstract

This paper describes the new 3-channel immersive digital video projection system installed in Tampere Planetarium. The system is based on the newest, ultra-high resolution video projectors provided by BARCO Projection Systems. The display solution including the definition of field of view, edge blending zones and geometry correction has been designed in cooperation with the planetarium staff and Barco engineers. Digital methods have been developed in-house to help and make content creation efficient and economical. Excerpts from the first own production "Out of Stardust" are shown.

1. Introduction

Tampere Planetarium is one of the pioneers of applying new technology in dome environment. In 1988 we installed a system of four video projectors. In 1990 we were one of the first to introduce an interactive system that was based on a bank of laser disk players. Since 1993 we have been producing 3D-animations and computer graphics in-house. In 1995 we replaced our old video tape players and laser disk players with hard disk based digital video recorder/players. In 1997 the planetarium was renovated to have a unidirectional seating system.

For many years we have been planning to have a partial or full dome video system. Our planetarium is part of a major attraction complex of the Sarkanniemi Theme Park. Because of other investments and favourable economics the video system investment became feasible during last autumn.

For certain reasons we did not want to buy a ready-made system from any vendor. Because of our long experience with 3D-animations, computer graphics and digital video we wanted to have a tailor-made installation designed according to our expectations and requirements. Especially, we wanted to be able to make our own productions and develop digital methods to make these productions efficient and economical.

The most important requirement was that the system had to be as flexible as possible to allow all kinds of image sources and generators. The system had to accept video sources from standard to high definition and be capable for line multiplying. Computer image sources from standard to super high resolution and low to high frequency had to be able to be connected. The system also had to have fully adjustable geometry correction and edge blending for different image sources and these had to be available both for pre-rendered video materials and real-time image generators. Finally, the system had to have the optimum price-quality relation.

In the beginning of 2001 we started cooperation with BARCO Projection Systems to have such a display system in our planetarium. After many discussions and e-mails with Barco engineering team the final description of the
system and quotation was approved by us in late autumn. The system was installed in the planetarium in March 2002.

2. Description of the display solution

The display system consists of three BarcoReality 909 Split-Pack video projectors which are located on the perimeter of the dome 60° from each other. The dome has a diameter of 13 meters and the projected image covers a 195° horizontal and a 60° vertical field of view. Each image covers 75° horizontally and the images are geometrically corrected so that their vertical edges follow constant azimuth. There is a constant 15° horizontal edge blending between the images. The lower and upper edges follow constant altitudes of 0° and 60°.

The video projectors are equipped with optional extensions to handle geometry distortion and advanced edge blending between the sources. Video line doubling and line quadrupling are available for video sources.

We are using three DPS Reality digital recorder/player cards as video image sources. These cards record and play uncompressed/compressed digital PAL/NTSC standard definition video with 4:2:2:4 sampling.

In Europe we are using PAL format and the raster size of digital video frame is 720 x 576 pixels. With 15° edge blending the projected image of 195° x 60° corresponds to 1872 x 576 pixels.

In the future we plan to use high definition video format up to 1920 x 1080 pixels per channel or image generators up to 1600 x 1200 pixels per channel.

3. Show production

We have produced our planetarium shows in house since early 1990s. From 1993 we have been producing 3D-animations with 3D-software, i.e. 3DSMAX, Softimage XSI and Alias Maya.

To create animations for the immersive panorama video system we have developed new digital methods. In our case we have to render images and animations which have equidistant cylindrical coordinates extending from -97,5° to +97,5° horizontally and from 0° to +60° vertically.

We started to solve the problem using 3DS MAX. Since the standard scanline camera of 3DS MAX is not suitable to render such images we tried different plug-ins. We found that e.g. FinalRender plug-in from Cebas can render such images. However, FinalRender makes use of raytracing and it turned out to be much too slow for our short production schedule.

To get a faster solution we wrote a MAX script based on using the standard scanline camera of 3DS MAX. In practise for each animation frame we render 39 narrow pieces of images ranging only 5° horizontally and from -60° to +60° vertically. We start by aiming the camera to -95° in horizontal direction and render an image from -97,5° to -92,5°. Then we turn the camera to -90° and render another image etc. Finally we stitch the 39 pieces together to get a single frame ranging from -97,5° to +97,5° horizontally and from -60° to +60° vertically. The
final frame has a pixel size of 1872 x 1910. All this is automated in the MAX script.

In the next step we drop off the lower half of the frame from -60° to 0°. The resulting image is 1872 x 955 in pixels.

The standard camera of 3DS MAX renders images by projecting the 3D scene onto a plane. Therefore we get images with a distortion which increases with angular distance from the image centre. Due to the method described above the distortion occurs only in vertical direction in our case. The correction for this distortion is fairly straightforward to formulate geometrically and we wrote a C++ program to correct the animation sequences automatically. After the correction the frame size is 1872 x 576 pixels.

We layer animations, add effects and make other postproduction with Adobe After Effects. Then we split the final sequences into three parts (left, centre and right) in After Effects or with special C++ software written in-house. The resulting animation sequences have a size of 720 x 576 pixels that is compatible with our DPS Reality video cards.

The methods described above can also be used to create content for any image format like high definition video which is our plan for the future.

4. First production

We started to produce our first show last autumn when the display system was still in planning stage. Manuscript was ready in November and in January we started the first 3D renderings months before we had any chance to check them in the planetarium. The production schedule was very tight because we had to solve many technical questions described above before the final rendering of the animation sequences. The first production “Out of Stardust” had its opening on May 11th, 2002.
SPACE: Starlab Program of Astronautics and Cosmic Exploration (Workshop)

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Abstract
This workshop will be about “SPACE,” which is the name of a Starlab program, intended for elementary school students (8-10 year olds). It is designed to simulate a space trip in a classroom or a planetarium. This program involves students, teachers and parents in an effective way and is best conducted over a three day time period. Approximately 2 hours each day are dedicated to the program. Students conduct research and create projects that involve artificial satellite model building and designing imaginary alien worlds that are illustrated with hand made slides. They explore the effects of micro-gravity on common objects in spaceships and learn about our place in space.

Students and teachers then experience a presentation given using six different Starlab cylinders (Earth, Transparent, Deep Sky, Solar System/Milky Way, Greek mythology and Native American mythology) and student created materials.

The materials developed during the program (artificial satellites, tunnel, drawings, homemade slides etc.) are shown to the children’s parents in a school exhibition at the end of the school year. An evening sky observation session is held during the last days of the school year. This time with students and parents is devoted to the observation of constellations and then artificial satellites.

During the “SPACE” program, elementary school students experience three phases:

1. Introduction to the following subjects:
   elementary knowledge about the “geography” of the cosmos (from the Solar system to the galaxies); how our planet appears from space (Earth images taken by satellites); and what happens in micro-gravity conditions.

2. Creating original models of artificial satellites or space ships, images about imaginary alien worlds and drawings of common objects floating in the space ship.

3. Experiencing a Starlab lesson that makes use of six different Starlab cylinders (Earth, Transparent, Deep Sky, Solar System/Milky Way, Greek mythology, Native American mythology). During this final part of the program, the students take an imaginary space trip where they explore alien worlds. At the beginning of this trip, students see common objects floating in the spaceship. They travel through our Solar System and out to view the galaxy. Then they visit alien worlds that are represented with original slides created by children. Finally they travel back home to view the night sky and imagine constellations.
If one of the goals is also to have students learn some English during the program, activities that involve English teachers are included. The program is particularly designed for the use of Starlab inside a classroom, without inflatable dome (“Magic Walls”), but can be also presented under the dome.

I. PREPARATION FOR THE SPACE TRIP

A. Materials needed:
   1. A transparent cylinder that shows figures (shapes) of common objects imagined in micro-gravity conditions. When daily motion is turned, on this cylinder can be used to simulate the situation where all these things appear to float inside a space ship.
   2. A transparent cylinder that shows figures (shapes) of spaceships and satellites. When daily motion is turned on, this cylinder can be used to simulate their movement around the observer and therefore around the Earth.

B. Student preparation:
   1. Through preliminary investigation in the classroom, students must learn basic information, about what happens in conditions of micro-gravity and about astronautics in general.
   2. Students must also learn to make comparisons between an Earth atlas and the photos of our planet taken from space. Students need to be able to recognize the details of these images (rivers, lakes, mountains and so on) and to draw a map of these characteristics on a transparency that can be shown to the classroom by using the transparent cylinder like an overhead projector. This activity will help students to prepare images of an alien surface by imagining how their alien planet would appear from space.
   3. And finally, it is necessary that students have a basic knowledge of the geography of the universe. They should be able to define the terms: galaxy, solar system, planet, moon, star, and constellation.

C. Creative works before the space trip:
   1. Spaceships and artificial satellites
      Using paper or other light materials, students need to build models of artificial satellites or spaceships. Then hang the models on the ceiling of the classroom or in the dome. A lamp will light up the models, like when satellites are visible in the night from sunlight reflecting off of them. One at time, the students will tell about the function and characteristics of their created object.
      Two solutions for the background of the satellites: a wall in the classroom can be covered with many photos of the Earth taken from space. The satellites can be hung from the ceiling in front of the wall; the images of Earth from space can be stuck on a piece of cardboard that can be used as the background for the satellite. This second solution would make it possible for students to carry the small model home.
   2. Tunnel
      When “Space project” is realized without the inflatable dome (Magic walls version), we suggest that a tunnel be prepared at the door of the classroom. This will recreate, for the students, the idea of entering into a special site. The tunnel is the entrance to the inside of the space ship (a normal school room but
completely dark).

It is also necessary make the inside of the room dark for the “Magic walls” projection. Use cardboard to close the entrance of the room, like a fixed cardboard door, and create a hole where the tunnel will be attached. Cover all windows to keep out the light.

3. Floating in space

This part of the program is devoted to teaching the children about living in space. It could be used to give students the feeling of “freefall” and an understanding of gravity’s pull.

We select a list of common objects of daily life and imagine what will happen when these objects are in space. We prepare a special transparent cylinder with the drawings of these objects (see the list). During the projection (daily motion) the objects appear to be floating in space.

Each object will be represented with a cardboard shape projected on the ceiling (Magic walls version) using the transparent cylinder. Each object will be also indicated with the corresponding English word. That involves the English teacher in the classroom.

Floating in space list of objects:

- Copybook/exercise book with a pencil;
- Paper Towel (moist/clammy towel)
- Metal mirror (not glass)
- Comb
- Toothbrush
- Eye shades and Ear plugs (are needed to give the illusion of night; the normal 24-hour sunrise to sunrise sequence occurs every 90 minutes as the shuttle completes one earth orbit)
- Toothpaste/dentifrice (edible/eatable not foaming)
- Spoon (can deliver their cargo at any angle. Food can stick to either side of a spoon)
- Condensed milk (and other foods inside small tubes)
- Dehydrate fruit (on a spit)
- Water bag with straw (straw with clamps)
- Sandwich (inside a triangle plastic box); pay attention to the crumbs!
- Toys: yo yo, magnetic marbles, coiled spring
- Fan (recycling air)
- Eye shades and Ear plugs (are needed to give the illusion of night; the normal 24-hour sunrise to sunrise sequence occurs every 90 minutes as the shuttle completes one earth orbit)
- Toothpaste/dentifrice (edible/eatable not foaming)

4. Alien worlds

It is possible to create wonderful images of these imaginary alien worlds using homemade slides containing colored plastic, salt, sticky liquids and other materials not opaque to the light between the two sides of the glass. The sticky liquids can also give an idea of changes that can be seen in the appearance of the planet. Students imagine that they have taken these photos during their space trip. For each photo the students prepare a map, on a transparency, that contains the description of the features in the photo.
II. SPACE TRIP

The main steps of the space trip will be the following:

1. Students enter inside the space ship, through the tunnel, one by one. When this experience was tried for the first time, in October 2001, the children enter in the dark room where there was a surprise. The pilot of the space ship was Susan Reynolds Button, dressed like an astronaut. She spoke in American and the classroom teacher translated. Susan presented the main events of the space journey. We needed to reduce her part of the script to only a few sentences and words because the translation from American to Italian takes a long time.

2. Presentation of space ship pilot (English teacher) and discussion of reasons for the use of English words during the activity. English is the language of science, the only language of every astronaut.

3. Astronauts (students) take their places inside the space ship.

4. Ignition and lift-off;

5. Micro-gravity conditions (transparent cylinder projection with selected objects). Then the spaceship pilot, English teacher, reads the words one at a time, and the space ship pilot assistant, Starlab operator, describes what happens to each object in conditions of micro-gravity.

   Each student was assigned one of selected objects. When pilot read the word the student must recognize the object. If not, the Starlab operator indicates with the pointer the corresponding figure on the ceiling.

6. Window on space: the pilot opens the space ship and the astronauts see the stars (Deep Sky cylinder). The symbols, Messier objects, will be imagined as the alien planet locations and will be the goals of our trip.

7. The space travel begins.

8. Travel through the Solar system (Solar system cylinder, galaxy covered).

9. The space travel continues outside the Solar System at the maximum speed, then outside the galaxy (Solar system cylinder, Starlab operator shows only the galaxy).

10. Return to the Earth with four stops at Alien worlds. Using Starlab as an overhead projector, the student’s homemade slides and the corresponding maps will be projected at this time during the space trip.

11. Return to the Earth. Students make naked eye observations of the sky from a dark site. They observe the stars and projections of the figures of the constellations invented by the Greeks and/or Native American Indians.


III. FINAL EVENT

The materials collected during the program (artificial satellites, tunnel, drawings, home made slides and so on) will be shown to the children’s parents in a school exhibition at the end of the school year.

   An evening sky observation will also be organized during the last days of the school year. The sky observations will be especially devoted to the observation of artificial satellites and constellations.

   We thank the teachers, parents and students of the S. Quasimodo Elementary School of Brescia who enthusiastically participated in this experience which was held for the first time, in October 2001, at their school.
Abstract

Relationships between Italian Planetaria and colleagues from other countries are steadily increasing. In the past few years, over 80 planetarians visited our country during the following dates: The First European Meeting of Itinerant Planetaria (1995); “A Week in Italy for an American Planetarium Operator” (yearly since 1995); each year foreign colleagues have visited during our National Meetings and in 2001 colleagues from other nations attended a meeting in Italy with the French Speaking Planetaria Association.

Last year, for the first time, the IPS Council Meeting was held in our country, in Castel Gandolfo (Vatican State). The yearly “Day of Planetaria” is another example of collaboration between Italian and foreign planetaria.

In Italy, at the present time, there are only three planetaria that are 10 meters or larger. This represents a unique situation among European countries. However, Italy is experiencing growth in new medium and big facilities. The next National Meetings, the National Starlab workshops and a special tourist plan offered to planetarians will be other occasions to come to know new models, new facilities and our beautiful cities of Northern Italy (2002) and the Central Italy (2003).

Join us and get in touch with us if you are interested to know more about our country. All these initiatives and the situation of Italian Planetaria are illustrated very well through many images in the science pages of our Internet site http://www.cityline.it.

“Invitation to Italy with the Sky in the Eyes” is the title of our new web page that includes all of our programs that are devoted to foreign planetarians interested in visiting our country. Our web pages describe four ideas: A Week in Italy for an American Planetarium Operator; A stay of two hotel nights (prize for colleagues of Eastern European Countries); A tourist program for planetarians and teachers, for individuals or groups; Guests of the National Meetings of Italian Planetaria.

During our meetings with Italian colleagues there are some foreign speakers that can demonstrate planetarium programs produced abroad. One of the latest shows presented was “Saving the Night”, that is a planetarium program designed to promote dark skies. The Southeastern Planetarium Association (SEPA) produced this program. If we receive show materials before the end of August we can organize a presentation of the show at the meeting. We will send all materials back afterwards.
Yearly Contests — Two Prizes

Each year, since 1996, Serafino Zani Astronomical Observatory organizes an initiative called “A Week in Italy for an American Planetarium Operator” in collaboration with the Mobile Planetarium Committee of the International Planetarium Society and Learning Technology Inc.

An American planetarium operator who wins this contest receives a chance to get to know Italian culture, to work with students and to do some site seeing. Transportation from the United States is provided, along with bed and meals from Monday to Sunday (For lunch and dinner Saturday and Sunday, they are on their own).

The planetarian who wins this trip presents lessons in English with the itinerant planetarium Starlab to Italian students of English. He or she presents no more than four lessons every morning for a total of four each day. Each lesson is at least 60 minutes in length and can be about traditional topics for planetaria such as: daily motion, orienteering, latitude motion, solstice and equinox, constellations, and so on. Or, the non-astronomical Starlab cylinders can be utilized for a lesson about such topics as: biology, tectonics, geography, ocean currents or meteorology. A classical night sky presentation on mythology is very popular. The final part of the lesson could be dedicated to Native American mythology by using the related Starlab cylinder.

The morning astronomical lessons may be in Brescia or another nearby city. All lessons and presentations will be conducted in the American language. A preliminary text (or photocopy from a book) of the lesson is required, along with a glossary of vocabulary words, so teachers will have ample time to work with their students before the Starlab experience. It is important for the students to learn new words, such as those used in mythology. During the afternoons there are no other engagements, providing an opportunity for touring the locale and nearby cities.

On Friday evening, the teacher will make a presentation of Native American mythology, or another culture’s mythology (such as African or Chinese), and constellations for the general public. The presenter will provide an introduction with slides, about his or her experiences in the diffusion of astronomy in the United States, and then make a presentation inside Starlab.

This year, at the conclusion of the week, a national portable planetarium workshop will also be held. This workshop is open to all people interested in learning more about the use of a mobile planetarium and in particular Starlab. The workshop was organized with support from the Italian representative of Carl Zeiss and therefore, there will be no registration fee for participation.

A prize will be offered to help support representation at this workshop from Eastern European countries. Only operators from an Eastern European country may apply. The winner must have submitted the most interesting paper proposal about promoting astronomy to the public and to schools.

The paper submitted by contestants must include a short description with images about some activities that promote astronomy to the public and to schools in the author’s country. The paper must be designed for a presentation of not more than 30 minutes and may include activities designed not only for the planetarium but also for other venues or institutions. Paper submissions must be received by August 31st and the text must be written in English.
The workshop organizers will examine all submitted documents and will select a winner.

The prize of two free nights in a hotel in Brescia during the conference, on October 25th and 26th, will be awarded to the author of the most interesting paper. The winner will be informed before the end of September and will present his or her paper during the workshop in October.

Texts and some of the images must be sent before August 31st to the following addresses:

Loris Ramponi, Osservatorio Serafino Zani, via Bosca 24, 25066 Lumezzane (Brescia), Italy, info@serafinozani.it

Patricia Lipovska, Chalupkova 6, 08005 Presov, Slovakia, e-mail: plipovska@pobox.sk

An Astronomical Tour

In the Brescia area we organized two international planetarium meetings, the first “European Meeting of Mobile Planetaria” was held in 1995 and the “Meeting of French-Speaking Association” was held in 2001, it involved planetarians from France, Switzerland, Belgium and from the far La Reunion Island. On other occasions colleagues from different nations also joined us to participate in an “Astronomical Tour in Brescia” (*).

The program for planetarians and teachers as tourists is divided in two parts: individual visits and group visits. The second one can include a special tour guide, a private bus if requested and it is organized in collaboration with a local travel agency. Individual and group visits include a tour to museums and monuments of astronomical interest in the city of Brescia, train fares (places to visit are only two hours by train from Brescia), hotel reservations in Venice and two or more days stay in the Dolomite Mountains are included.

With the help of a local travel agency it is also possible to reserve hotels and train tickets for travel to any other Italian city. The area around Brescia is well known for its natural beauties and historic places such as the lake of Garda and the stone engravings of Valle Camonica, one of the most important sites in the world. Brescia is near the famous cities of Verona and Milan, which are only one hour by train, and from Brescia there is a train connection to Florence, only 3 hours by fast train. If requested, it is also possible to organize a visit to other Italian planetaria. More information is available in our Internet site.

(* This astronomical tour includes: a XVI century astronomical clock in the main square of the city (Piazza della Loggia); a horizontal sundial of 1792 in the church of S. Giuseppe nearby; a XIX century painting “Newton discovers the refraction of light” (City Art Museum) with many elements of astronomical interest; an astronomical globe of Henricus Hondius; a collection of old astronomical and science instruments and clocks, including a 1052 year astrolabe that was one of the main pieces in the year 2000 at Greenwich Observatory (in the big exhibition about “Time”) All these pieces are housed in the Santa Giulia Museum, the most famous one in the city of Brescia. The tour can end in the castle of Brescia, which is located on top of the small hill that marks the center of the town. The castle offers a beautiful view of the city and a relaxing walk in the castle garden where a small popular astronomical observatory can be visited.
National Meetings and Latest Italian Projects

The National Meeting of Italian Planetaria is held each year in October. The 2002 meeting will be held on the 13th of October in the natural park called “Valli di Ostellato.” This park is located in the Ferrara area that is 30 km from the Adriatic Sea. A piece of curiosity: this park is 5 meters below the sea level. The astronomical activities in the area are managed by a local group of amateur astronomers, Gruppo Astrofili Columbia. This group makes use of a popular observatory and many portable domes, metallic and inflatable structures of up to 8 meters. These facilities, the star projector and auxiliary special effects are all homemade. Therefore, the 2002 meeting will be especially interesting for operators of small and mobile planetaria.

The next meeting will be held in October 2003 in the convent of Amelia, where a 6-meter planetarium is working, and in Rome, in the Museum of Roman Civilization where a planetarium of 14 meters will be open. The 2003 meeting will focus on the latest planetarium projects in our country and to the latest medium size domes, such as the “City of Science” 9.8-meter planetarium in Naples. The planetaria to be demonstrated are manufactured by Gambato (the main Italian manufacturer of planetaria), RS Automation Industrie (SN model) and Carl Zeiss (ZKP 3 model, the first installed in Italy).

The “City of Science” in Naples is the biggest science center in Italy. It contains 10,000 square meters of exhibitions, including sections devoted to children. The space for children is also well equipped with a small planetarium. The new planetarium was installed under a dome of 9.8 meters (75 seats). The Naples planetarium will be the first Italian dome with regular recorded shows and a Sky Skan all-sky projection system. The planetarium coordinator there is Alessandra Zanazzi (zanazzi@cittadellascienza.it). There are only three planetaria of 10 meters or more in Italy at this time.

Other interesting planetarium projects include Science Centers to be opened in Rome and Turin, the Florence planetarium that is going to move from the History of Science Museum to a new site and the renovation of the Milan Planetarium, that remains the biggest planetarium in Italy.

Our International Collaboration

We have been coordinating a “Day of Planetaria” that has been held in different countries yearly since 1995; Italian planetaria have been involved in this project since 1991. This initiative is an important opportunity for involving the international community in a collaboration that aims to increasingly promote knowledge of planetaria to the public. The next “Day of Planetaria” will be held on March 16, 2003.

The following are our suggestions to institutions that can take part in the “Day”:

1. Links to all planetaria that participate in this project are listed on the science web pages of the site http://www.cityline.it

Planetaria that are usually open on Sundays are invited to collaborate with the “Day” by indicating their interest to the Italian Planetariums’ Friends Association. They can then send the address of their homepage; we will create a permanent link between their site and “http://www.cityline.it”.

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We also suggest that planetaria create a permanent link to our site on their own website. A representative in each country could also collect a list of activities and programs of this special “Day of Planetaria.” In Slovakia, for example, such programs are collected by Patricia Lipovska and then reported to the Italian Planetariums’ Friends Association.

2. During the “Day” planetaria can offer their ordinary program or organize special events (such as lessons, shows, exhibitions, practical sky viewing and so on) that are low cost or free to the public. Obviously during the events (monthly, weekly or daily programs you chose to provide) we suggest that you indicate that “March 16th, 2003” is the annual “Day of Planetaria” and that it is celebrated in many different countries on the same date. It is not necessary to make a big effort in order to be able to join us in the celebration of the “Day.”

3. In the leaflet that describes your own planetarium program or in a special leaflet printed for the “Day”, planetaria are invited to reproduce the logo of the “Day of Planetaria” (available at the already mentioned internet site).

4. During the “Day” the entrance to some planetaria is free.

5. We are inviting all planetaria, not only the European ones, to take part and to support the “Day.” This “Day” could also be held in conjunction with celebrating an event that is unique to your planetarium. For example, anniversaries of planetarium buildings, or openings, or ceremonies to honor past directors or special lecturers could be celebrated as part of the “Day.”

6. This initiative provides a good chance for diffusing the knowledge of planetaria to the public at large. Mass media attention is attracted to this event because it is held in many cities around the world. Obviously each planetarium is invited to send “press releases” to local media indicating that March 16th, 2003 is the “Day of Planetaria”.

7. The junior section of the site devoted to the “Day of Planetaria” contains a permanent exhibition of children’s astronomical drawings.

   We suggest that planetaria send us a copy of one or more of the best children’s drawings collected in the past few years or to select the best drawings of young visitors to the planetarium in the last few months. Original drawings will be sent back afterwards.

   In the future, we hope that other countries will join in this initiative. For further information or suggestions you can contact us at: Associazione Amici dei Planetari, c/o Centro Studi e Ricerche Serafino Zani, via Bosca 24, 25066 Lumezzane (Italy), fax 30/872545, e-mail: info@serafinozani.it.

**Conclusion**

Only the most essential and specific details of our initiatives have been described here. We have shared our suggestions concerning activities and ideas of collaboration between planetaria from different countries.

We explained our attention to activities of international collaboration that do not sound particularly exciting, like a “staff exchange” or like planetarium shows that are produced through the efforts of other planetaria.

Therefore, these are simple but deeply touching initiatives that are listed. Those efforts can encourage contacts, visits and cooperation between the domes and are supposed to be long lasting. These represent ways to pay attention to the possibility of hosting foreign colleagues or to encourage their involvement in meetings, workshops and special initiatives. These also can be ideas that can increase our contribution, as an IPS Affiliate, in the common house of the International Planetarium Society.
Storytelling In Starlab (Workshop)

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Abstract

Storytelling is an integral part of the planetarium experience. The retelling of many ancient mythological legends can be a wonderful way to show how humans have always sought connection between themselves and the earth and sky. Stories will be presented on Native American sky lore and the possible origin of the earliest constellations.

For this workshop I would like to present some of my favorite stories as I tell them during my programs. I often begin programs by pointing out the Big Dipper and the Great Bear and explaining that as you become familiar with the sky the best thing to do is to learn the easy constellations and use them to find other less obvious pictures in the sky. This frequently leads into a discussion of the possibility that the Great Bear in the sky may be one of the first constellations to ever have been formed in the mind of humans and be placed into the sky. As described in a Sky and Telescope article by Dr. Alexander Gurshtein (June, 1997) Ursa Major may have been created as long as 30,000 years ago by cave dwelling paleolithic peoples. Over the ensuing millennia these cave dwellers took the bear in the sky with them as they migrated to many different parts of the world. This may explain why some very distant cultures in Siberia and Alaska as well as the ancient Greeks see a similar creature in the same stars. This discussion easily leads into one of my favorite planetarium stories of the Kiowa legend of the origin of Devils Tower and the Big Dipper. This story depicts a beautiful connection between the Kiowa, the land, and the sky. As with so many mythological stories there are many variations. The Kiowa story I tell comes from the book The Way To Rainy Mountain by N. Scott Momaday.

Using the Starlab Native American cylinder I will also tell some Navajo and Shoshone stories of the sky. This cylinder lends itself to some wonderful stories. The Native American cylinder, unlike some of the other mythological cylinders, is not so busy and several stories from different tribes can be tied together - linking up the entire sky. Beginning with the Navajo creation story I eventually lead into a milky way creation story of the Shoshone. This story is known as How Grizzly Bear Climbed Into The Sky, which I learned from the book Keepers of the Night by Michael Caduto and Joseph Bruchac.
Comprehending The Universe

Big Bang by William Stafford

A shudder goes through the universe, even long after. Every star, clasping its meaning as it looks back, races outward where something quiet and far waits. Within, too, ever receding into its fractions, that first brutal sound nestles closer and closer toward the tiny dot of tomorrow. And here we are in the middle, holding it all together, not even shaking.

Hard to believe.

When William Stafford wrote this poem (at age 80, two weeks before his death in 1993) he was doing something very similar to what planetarians try to achieve everyday: gain a sense of how humans fit into the universe and share it with others. Poetry attempts to explain the experience of being alive in a world that science attempts to describe. As new information is gathered and the story of science evolves poetry continues to help us comprehend the ever more bizarre nature of the universe. Poetry can help remind us of the wonder we find living in the universe and why we went into the planetarium business in the first place.

The amount of poetry that describes, tries to explain, or in some way relates to the stars, the sky, or humanities place in the universe is staggering. Throughout recorded history perhaps every person who has ever written poetry has at some time written about the sky. Shakespeare often referred to eclipses, the sun and moon, and the stars in his poetry and plays. Emily Dickinson wrote a poem entitled Arcturus. Edgar Allan Poe was one of the first people to offer a correct solution to Olber’s Paradox in his wild treatise Eureka-A Prose Poem written in 1848; this remarkable work also anticipated an expanding universe. We should never forget Walt Whitman who constantly reminds us to be on our toes with his Learn’d Astronomer poem.
Uses of Poetry

Poetry can be used in the planetarium in endless ways. In my portable I offer a program called Poetry In The Planetarium. The entire program is fashioned around the reading of poems about the sky, while also describing the night sky at the time of the show. I also recently presented a workshop at a statewide festival of Colorado poets. The planetarium, especially the larger venues, can provide a dramatic setting for a guest appearance by a local or regional poet reading under the stars.

Poetry can also be used as an educational tool to teach about the sky. And it can be a very educational and fun activity to try to write your own astro-poetry. I sometimes use my poems to begin or end a program or to introduce specific topics. My poem A Walk In The Sky is fun with young students and encourages them to begin looking at and thinking about the sky. I often use my poem I Am Orion to introduce a program about Orion and the winter sky.

A Walk In The Sky

I went for a walk in the sky.
Why? Oh why,
Did I go for a walk in the sky?
I wanted to have a good look around.
I wanted to find what could be found.
I went with my friend Jack the hound.
I went for a walk in the sky,
And my feet never left the ground.

I went for a walk in the sky,
You can go for one too.
Open your eyes, shake your feet,
And do the space walk boogaloo.
It’s so easy if you just look up,
See there! Seven stars shaped like a cup.
There’s a horse with wings and a lion,
Swimming fishes, and Orion.
There’s an eagle, a swan, and a crow,
All flying up so high,
Waiting to meet you, when
You take a walk in the sky.

Go ahead and take a chance
Anyone can do the space walk dance.
No matter how big or small your girth,
No matter the year of your birth,
We are all astronauts
Traveling on Spaceship Earth.

I Am Orion

I am Orion.
I have known you longer than you’ve known me.
I saw your desert fires burning
in the hills east of Galilee,
when you turned your eyes skyward
and finally found Me.
I am Orion.
I once lived upon your land
I swam across the oceans,
in the fields I was a Hunter so grand.
So many adventures I had at that time,
I danced with Diana
till I was wounded and blind.
I wandered east into the rising sun’s glare.
I screamed to old Helios,
I screamed a dare.
Into his rising I gazed with a stare.
I challenged the Gods
for I knew that I could.
But in my triumph on the Scorpion I stood.
So I was banished above to the sky.
For living too fully?
I still wonder why.
I am Orion.
The bully, the brawny, the bragging one.
My right shoulder laughs at your little yellow sun.
I’ve got a knife. I’ve got a club.
I’ve got a shield that drips the lion’s blood.
I’m heading west now with my own charioteer,
I have my two dogs and I’m traveling with no fear.
No raging bull’s gonna stop me,
I’ve got a thousand fires in my heart and I’m down on my knees.
If it’s the last thing I do I will catch those Pleiades.
I am Orion.
I rise in the east when the cold winds blow.
At the end of your feast see my belt stars aglow.
I am a constellation traveling the sky so true.

Look, I’m home to red stars and blue, and the wondrous nebula M-42.
I hide the Horse’s Head and wouldn’t you like to see, all the Mysteriies inside of Me.
I wish, I wish you could see the view from here.
My telescope has a focal length of one entire light year.
I can see Everything so very clear:
I saw your Ancient Ones Arrive and Disappear, scattered like dust across your shiny blue sphere.
I see you still with your Pomp and Circumstance, as I behold your journey through Life’s Great Dance.
I am Orion.
I have known you longer Than you’ve known me.

Looking for a way to enliven a program or reinvigorate yourself? Having difficulty explaining the inexplicable? Trouble comprehending the incomprehensible? Try some poetry.

Sources
Poems about the sky by individual poets appear in innumerable books and magazines. Chris Impey, an astronomer at the University of Arizona, wrote an article in the Astronomical Society of the Pacific’s Mercury Magazine (Volume 30, Numbers 1&2) entitled, Reacting to the Size and Shape of the Universe. This excellent article discusses how writers and poets have attempted to make sense of the universe. Collections that include poems specifically about the sky that I have found include:


Introduction

A popular introductory activity to do with students is building a scale model of the solar system. Instructions for such activities are found in many texts and teacher guides (Broman 1986; Coyle et al. 2001; Colby et al. 1998). A large list of websites describing scale models is available online at http://www.voyageonline.org. Models in public spaces have been built by many science museums, including a new one on the National Mall in Washington, DC, developed by the Smithsonian, NASA, and the Challenger Centers (see http://www.voyageonline.org/). Because of the large distances modeled, such scale models require relatively tiny diameters when compared to interplanetary distances. These demands mean that many teachers find it difficult to use the same scale for both the diameter of the planets and their distances. Making non-scale models, with different scales for diameters and distances, often makes matters worse, confusing students more, rather than dispelling misconceptions.

The most egregious issues are reported on in these studies:

• A study of 24 second-grade students in 1982 found that boys and girls did not have a significant preference for the Sun being larger than the Earth (Klein 1982), even though the Sun is roughly one hundred times larger in diameter and one million times larger in volume.

• Among 200 eleven- to thirteen-year-old Italian students interviewed, there was no distinction between stars and planets in the sky (Loria et al. 1986). A survey of 1,414 students found that roughly half of high school students believe that there are stars (other than the Sun) in our solar system, interspersed with the planets (Sadler 1992).

• Roughly 75% of 1,414 students imagine the Earth orbiting closer than its 100 solar diameters from the Sun (Sadler 1992).

These misperceptions of the relative sizes and distances within the solar system play out in ways that inhibit understanding of more...
sophisticated astronomical concepts (Sadler 1998). For example, most students and adults, as well as some teachers, think that the Moon’s phases are caused by the shadow of the Earth obscuring part of the Moon’s face, essentially a monthly lunar eclipse (Keuthe 1963; Cohen 1979). This would make a great deal of sense were the Moon only a few Earth diameters away from the Earth. Eclipses would indeed occur every month and last for many days. Learning about the actual scale sizes and distances helps to dispel this misconception, since eclipses actually last for only a few hours. In addition, most people think that the Sun and Earth are relatively close to each other and that the Earth moves in a highly elliptical orbit, resulting in the seasons (Touger 1985; Furuness and Cohen 1989). Discovering that the Earth’s orbital radius varies little helps to convince learners that the explanation for the seasons that does not involve changing Earth-Sun distance.

### Constructing a Scale Model

The key feature of this new scale model is that it can be duplicated by computer on a laser printer with all planets visible to the naked eye. Typically printers can reproduce at 300 dpi, although those with a resolution of 1200 dpi are becoming increasingly popular. The limiting object in the solar system is the planet Pluto, with a diameter of 1,412 miles. If Pluto were to be represented by a single pixel at 300 dpi, its scale distance from the Sun would be 700 feet, larger than most athletic fields. Also, a single pixel may not reproduce reliably. Moving to a 1200 dpi printer and using a Pluto image of 2x2 pixels, the scale distance to Pluto shrinks to 354 feet with a solar diameter of 1.0”. This is a very convenient scale of approximately 1”:1,000,000 mi. (or 1:5x10^10 in dimensionless units).

The diameter, distances, and incremental distances at this scale are shown in the table below. Images of the Sun and larger planets were taken by students using the MicroObservatory telescope (Sadler et al. 2001). These images are available over the web at [http://mo-www.harvard.edu](http://mo-www.harvard.edu). Each image must be shrunk to the proper size to produce an accurate model.

<table>
<thead>
<tr>
<th></th>
<th>diameter (km)</th>
<th>diameter (mi)</th>
<th>dist from Sun (km)</th>
<th>dist from Sun (mi)</th>
<th>scale size (in)</th>
<th>scale distance (ft)</th>
<th>feet farther</th>
<th>scale distance (m)</th>
<th>meters farther</th>
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<tbody>
<tr>
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<td>1,391,900</td>
<td>864,534</td>
<td>-</td>
<td>-</td>
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<td>3,022</td>
<td>57,950,000</td>
<td>35,993,789</td>
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<td>108,110,000</td>
<td>67,149,068</td>
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<td>149,570,000</td>
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<td>13.6</td>
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<td>29,155</td>
<td>2,870,300,000</td>
<td>1,782,795,031</td>
<td>0.034</td>
<td>171.8</td>
<td>86.4</td>
<td>52.4</td>
<td>26.3</td>
</tr>
<tr>
<td>Neptune</td>
<td>45,432</td>
<td>28,219</td>
<td>4,499,900,000</td>
<td>2,794,968,944</td>
<td>0.033</td>
<td>269.4</td>
<td>97.6</td>
<td>82.1</td>
<td>29.7</td>
</tr>
<tr>
<td>Pluto</td>
<td>2,274</td>
<td>1,412</td>
<td>5,910,000,000</td>
<td>3,672,670,807</td>
<td>0.002</td>
<td>354.0</td>
<td>84.6</td>
<td>107.9</td>
<td>25.8</td>
</tr>
</tbody>
</table>

**Table 1. Actual and scale sizes and distances in the solar system**

The model described can be printed on ordinary paper or upon peel-and-stick labels. I prefer Avery 1616 white labels with 1” diameter circles. These come 15 to a small page, of which the current model uses only 10 circles and 5 circles remain unused. Each package has 40 of these 15-circle sheets and cost me $4.79 per package or 12 cents per model. I had some difficulty in properly spacing the images and needed about an hour to adjust each image properly in the center of every circle. Using a word processor is difficult for this purpose. I found that by using a spreadsheet program (Excel 98) and leaving columns and rows between each set of cells containing images, I could make adjustments fairly easily. I printed on paper until I had a satisfactory image and then ran my set of stickers. Although colored images
would be more attractive, my 1200 dpi printer only outputs in black and white. The image is shown in Fig. 1. I am not sure of the quality that can be seen here, but interested readers can get a copy by emailing me at psadler@cfa.harvard.edu.

Figure 1. Reproduction of the peel and stick solar system.

When constructing a scale model with students, it is useful to point out that angular relationships are preserved. The Sun looks just as big from the Earth in the scale model as it does in the real sky (less than a finger-width wide). One should also point out that the planets are not really arranged in a straight line, but are distributed in pretty much a plane around the Sun.

One, of course, can construct models of other astronomical systems in a similar way. My colleague David Aguilar suggests the inclusion of the next closest star, Proxima Centauri (0.2 inches in diameter and 171 miles away at this scale). While our neighboring star will not fit on an athletic field, including it helps to dispel the notion that there are stars other than the Sun in our solar system. Other models that could be built are our local group of galaxies including the Large and Small Magellanic Clouds, nearby globular clusters, and the Andromeda Galaxy. My colleague Hal Coyle thinks that including questions about each planet or additional facts on each sticker could interest more students in the model.

Summary

Building scale models is an important and useful activity for learners. Most people have ideas about relative sizes and distances in astronomical systems that are incorrect. These misconceptions impact their understanding of more sophisticated concepts such as the causes of lunar phases and the seasons and the feasibility of space travel to other solar systems. Learners are often very familiar with accurate scale models from building their own replica models or playing with dolls and action figures. Beginning with scale models of astronomical systems is recommended before moving to nonscale models so that learners have a reference with which to compare less accurate models. Using familiar quantities to set up models (feet, inches, paces, etc.) and ratios (e.g., the Earth is 100 solar diameters from the Sun) helps people relate to and be able to reproduce the models that they build. Producing scale models on a high resolution printer allows all learners to construct their own miniature universes at home, where they have more time to inspect and reflect on the model’s ramifications.
Acknowledgments

Thanks to my colleagues David Aguilar, Mary Dussault, Roy Gould, Bruce Gregory, Marcus Leiberman, Bill Luzader, Sam Palmer, and Irwin Shapiro for their thoughts and insights concerning scale models. Hal Coyle aided in editorial review and through his extensive classroom and curriculum development experience. This work has been supported by the National Science Foundation, the Smithsonian Institution, and the NASA Universe Forum.

References


A New Door for Science Education: the Museum Aerospace Education Alliance, a Partnership with NASA

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Abstract

The Museum Aerospace Education Alliance is a new collaboration between NASA, the Association of Science and Technology Centers (ASTC), and several science centers and museums. Members of this collaboration will work with NASA engineers, scientists, program managers and mission planners. The goal: to develop programs and exhibits for science center and museum communities.

The first meeting of the Museum Aerospace Education Alliance was held at the Goddard Space Flight Center in Greenbelt, Maryland in early April 2002. The mission of MAEA: “to support education excellence in Earth Science, Space Science, Biological and Physical Research, Human Development and Exploration of Space and Aerospace Technology in America’s science center and museum community”. In a nutshell: the alliance wants to find ways for those of us in the museum and science center field to work with NASA more efficiently.

Attending the meeting were staff from NASA, from ASTC, and from five science centers and museums which have had long-term relations with NASA. These museums include the Bishop Museum (Hawaii), the St. Louis Science Center, the Denver Museum of Nature and Science, the Maryland Science Center, and the Center for Science and Industry (COSI) in Columbus, Ohio.

NASA staff attending this meeting included:
- Frank Owens, Director of NASA Education Division
- Pam Mountjoy, Informal Education Program Officer
- Nora Normandy, Outreach Officer, Public Affairs
- Debbie Brown, Education Specialist

Bonnie Van Dorn, the Executive Director of ASTC, attended all sessions, as did Sean Smith, Director of Government relations for ASTC.

The CEOs of several of the five museums attended this meeting. A number of other staff from the five museums attended as well, including several staff who are currently active in the planetarium field. These included James O’Leary (Director of IMAX/Planetarium at the Maryland Science Center), Terri Gipson (Associate Director of Science and Galleries, St. Louis Science Center), and Mike Shanahan.

The overall aim of the meeting was to develop ways in which NASA, ASTC, and science centers can work together more efficiently in planning exhibits and programs. For example, the alliance will provide streamlined ways to connect exhibit and program developers with the appropriate NASA scientists and mission operations staff. In general, a major goal of this alliance is to provide ways to hook up aerospace educators with the right people at NASA.

MAEA also hopes to work with NASA in providing “early warning” and press/AV materials.
for the major NASA missions. If the “product” of NASA can be thought of as its wide array of missions-Mars rovers, shuttle flights, satellites, ISS, etc.-then the alliance can make it easier to get these products to our museum and planetarium customers. This is something that has already been done in areas like Anita Sohus’s slides and guides to various JPL missions (the Eros landing, the Mars Odyssey) and John Stoke’s work with the Hubble Space Telescope. These programs are good models for what the MAEA would like to achieve.

Other elements of this alliance include:

* Meetings (at least once a year) between MAEA members and NASA staff to gain a better understanding of recent discoveries and to get plugged into upcoming NASA missions.
* Dissemination of such materials through a MAEA web page.
* An online bank of materials: demonstration scripts on aerospace topics, education activities, science theater productions, etc.
* A lecture at the annual ASTC conference by NASA scientist.
* A guide to who you can call at NASA to get help right away for whatever project/mission/etc.
* Support for the big events (Astronomy Day, Space Day, etc.) in terms of early warning and in terms of materials provided by NASA. From the discussions at the April 2002 meeting, it was clear the launch of the Mars Rover and the Centennial of Flight were among the biggest NASA-related events of 2003.

One exciting idea discussed in the MAEA planning meeting is the proposal to have an ASTC person actually assigned to the NASA Education Office. This position would be at least a one-year position (two years would be very beneficial, but perhaps not practical for the staff involved) which would rotate among staff from the science center community. The position would be in Washington DC, working closely with staff from the education office.

There are also plans to fly a set of activities and experiments on a 2003 space shuttle flight. These activities will be developed by staff from all five of the museums involved in the Museum Aerospace Education Alliance.

The alliance will also be a channel for providing information back to NASA in terms of technology needs (for an on-line image), information needs and program needs. Brief surveys will be distributed to staff attending both the IPS session on the MAEA program, and to those attending the ASTC session in October 2002 at Discovery Place, NC.
NRAO & Planetariums

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Abstract

The National Radio Astronomy Observatory (NRAO) is a research facility of the National Science Foundation operated by Associated Universities, Inc. The NRAO provides state-of-the-art radio telescope facilities for use by the scientific community. We conceive, design, build, operate and maintain radio telescopes used by scientists from around the world. There are studies of virtually all types of astronomical objects known, from planets and comets in our own Solar System to the most distant quasars and galaxies. With facilities in four states, NRAO includes among its operating telescopes, the Green Bank telescope in West Virginia, the VLA in New Mexico, the VLBA remotely controlled from New Mexico, and the Atacama Large Millimeter Array being built in Chile. The NRAO is seeking partnerships with science museums, which I interpret to include planetariums and I am seeking your input as to the most effective ways the NRAO can assist your operations.

Some of you probably associate NRAO, the National Radio Astronomy Observatory, with Green Bank or the VLA, but it includes both and more. I would like to give you an overview of the NRAO and request your input as to how we can best help the planetarium community, other than as a source for funds.

The radio astronomy window, of course, is that other window, besides the visible spectrum viewable via our eyes, which the Earth’s atmosphere also allows to penetrate to the surface. Radio astronomy came into prominence as astronomers belatedly realized that there was a wealth of radio sources out there, principally non-stellar, that were sending us energy and information.

Karl Jansky's work for Bell Telephone Laboratories in 1931 and 1932 led to the discovery that one of the sources of radio interference for transatlantic communications was from the direction of the Milky Way’s center. In 1937, Grote Reber began mapping the principal sources of radio emission in our galaxy. With the end of World War H, radio astronomy grew rapidly and by the beginning of the 1950s was being studied in several locations in the United States. Eventually astronomers requested that the National Science Foundation, NSF, establish a national radio observatory at which cutting-edge instruments could be developed for the benefit of astronomers throughout the world. In 1956 the NRAO was founded as an NSF facility, operated under a cooperative agreement by Associated Universities, Inc. (AUI founding universities were Columbia University, Cornell University, Harvard University, The Johns Hopkins University, Massachusetts Institute of Technology, the University of Pennsylvania, Princeton University, the University of Rochester, and Yale University).

Green Bank's first telescope, the Tatel 85-foot, was completed in 1959. The 300 foot telescope was completed in 1962, followed by the 140-foot telescope in 1965. In the mid-1960s, the administrative headquarters of NRAO were moved to Charlottesville, Virginia on the western edge of the University of Virginia campus. The Observatory's newest telescope, the Robert C. Byrd Green Bank Telescope, GBT, achieved first light on August 22, 2000. This telescope is the world's largest, fully steerable, single-dish, radio telescope. At 148 meters tall,
the GBT is taller than the Statue of Liberty and the surface of its dish measures 100 by 110 meters. The GBT is an unusual design with an off axis feed arm, so that the receiver is not in the incoming ray path, and eliminates reflection and diffraction that ordinarily complicate a telescope’s pattern of response.

The Very Large Array, VLA, located on the plains of San Augustin, west of Socorro, New Mexico, one of the premier radio telescopes in the world, is an array of 27 radio antennas in a Y-shaped configuration. Each antenna is 25 meters in diameter. The data from the antennas is combined electronically to give the resolution of an antenna 36 kilometers across, with the light gathering-power or sensitivity of a dish 130 meters in diameter. It was formally dedicated in 1980 and as most of you know, starred in the movie Contact, which was released in 1997. Something we don’t seem to hear very often - the project was completed within budget and nearly one year early. The VLA can be used in 4 configurations. In the largest “A” configuration, the antennas extend over the 21-kilometer length of each arm. This simulates a single dish that is 36 kilometers in diameter, where we have the most magnification and can see the greatest detail. In the smallest “D” configuration, the antennas are all within 0.6 kilometer of the center. In this configuration, we can study the overall structure of the source being observed. An expansion of the VLA, called the Expanded Very Large Array, EVLA, is underway. When completed it is anticipated it will be ten times better than the VLA.

The Very Long Baseline Array, VLBA, is a series of ten radio antennas spread across the United States and its territories from St. Croix, the Virgin Islands, to Mauna Kea, Hawaii. The array operations center (AOC) is located in Socorro, New Mexico. The ten antennas are each 25 meters in diameter and the longest baseline is 8,600 kilometers. The first observations involving all ten antennas occurred in 1993. The VLBA is the world’s largest dedicated, full-time astronomical instrument. Its highest resolution is better than one milli-arcsecond, about the precision equal to being able to read a newspaper in held in New York from the distance of Los Angeles.

One of the newest projects is the Atacama Large Millimeter Array, ALMA. This is an international collaboration involving the NRAO to develop and build a state of the art radio telescope for millimeter and sub-millimeter wavelengths. Current plans call for 64 12-meter antennas. Like the VLA the array will be moveable; at its largest spread 14 kilometers wide and at its smallest spread only 150 meters. The array is destined for the Atacama Desert in Chile one of the driest places on Earth, to eliminate atmospheric moisture, which absorbs photons of these wavelengths. This site is 5,000 meters high in the Chilean Andes, higher than the highest peak in the continental United States. Much of the project staff is currently based in Tucson. Astronomers hope to use ALMA to study galaxy formation from the beginning of the Universe to the present and to capture images of stars and planets forming in our own galaxy.

In addition to these observing facilities, NRAO also operates its Central Development Lab (CDL) in Charlottesville, Virginia. This is where many of the tiny and sophisticated electronic devices that are the heart of these telescopes are developed. The CDL designs, builds, and rigorously tests the central components for radio astronomy. The NRAO along with the Netherlands Foundation for research in Astronomy, the Berkeley-Illinois-Maryland Association, the Australia Telescope National Facility, and the U.K. Jodrell Bank Observatory … MERLIN/VLBI National
Facility have designed and maintain a system for processing data from both single-dish and aperture synthesis radio telescopes, called AIPS++ (Astronomical Information Processing System).

Visitors are welcome at both the VLA Visitor Center off U.S. Highway 60, about 50 miles west of Socorro, New Mexico and at Green Bank. Tours of the Green Bank site are regularly offered from Memorial Day through Labor Day. At Green Bank, a Visitors Center is currently under construction and scheduled to open at the end of this year. For more information check out the NRAO website at http://www.nrao.edu and please add it as a link on your website.

Currently NRAO is seeking to enrich its education and public outreach efforts. As part of that effort I am seeking input from the Planetarium community as to what information, images, data would be most useful to you both for show production efforts and other educational endeavors? What format for this information would be most practical for you? Once you’ve had a chance to see the website, please tell us or me, what you thing works best. And what you most like to see changed or added to our website?
Domes – A Critical Element of Projection

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Abstract
Domes are a critical element of the projection system for every planetarium. As the largest optical element of any dome theater, and with the introduction of brighter and higher resolution displays, dome screens play an increasingly critical part to the success of the planetarium display system. Understanding their performance with regard to gain curves, how they work with various projection locations, and audience volumes is important. In addition, other elements of the dome screen such as catwalk access behind the screen, seaming techniques, acoustic properties, cleaning and other maintenance, as well as various support options need to be considered. Older domes can benefit from upgrades as well. Many prospective planetariums spend a lot of time researching and comprehending dome projection systems and instruments, without optimizing the characteristics of the largest optical element – the dome screen.

Introduction
Domes have always played an integral part in the role of planetariums. They are as important to the system as the optical instruments or video systems that get scrutinized to the last detail. Since the dome is yet another optical element in the system, it is important that they are well understood. It is essential for anyone who is planning for a new planetarium or upgrading an existing system to understand the performance and options for domes. Consideration needs to be given to the proper selection of the optical surface, acoustic considerations, access behind the screen, support options and maintenance.

Optical Performance
The most important consideration for any dome is the optical performance of the screen surface. The basic principle of any dome screen is to reflect the images projected onto it with as much brightness, contrast and true color preservation as possible. The brightness of an image on a dome is a function of the projection source and the reflectivity or gain of the dome. Since dome screens do not add or use energy, brightness is a matter of how the dome distributes the light. Overall brightness of a display is a result of the projection equipment selected. The role of the dome is to reflect the light from the projection equipment back to the audience. Gain numbers, or more accurately – "gain curves" provide the necessary information for determining how a dome will reflect the light. By definition, Gain is a unitless number that is determined by measuring the light reflected from any sample in Foot-Lamberts, and comparing it with the same measurement from a lambertian sample (unity gain). The ratio of those two numbers is the gain. This measurement is
performed on a device known as a photogoniometer. [Figure 1].

Dome gains are usually referred to as a single number. This number represents the gain of a sample at zero degrees incidence and zero degrees reflectance. A much more important and accurate consideration for a dome’s optical performance would be the curve generated by an incidence angle (projection angle) and the entire considered reflectance angles of the audience volume (audience location) [Figure 2]. A whole family of curves can be generated through the utilization of various incidence angles in conjunction with the reflectance angles [Figure 3]. This curve will determine how evenly the light is spread throughout the theater space. Often people consider that a higher gain curve will provide a brighter image. Domes cannot add any energy to the image, it can only distribute the energy, or reflected light and the gain curve of an optical coating indicates how the dome will perform.

A higher gain will give a higher brightness at the zero degree incidence, zero degree reflectance, but at the expense of other areas of the theater [Figure 2]. Very high gain materials, while very bright in some areas will render other areas of a typical theater volume less bright than a low gain material which gives an even distribution of light across the area. In addition, because of the basic geometry of a dome theater, secondary reflections, often referred to as cross-bounce will have the effective result of reducing contrast.
Lower gains will help to yield higher contrast by limiting the secondary reflections (brightness and contrast are inversely proportional). Typical Imax theaters utilize gains of 0.38 to 0.45 depending on dome size. Most planetariums operate with gains of 0.45 to 0.55. Over time, many optical coatings have been examined for their utilization as reflective surfaces. Products from paints, to vinyl laminates to lenticular surfaces have been scrutinized for their practical application and their optical characteristics. Typical optical coatings are either factory applied through an automated, controlled process (powder coating) or painted by hand spraying on-site. Powder coating has the advantage of lab-controlled customized formulation, repeatability, durability and ease of cleaning.

**Acoustic Considerations**

Virtually all modern planetarium domes are provided with perforated panel construction. The purpose is two-fold. One reason is to provide acoustic attenuation and transmission. Just about everyone knows that a solid dome theater would provide a difficult acoustic environment for the audience. Sound from inside the theater, either from the audience or from other sound sources, would reflect back to the audience and provide a cacophony of sound. By providing a perforated screen surface, the sound is allowed to transmit through the dome to be absorbed by acoustic insulation on the backside of the dome. Acoustic studies show that the percent of the void area should be greater than 20% to avoid an acoustically reflective surface. Most dome manufacturers utilize a standard 23% void perforation pattern. Additionally, sound can be projected through the screen surface because of the perforations. This allows the sound from the show to come from the projected image rather than from a disorienting location such as under the dome, or from the back only. While the percent of the void area plays a role here, a more critical parameter is the thickness of the dome panel. Thinner panels allow a better transmission of the whole spectrum of frequencies. An additional benefit of perforated panels is the ability to allow airflow for the HVAC (Heating, Ventilation, and Air Conditioning)
system. In this manner, HVAC systems can provide the supply of air on the backside of the dome, allowing it to pass through the dome, and provide the return of the HVAC system on the audience side of the dome.

Access to the Dome

Access behind the dome is typically required for theaters that have speakers mounted on the dome structure, certain special effects projectors, alignment points, or for maintenance. The decision for the type of structures to be utilized is based on the type of access necessary (minor adjustment vs. major equipment changes), number of locations that require access, frequency of access, and building considerations. Catwalks are utilized for areas that require frequent access and/or major maintenance (speaker change out). An example of a catwalk is provided in figure 4 [Figure 4].

Another method of access to the back of the dome is a rotating ladder assembly. This is typically provided by using a radiused ladder, slightly larger that the outer diameter of the dome, and providing a rotating bearing assembly at the true zenith of the dome [Figure 5—next page]. Additional tracks at lower locations of the ladder allow further support through rolling wheel assemblies. Rotating ladders can provide access to most or all of the dome area, however they do not provide adequate support and room for major maintenance.

Support Options

When considering a dome with new construction, several support options need to be considered. Fundamentally, there are two (2) options, either hanging support from above, or base support from below. Hanging support [Figure 6—next page] provides the distinct advantage of an unencumbered area below the dome basering (structural ring at the base of the dome). This

Figure 4.
makes the space available for an open and flexible projection gallery. Further, by utilizing the basering as a support for projection equipment [Figure 7—next page], the area below the dome base is greatly simplified. The downside to the hanging support is the need to provide a roof structure suitable to provide loading considerations for the dome structure, catwalks, projection equipment, etc. The other option of a base supported structure [Figure 6] is the need for a support wall or a support ring that will provide some limitation to projector placement. Proper planning in the design phase with the projector supplier, dome supplier and architect will reduce the probability of interference. Either a continuous wall or ring beam is supplied or alternatively a stiff enough basering on the dome can allow for point loading through individual columns to the floor. The advantage of a base supported structure to the building designer is the easy loading to foundation structures as opposed to the roof structure.
Seaming Techniques

In order to provide a truly spherical surface, a projection dome is manufactured from discrete panels that are stretch formed to a compoundly curved die. The die is a wooden or composite form that is the shape of a section of a sphere. In order to provide a “solid surface” under projection, the panels are stitched together through various “seaming” techniques. These techniques vary, but typically involve an overlap at the seam, and special techniques to avoid too much build up of panel material at the corners. Some seaming techniques involve a “butt seam” where the panels do not overlap, but are butted together. What is important is that the seaming not be visible during projection.

Maintenance

Over time every dome will get dirty. Sometimes something more major will occur such as a damaged panel, or stains from a leaking roof. Dome screens should be cleaned on a regular basis to prevent the seams from becoming visible, as well as to keep the optical performance of the dome up to its original performance. If the dome was installed in a clean environment, and if the HVAC filtration system is maintained, domes can be cleaned from normal dust and dirt through a vacuum method. This can be accomplished from the rear side of the dome by an experienced technician skilled in climbing the dome and utilizing a backpack vacuum. Normal dust and dirt will pull through the perforations to the back of the dome, yielding a clean dome on the projection side. Other materials that will require cleaning methods other than vacuuming will need to be cleaned from the front of the dome utilizing solvents or other cleaners. Epoxy powder coatings are inert to just about any solvent and can be cleaned without damage to the optical surface. Proper maintenance of a dome will keep the system operating with its intended brightness and contrast.

Occasionally spare panels will be required should a dome panel ever become damaged. Panels that are pre-finished at the time of manufacture of the dome will match original panel finishes. These spares can be changed with any damaged panel to restore a dome to its original condition.

Conclusion

For either new construction or a refurbished theater, the theater designer and the end user need to consider all aspects of the dome. This includes not only the optical properties, but support options, seaming techniques, access, and maintenance. The dome screen should not be the weak link to the rest of the projection equipment.
Principles of Immersive Imagery

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Abstract
A discussion of practical ways to design effective imagery and content continuity for immersive dome screens. Develops a philosophy of immersive imagery by comparing and contrasting small framed images with giant immersive projections, and provides a toolbox of approaches to produce for these new screen spaces.

Books
The Power of the Center by Rudolf Arnheim - University of California Press 1988

Film As Art by Rudolf Arnheim - University of California Press 1957


Articles


Essays on Immersive Design
By Ben Shedd

Exploding The Frame
http://www.cs.princeton.edu/~benshedd/ExplodingtheFrame.htm

Designing for the Dome
http://members.aol.com/sheddprod2/papers.html#the%20Dome

Designing Effective Giant Screen Films
http://members.aol.com/sheddprod2/papers.html#Designing

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The Filming of “Ocean” in Omnimax.


Live Versus Taped: Audience Reaction to our Shows

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Abstract

We have surveyed our audiences on their reactions to our shows for several years. While all of our shows have some live components, our night sky show has the most extensive live component, and consistently surveys much higher than any other show, once seen. However, attendance numbers for our other shows tend to be higher. What do the people really want?  

We’re trying a new experiment this fall; specific show titles, but a significant live night sky portion to all of our shows.

We have surveyed our audiences on their reactions to our shows for several years. While all of our shows have some live components, our night sky show has the most extensive live component, and consistently surveys higher than any other show, once seen. However, attendance numbers for our other shows tend to be higher. What do the people really want?

I will be presenting information on our evaluations, our attendance numbers for some specific shows, and our conclusions and attempts to deal with those conclusions.

QUALIFIER

This is not an attempt to define or promote live shows or taped shows, or even an attempt to quantify the value of interactive shows. All of our shows are a mixture of the two, with varying amounts of live presentation and degrees of interaction. Some of our shows that are 80% live can contain very little audience interaction, depending on the audience and the presenter. Other shows that are only 20% live are highly interactive. However, you are feel to draw your own conclusions from the information I will provide.

TYPES OF SHOWS BEING COMPARED

1. Night Sky Show

Since the Arizona Science Center opened, we have been giving a live night sky show daily. This show has always concluded with a very visual “extravaganza” set to music; occasionally the show presenter throws in some descriptions of what the audience is seeing. It has also occasionally included a prerecorded “mini-show” of up to 10 minutes, at the beginning of the presentation. This show has been given at various times, and a couple of years ago we began presenting it at the school-optimized time of 11:30 in addition to an afternoon showing.

This show has also been given many different names, in an attempt to improve its marketability. (Changing the name has not resulted in any dramatic change in attendance, though.) It was originally known as Arizona Skies, which is the name used throughout the periods I’ll be presenting.

2. Main features

Our “main features” are prerecorded shows with significant live sections presented at least three times, and sometimes as many as 6 times between the recorded sections. In order to maintain the flow and continuity of the
show, music is played faintly during the live sections, and the visuals are the same in style to those used during the recorded sections. These live breaks can include use of our interactive buttons, but do not always do so; they do always include either a live presentation of new concepts or a review of difficult concepts already covered.

The shows which I will be comparing here include LightSpeed, MoonWalkers, If the Earth Were the Size of a Baseball, and Mars Mysteries.

ATTENDANCE FACTORS

I realize there are many factors to take into account:
* the number of people entering the science center
* the attractiveness of the logo or poster for a particular show
* the attraction of a show’s title
* the amount of marketing dedicated to a show
* the number of times and the time of day that a show is given
* the personal preferences of the cashier selling the tickets
* a connection between one show and a prominent exhibit
* and more

I must admit that when there is a poster or banner made for a particular show, it is made for the “main feature” and not the night sky show. I will try to minimize the other factors for this paper. The time slot that is chosen most by school groups (aside from the morning school shows) is the 11:30 time; we'll eliminate that from consideration. Aside from posters and possibly a banner, very little marketing is done for any of our shows. I also won’t consider any show that was created or used to connect to an exhibit. However, some of the factors cannot be removed, so I will not claim to present any conclusive results.

ATTENDANCE NUMBERS

We’ve switched showtimes around occasionally, which should allow for a better comparison between shows. I will not be including numbers for months in which we switched shows mid-month, or in which we switched showtimes mid-month.

* FEB - MAY 1999
  - LightSpeed: (12:30) 6,320; (1:30) 6,311; (2:30) 6,275
  - Arizona Skies: (3:30) 6,267
* JUNE - AUG 1999
  - MoonWalkers: (12:30) 8,462; (1:30) 7,166; (2:30) 8,903
  - Arizona Skies: (3:30) 7,458
* SEPT 1999
  - MoonWalkers: (12:30) 1,743
  - Arizona Skies: (3:30) 1,513
* OCT 1999
  - MoonWalkers: (12:30) 1,320
  - Earth Size Baseball: (1:30) 1,517
  - Arizona Skies: (3:30) 953
* NOV 1999
  - Earth Size Baseball: (1:30) 1,140
  - Arizona Skies: (2:30) 1,181
* DEC 1999
  - Mars Mysteries: (1:30) 2,390
  - Arizona Skies: (2:30) 1,248
Some of the showtimes and periods not considered were periods when shows were in transition, or when the main feature was shown to accompany a popular exhibit, which would naturally make it a stronger draw.

You may notice that some shows seem to draw more than their competition; Mars Mysteries appears to be a much stronger draw than Arizona Skies, while If the Earth Were the Size of a Baseball draws fewer than Arizona Skies. Most of the shows did better in attendance than Arizona Skies, in spite of, or perhaps related to being offered fewer times per day. Note that when the same show is given at 1:30 and 2:30, there is not much difference in the numbers between the two. I should mention that during the school year our stargazing show is now given more times per day than its competition, and yet its numbers have not improved.

SURVEYS

The Arizona Science Center Research Scientist, Richard Toon, regularly conducts surveys of the audience response to the planetarium shows. One of the key indicators is their rating of how interesting they found the show; they are asked to rate it on a scale from 1 to 5, with 5 being “very interesting” and 1 being “not interesting”. We’ve also compared the results by show presenter, to see if there were significant differences, as a live presentation can greatly vary depending on the quality of the presenter.

Surveys were done at different times; an attempt was made to gather at least 100 surveys for each show.

Earth Size Baseball 3.9  
LightSpeed 4.1  
MoonWalkers  3.9  
Mars Mysteries 3.9  
Arizona Skies : various responses, ranging from 4.1 to 4.7, depending on survey

Other surveys of other shows

Hubble: Eyes in Space 4.1  
Are We Alone 3.9  
Jurassic Planet  4.3  

By these results, you can see that Arizona Skies usually ranks high. It never ranks low, in spite of the number of times it has been surveyed. Survey results of Arizona Skies done in the same month but given by different presenters have a small range of difference, with even the lowest average being a 4.1.

OUR CONCLUSIONS AND ACTIONS

It appears that our audiences enjoy the live night sky show; from comments made during and after shows, they may often expect to see stars and constellations even when purchasing tickets to a show called “Mars Mysteries.” However, a variety of exciting show titles may attract more ticket sales, and prevent people from assuming that they’ve “already seen that one.”

We’re planning to try something different starting in the fall of 2002; all of our main features (or not including our children’s show and our school shows) will have a mini-show at the beginning with a particular focus, and will be followed by a live star section that contains some information on the mini-show. We will use the title of the mini-show. We hope to change out shows frequently, creating the perception that we always have something new. And yet by keeping the live sections, related to the current night sky, we hope to keep the audience’s interest in the constellations and meet everyone’s expectations.

If you want to know how it goes, just contact me next winter.

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Eyes on the Sky

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Abstract
A sampler of live, participatory school programs for many ages. Most of these emphasize a connection between the planetarium sky and the real sky and require only a star projector and simple supplies to run.

In this paper, I will describe some of the educational programs we carry out at the Bowling Green Planetarium, with emphasis on those that utilize the planetarium sky or require observation of the real sky. These programs need little equipment besides a star projector, so might be especially applicable to planetariums with limited equipment or which are located in dark-sky sites.

The facility
The BGSU Planetarium is a 12.2m horizontal dome in a university setting at a latitude of 40° north. It seats 118 students or visitors, has a Minolta II-B star projector, and was opened in 1984. The University is relatively large (17,000 students), but the city is relatively small (12,000 permanent residents).

The planetarium serves three primary audiences. University introductory astronomy classes meet in the planetarium on MWF during the academic year and daily in the summer. Public shows are run three evenings a week and some Saturdays from September through early May. Private groups (usually schools) can reserve programs during school year on Tuesday and Thursday and occasional other times.

A rooftop observatory is also connected with the planetarium. It houses an 0.5 m computer controlled telescope in the dome and several smaller portables can be set up on an open skydeck. The observatory is used for “stargazing” sessions by the general public (after planetarium shows) and by students in introductory astronomy classes (at scheduled times). The 0.5 m telescope is equipped with a CCD camera that is used for research training by physics/astronomy majors and graduate students.

A central tenet of my operating philosophy is that the real sky and its proxy, the planetarium sky, are at the core of why planetariums exist at all. Although our planetarium is a relatively well-equipped multimedia theater, we maintain a strong emphasis on the sky, both real and planetarium.

The sky in public programs
All our public shows begin with a live star talk, usually by me, but occasionally by one of my student workers. In the star talk, we show the constellations and planets of the current evening sky and sometimes include an astronomy module, which can range from telling myth to showing the progression of spectral types in Orion and the ring of bright stars around him.

The star talk is followed by a question and answer time before the planetarium show.
begins. The shows are multimedia programs, some created in-house, others purchased.

Our Friday and Sunday evening programs are followed by a real-sky observing session, weather permitting, in which we point out some constellations and look at one or more objects through the 0.5m telescope. The eyepiece assembly is constructed so we can readily switch between visual observing (for the public) and use of the CCD camera (for advanced students) without making an equipment change. These observing sessions last 30-45 minutes. Usually between one-quarter and one-half of the planetarium show audience stays for observing. People stay even on cold nights (5°F, -15°C). Our limiting magnitude on a clear, moonless, haze-free night is about 4.5.

The printed program we pass out to audience members as they arrive for the planetarium show always contains a star chart that shows the current evening sky. So in many ways we encourage the public audiences to watch the sky.

The sky in school programs
Visiting school classes range in age from preschoolers through students from other area colleges. Teachers can choose from a roster of about 40 multimedia shows and about 15 live interactive shows. The live shows are always centered on the star projector and its sky. The multimedia shows include a question and answer time but do not include a star talk except upon request. Here I will describe some of the live programs.

**Star Shapes (grades preschool to K, ages 4-5)**

The goal of the program is to have the children learn you can see stars and star pictures (constellations) in the sky.

I do this program only for small groups (20 or fewer) and seat the children on the planetarium floor in a circle. I begin by introducing them to the round shape of the room and to the idea that we'll pretend the ceiling is the sky.

Then using picture boards I tell a story of some children who watch the sky and find “star shapes” in it: the rectangle of Orion or the Bright Triangle (Vega, Deneb, and Altair). Next we pass out black construction paper (“pieces of the sky”), self-stick dots, and bright crayons, and the children make their own constellations. Then we introduce the idea that stars are made of something called “hydrogen” and are born in faraway clouds in outer space.

Finally, I bring up the starfield and show the constellation we learned about in the opening story. The last step is encouraging the children to watch the real sky with their parents (a convenient excuse for them to stay up late!).

So in a simple way, this activity introduces the idea of seeing constellations to very young minds. It takes about 35 minutes.

**Directions (grade 2, age 7)**

The goal of this program is to show that the source of directions lies in the sky.

After an introduction, four volunteers are sent to the cardinal points bearing large signs labeled N, S, E, and W.

Then I move the Sun across the sky for the dates December 21, March 21, and June 21 (all for our home latitude). Before each time, I call for guesses as to where the Sun will rise. Then we move the Sun, noting where it rises and sets and roughly how high it is in the south at noon. Volunteers with appropriate signs are sent to the azimuths of sunrise and sunset. During the June demonstration, I usually stop the Sun in early morning and ask whether it will reach the zenith at noon (at our latitude, it misses by 15°), and will usually bet a school lunch with those who say it will.
The students’ predictions tend to get a little better as the program progresses, but they are usually not too good. The students have not developed the formal reasoning needed to make good predictions, but they can readily see the concrete results.

The students learn that east and west are the general directions of sunrise and sunset, that the precise directions change with the seasons, and that south is the direction of the noontime sun.

Then we switch over to the night sky, see a few constellations, and demonstrate that the north star is stationary and marks the direction north.

The whole lesson takes about 35-45 minutes, shows a range of basic sky motions in a concrete way, and ties the directions to the sky.

**The Sun and Seasons (grades 3-6, ages 8-11)**

The goal of this program is to show the Sun’s diurnal motion in different seasons and at different latitudes.

It begins with demonstrations of the Sun’s diurnal path in December, March, and June, following the same steps and activities used in *Directions*, and done for our home latitude.

Then we stay with the June sun, but go to different latitudes, first north to Alaska and the North Pole, then south to the Equator and Australia. Volunteers with signs are sent to stand under the noon sun at each latitude.

Students learn the same points as in Directions, but also learn the Sun’s diurnal path changes as you travel north or south. In particular, they see the midnight sun in the arctic (usually a big surprise) and learn that the seasons in Australia are the opposite of those at home.

The lesson takes about 45-55 minutes. A similar program has been developed for the motions of the Moon, though it is necessarily more complex. A third related program samples stellar, solar, and lunar motions to show the roots of timekeeping in celestial motions.

**Sun in Earth’s Sky (grades 5 and up, ages 10 and up)**

The goal of this program is to examine in some detail how the Sun’s diurnal path varies with date and latitude. The program is run in the style of a science lab session.

First the students are given an explanation of the azimuth ring which will be used to measure solar rising and setting azimuths to the nearest degree. An altitude arm connecting the south point and the zenith is also explained and will be used to measure the sun’s midday altitude to the nearest degree.

Then the students are given a worksheet that contains lines for each motion of the Sun that will be demonstrated. For each motion, the student must predict the rising and setting azimuth and the midday altitude and then record the observed values when the motion is demonstrated. Then predictions and observations are made for the next motion, and so on.

The first set of motions demonstrates the Sun’s diurnal path on the solstices and equinoxes at our home latitude. The predictions for the first motion (usually an equinox) are merely guesses, but the predictions rapidly improve, and the students concretely discover the seasonal patterns and symmetries.

The second set of motions demonstrates the Sun’s diurnal path for the summer solstice at a grid of latitudes, beginning at the home latitude and gradually moving north to the North Pole, and the gradually moving south to the South Pole. The first one or two lines of predictions are rather poor, but the students quickly discover the patterns both of noontime altitude, where the changes with latitude are pronounced, and of rising and setting azimuth, where the changes with latitude are much more subtle, except at high latitudes. By the end, many students are attuned to changes of as little as a couple degrees in azimuth!
This program takes 60-75 minutes to complete if the entire grid of motions is demonstrated. Similar programs have been developed for the motions of the Moon and planets.

**Kepler Second and Third Laws (grades 11 and up, ages 16 and up)**

The goal of these programs is to show how these two heliocentric laws are derived from geocentric observations. Both are run in a science-lab mode. I have described both in detail elsewhere, so will recount them only briefly here.

**Third Law:** Students made methodical observations of the motions of the five naked-eye planets along the planetarium’s ecliptic and record dates of conjunctions. The dates of conjunction are used to determine the synodic period, which are combined with the change in ecliptic longitude of conjunction to calculate the sidereal period.

For the inferior planets, the maximum elongations are measured and used to calculate the orbital radius in AU. For the superior planets, the dates of quadrature are determined and used in a somewhat complex way to determine the orbital radius in AU (when a superior planet is at quadrature, the Earth is at maximum elongation, as seen from that planet). Students are given an extensive work packet explains the procedures in detail, provides space to record observations, and guides them through the calculations. This exercise is described more fully in the proceedings of the 1996 IPS conference in Osaka.

**Second Law:** Students make methodical observations of the positions of Mercury, Mars, and the Sun along the ecliptic on sets of carefully chosen dates. Knowing a planet’s position and the date, the geocentric ecliptic longitude can be converted to a heliocentric longitude, using a provided chart of the planet’s orbit and Earth’s orbit. In this way, a planet can be traced around its orbit. Chords connecting positions equally spaced in time give a dimensionless velocity for the planet. Mercury and Mars have sufficiently eccentric orbits that measurements made with a good star projector can show the variation of velocity around the orbit. As with the third law exercise, students are given an extensive work packet explains the procedures in detail, provides space to record observations, and guides them through the calculations. This exercise is described more fully in the proceedings of the 1998 IPS conference in London.

**The sky in university astronomy classes**

We typically teach four to six large introductory astronomy classes in the planetarium each semester. Most classes have about 115 students and meet three times a week in large-class format. The teaching load is shared among three or four instructors. We do not have graduate student assistants or “quiz sections.”

Our sky-related goal is to equip our students for a lifetime of enjoyable skywatching. We give students extensive exposure to the planetarium’s sky typically center about two to three of the semester’s fifteen weeks on the naked eye sky, its phenomena, and their explanations.

All the instructors use the star projector extensively to teach sky motions and cycles. We all teach some constellations but none of us places too strong an emphasis on them. The left column in Appendix A lists the complete set of phenomena we show using the star projector, though none of us shows all of them in any one course.
We also give our students exposure to the real sky by requiring them to attend a “stargazing session” at the Observatory. Our operating style here is shaped by the need to accommodate a large number of students (500 or more per semester), a relatively cloudy climate (two nights out of three are cloudy) with fairly cold winters, and our moderately urban location. The stargazing sessions are conducted by a team of undergraduate students. They are scheduled on four nights a week and each student is required to attend one session during the semester.

The typical session lasts about an hour. The student operators show several constellations and whatever planets are visible. Several portable telescopes are trained on the moon, planets, and deep sky objects. Finally, the workings of a reflecting telescope are explained and a visit is made to the half-meter telescope and one or two objects are shown through it.

We also offer an extensive set of optional observing projects for extra credit. These fall into two primary categories. “Basic” projects are ones students can do at the Observatory after a scheduled stargazing session. They typically involve sketching the Moon or planets as seen through a telescope. “Advanced” projects are ones that students can do on their own at home. They range from simple projects like recording the direction of sunset once a week to intermediate ones such as photographing constellations to advanced ones that involve measuring the circumference of the Earth. These projects are listed in Appendix B.

I have also developed an honors-level naked-eye astronomy course that permits more extensive use of the star projector than is possible in a large class and involves more advanced exercises, explanations, and observing projects.

In all these ways, we introduce our various audiences—university students and public and school visitors—to the real sky both through direct observation and experience with the planetarium sky.
## Appendix A: Planetarium sky demonstrations and real sky observing projects

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<td>Constellation album</td>
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<td><strong>DIURNAL &amp; LATITUDE MOTION</strong></td>
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<td>sidereal vs. synodic month</td>
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<td>change of pole star</td>
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<td>change of visible constellations</td>
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Appendix B: Observing Projects

Basic observing projects

Moonsketch: Make a sketch of the moon, as seen through a telescope, and record the details of what you see.

Planetsketch: Make a sketch of the planets that are up, as seen through a telescope, and record the details of what you see.

North Star: Record the location of Polaris and some northern constellations in the sky at two times during the night and look for changes.

Orion: Record the colors of stars in the constellation Orion as a means of recognizing stars of different temperature. (Limited to winter months when Orion is up.)

Advanced Observing Projects

Setting Sun: Record the location and time of sunset (or sunrise) at least once a week throughout the semester to discover trends and changes.

Measurement of latitude by star trails: Make a half-hour photograph of the trails of rising or setting stars. Use the angle of the trails to the horizon to calculate your latitude. **Camera required.**

Changes in the sky: Attend two stargaze sessions at least two months apart and carefully record the changes in the sky between the two visits.

Star colors in Orion: Take a color photograph of the constellation Orion. Use the colors to rank the stars in order of temperature. **Camera required.**

Setting moon: Record the location and time of moonset and the moon’s phase every clear night for two weeks from new to full moon to discover trends and changes.

Moon motion: Record the location in the sky and phase of the moon nightly for two weeks from new to full moon to discover patterns.

Midday altitude of the Sun: Measure the length of a stick’s shadow at midday once a week all semester. Use these lengths to calculate the Sun’s altitude at midday and note weekly changes.

Constellation album: Photograph at least ten constellations, assemble the photos in an album, and identify each constellation its connect-the-dots figure. **Camera required.**

Motion of a planet: Select a planet visible in the night sky and carefully measure its position relative to nearby stars once a week all semester to chart its path through the starfield.

Variable star: Use binoculars to monitor how an assigned star varies in brightness. Record how much the brightness changes and how long one cycle of change takes. **Binoculars required.**

Length of the month: Record the moon’s phase and position in the starfield nightly for five weeks to measure the length of two kinds of month, sidereal and synodic.

Shape of the moon’s orbit: Photograph the moon nightly for a month. Measure the changes in its size and discover how its distance from the earth varies during the month. **Camera and telephoto lens required.**

Circumference of the Earth: Measure the altitude of the Sun or Polaris from two latitudes at least 150 miles apart. You must build the measuring device, measure the altitudes to an accuracy clearly better than 1%, and use their difference to calculate the Earth’s circumference.
Building an Observatory for Public Outreach

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Abstract

We have completed phase I of an on-campus observatory for public star parties associated with the Ott Planetarium. We will also use the observatory for research projects with our physics majors. Details showing how we designed and built the observatory using preformed concrete bridge abutments will be presented. The result is an observatory structure that is fairly inexpensive (under $30k) for an industrial strength building. It was fast to build, is exceptionally robust and is easily expandable. It currently houses nine telescopes including a 25" Dobsonian. Three of the telescopes are wheelchair accessible. Soon, real-time images will be directly downloadable to the planetarium dome. Expansion options and trade-offs will be presented including remote control, a dome, adaptive-optics, etc. The benefits and funding of such a project will also be discussed.

Figure 1. Department of Physics Observatory, the building dimensions are 12 feet X 24 feet X 10.5 feet (3.6m X 7.3m X 3.2m) (W X L X H). Notice the red lights on the exterior.

Introduction

A public-access observatory is a natural extension of planetarium operations. Ideally it would be located next to the planetarium, have dark sky, be inexpensive, have the capability to expand, be wheelchair accessible and easy to maintain and operate. Clearly, most of these features are impossible for the average planetarium. This paper details an observatory that actually comes fairly close to meeting these parameters.

We built an observatory for under $30k (USD) that fits in the parking lot next to the planetarium (we used six parking spots). We can
control the parking lot lights from inside the observatory. It was easy to build and it is very solid and will support future expansion. It is largely wheelchair friendly. Finally, one or two students can have it set up for an observing session in under 30 minutes.

The project had other unexpected results too. We have received substantial media coverage, donations and funding as a result of the observatory. Every newspaper, several radio and TV stations all picked up the story with nearly zero public relations efforts on our part. We also acquired a large number of donations ranging from a CCD camera to several fairly new 20-cm (8-inch) Schmidt Cassegrain telescopes (SCT) and a 64-cm (25-inch) Dobsonian telescope. Finally, it has been remarkably easy to obtain both internal and external grant monies for expansions and improvements in the telescopes.

**Location**

We own a remote site on top of a 2,700 meter (9,000 feet) mountain top that is an hour’s drive from the planetarium. The sky is quite dark and we are planning a future observatory for that site. However, we didn’t want to use that for our weekly public star parties and planetarium shows because of the distance. One option is to control it remotely and view the results on the dome. But remote access observatories lose the personal interaction that one gets by viewing through the eyepiece directly. Additionally, a remote observatory is much harder to maintain and access than one located directly next to the planetarium.

We choose a location in the parking lot adjacent to the planetarium. This solved many problems but presented new issues too.

In choosing a parking lot location you must be attentive to the direction of car headlights from the people leaving the star party early. You also need to make sure that other parking lot users, i.e., traffic that is not associated with the observatory activities, do not generally illuminate the observing area with their headlights. It is paramount that you gain easy control of the parking lot lights too. Of course, you need to carefully assess the positions of external lights that you can’t control. (We had to contend with both on and off campus light intrusion, including stadium lights. Choosing the location carefully has minimized the impact of the surrounding lights.)

An important safety issue is the potential for auto-pedestrian accidents. While this is always a concern, it is made worse because the parking lot lights are turned off and it is fairly dark. This is especially troublesome with children due to size, activity and clothing choice. An example of this problem in the USA is cub scouts in dark blue uniforms excitedly running around on a black asphalt parking lot with no lighting. These children are nearly invisible. For this reason we actually encourage the use of headlights near the observatory. We have found that the vast majority of headlights are from cars leaving the star party and are thus pointed away from the observatory.

In an earlier safety study when we were doing “sidewalk astronomy” we had the campus police use radar to monitor traffic. Several cars were measured at speeds exceeding 50 MPH (80 KPH) in the parking lot. For our observatory we choose a short “dead end” parking lot. The size and lack of through traffic help to naturally reduce automotive speed. By placing the observatory at the far end of that lot we have nearly eliminated traffic next to the telescopes.

As you choose your location, you need to consider the entire route that people will take from the planetarium to the observatory to their cars to the road home. Make sure that people walking between the planetarium and the observatory do not have to cross unlit heavy or high speed traffic lanes.
It is worth noting that the administration funded the observatory in large part due to safety concerns. Our earlier sidewalk and rooftop star parties were just not worth the liability risk. It was decided that a well thought out public observatory program was less expensive than a single lawsuit. (Of the many safety issues with the rooftop location, the two most common ones were people hanging over the edge and children throwing objects down to the sidewalks below.)

An unanticipated advantage to locating an observatory in the parking lot is ease of access by the local amateur astronomy society. By roping off a large portion of the parking lot we can easily accommodate large attendance events such as eclipses, transits, etc. The amateur astronomers simply drive into a parking spot then unload and setup their telescopes right next to their car. This encourages support from such groups and has been a valuable asset for us.

Observatory Design

The building is a prefabricated, two-piece, concrete storage building with an “L” shaped concrete slab region around it for setting up telescopes. On the concrete slab we mounted several permanent, polar-aligned, telescope piers for the SCT’s. The structure is strong enough for future expansion with a roof mounted telescope and dome.

The most common building method for small structures is wood frame construction. This is easy to do but is labor and cost intensive. Further, it does not dampen vibrations well and is not suitable for later installation of a roof mounted telescope and dome. Concrete is an excellent building material but is expensive to create on-site. Roll-off-roof
observatories take up a lot of space with the roof supports and, by design, can never be expanded to have a dome installed on top. Roll-off-roof observatories are also significantly more complicated than the simple storage facility we wanted for phase I of this overall project.

We looked for an alternative method based on concrete burial vaults. The reasoning was that since they prefabricate small concrete boxes maybe they could make a larger one. We discovered that several local companies that make burial vaults also create larger preformed concrete products. The key to reducing the expense of the project is locating a company with a preexisting form (mold) of the right size. This turned out to be our solution.

The main building is made from two mated concrete shells. The shells are modified preformed concrete bridge supports used for highway construction. There are two types of bridge supports - arched and square. The arched supports are the most common and are not usable. The square ones are perfect however. The companies that supply these have reusable forms that they pour the concrete into thus eliminating on-site forming costs. The forms can easily be modified to have end walls added and those can be “blocked out” to allow for a door. The two halves are then transported by flatbed truck to the building site. A 60-ton crane (each half of the shell weighs over 34 tons) sets the bottom half on the prepared ground or existing parking lot surface. The crane then mates the top half to the bottom and your building’s shell is nearly complete in under two hours. While these manufacturers often modify their forms, it was the first time this company had used them to make a building.

Of the many advantages to this method, one is the lack of footings. The bottom half of the building shell is solid reinforced concrete that is continuous with the walls. There is no need for a separate concrete floor pouring or for footings to anchor the monolithic structure to the ground. This eliminates engineering, excavation, forming and pouring costs.

The interior was left as unfinished concrete but could easily be covered for aesthetics. We added electrical outlets, lighting and lighting controls. We also laid several runs of large diameter electrical conduit that passes under the concrete slab from the telescope sites to the interior of the building. This allows us to chase wires for electrical power and for future CCD cameras and computerized telescope control. Thus, we have almost completely eliminated wires that people could trip on. It is also wise to stub out several empty pieces of electrical conduit from the outside to the inside of the building. This will allow for unanticipated future modifications without needing to drill holes into the building.

The exterior is covered with stucco on the walls and a rubberized coating on the roof. The concrete is alleged to be waterproof and there is a tar seal between the two halves. The manufacturer claimed that we would not have to do anything to the exterior. In practice however the appearance is pretty rough so we added the surface treatments mostly for aesthetics.

Finally, we have been slowly adding permanently mounted, polar-aligned, telescope piers. A collection of small SCT’s is kept in a cabinet by the front door. The cabinet allows us to keep the

![Figure 6. We installed a storage cabinet for small SCT’s next to the main door of the observatory.](image)
scopes at the ready with eyepieces in place and finder scopes fairly well aligned. The shelves in the cabinet will have wide slots routed out to allow the top mounting screw on the telescope base to remain installed. The result is that we can have a clock-driven telescope ready for use in under sixty seconds.

The entire cost was just under $30,000. This included the building, steel double doors, lighting, electrical work, poured reinforced concrete slab on two sides, trenching for power lines, three telescope piers and wedges, and exterior stucco and roof treatments.

**Operation**

Phase I of this project has no dome. The telescopes are simply stored inside like a shed. When we need to use the observatory we pull out the telescopes and distribute them around the building. A single staff member can set up the entire operation in about 45 minutes. (It is easier and safer for two people to roll out the 25-inch dob, but one can do it.) About half of that time is spent on star alignments for the digital setting circles that four of the scopes have.

For rapid use the four SCT’s can be pulled out of the front cabinet and set into place on the piers in under 10 minutes. These telescopes have solar filters available and with the polar aligned piers are exceptionally easy to use during the day for tracking the Sun.

We are a small planetarium with a part-time staff comprised of students. To work in the planetarium and observatory you must be a physics major, have earned an “A” in the Introduction to Astronomy course and promise to enroll in the advanced Astrophysics course. Yet, despite this solid background, they are not amateur astronomers. Rarely do they know the sky well enough to find faint objects in a city sky. Having large crowds standing around while the observatory staff are hunting back and forth for faint fuzzy objects just doesn’t work. What we do is start by getting bright and/or easily located objects (planets, Moon, M57, etc.) in those scopes that don’t have digital setting circles (DSC). Then, with the DSC equipped scopes and pre-aligned piers they are able to quickly locate the fainter celestial objects.

One advantage to this ease of operation is that I can rent out the observatory to private groups. We have two approaches to this. Of course there are the usual large group star parties where people just look through the scopes and ask questions. We also offer (and encourage) star parties for very small groups. With the small groups (ten people or less) we educate them about the different telescopes and show them how to setup and use the telescopes. Soon we will also be able to teach them how to use a CCD camera with a telescope.

Finally, we added a work bench inside and a set of hand tools for maintaining the telescopes. While all these tools are available next door in the planetarium, it is simply impractical to run over there every time you need...
Problems

We have found three significant problems with the facility - dust, heat and light pollution.

There is a lot of dust generated in a parking lot. The door needs to be better sealed against dust intrusion. We plan to add additional rubber sweeps and rubber seals. We want to try to keep the number of telescope covers to a minium so that we can setup the telescopes more quickly.

The second problem is heat. Both the parking lot and the building heat up substantially during the day. Heating of the parking lot is only a major problem when the telescopes are used at high magnification. It is worth noting that eliminating the parking lot would not solve the problem because the surrounding city generates its own heat waves. With the building being hot the stored telescopes are hot. This causes subtle image, focus and alignment problems when the telescopes are first pulled out and used in the cool night air. Again, this has turned out to be a fairly minor issue that can be solved by pulling the telescopes out a little earlier in the night.

Light pollution is our biggest problem. There are two aspects to this problem - the nearby lights that directly affect the telescopes and the low contrast, bright sky caused by the encircling city. (On the “bright” side this tends to wash out image turbulence problems caused by heat.) The obvious problems are not having enough contrast for galaxies and other nebulae and not having enough stars to easily find faint objects with the finder scope. Just as annoying as the city lights is the stray light at the eyepiece from nearby lights. Often we will arrange for a staff member to stand in just the right spot to cast a shadow on the observer. We have obtained agreements from most of the owners of surrounding lights to change to shielded lights if they ever upgrade or replace the existing light fixture. By inviting the neighbors over for a free star party or two we have been able to get some of them to turn off their exterior lights on the nights that we have our scheduled star parties.

An small unexpected problem also arose, because we are in a university parking lot we had students parking on the telescope pads. We solved this problem by installing removable posts made of PVC pipe with a cap on the top and a few strips of reflective tape. This was accomplished by boring slightly oversized holes in the concrete pad spaced at about the width of a car. We then set the poles into the holes. We rarely need to remove these posts, but when we do they simply lift up out of the hole. One person discovered this and parked behind the poles. A parking ticket solved that problem and it has never happened again. The advantage to PVC pipe is that a wayward car will simply snap off the pipe without damage to the car or the concrete. You can then saw off the damaged bottom of the pipe and reinstall it. Even if it is completely destroyed, the cost of a replacement post is insignificant.

Results

We have been running this facility for two years now and feel that it is an unqualified success. There were over a dozen newspaper articles in seven daily and weekly newspapers for the opening nights alone.

The biggest surprise was in the form of equipment donations of telescopes and accessories to the new observatory. A local health science professor had a 25-inch Dobsonian telescope that was too large for him to move around near his cabin. He donated it to us, we changed the wheels and it is now easy to roll out and use on the concrete surrounding our observatory building. Two people each donated excellent-condition 8-inch SCT’s. A local amateur
astronomer donated an SBIG ST-6 CCD camera.

So many people wanted to donate 60-mm and 90-mm refractors that we started referring them to scouting and school groups. (We kept a couple of these refractors for demonstration purposes and for casting images of the Sun.) One person asked what we needed to improve our 16-inch Dobsonian telescope and donated $1,500 on the spot for a new equatorial mount! Not a single one of these donations were solicited, they were all spontaneous once they saw the articles in the papers or came out to one of the two opening night star parties.

With the facility in place and a good record of attendance, it is proving to be reasonably easy to obtain small amounts of additional funding. We secured a state Office of Museum Services grant to buy a small automated “goto” scope for $3,000. An internal university grant provided digital setting circles for the 25-inch scope, eyepieces and computers. We are awaiting word on a $5,000 state grant for a color filter wheel and a new Dobsonian truss tube assembly for the 25-inch scope.

This brings up a curious point that we had not budgeted for. With all the donations we received there were unexpected direct expenses on our part. For example, we needed to purchase an industrial strength 12-foot ladder for the 25-inch telescope. All total, the donations actually cost us over $1,000. Of course we gained much more than that, but do be forewarned. Additionally, it was felt that several of our telescopes needed some well overdue upgrades, repairs, adjustments and accessories. No one wants to open a new facility containing ragged equipment. All this adds to the cost and needs to be anticipated in any grant requests.

Usage

The observatory has experienced significant use in the two years that we have been operating it. Below are examples of the activities that have been scheduled for the facility.

1. Public star parties, scheduled weekly.
2. Private star parties for school groups, honors students, families, individuals, scouts, etc.
   We even had two birthday parties use the facility.
3. Astronomy classes: solar viewing and special event viewing (comets, eclipses (here and at Jupiter), special projects, etc.).

The Ott Planetarium only has public shows on Wednesday nights. For many years we setup telescopes on the sidewalk or roof. Typically, about half of the audience in the last planetarium show would stay to look through the telescopes. With the observatory that has clearly changed to nearly 100%. Indeed, some people who attended the earlier planetarium show specifically wait around to come out to the observatory. There are also a few people that come only for the observing session. On an average Wednesday night we have 30 to 40 people visiting the observatory for the star party. The duration of their stay depends mostly on the ambient temperature. (Northern Utah winters can be severe.) Visits of 30 to 60 minutes are common with occasional visitors staying for more than 90 minutes.

When renting the facility we charge an hourly rate that matches the price of our...
planetarium shows - $40 per hour. The direct costs to the planetarium budget for two staff members to operate the observatory (including setup and tear down) is about $20 per hour of usage. The vast majority of patrons who rent the facility use it for one hour with the extreme being three hours.

**Future Plans**

In the near term we plan to complete installation of the donated CCD imaging system and the computer interfacing for two of the telescopes. A major reason for this is accessibility for disabled patrons that can not easily look through an eyepiece.

We also plan to add a simple adaptive optics unit and a spectrometer. This will allow us to use the facility for research with our physics majors. We can also pursue summer programs such as “teacher as scientist” and elder hostel type activities with this equipment.

We will eventually connect the observatory to the Internet. The cost of trenching in a line is much higher than installing a wireless LAN. Once that is installed, we can download pictures real time into the planetarium dome.

We plan to mount several more piers and improve the mounting systems for some of our older telescopes. We also want to add DSC to all of the scopes.

Phase II of the observatory is estimated at approximately $30k to $50k depending on options. The majority of that would be the installation of external stairs to the roof and a dome to house the 16-inch telescope. (Industrial strength outdoor stairs are surprisingly expensive and constitute a significant fraction of the total cost of Phase II.)

**Conclusion**

The use of preformed concrete highway bridge supports resulted in a fairly inexpensive and very robust structure to house our telescopes. The observatory is easy to use and resulted in numerous donations. Public response has been high and the cost of operation has been very low. One of the most important aspects of a project such as this is careful attention to details when choosing the location of the building. Additionally, the unconventional construction method used for this facility is strong enough for a future dome on the top as “phase II” of a project such as this.
Using Cartoons to Teach Astronomy

By Eileen M. Starr
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Abstract
Cartoons can be used to introduce and emphasize astronomical concepts. Students tend to be much more interested in understanding the principles shown in cartoons because now they “get” what a cartoon is all about. Cartoons are also a good way to begin class because students stop talking, and look to the front of the room to read the cartoon of the day.

I have found that cartoons can be used to introduce and emphasize astronomical concepts in an introductory earth science class. Earth science is an option for students to complete the two, laboratory science requirement of the University. The class is also required by elementary education majors, and also for secondary science majors.

Students love to look at cartoon. Fifteen seconds before class begins, I place a cartoon on the overhead projector in the room. Students stop talking, and look to the front of the room to read the cartoon of the day. This is very helpful when one has a class of 60. Plus someone in class knows that I will volunteer them to tell us why I am showing the cartoon, and what the point of the cartoon is all about – as they see it.

Cartoons are understood because they reflect the shared knowledge of a culture. Some of our foreign students have no idea what the point of a cartoon is all about. If you have had trouble understanding a cartoon, it is because, somewhere along the way, you have missed out on that shared information. Students tend to be much more interested in understanding the principles shown in cartoons because now they “get” what a cartoon is all about.

The cartoons come from the New Yorker magazine, and from the comic strips such as Dennis the Menace, Frank and Ernest, The Family Circus, Peanuts, Rose is Rose, Hi and Lois, Garfield, Herman, Calvin and Hobbs, The Far Side, and even the cartoon is Bazooka bubble gum. I use the cartoons for review of what I’ve covered previously. The earth science class meets three days a week. When you were a student did you ever wonder what was going on in class? The cartoon allows the students to recall what we were doing during the last session.

Let me give you some examples of cartoons that were especially effective during the astronomy portion of the class. Astronomy was taught for about four weeks, of the sixteen-week class. It is taught as an earth-based class so topics only cover those that you can experience from the earth. That removes black holes and stellar evolution from the class. Yes, I have cartoons for the other topics we cover in earth science: weather and geology.

Because the skies are absolutely black, and unpolluted in North Dakota, I used the planetarium for eight two-hour sessions teaching the students about constellations. Most of these
students grew up on a farm, and had looked at
the stars for their entire life – but never knew
what they were seeing. They were very
interested in learning the names of what was up
there. I use a number of constellation cartoons,
which we discuss in class. There are many
cartoons that show play on words. Others deal
with puns such definitions that deal with stars
that are not in the sky.

Some discuss how hard it is to see the
constellations, others propose new names for
the constellations, while others discuss star
phenomenon such as twinkling. Some cartoons
show astronomers as pranksters. Some of the
cartoons deal with the planetarium. Others refer
to the motions of the earth.

Some cartoons highlight the members of
the solar system. Examples are cartoons about
the moon, sun, and solar system. Other
cartoons refer to changes in the universe, and
the size of it all.

Cartoons and a fun way to teach about
astronomy.
Hubble Happenings

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Abstract  
An overview of products for planetarians from the Space Telescope  
Science Institute, plus news from the refurbished telescope.

Introduction  
Hello. I’m John Stoke, from the Office of Public Outreach of the Space  
Telescope Science Institute in Baltimore. We’re the science and operations  
center for NASA’s Hubble Space Telescope, as well as for the Next  
Generation Space Telescope which is now under development. Some of you  
may remember me as a fellow planetarian, through my former work on both  
the technology and show production sides of our profession.

Today I’d like to share with you an overview  
of our activities and plans as they relate to the  
planetarium community, and also solicit your  
input regarding future activities.

Hubble Space Telescope Status  
First, an update on the status of the  
spacecraft. Shuttle astronauts on flight STS 109  
successfully conducted the fourth Hubble  
servicing mission in March of this year, SM3b. It  
was the most ambitious servicing mission ever,  
and has given Hubble more than just an  
extended lease on life; the telescope has in  
many ways been reborn:

- NICMOS, the Near-Infrared Camera &  
  Multi Object Spectrometer, out of service  
  for several years because of depleted  
  nitrogen ice coolant, is now back in  
  operation thanks to a new experimental  
  cryocooler that is working very well.
- Hubble’s “heart,” the Power Conditioning  
  Unit was successfully replaced, even  
  though it was never meant to be  
  serviced in space.
- New rigid Solar Arrays are providing  
  25% more power, and all of the  
  problems with flexing and vibration due  
  to thermal changes are gone.
- The Advanced Camera for Surveys  
  (ACS), actually three cameras in one, is  
  delivering on its promise of a ten-fold  
  improvement (twice the field of view, five  
  times the sensitivity) in “discovery  
  power” over our previous flagship  
  camera, WFPC2.
I suspect that you’ve all seen the new images coming from ACS, so I won’t take the time to show them here. Hubble’s renovation has generated an enormous amount of renewed public interest; for our mission it really feels like 1994 all over again! There are a lot more exciting images queuing up, and Hubble will be doing some new larger-scale survey programs this year, so stay tuned!

New Planetarians Join STScI!

Although this is somewhat old news now, it’s new since the last IPS meeting, so I should formally announce that several people from our community are now with the Office of Public Outreach. Dr. Ian Griffin, formerly Director of the Armagh Planetarium, and then of the Astronaut Memorial Planetarium in Cocoa Beach, and then of a science center in New Zealand, has become our new Head of public outreach. He shares my enthusiasm for working with planetarians to get the Hubble word out.

Dr. Frank Summers has just joined us from the Rose Center of the American Museum of Natural History. Frank has very impressive credentials in the realm of astrophysical visualization. He worked on galaxy sequences for the IMAX film Cosmic Voyage and curated the Rose Center’s exhibits. He brings with him a grant from the supercomputing center in Champaign/Urbana to create an Astronomy Visualization Library that will make scientifically accurate visualizations of cosmic phenomena available to planetariums and other users worldwide.

I would also like to introduce Bryan Preston, who has joined us as a full time Museum and Planetarium Product Developer. Bryan has worked very effectively for several years on the Hubble mission in our Astronomy Visualization Lab. He’s an accomplished video writer and producer and will be working alongside me to accelerate the production pace for new products to serve the informal science education community.

An Overview of our Office of Public Outreach

I thought it might be helpful to give you a snapshot of our “corporate structure,” so that you can see how the activities I’ll be discussing fit into the overall scheme of the Office of Public Outreach.

We are organized into four divisions:

- Our News Branch, headed by former planetarian Ray Villard, provides much of OPO’s “life blood,” creating a constant stream of press releases, images, and animations.

- The Formal Education Branch addresses the K-12 education community, primarily through the production of on-line curriculum support materials as available on our Amazing Space web site, and through production of printed materials such as lithographs and posters.

- The Online Outreach Branch creates and updates our Hubblesite web site, which enjoys enormous popular support.

- Finally, the Informal Science Branch (that’s me!) looks after relationships with planetariums, science centers, natural history museums, and other free-choice learning venues. Our mission is simply to “go forth and do good things” with the informal science education community.
Current Planetarium-Related Projects

What are we presently doing with the planetarium community? Well you can learn about a lot of it by visiting our dedicated website: http://informal-sci.stsci.edu. A quick review of our offerings:

- We’re making available top-notch slides through the IPS Slide Service. Whenever a cool new Hubble image is released, we make up a batch of 1st generation slides on our photolab’s film recorders, and send these in bulk to Jeff Bowen, who distributes these to IPS subscribers. This represents a very cost-effective means for you to get good Hubble slides and I’d encourage you to visit the IPS website to learn how to subscribe.

- We’re building on on-line mpeg 2 video clip library. You’ll be able to download broadcast quality animation clips from this library, that you can play on video clip players, such as the ones offered by Adtec, Alcorn McBride, and Bowen. On request, we can also provide clips on CD and DVD.

- We offer a free multimedia presentation program called ViewSpace. It comes on CD, and the idea is for you to provide a PC to our specifications, and a display screen in your lobby. This could be a big monitor, a plasma display or a data grade video projector. ViewSpace runs as a stand-alone looping slide show that features beautiful Hubble images, music, digital video clips, and descriptive text. We update them periodically, so this provides a great way for you to have an up to date exhibit for your lobby.

  Several exciting new developments are happening in ViewSpace. First, we’re offering a higher-resolution version for plasma screen display.

  Second, we’re now testing a scheme that allows us to “broadcast” high-resolution presentations via the internet, so that if you have a computer attached to the internet, we can send you updated Hubble content as soon as it’s available. Imagine being able to show visitors to your lobby the latest image the moment it comes out of embargo, all without having to do any work!

- We have a major touring exhibition on the Hubble Space Telescope, available for lease in 2000- and 5000-square foot versions. The Smithsonian Traveling Exhibition Service (SITES) is booking the exhibition all over the country; contact them if you’re interested in having it in your facility. We provide extensive support and extra goodies if you book the exhibition!

- We’re getting our feet wet in the exciting new realm of fulldome immersive visualization. A colliding galaxies visualization created by Frank Summers now plays ten or more times daily at the National Air and Space Museum. As with most everything we produce, we’re happy to make it available at no fee.

- We have a new 9-minute video mini-documentary entitled “Hubble Reborn,” that is in the style of the very popular (and award winning!) mini-doc “Hubble: The First Decade” that we released in 2000. We’re offering this as a free VHS, MPEG 2, or DVD video to planetariums in the USA. (If you want a DVD, please send us a blank DVD-R.)
➤ We are generally busy with several special projects at any one time. Right now we’re working on projects with the National Park Service, National Air and Space Museum, New Mexico Museum of Space History, Millennium Arts Center, Southeast Museum of Photography, and others.

➤ We are always ready to assist with special requests, including requests for materials to hand out to teachers when you do teacher workshops. Please feel welcome to contact us anytime.

➤ We have a hundred Ph.D. astronomers under one roof and are happy to try to broker introductions when you need an astronomer for a talk or for a consultation.

➤ We offer early access to Hubble press releases for planetarians who are in contact with local news media and are called upon to provide expert commentary on astronomical discoveries. This is also a great way to help you prepare up to date exhibits and programs.

➤ We’ve also been designing a series of very beautiful lobby display transparencies, for installation in light boxes. You’d need to provide your own 30x40 inch light boxes in a portrait orientation, and pay the cost of reproduction of your Duratrans. A series of these can really make a stunning impression in a darkened planetarium lobby.

We’re set up at the NASA booth in the vendor’s hall and we’ll be here for the duration of the conference, so please find us and let’s chat about how we can work together.
Astronomy in India: Past and Present—A Quick Survey

By Prof. R. Subramanian
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May I, on behalf of the M.P.Birla Institute of Fundamental Research Calcutta and on my own behalf convey hearty congratulations to the organisers. May I also convey congratulations as President of the International Planetarium Directors’ Congress.

On this occasion I propose to present briefly some phases of the development of Astronomy in India from ancient times and Astronomy Education in India.

India is one of the countries of the world which perhaps not only saw the first dawn of civilization on earth but also a country where great culture flourished earlier than 4000 B.C. Other regions where similar civilizations flourished were China,, the Middle East and South America. All were concerned with the birth of the most ancient of all sciences,- Astronomy. They observed the stars and celestial events meticulously to follow the passage of time and work out some type of calender.

In India the sages of ancient times who composed the hymns of the Vedas (which perhaps are the earliest scriptures of the world available to humanity) incorporated several astronomical references particularly in Rig Veda. The ritualistic aspect of the Vedas depended on Astronomy for fixing the time of festivals and sacrifices. The four cardinal points, the Equinoxes and the Solstices were recognised in India as early as the Vedic times. One of the systems of astronomical reference namely the “27/28 Nakshatras” (Lunar Mansions) was independently developed in India. The starting point Dhanista Nakshatra in Makara Mandal was recognised as the point of winter solstice and the summer solstice was at the middle of Aslesha. Later observers had noticed that the solstices had receded.

Moving to the period of Vedanga Jyothisha, said to have been compiled by Lagadha, we come to the start of the era of computational astronomy. This was around 1350 B.C. The work mentions that Dhanista headed the list of Nakshatras but with the passage of several centuries the point receded to the next nakshatra Sravana and that became the starting point. Simultaneously the vernal equinox point was also used as the starting point and that point which was in Krittika yielded to Bharani and later to Aswani for the same reason of the precession of the equinoxes. That arrangement of counting from Aswani has stayed on till today.

The Vedanga Jyothisha gave a Luni Solar Calendar on a five yearly period in which there were 1830 civil days, 60 Solar months, 62 lunar months and 67 Nakshatra months. This means that the year was 366 days, the lunar month 29.52 days, and the moon’s sidereal period 27.313 days. The small error that was accumulating must have been removed by periodical adjustments.

Leaving behind Vedanga Jyothisha through centuries we arrive at a very fruitful period in Indian Astronomy starting from about 400 A.D. with a galaxy of great Astronomers. In this Aryabhata I holds the special position of “the father of astronomy”. He produced the great treatise “Aryabhatiya” and laid the foundation of
Siddhantic Astronomy. He was followed by other illustrious astronomers like Varahamihira, Brahmagupta, Lalla, Munjala, Bhaskara and others. The Panchasiddhanthika of Varahamihira of the sixth century is a major work on Mathematical Astronomy of early India and provides a resume of five schools including Saura which was further developed in a later period and perfected as a complete treatise of astronomy. The Indian Astronomers were marvelously correct for their determination of the length of the Lunar month (29.53058 days) which is now found to be correct to a fraction of a second. As regards the length of the year it is more than sidereal year by 3.5 minutes. The distances of the planets from the Sun which they calculated compare favourably with modern values. The equation of time was known to the astronomers from the time of Varahamihira. The observations and computations of astronomical data continued, though it took a back seat due to the political situations and foreign invasions. Finally there was a silver line after the end of the Moghul rule. Maharaj Jai Singh II who ruled the princely state of Jaipur from A.D. 1699 to 1743 established five astronomical observatories at Ujjain, Jaipur, Varanasi, Delhi and Mathura. It was his faith in astrology that led him to study astronomy to get accurate positions of celestial bodies. These observatories were masonry structures and are based on the pattern of Ulug Begh at Samarkhand. Of these, one such at Delhi and Jaipur are preserved well, particularly the one at Jaipur. They are known as Jantar Mantars. They are all masonry structures designed for the determination of the position of heavenly bodies by any of the three systems of coordinates, -right ascension and declination; celestial longitude and latitude; and altitude and azimuth. At Jaipur there is also a big brass astrolabe of diameter 7 feet, which Maharaja Jaisingh used for quick computation.

The East India Company at this period moved into the activity of setting up an observatory at Madras. This observatory of the company was essentially for finding out the longitude and time for the company’s ships sailing in and out of Madras. This observatory which was founded in 1792 functioned at Madras until 1898 when most of the equipments were shifted to Kodaikanal at a latitude of about 10 degrees and at this place a new solar observatory was started and functioned. The old Madras Observatory was devoted specially to astronomy on position. The Madras observatory had a transit circle and some of you may perhaps be familiar with the Meridian Circle observations. It is to this Madras catalogue of stars that Chintamani Raghunathachari, an assistant in the Madras Observatory catalogued and added nearly 40,000 observations of stars. He also discovered two variable stars. Around 1885 the Madras observatory entered actively into the new science of astrophysics and established a full fledged solar observatory which started functioning from 1898 and it is still continuing. The principle activities of astronomical research at that stage was essentially confined to Madras, Kodaikanal, one observatory at Hyderabad and the observatories that existed for a few decades at Lucknow and Trivandrum. This was essentially the scene till Independence of the country (1947).

The Kodaikanal Observatory which was established at a time when Solar Physics itself was in its infant stage has grown today with addition of several modern optical instruments and ranks among the foremost observatories of the world, which have made valuable contributions to our understanding of the Sun and its atmosphere.

It is one of the few observatories in the world which has a continuous record of the Sun over a period extending 70 years.

Of the other observatories one was the Nizamia Observatory which was established in 1908 under the auspices of the Nizam Government, it had a 15” refracting telescope and a 8” astrograph with a 10” telescope. Again
at Varanasi an observatory was founded in 1954 which moved to Nainital towards the end of 1955 and the buildings of the observatory were completed in 1961. The observatory is equipped with several excellent refractor telescopes. There are also a 10\textdegree refractor and some transit telescopes. More recently there was tremendous development in the setting up of India’s largest optical telescope, the 2.3 metre Vainu Bappu telescope which became operational in 1986 and has completed 10 years of operations on the 6th January, 1996. This indigenously built telescope was the brain child of the late Prof. Vainu Bappu, perhaps, the greatest observational astronomer of the country. He is the only Indian so far who had been elected President of the International Astronomical Union. Perhaps, one may recall here that it is at this observatory (at Kavalur) that the rings of the planet Uranus were jointly discovered by Prof. J. C. Bhattacharyya and the young scientist Kuppuswamy.

In recent decades there have also been tremendous developments in the field of radio-astronomy and a very large fixed radio-telescope operating at decameter wavelength has been set up at Gauribidanur in south India. There is also a very large steerable radio-telescope at Ooty (Udagamandalam). It consists of a 530 metre long 30 metre wide parabolic, cylindrical antenna. This had become operational in 1970 and was conceived, designed and fabricated during the period 1963 to 1970 by Prof. Govind Swarup, F.R.S. who may be said to be the father figure on the scene of radio-astronomy. Right now Prof. Govind Swarup is heading the project of the giant meter wave radio telescope near Pune which has been completed recently and become operational. It is the world’s largest radio-telescope operating in the frequency range of 38 to 1500 megahertz.

It is not the intention of this paper to go into the details of the astronomical research work that has been done in recent years through special packages set up on space platforms. But as a last part of this paper I will quickly go through the scene of the setting up of science museums and planetaria in India. It was in the mid fifties that I had set up the first medium sized planetarium in the campus of the National Physical Laboratory, New Delhi under the guidance of the Director the late Sir K. S. Krishnan. From 1956 this Planetarium has been essentially used for popularizing astronomy to school students. It was at the same time the nucleus of the science museum was also set up in one part of that campus where several scientific working exhibits and models were kept.

The major facility of a large planetarium for the first time was set up by the industrial house of Birlas in Calcutta in 1962 which was formally inaugurated by the then Prime Minister of India the late Pandit Jawaharlal Nehru. It has been the country’s largest Planetarium and one of the largest in Asia.

The M.P. Birla Planetarium through the last three decades has designed and presented to the public and students more than 200 astronomical projects dealing with many facets of Astronomy, Astrophysics, Celestial Mechanics, Space Science, History of astronomy as well as Mythology concerning stars and planets. The planetarium has also been conducting a series of graded school programmes for children of various age groups. Almost from the very beginning of this institution, it has been conducting a free evening course in astronomy and it has recently also established a Post-Graduate Diploma Course in astronomy & Planetarium Sciences.

The M.P.Birla Planetarium has been hosting and participating in several National and International seminars in astronomy and connected fields and has been regularly organizing astronomical expeditions for the studies of the Solar Eclipses and other Celestial events. The Planetarium has also been organizing special lectures and exhibitions in connection with centenaries of astronomers like Galileo, Kepler, Tycho Brahe and others.
The Planetarium shortly proposes to set up an astronomical observatory with a Celestron C-14 Telescope and attached CCD Cameras. When established, it will be one of the most useful observatories in the North-East region of this country.

The Planetarium has been regularly bringing a scientific Journal called “The Journal of M.P.Birla Planetarium” wherein appear contributed articles from astronomers from India as well as from abroad. Prof. R. Subramanian, Director, is the Editor-in-Chief of this Journal and an editorial board has been set up for the assessment and suitability of the articles received for publication. In recent years, the Planetarium has also brought out some astronomical publication like “the Bust Stories”, “A Brief Introduction of Astronomy”, “Ephemerides of the Sun. Moon and Planets (1995-1999)” and yearly calendars as well as picture postcards.

In the light of continuous services of the dissemination of astronomical knowledge and popularization, the Birla Planetarium was chosen as the venue for the 7th International Planetarium Directors’ Congress 1980, when astronomers from all over the world attended and delivered lectures. Mr. R. Subramanian, Director has since been elected the Vice-President of this International body.

Recently, the Planetarium has also set up an Electronics Laboratory for design and fabrication of scientific equipments for the automation of several audiovisual effects which will be used in presenting astronomical data to public and students.

A very important development of recent years for recognizing talents and rewarding their meritorious work has been the setting up of the M. P. BIRLA MEMORIAL AWARD and LECTURE to be given once in two years to a distinguished scientist and dedicated lifetime of research work in the fields of astronomy, astrophysics and space science. Under this important scientific activity the award for 1993 was given to the distinguished cosmologist Prof. J. V. Narlikar; in 1995 award was given as mentioned earlier to the distinguished Radio-Astronomer Prof. Govind Swarup, in 1997 the award was given to Prof. K. Kasturirangan, Chairman of Space Commission and Chairman of the Indian Space Research Organization. Through the last quarter century, along with his distinguished team, he conducted researches of the highest order in the field of astronomy and space instrumentation and that put India in a prominent position among the countries of the world in this field. In 1999 the award was given to the distinguished Solar Physicist Prof. S.M. Chitre of Tata Institute of Fundamental Research, Mumbai and in 2001 to Prof. K.D. Abhayankar, formerly the Head of Department of Astronomy, Osmania University, Hyderabad.
Building Models of Sky Islands and Space Observatories

By Brian Sullivan

The objective of this presentation is to show how planetariums can create good looking visuals at a low cost. Because of the economy and 9-11 planetariums have been facing large budget cuts. With today’s technology in computers and computer graphics good visuals can be produced but for most places the cost is too high. A lot of planetariums have no video and a low budget to sustain computer graphics. Good visuals always sell a show. What I hope to accomplish is a guide to producing visuals showing hot topics within astronomy and various space programs.

Today the biggest goal for manned space flights is the construction of the International Space Station. It is the largest man made structure ever to be assembled in Earth orbit. A complex maze of manned modules and structured elements, to build models either in plastic or as an electronic visual, is a big challenge. Already there exists three model kits of the ISS that are on the market.

1- Revell/Germany 1/144 scale ISS kit for $78.00
2- Heller’s 1/125 scale kit for $30.00
3- Intermountain Railway 1/144 scale kit for $150.00

All kits would require two solid weeks of construction and painting. A plastic model space station would not only supply you with visuals for your star theater shows but would also give you a good exhibit model to display at your planetarium. In essence you get two for the price of one.

The Heller’s ISS is very well detailed but comes with no Space Truss and no Primary Solar Panels. I assembled the Heller’s kit to show the entire Phase-A of the ISS. The kit comes with only one Soyuz spacecraft but for $5.00 you can get an additional Soyuz and Progress spacecrafts to include with your station. Because of the 1/125 scale you can see a lot of exterior detail. The only Space Shuttle kit that could mate with the Heller’s ISS is the Tamiya 1/125 Columbia Space Shuttle however this kit is out of production.

Intermountain Railway ISS comes with painted parts however several of the pieces don’t fit well and the main Truss of the station comes as a solid unit- which doesn’t truly display the real ISS. My personal favorite is the Revell/Germany 1/144 scale ISS. The pieces are very well detailed and the parts fit very well. You need to spend about $60.00 of spray paint to cover the station. The Solar Panels are very well constructed but I made a few modifications. The Solar Panels themselves were made with Photoshop 6.0. I had 16 panels printed as Laser Prints with a flat finish. I used a plastic sheet sprayed with Metallic Gold for the Solar Panel mounts. I then used Super 77 spray adhesive to glue the panels onto the Solar Array Structure. The Revell/Germany kit also comes with the ESA’s Jules Verne Supply Module. I enhanced the Solar Panels with Evergreen Sidewalk sheets. I used French Blue spray paint for the primary color of the panels.

The Heller’s Columbia Science Module comes complete with the exterior science packages. The Revell/Germany does not but a simple module design can be assembled using Evergreen Sheet Plastic. Also Revell sells a complete 1/144 scale Space Shuttle kit that would mate well with the ISS. You will have to assemble the Spacehab Module from scratch that goes into the Shuttle Cargo Bay. Most of my color information of the ISS comes from the NASA Website:

http://www.nasa.gov.

For size comparison I also assembled the Revell’s 1/144 scale MIR Space Station. Shown with both Shuttle and MIR you can really display the true size of the ISS. Currently I’m working on a 1/32...
scale model of the station as well as a complete database of the ISS using 3D Studio Max and Multi-Gen Creator.

In 2006 when the station is complete, a lot of proposed Astronomy Experiments will be conducted. One proposal is the Jovian Planet Finder (JPF) Space Telescope that would “clamp” onto the Truss structure of the ISS. To build a model of this design I used regular 1 ply black illustration board for the primary structure with Evergreen Sheet Plastic glued onto the Exterior surface. I then glued on household tinfoil for the Exterior Installation covers. The Truss design was an enlarged section of the ISS made with Plastruct Square Rods.

Many Space Telescopes in the near future will be hot topics in the Astronomy Community. Because of Spectra Readings and Doppler Shifts we now know that there are planets orbiting other Stars. For the next twenty years astronomers using Space Telescopes will search for Terrestrial planets. It’s a popular subject that could really boost your planetarium attendance. Showing these telescopes as real looking images would help enhance your planetarium shows and exhibits. The new proposed Discovery Mission: Kepler Space Telescope will search and map locations of these new worlds. The large scale model I made of the Kepler began with Evergreen Sheet Plastic for the primary structure. Each module on the telescope was handmade using the actual blueprints as a guide.

In 1998 I assembled a large model of the Terrestrial Planet Finder for the Adler Planetarium in Chicago Ill. It was made for a show called “In Search of New Worlds”. It is a three foot model using Plastruct Ladder sections for the Main Truss. I used 3M tape hubs for the mount of each telescope tube. I used 1 ply black illustration board for the primary building design of the central module, then used sheet plastic for the exterior cover. Usually I spray flat black spray paint for the base coat of any model then I would apply the exterior color of the various modules. 3M tape hubs are great for model construction. You can see where I used them for the rear section of a Japanese Space Telescope along with a plastic salad dressing container.

For the Chandra X-Ray Telescope I used a lot of plastic parts from 4 Skillcraft HST model kits. Primarily the module part of the secondary mirror mount was used for the front of the Telescope. Also the Skillcraft model assembles well for an HST model. Here you can see where I modified the model to look like the current design with the new Solar panels from the last HST Service Mission. Monogram’s 1/72 scale Space Shuttle Kit mates well with the HST model and makes for a very good Exhibit.

AT the last minute I had a quick assignment to assemble the ESA’s Herschel Space Telescope. I only had two days so I quickly used an empty Pringles Chip Can with two Salad Dressing Bowls for either end. I used Evergreen Sidewalk sheet plastic for the module structures. The ESA logos I got off the ESA Website and had it printed as a Laser Print.

If you don’t have the time or money I have recently compiled images of most of my plastic and computer graphic models into a catalog called: Digital Spacecraft Images

It shows most of my Space Telescope Models as well as Lunar and Comet Probes, Interplanetary Spacecraft and Missions to Mars. You can get images either as 35 mm slides or databases made with 3D Studio Max. Prices vary but often I keep the price tag low to accommodate planetarium budgets. The catalog will continue to grow as I work on various NASA/ESA projects in the near future. Also the 1/32 scale ISS model images are available within the LM Images All-Sky Catalog.

I have several people to thank for their help. Laura Misajet of LM Images and Rod Landis from the NASA/Jet Propulsion Labs. If you have further questions after IPS you can send them to my E-Mail address at Sbrian62@qwest.net

I will try to answer them as quickly as possible.
Questioning the Big Bang—An Update for Planetarians

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Abstract

A minority of American adults believe our Universe had an explosive beginning. This is probably because of they’ve never had an opportunity to learn any astronomy that covers this subject. Since virtually all astrophysicists accept the Big Bang theory as a well established model for the Universe, this problem presents a major educational gap that needs bridging. In this paper I will review the evidence supporting the Big Bang theory. I will discuss the usual underpinnings of the theory, including the expansion of the Universe and the cosmic microwave background radiation. I’ll also present a couple of relatively new observations that add additional strong support to the theory. Finally, some of the more amazing conclusions of modern cosmology, such as dark energy, will be reviewed and I’ll outline the questions that upcoming astrophysical observations, such as NASA’s MAP spacecraft (see figure 1), will attempt to answer.

Introduction

The most frequent questions I have received from visitors when they finish going through the Rose Center for Earth and Space in New York, are: “How do you know there was a Big Bang?,” and “Isn’t it just one theory among many?” These may not be too surprising, because the NSF’s Indicators of Science and Engineering 2000, states that only 33% of American adults believe the Universe began in a Big Bang. For comparison, 72% of adults believe in the Copernican Theory. Since the Big Bang is our current, contemporary scientific model of the Universe, this is a pretty dismal statistic. Even the somewhat unpopular (at least in America) belief in biological evolution tops the Big Bang number by ten points! Clearly there is an opportunity here for astronomical and planetarium educators. Although the subject can be extremely challenging to present, it’s vital that we do so since it’s one of the most active frontiers of contemporary astrophysics and the basis of our scientific world view.

Figure 1. Launch of MAP Spacecraft, June, 2001. Photo Courtesy of Kennedy Space Center.
This paper was written to help equip planetarians to deal with these questions and bring them up to speed on the current frontiers of Big Bang cosmology. The different relevant scientific models will be outlined. I will describe the evidence that supports the most robust of these models: the Relativistic Hot Big Bang Model. Next I will indicate the extensions to this model that are supported by empirical evidence. Then I will review briefly some theoretical speculations that are currently popular and often misleading. Upcoming observations will be previewed and then I will wrap up the paper with a brief discussion of the specific challenges planetarium educators face and some strategies they might pursue in helping people understand the Big Bang.

The Big Bang is Described by Scientific Models

When scientists discuss the Big Bang, they’re usually discussing a scientific model. The Big Bang is no longer a hypothesis among cosmologists. In the 1920s when Edwin Hubble discovered the expanding Universe, the Big Bang was merely a hypothesis. But this changed in the middle of the Twentieth Century as evidence eventually pointed the way to a theory that could yield testable predictions. When the Cosmic Microwave Background (CMB) was discovered by Penzias and Wilson in the 1960s, nearly all astronomers were convinced that the Big Bang was real. The key to understanding this acceptance is to realize that it can now be described as a model that relies on accepted physical laws and can make definite predictions that can be observed.

The Big Bang is a historical model in almost the same way as the theory of evolution. Through predictions these models make, data from past epochs can be tested. In a certain sense astronomers are like paleontologists who find older fossils the deeper they dig. Because the speed of light is finite, we are always excavating space the farther we peer with our telescopes. Although the individual laws of physics, which make up the mechanics of the Big Bang model can often be tested in the lab or close to the Earth, for the most part the Big Bang should be considered as a historical scientific model.

It’s important for our audiences to understand what a scientific model is and how it is tested. In practice there is more than one variant on the model for the Big Bang. Sometimes we hear about new hypothetical speculations about cosmology in the news and how they might invalidate the Big Bang. For the most part these claims are hyperbolic and unable to undercut the core model without observations to back them up. This core model that we believe to be true is called the Relativistic Hot Big Bang Model.

Relativistic Hot Big Bang Model

The Relativistic Hot Big Bang Model, or RHBBM for short, is what nearly every cosmologist means when talking about the Big Bang. The evidence for it is quite robust and will be reviewed in the next section. Below I’ve listed the scientific statements that constitute this model. Mathematically, it’s little more difficult than what is presented here; this is a mathematical model that can yield numerical predictions about the average state (e.g.: temperature and density) of the Universe at almost any time in the past or future. Here’s the model:
• The Universe is assumed to be homogeneous and isotropic.
• Einstein’s General Theory of Relativity provides the dynamical equations (called the Friedman solution) that describe how a Universe made up of specific constituents and conditions will evolve over time.
• Hubble’s Law of expansion relates distance and redshift on cosmological size scales – typically over a hundred million of light years. The farther a galaxy is the higher its redshift.
• Redshift (z) is interpreted as due to expansion of the Universe.
• The average density of baryons is proportional to \((1+z)^3\). In other words, the farther one looks back in time, the higher the redshift, and therefore the higher the density of baryons. (Baryons is the family of matter that protons and neutrons fall into. Most normal matter is made up of baryons. Electrons belong to the family of particles called leptons and are a much more minor constituent in terms of mass density.)
• The temperature of the electromagnetic radiation in the Universe left over from the Big Bang scales as \((1+z)\). Today we measure this radiation as having the spectrum of a Black Body at temperature of 2.736 K (see figure 2). This temperature means the radiation is primarily in the form of microwaves.
• This model depends on a set of parameters like the density of matter and amount of curvature of space. These parameters are actually few in number.

This model’s simplicity has great appeal to cosmologists. It also leads to straightforward predictions that can be tested. That’s what makes it scientific. The most important extensions to this basic model are ones that can be evaluated too. Science is not a dogmatic enterprise, so it’s natural that models are continually being refined and tested.

Figure. 2. CMB Spectrum from COBE. Image courtesy Goddard Space Flight Center
Outline of Evidence for RHBBM and its Empirical Extensions

The RHBBM is supported by four important lines of evidence. The first is the uniform expansion of the Universe. Edwin Hubble discovered this effect when observing relatively nearby galaxies some seventy years ago. We see the uniform expansion extending now to redshifts of four and more, which corresponds to an epoch when the Universe was five times smaller than it is now. The dynamic solutions to Einstein’s equations were spurred on by Hubble’s discovery. Astronomers continue to confirm this expansion. Hubble’s law of expansion is a major indicator of the uniformity and isotropy of the Universe too, since Copernicus ultimately taught us that we have no reason to believe that we are at the center of the Universe.

The second, and historically the key, piece of evidence for the RHBBM is the CMB mentioned above. In the last decade, refined observations have shown us many details of the CMB spectrum and tiny spatial variations that continue to lend support to our model. Specifically, we have found that the spectrum is perfectly thermal — a Black Body (see figure 2). This is important because it indicates that the entire Universe was at one uniform temperature when the radiation was formed. The only reasonable way to do this is with a hot, dense beginning.

There have been challenges to a hot cosmological origin of the CMB, but these alternative hypotheses have given way in recent years. Part of the reason is because of how perfectly thermal spectrum is. It’s very hard to make such a spectrum without a single, dense source like the early Universe. The other reason is that we can measure the CMB indirectly in the spectra of distant quasars and stars. We find that it’s not just a local effect. We’ve also discovered that when we look at high redshift quasars, the CMB they are bathed in is hotter by just the amount we would expect if the Universe were more compact when the light was emitted.

The third line of evidence is really a confirmation of a major prediction made by the RHBBM. If the Universe were indeed hotter and denser a log time ago (the equations above show how to calculate these physical conditions), then one can predict the abundances of elements. It turns out that the Universe was only hot long enough to fuse protons and neutrons into the lightest nuclei like deuterium, Lithium and Helium. The model makes specific predictions that are now well confirmed.

Finally, there is pervasive evidence that the Universe emerged from a simpler state in the historical record of the evolution of both cosmic structure, namely the clustering of and development of galaxies themselves. In addition, the nuclear evolution of matter indicates succeeding generation of stellar furnaces have continually refined the cosmic brew into heavier and heavier elements. Our galaxy contains a succession of stellar populations that are like fossils from earlier, more primitive, epochs of the Galaxy. The famous Hubble Deep Field revealed galaxies in the distant past as they were being assembled from smaller mini galaxies. Deep surveys of galaxy clustering also reveal evidence for the development of cluster structures over time. These evolutionary lines of evidence continue to be strong evidence that all we see did proceed from a hotter, denser, simpler beginning – the essence of the RHBBM. But we are also finding new empirical evidence for what I call extensions to this basic model.

Empirical Extensions to the RHBBM

The basic RHBBM is in good shape. The most active field of cosmological research is in exploring extensions to this model. These additions build upon the current theory in two ways. First, they effectively add new density parameters to the equations of
motion for space as a function of time. In decades past we believed that the Universe was only made of the type of matter we know best — baryons. Now we allow other forms of matter and energy too. We also have an extension for the Big Bang that includes a very early epoch when the Universe is predicted to have been expanding exponentially with time. This extraordinary early epoch is called Inflation.

Inflation is an extension to RHBBM that is used to explain the amazing uniformity of the Universe. It’s also a natural result of models of the fundamental forces of physics. It’s not necessary to have an inflationary epoch, but if one doesn’t then one has to make very specific predictions about the initial uniformity and flat (Euclidean) geometry of the Universe. Most cosmologists have found that a very brief period of cosmic inflation in the first $10^{-33}$ seconds of the beginning seems to yield the most elegant theory. The COBE spacecraft observed that the fluctuations of the CMB seen across the sky are what are predicted by inflation. Although this evidence is well regarded, the cosmological jury is still not 100% behind inflation. Future observations will tell us soon if this is an extension that will be widely believed.

Observational evidence, over the past several decades, has continued to mount which indicates that the Universe cannot just be made of matter in the form of baryons. The motions of galaxies and stars in galaxies argue for an unseen type of matter that has gravitational force, but does not interact with electromagnetic radiation. In effect, we are blind to it. But we can detect its effects. For example, distant clusters of galaxies are seen to be distorted by intervening gravitational lenses (see figure 3). We call this type of matter Cold Dark Matter. It seems now that this matter is much more prevalent than baryons by a huge factor. Although this fact might seem strange to us, there were many subatomic particles that we have had no indication even existed until we had the technology to detect them. Neutrinos are a good example. Nevertheless, it is a stunning result to think that Cold Dark Matter is about ten times more prevalent than baryons.

As if Dark Matter weren’t strange enough, in the past few years astronomers have found evidence that the expansion of the Universe is actually speeding up. The primary discovery was through the observations of extremely distant supernovae. Type Ia supernovae should all be the same intrinsic brightness when they detonate. As a result, we can calculate a distance from their apparent brightness presuming the Universe is expanding steadily. But, these far

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**Figure. 3. Gravitational lensing.**
beacons appear to be fainter than we would expect for their redshift. This
means is that the expansion of the Universe is accelerating.

We don’t know exactly what is causing the acceleration, but Einstein’s
Theory of General Relativity can account for the effect. The same
equations of motion used in the RHBBM permit a Dark Energy term. It
appears as a density much the same way as baryon density and dark
matter density. But, in the dark energy case the term in the equation of
motion appears with a negative sign. So, rather than seeking to pull the
Universe together, which the matter densities do, dark energy density acts
like an antigravity term.

Astronomers are also starting to glimpse evidence for accelerated
expansion in their studies of the evolution of clusters of galaxies and
quasars. The Sloan Digital Sky Survey and the 2DF Survey will make
important contributions by pinning down the trail acceleration by dark
energy. But, even if observations bolster the case for dark energy and dark
matter, they will not tell us the fundamental nature of these mysterious
constituents.

These empirical extensions of the RHBBM now constitute our most
complete model of the early Universe. During the coming decades
astronomers will be launching new telescopes into space specially
designed to observe distant supernovae and make even more precise
observations of the CBR. We are deploying similar observatories in our
most microwave dark site on Earth – the South Pole. The data from these
telescopes will be compared to extensive surveys of the clustering of
galaxies and quasars, refined observations of gravitational lensing, and
spectroscopy of distant quasars. Finally, throw into the mix a variety of
large and small fundamental physics experiments and we should be able to
pin down the fundamental parameters of this more complete model of the
Big Bang within the next decade. To meet this challenge, there is now a
new breed of cosmologists adept at weaving the story of the many different
experiments to reveal these parameters. They call their work precision
cosmology. Yet as accurate as this work is likely to be, there are and will
still be questions at the boundary of even our most exact models. And it’s
these latter questions that seem to grab newspaper headlines.

Speculative Extensions to the
RHBBM

Within the limits of our current laws of
physics there appear to be no serious
challenges to the RHBBM. Any vestigial
arguments for the Steady State Theory became
blunted seriously after the COBE mission in the
early ’90s. But it’s precisely the limits of the
RHBBM and its extensions that define the
frontier and motivate fascinating new
hypotheses. We are all aware of these types of
questions from any conversations we’ve had
about cosmology whether it be our peers or the
general public. Most people want to know the
answers to big questions like: “What happened
before the Big Bang?” and “What is the Big Bang
expanding into?”

Research cosmologists ask these
questions too, but are generally more focused on
ones about how they can unify Einstein’s
theories with quantum physics and the
fundamental forms of energy, matter and
geometry in our Universe. These theorists have
invented models too, but most of them are
speculative because they do not rely yet on
empirical measurements. Since they explore
what philosophers call boundary questions, and
usually make extraordinary claims about reality at its most fundamental, they also attract attention from the press.

Stephen Hawking is a perfect example of a physicist who operates at the conceptual boundaries of our understanding of the Universe. He has generated fascinating speculative extensions in the realm of black holes and the challenge of unifying gravity with quantum physics. His books feature his theory of how the Universe might have begun in such a way that there was no boundary to space-time at the very beginning. Although challenging to understand and picture, like so many of his other theories, these ideas need to be taken seriously. But we must also understand that even such fundamental new ideas are but another extension to the RHBBM – and they are currently only hypothetical. Empirical evidence will ultimately be needed to elevate these speculations to become secure features in Big Bang models.

Recently there have been other fascinating speculations about the geometry of space-time itself. Most of them, whether they are investigating the idea of parallel dimensions or tiny, multidimensional quantum strings, involve new geometric interpretations of the Universe at either the large cosmological or tiny quantum boundaries. They are all attempts to paint a complete big picture of the Universe. Some of them may ultimately succeed.

When all the modern extensions that are well founded are combined, then what is the picture we are left with? The RHBBM is the same as it’s been for the past decade or so. The new empirical extensions are indicating that the landscape of the Universe now seems to be perfectly flat, just like that which we learned about in high school geometry. To achieve this flatness, however, we need much more matter and energy than we can see. The current Big Bang model under discussion requires that some sixty five percent of the energy in the Universe must be this new mysterious dark energy. It is this dark energy that could well be powering the accelerating expansion recent observations of distant extragalactic supernovae seem to be indicating.

And the baryons, of which we and the stars are ultimately made, may well be only a minor constituent of all the matter and energy making up the Universe! It’s as if we’re now in the midst of another Copernican Revolution. Only instead of being dislocated from the center the Universe, we are learning that the type of matter most important to us is but a mote in the cosmos. (See figure 4.)

Scientists are now focusing their new observations on the latest parameters of the Relativistic Hot Big Bang Model, including dark energy, dark matter and an early inflationary epoch. NASA’s MAP spacecraft (see figure 1), because it extends our cosmically inadequate senses, will provide some more answers; but it will take more observations by other special telescopes and detectors to yield a refined story of how the Universe began. The MAP team should release its first new data at the end of this year. And within a decade, we should have that detailed model and evolutionary tale. Maybe then more than a third of American adults will believe in the Big Bang.

Yet no one should ever stop questioning aspects of the Big Bang Theory. Because if
there’s anything science has shown us it’s that as we probe deeper and ask more sophisticated questions, the answers we get invariably yield more questions. Although the power of our science and technologies is great, we’ve only been at it a short while, a mere hundreds of years. The Universe has been using physics hundreds of millions of times longer than we have. We still have some catching up to do.

Challenges for Planetarians

Any planetarian knows that teaching lunar phases can be very hard work. So how can we possibly help people understand the Big Bang model? The abstractions of the concepts are particularly challenging for any attempts at visualization. The scales involve range from the sub atomic to the entire Universe itself. Nevertheless, there are several ways to help planetarium audiences and astronomy students begin to tackle this problem. Here’s a list of things that might be done:

1. **Emphasize the human stories involved in the discoveries.** It’s always important for our audiences to understand that the science is done by real people. There are outstanding individual stories, like those of Hubble, Einstein and Hawking, but we need to transcend even them by revealing how their ideas grow into scientific models and paradigms through the work of literally hundreds of researchers.

2. **Focus on the fact that the RHBBM is as an empirical, historical model.** It’s the result of years of theorizing, observing and wrangling. It’s not unassailable dogma, but the work of the scientific community.

3. **Teach that there are levels of precision in the model and its extensions.** So, although few astrophysicists would question the RHBBM, many have issues with the empirical extensions and are working to refine them. And we need to help people understand that one speculative extension that they hear about in the news needn’t upset the basic model. Our knowledge is imprecise and will be revised and refined continually on into the future. That’s the nature of science.

4. **Underscore the big ideas and keep them as simple as possible.** For example, it’s always useful to tell them that we have robust evidence for the RHBBM and it’s not just an idea. But, it also makes amazing predictions about the constituents of the Universe and its future fate. Separate parts of the model might be more easily explained than the entire story.

5. **Help people distinguish boundary questions from those at the actual research frontier.** Humans seem to be wired to ask big questions and planetariums seem to be a perfect forum for such discussions. The RHBBM operates near the boundary for most people, but actually cannot make statements about what ultimately started the Universe expanding or whether ours is one of an ensemble of numerous smaller universes. This is especially important in helping people think critically about hypothetical extensions that routinely make it into the news. Scientists are far more pragmatic about the questions they ask – they want to receive answers that will make them famous and receive funding for their work.

6. **Talk about specific upcoming missions.** The Big Bang is a model that
is being tested daily by astrophysicists. And there are very important missions to come. See the bibliography of this paper for some URLs to keep up to date.

7. Admit that many of the questions are open and will likely remain so for a long time to come. It’s dangerous to present science as a collection of facts rather than the process that it is. The Big Bang model didn’t just appear as someone’s bright idea, but it is a work in progress. It has many open questions.

There are probably other and even better strategies that educators can take in explaining the Big Bang. The description of the Universe contained in the Relativistic Hot Big Bang Model is now an empirical fact. We owe it to our audiences to help them successfully begin to grasp it. And it’s our duty to help them understand their own cosmic home.

**Bibliography**

There are several excellent references that should be in every planetarian’s Big Bang bookmarks file or folder:

The first are some URLs that point to pages on the Internet.

The NSF *Science Indicators* document referred to above may be found at: http://www.nsf.gov/sbe/srs/seind00/frames.htm

You may follow the critical CMB observations called MAP by following this link: http://map.gsfc.nasa.gov/m_mm.html

The following is a web site called “Level 5.” It’s a gateway into fundamental references and research in cosmology. Some things are easier to digest than others, but essentially everything is here: http://nedwww.ipac.caltech.edu/level5/index.html

Ned Wright, the keeper of the previous site, also has a great cosmology FAQ page: http://www.astro.ucla.edu/~wright/cosmology_faq.html

If you’re interested in keeping up with the search for dark energy, here’s the place to start: http://panisse.lbl.gov/


Last, but not least, is the COBE CMB observations web site. It’s been a decade since these observations, but they were critical to the proof of the RHBBM: http://space.gsfc.nasa.gov/astro/cobe/cobe_home.html

As for written articles, here are a few that should be in everyone’s files if they want to teach the public about the Big Bang — the HRBBM in particular. What’s important about these is that they are written by the researchers for a nonspecialist scientific audience. They’re not popular science writing, which, frankly, can often confuse the issues. These articles may be somewhat challenging, but they are carefully crafted to explain the limits of what we know in precise language. They’re fundamental review articles.


Turner, Michael S., *Why is the Temperature of the Universe 2.726 Kelvin?*, Science
Skywatchers of Africa

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Abstract

Since the beginning of human experience, the people of Africa have used their knowledge of the sky to meet their physical needs for survival, and for navigation. They have used the sky as a guide to build their societies, and for calendar making. The sky also shapes their spiritual lives; playing an important role in many ceremonies and providing clues to the deepest human questions.

A new sky show at the Adler Planetarium, Skywatchers of Africa, examines several cultures, past and present, from across the African continent. The show presents how these examples are similar to the experience of people all around the world.

Under One Sky is the theme of the Adler Planetarium’s year long focus on how the world’s cultures relate to the sky. Skywatchers of Africa is a central element in the Adler’s exploration of this theme and the importance of the sky in the lives of all people.

The 2002 Program Theme

For 2002, the Adler Planetarium & Astronomy Museum has created a year long programming theme: Under One Sky. This theme includes all types of museum programming including exhibits, lectures, special events, educational demos and activities... and most importantly of all Sky Shows. Under One Sky celebrates cultural diversity while highlighting the commonality of experience shared by human beings the world over. Using the lens of astronomy, we explore cultures around the world and throughout history. We examine how people everywhere have incorporated sky observation into their cultures and continue to weave the heavens into their lives.

Skywatchers of Africa is a new Sky Show which opened in March as part of this year long celebration. The continent of Africa was chosen to represent the theme because of the great diversity of cultures, both past and present, available there and because of the place that the continent holds in the genesis of all things, including sky observation. The show fosters a greater understanding among our visitors of people around the world.

Skywatchers of Africa is the second in a series of planned shows, following after Spirits From the Sky, Thunder on the Land, which are intended to bring the astronomical traditions and discoveries of cultures from around the world into the planetarium. Here follows a brief overview of the astronomical topics and cultures that are discussed in Skywatchers of Africa.

Overview of the show

Africans look to the sky as a vital part of the natural world. Among African traditions, the mysteries of the heavens are tied to the mysteries of human existence in a circle of life and death that flows in unceasing currents of being. African tribes and cultures have long observed the stars and woven the heavens into their lives in search of both wisdom and practical knowledge.

Skywatchers of Africa takes us to the dawn of human life on earth where the first humans contemplated the heavens. Night has just fallen...
in North Africa and the sky is revealed in all its splendor. The stars come out like the eyes of a thousand of ancestors. Almost nowhere on Earth is the night sky more brilliant than on the wild and open plains of Africa. From this breathtaking view we journey into the stunning physical and cultural diversity of Africa, and explore the relationship of Africa’s diverse cultures to the heavens.

Our story begins with a West African Yoruba creation story explaining the origins of the land. The Yoruba, one of Africa’s classical cultures, believe in the heavens as the giver of life and find in them spiritual fulfillment. This creation tale is narrated by a Yoruba storyteller and uses the planetarium dome as an environment to create a mythic space in the minds of the audience.

We next examine evidence that the first humans on earth looked to the skies for survival. The evidence is an animal bone which bears notches almost certainly tracking a lunar cycle. This bone from the Lebombo region of South Africa dates from 38,000 years ago, reminding us that people on this continent have been astronomers for centuries and millennia. From there we move on to the Nabta region of southern Egypt where recent archaeological findings show stone circles from 10,000 years ago that mark the solstices and cardinal directions. These circles predate classical Egyptian culture.

Some of the most well known African astronomical stories come from ancient Egypt, where 4000 year old writings still survive. We examine Egyptian beliefs surrounding Sirius and Orion. The spiritual beliefs of the Egyptians, as they relate to the sky, are examined including the sky’s symbology with life, death, and the afterlife. The astronomical alignment of the Pharaoh’s tomb in the Great Pyramid of Khufu is explained. We also show how the sky observation influenced Egyptian society on a community level. Throughout the show we point out how astronomy is incorporated into everyday life as well as people’s mythologies and beliefs.

The nomadic Tuareg and East African traders, who to this day traverse an area of Northern Africa larger than the continental United States, use the stars to navigate across the desert. Locating Polaris is demonstrated from the Tuareg point of view and latitude is demonstrated in a night journey across the Sahara.

We encounter other examples of African cultures weaving the skies into their daily lives. The Dogon people of Mali create their communities and construct their architecture based on a rich heritage of celestial observation and sky based mythology. We then travel to Kenya where the ancient Cushite peoples created a stone construction at a site now called Namoratunga. The calendrical alignment of the stones is demonstrated using the rising stars against the horizon.

The coastal peoples of East Africa and Madagascar used celestial navigation in their sea faring trading expeditions. We revisit Polaris in the context of a new culture and point out the commonality of experience between the people of the sea, people of the desert, and the people of our own culture today. All using the same observational methods for the same purposes in different cultural contexts.

Diversity overlaying shared experiences can also be found in the role played in many different cultures by the star cluster that we know as the Pleiades. Although observation of the Pleiades’ risings and settings are common throughout Eastern, Central, and Southern
Africa, *Skywatchers of Africa* reveals that differing tribal interpretations of these events vary in accordance with local weather patterns and customs. And yet, we marvel at how many African peoples from different parts of the continent knew the stars by the same name, revealing that cultural nuances and customs were carried throughout Africa, creating profound cross-cultural relationships and interaction with the skies.

As the show concludes we look back to Africa as our ancient home, and that of all humans, whether we trace our origins to recent centuries or to the almost unimaginable distant past. Each of us has ancestors who looked to the African skies for survival, to define their communities, and to find spiritual meaning and guidance. As we listen to the stories of Africa, we find links among their cultures to people all over the world. We realize that all humans – past, present, and future, next door or across the globe – are our brothers and sisters living under one magnificent sky and finding and sharing in the majesty of the heavens.

*Skywatchers of Africa* is an important contribution to the Adler’s 2002 theme, *Under One Sky*. The show invites our audience to explore a new culture, new ways of life, and new ways of thinking. Yet, *Skywatchers of Africa* also connects African traditions, and astronomy with the experience of all humans who, like Africans, seek answers in the heavens. *Skywatchers of Africa* invites us to contemplate our own ancestry and culture and encourages us to think beyond our familiar surroundings to the vast world in which we live.

*Skywatchers of Africa* was written by Dr. Marvin Bolt and myself. Research and content coordination was conducted by Dr. Keith Snedegar. The show runs 30 minutes and has been well received by all audiences. The original artwork is a mixture of painted scenes, photography and digital manipulation that creates a visual atmosphere for each culture to exist within. The original music also evokes a mood of being in Africa. The show is able to transport the audience to a world which may be unfamiliar yet is compelling. We have used this as a framework for presenting a wide variety of astronomical topics, both cultural and scientific, which brings the audience closer to an understanding of the rich sky traditions that we share with others around the world… *Under One Sky*. 
Devised for 38 degrees north latitude. Windows for other northern latitudes could easily be designed and substituted. Southern latitude windows could also be created but, of course, would require a southern hemisphere star wheel.

Constructing the planisphere is quite simple and straightforward, if you carefully follow the attached instruction page. Take care that duplicates of the star wheel and horizon window graphic are exactly the correct size and that the copies are of high resolution so that the fine details are retained. The former caveat is due to the fact that some printers and photocopiers print slightly larger or smaller than the original.

This planisphere has several advantages. It is quite inexpensive, especially if you recycle outdated software CDs or CDRs that failed to burn properly. [Yes, you no longer have to throw them away or use them as drink coasters!] Even if you have to buy blank CDs, they cost but a few pennies each when purchased in quantities at computer or office supply stores. Similarly the standard jewel cases can be found new for less than 50 cents a piece, or even free after rebates or coupons in promotional offers. Another benefit of this planisphere is that it’s more durable than most paper or cardboard versions that are often used in astronomy classes. Keeping the jewel case closed after setting the planisphere helps to prevent damage from dew on damp evenings. One of the nicest features of this planisphere is that it doesn’t require the intrusion of a rivet or paper fastener as a bearing for the star wheel. This means that, unlike most planispheres, this one can truly show Polaris as it should be.

There are several ways to extend the concept of the CD planisphere. My first thought was to also use it to make a simple form of the nocturnal, a circumpolar star clock. A version of the star clock is attached. John Mosley suggested making alternative versions that show, for example, coordinate systems or moon phases. He remarked that the low cost and paper media would allow each student to have his own and to be able to mark on it. Stephen Edberg suggested making a more precise version of the star clock showing a magnified map of the true offset of Polaris from the celestial pole for amateur astronomers to use in telescope polar alignment.

My friend Richard Hill has developed a simple spectroscope using a cardboard box and reused CD ROM. Instructions for making this device can be found at this web address:
http://www.lpl.arizona.edu/~rhill/spect/cdspec.html

I hope that educators will find this activity of use and I welcome your questions, comments, suggestions, and extensions.
The Celestial Dome Planisphere
by Ken Wilson, Science Museum of Virginia

Instructions

Materials Required

a.) One (1:1) copy of the Horizon Window and Star Wheel. Instructor should test printouts and copies to make sure that no enlargement or shrinkage has occurred due to printer and copier variations.

b.) One standard CD [Compact Disk]—audio or data

c.) One standard CD jewel case

Tools Required

a.) Scissors or small X-Acto™ knife

b.) Transparent tape (e.g., Scotch™ Magic™ tape)

c.) Glue stick (or other suitable adhesive for paper and plastic)

Procedures

a.) Carefully cut out the Star Wheel and Horizon Window using scissors or small X-Acto™ knife. Take special care in cutting the round outer border of the Star Wheel and the base and corners (labeled “A”) of the Horizon Window.

b.) Carefully cut out the oval window of the Horizon Window.

c.) Using a glue stick, coat the surface of one side of the CD with glue and carefully stick the Star Wheel to it so that the outer circle of the Star Wheel coincides and is centered with the outer edge of the CD.

d.) Using small pieces of transparent tape, cover the top of the central spindle of the CD jewel case so that the sharp edges of the fingers won’t tear the paper of the Star Wheel.

e.) Insert the CD mounted Star Wheel into the CD jewel case.

f.) Test the Horizon Window by carefully placing it such that the base corners (A) fit evenly into the corners of the CD jewel case and the upper curve aligns evenly below the arc of dates on the Star Wheel.

g.) Place dabs of glue from the glue stick on the black plastic of the two corners of the CD jewel case nearest the hinge of the jewel case.

h.) Carefully place the Horizon Window such that the base corners fit evenly into the corners of the CD jewel case where you placed the dabs of glue. Before the glue sets, adjust the alignment of the Horizon Window so that the curved edge with the hour marks is even with the inner circle of the days and months scale on the Star Wheel when it’s mounted on the jewel case.

Usage Notes

a.) Determine date and time of stargazing. Turn Star Wheel until date aligns with time of observation.

b.) Hold planisphere vertically such that the direction you are facing is closest to the ground.

c.) The outer edge of the oval hole in the Horizon Window represents the horizon.

d.) The area near the middle of the oval hole in the Horizon Window shows stars located almost overhead.

e.) Constellation names are in all capital letters.

f.) Star names are in mixed case letters.

g.) This planisphere is designed for a 38 degree north latitude but should be useful up to 10 degrees north or south of that.
Celestial Dome Planisphere

Horizon Window (top)  

Star Wheel (bottom)
The CD Star Clock  
*by Ken Wilson, Science Museum of Virginia*

**Instructions**

**Materials Required**

a.) One (1:1) copy of the CD Star Clock graphic page. Instructor should test printouts and copies to make sure that no enlargement or shrinkage has occurred due to printer and copier variations.

b.) One standard CD [Compact Disk]—audio or data

c.) One standard CD jewel case

**Tools Required**

a.) Scissors or small X-Acto™ knife

b.) Transparent tape (e.g., Scotch™ Magic™ tape)

c.) Glue stick (or other suitable adhesive for paper and plastic)

**Procedures**

a.) Carefully cut out the Star Wheel, Time Arch and Horizon pieces using scissors or small X-Acto™ knife. Take special care in cutting the round outer border of the Star Wheel; the base and corners (labeled "B") of the Horizon; and the top of the time arch and its corners (labeled "A").

b.) Using a glue stick, coat the surface of one side of the CD with glue and carefully stick the Star Wheel to it so that the outer circle of the Star Wheel coincides and is centered with the outer edge of the CD.

c.) Using small pieces of transparent tape, cover the top of the central spindle of the CD jewel case so that the sharp edges of the fingers won’t tear the paper of the Star Wheel.

d.) Insert the CD mounted Star Wheel into the CD jewel case.

e.) Test the Time Arch by carefully placing it such that the base corners (A) fit evenly into the corners of the CD jewel case.

f.) Place dabs of glue from the glue stick on the black plastic of the two corners of the CD jewel case nearest the hinge of the jewel case.

g.) Carefully place the Time Arch such that the top corners fit evenly into the corners of the CD jewel case where you placed the dabs of glue.

h.) In a similar fashion place dabs of glue in the other two corners and place the Horizon piece so that the “B” corners fit snugly in the corresponding corners of the jewel case.

**How to Use**

a.) Determine month and time of stargazing. Turn Star Wheel until month aligns with time of observation.

b.) Face the direction north and hold the star clock up so that the Horizon part is lowest and the Time Arch is highest.

c.) The stars marked on the Star Wheel should now correspond with the stars you see in the sky.

**OR**

a.) Face the direction north and hold the star clock up so that the Horizon part is lowest and the Time Arch is highest.

b.) Turn the Star Wheel until the orientation of the stars on the Star Wheel match that of the real stars.

c.) Find the current month on the Star Wheel and the nearest time marked on the Time Arch will be the time of night.
The CD Star Clock

Time Arch

Star Wheel

North

Horizon

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Visualizing... [Poster Papers]

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The three poster papers discuss various aspects of the production process we pursue here at the Rose Center. They were intended to complement Carter Emmart’s oral presentation on Thursday, “8.1.4 Making the Rose Center Space Shows.”

PDFs of the posters are in the Supplement folder in the IPS 2002 Proceedings CD-ROM, or they can be downloaded from http://research.amnh.org/~wyatt/IPS2002/

[Images and text of the posters are on the following pages.]

Visualizing Our Solar System

Ryan Wyatt and Carter Emmart, Rose Center for Earth & Space, American Museum of Natural History, New York, New York

The latest production from the Rose Center for Earth & Space, The Search for Life, includes fly-bys of several planetary bodies, a touchdown on Mars, and a replay of the Earth’s evolution. Real data formed the basis for these visualizations. In this poster, we describe the techniques used to change Surveyor and Pathfinder data into realistic fulldome environments, and we outline the steps used to depict the Earth’s evolution as seen from orbit.

N-body simulations by Kokubo et al. provided the basis for our visualization of the formation of the solar system. We represent each particle in the simulation with an asteroid-like object. As the system evolves, particles accrete, and we represent more massive particles with larger objects. In order to convey the accretion process, we chose to exaggerate both the size of the objects as well as the scale height of the particle distribution—in actuality, the disk would be razor thin, and the particles would be too small to be resolved by the video display system. We also added blue haze to suggest scattering from dust. Note that the image of the Sun reddens as we look through the dusty disk.

[Text area 2]

After observing accretion in the forming solar system (at left), we zero in on the early Earth. The four images below show Earth at different points in its history. We initially illustrate a cratered surface with volcanic activity and a relatively thick, outgassed atmosphere (upper left). We then show Earth surrounded by a ring of material, partially cleared by its newly-formed moon; at this point, we see no surface water (upper right). Using Chris Scotese’s time-evolved models of plate tectonics and estimates of ocean levels, we show “snapshots” of Earth at various points over the last few hundred million years (lower left). Finally, we end with the modern globe, its recognizable features of human origin revealed on the nighttime side (lower right).

Because we leap through billions of years in the...
sequence, we change the starfield in the background accordingly, with a randomized function that keeps the overall distribution of bright stars along the band of the Milky Way.

Our flight path over Mars takes us across Vallis Marineris, Olympus Mons, and the Tharsis Plateau. We use Mars Global Surveyor MOLA data (without exaggerated elevation) as the basis for our approach and fly-over. A high-resolution texture map is wrapped over radar data to provide a representation of the Martian surface. We then composite an atmosphere with appropriate scale height. “Landing” on Mars then makes use of an elegant flight path over a publicly-available VRML model. The model reconstructs the three-dimensional terrain around the Pathfinder site using the lander’s stereoscopic imagery. The data have serious limitations, but slight motion superimposed on the model reveals the dimensionality without revealing its shortcomings.
Visualizing Star Formation

Ryan Wyatt and Carter Emmart, Rose Center for Earth & Space, American Museum of Natural History, New York, New York

The latest production from the Rose Center for Earth & Space, The Search for Life, depicts the formation of a star cluster and surrounding ionized region. Several terabytes of astronomical simulations formed the basis for these visualizations. In this poster, we detail the process involved in working with the direct product of astronomers’ research and interpreting it for a general audience. We address such questions as, “What color does one make the invisible gas?”
The series of seven images above follows a flight path into the Milky Way toward the Sun’s position. The red-and-blue square represents a magneto-hydrodynamic (MHD) simulation of expanding supernova bubbles; the square measures about one kiloparsec on a side. The red cube (visible in the last few frames) represents a separate simulation of a turbulent region where two supernova bubbles intersect; the cube measures about one parsec on a side, and a sample data cube appears at right. The images were used to design a flight path through time-evolved data. The sequence was then rendered using volumetric techniques (see above right).

The four dome originals shown here result from the San Diego Supercomputer Center (SDSC) volumetric visualization of a one-parsec-sized MHD simulation by Mordecai-Mark Mac Low, a researcher at the American Museum of Natural History. The simulation models a turbulent region that develops pockets of sufficient density to form stars. In the show, we depict the cool, dense gas as blue, with its brightness proportional to a low power of its density. (Individual members of a star cluster, modeled in a separate nbody simulation, appear embedded in the blue cloud.) As soon as a bright star forms in the center of the region, it ionizes the surrounding gas, and the gas begins to glow green (doubly-ionized oxygen) and red (singly ionized hydrogen).

Visualizing Exoplanets to Extragalactic Space

Ryan Wyatt and Carter Emmart, Rose Center for Earth & Space, American Museum of Natural History, New York, New York

The latest production from the Rose Center for Earth & Space, The Search for Life, shows the positions of exoplanetary systems in the context of our local solar neighborhood, which is in turn positioned within a model of our galaxy and the observed structure of extragalactic space. Numerous astronomical datasets provided the basis for these nested visualizations. In this poster, we review the availability of public-domain data and describe the real-time software we use to preview and interact with the data.

In the new show, we illustrate a hypothetical exoplanet system with a Jovian planet at approximately 1 A.U. from a solar-type star. The planet’s cloud bands resemble Jupiter’s, but the colors suggest scattering from increased water vapor—because the planet is closer to the star than Jupiter is to the Sun, we see more scattered blue light, and the planet shows less contrast between bands. A terrestrial moon with a tinted atmosphere orbits the planet. We have tried to underscore the system’s differences from Earth and Jupiter.

A final render of the Milky Way and our extragalactic environment. The Large and Small Magellanic Clouds are visible on the left-hand side of the image; the Zone of Obscuration cuts along the center.

The four pictures above are snapshots from our Partiview / Virtual Director software, selected along a flight path that takes us from the solar neighborhood to well outside the Milky Way. The circled stars (Upsilon Andromeda, GJ 876, etc.) all show evidence of exoplanets; the wireframe sphere has a radius of approximately forty light years (the distance relatively powerful radio signals have travelled from Earth). Departing the galaxy, we place humanity’s impact on our environment in a cosmic perspective.

Another image from Partiview, the above shows a layering of various data sets on top of the...
Milky Way model built at the American Museum of Natural History and Hayden Planetarium. We use the software as a production tool, allowing us to view flight paths composed in Virtual Director, related software developed at the National Center for Supercomputing Applications (NCSA). The ability to view nested data sets in appropriate scale and context to one another proves valuable in an educational context as well.

The Partiview software is available for free, online at http://www.haydenplanetarium.org. Follow the links to the Digital Universe.
GOTO Gateway 2002

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Abstract
It is time to explore with GOTO!

Young Seizo Goto started making dozens of one-inch telescopes in his backyard for amateur astronomers in Japan, GOTO’s anxious wonder of inventions began. Now 76 years after the foundation of GOTO, our planetariums cover from the 3 meter dome to the 50 meter dome. In recent years in a respectful manner of our service, we have contributed countries and regions like USA, India, Korea, China, Taiwan, Chile, Paraguay, Philippines, Egypt and Japan in different products of not only Astronomical Telescopes but also in Large format film projectors and Planetarium projectors.

While this IPS2002 in Wichita was a surely successful International conference, we do hope many more to come. While we displayed 2 of our best planetarium products for small dome utility. We hope and invite you to frequently visit our web-site at http://www.goto.co.jp

While CHRONOS is a rapid growing and flagship product of GOTO as bringing a breakthrough into this dome size format (8-12 meters), a NEW EX-3 is a classroom planetarium answer for you from GOTO.
The Planetarium as a Site for Informal Science Education
[Panel Discussion]

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Panel Abstract
Panelists from four continents will explore the use of the planetarium as a site for informal science education. The presentation will focus on three areas:

1. Examples — In what ways does your planetarium serve as a site for informal science education?
2. Challenges — What are some challenges that your planetarium faces in your efforts to carry out informal science education?
3. Resource Sharing — What suggestions could you offer for ways in which planetariums can share resources in informal science education? The panelists will discuss their common resources as well as those that are unique to their geographical region. This panel discussion has been organized by the IPS Education Committee. Through the Education Committee, special emphasis will be given to resource sharing and methods to follow up the ideas presented by the panelists.

Introductory Remarks by Gary Sampson, Panel Moderator
According to the National Science Foundation in the United States, “Informal education engages students, educators, and the general public in settings away from the classroom (e.g. school field trips to science centers).” Informal education combines educational substance with the excitement of successful public outreach. Thus, informal science education fills a gap between formal science education on one hand and public outreach on the other hand. The intention of informal education is both to provide a learning opportunity and to motivate further learning and lifelong interest.

The key components for informal science education in the planetarium include a program idea and an audience. The audience is normally drawn from the local community and can include the general public, scouts, girls and boys clubs, youth groups, school groups, and even senior citizens’ groups.

The program idea often comes from the local planetarium as well. For example, there are
numerous planetaria that present skywatch programs both in the planetarium and outdoors, weather permitting. Beyond the local community, excellent program resources for informal science education are available from a variety of sources. Notable among these resources are those of the National Aeronautics and Space Administration (NASA) in the United States. NASA’s Office of Space Science (OSS) has a mandatory education and public outreach component for each mission. These are just a few examples of programming possibilities from NASA:

- SSE Forum and the Hubble Space Telescope Institute, which provide up-to-date slides for IPS members on a subscription basis
- OSS DePaul University which facilitates the Great Lakes Planetarium Association Space Advisory Committee for program ideas and resources
- Collaboration with planetaria to produce planetarium programs such as Boston Museum of Science’s program about the FAME (Full-Sky Astrometric Mapping Explorer) mission
- The Explorers Project, a collaboration between NASA’s Education Division and the Bishop Museum in Hawaii, which has produced a series of programs that are available to planetaria in the United States at no cost

It is obvious that a multitude of program resources for informal science is readily available to planetaria. To facilitate the sharing of resources and ideas for informal science programming, the IPS education Committee has set up three venues:

- The “Focus on Education” column in the Planetarian
- Online lesson bank on the IPS web site
- Space Science Education web site links, also on the IPS web site

As a follow-up to today’s panel discussion, the pertinent resources that are discussed will be shared through the three venues that the IPS Education Committee has set up. Further sharing will be encouraged as an ongoing process to provide program material for informal science education to planetaria on a worldwide basis.

**STATEMENT BY PROF. ANTHONY FAIRALL**

Aside from our regular presentations (which primarily serve an educational purpose) we run evening courses in the planetarium, i.e. lectures open to the public without examinations. By evolution, two main courses have survived. Our “Cosmos” course includes an overview of the universe, the evolution of stars, formation of planets as well as galaxies and cosmology. The “Starfinder” course provides a detailed understanding of the celestial sphere, as well as familiarity with the night sky. “Starfinder” has proved the more popular and it currently sells out even when offered four times a year. It is pleasing to see this course appeals to a complete mix of ages and cultures. Consequently, for the moment, we have dropped “Cosmos” but built some of its elements into “Starfinder”. Skilled presenters are our greatest need. It might also be possible to import complete “courses” from other planetariums to expand our repertoire.
STATEMENT BY LORIS RAMPONI

The activities of Serafino Zani Astronomical Observatory (Lumezzane, Brescia, Italy) often include the use of planetarium for informal science teaching. Fixed and mobiles planetariums are used for the different programs. Sunday family shows, including story reading about sky legends, evening projections for the general public that follow our astronomical courses, special activities (“Magic Walls”) inside libraries and natural park visitor centers (“Star Parks”), and science and theater shows under the dome, are some examples of our programs for informal science teaching.

Through all of these activities we try to include the use of planetarium in all our public initiatives, not just during the programs devoted to astronomy. For example, in one of the public evening lessons about a course on the elementary use of microscopes, we use a special Starlab cylinder. Inside an art museum we show the figures of Greek constellations after the description of a XIX century painting of scientific interest. In this way the planetarium projector becomes a spectacular tool to keep up the attention of the public and to diffuse science and astronomy to people that usually are not interested in these topics.

Many of these experiences will be described by 35 mm slides, and are collected in a reference list that will be given during the panel discussion. Every year we organize a special week in which colleagues interested in knowing more about our programs can participate.

STATEMENT BY APRIL WHITT

Fernbank Science Center has been offering informal education in the planetarium since we opened in 1967. Our general planetarium programs bring the latest astronomy information to members of the general public. Science Olympiad students visit during the spring for help with their competition studies. Over the last year, scout groups have become a focus of our programming as well. Girl and Boy scout groups have attended planetarium shows and workshops to earn badges or patches. As Georgia’s Star Station One™ site, Fernbank works with school and public groups interested in the International Space Station.
Scriptwriting for 21st-Century Planetariums

Panelists
Carolyn Collins Petersen, Chairperson
William A. Gutsch
Philip Groce

Thomas Kraupe
James Manning
Kris McCall
Isshi Tabe

Introduction of the panelists followed by 5-minute statements and discussion

Carolyn Collins Petersen

Carolyn Collins Petersen is vice-president of Loch Ness Productions and responsible for all script research and creation. To date, she has written shows that have been shown in more than 700 planetarium facilities worldwide. As an active science writer, Carolyn contributes to such magazines as Sky & Telescope and StarDate. She is first author of the widely popular Hubble Vision (Cambridge University Press), and co-editor of The New Solar System (Sky Publishing and CUP) A planetarian since 1980, Carolyn was named an IPS fellow in 1986. She has served as IPS publications chair and as President of the Rocky Mountain Planetarium Association. Carolyn was an editor at Sky Publishing Corporation, working on books and products, Sky & Telescope Magazine, and served for three years she served as editor-in-chief of SkyWatch Magazine. Prior to that she spent 8 years as an astronomy researcher at the University of Colorado while completing work for a masters’ in science journalism.

Welcome to Scriptwriting for the 21st Century Dome. I am honored to chair this session along with my esteemed colleagues up here in front of you.

The idea for this workshop germinated last year in an email discussion about creativity between Phil Groce and me. One thing led to another and finally Phil wrote, “You know, Carolyn, you ought to host a seminar or something on scriptwriting at IPS.” So, after flurries of emails, here we are!

We’re all going to give short statements about our vision of scriptwriting for 21st century domes. Then, we’ll open up the floor for discussions and questions. I’ll start off the proceedings with my own statement.

Writing for the planetarium audience gives us a chance to create for a unique medium that occupies a distinct niche in education and public outreach. As we’ve already seen in the presentations last night and will see throughout the week, it’s a dynamic medium with a lot of exciting stuff happening — particularly in the technology department. And it requires us as writers to flex a unique set of mental muscles. What matters your ability to tell a story. As a planetarium scripter, I’m putting words in the mouth of a narrator, who in turn is using artistic expression to place those same words inside the minds of the audience. And the audience is — or should be — our most important consideration.

And audience is what I want to stress to a scriptwriter. It is absolutely imperative that you know the physical requirements of the theater you’re writing for — but when it comes to putting words on paper, you have to remember that it’s not the instrument or the dome or the administrators or the city you’re writing for. It’s the people who paid money to get in and are settling down into a seat, gazing expectantly at the dome, and waiting to be entertained, educated, amazed, and awed. They’re who you’re doing it for — and this is true no matter what you’re writing.
Lois McMaster Bujold is a writer of some very interesting and personable science fiction books. In her book *Dreamweaver's Dilemma*, she talks about the craft of writing and the essential interplay that writer and reader have with each other. I want to share some of her thoughts with you. Even though she's speaking primarily about books, substitute the words “planetarium show” for the word “book” and it is very appropriate.

“The book is not an object on the table, it is an event in the reader’s mind. It’s a process through which an idea in my mind triggers an idea, more-or-less corresponding, in yours…. The book, if you like, is not the story but merely the blueprint of the story, like the architect's drawings of a house. The reader then is the contractor, the guy who does the actual sweat-work of building the dwelling. From the materials in his or her head, the ideas, the images, the previous knowledge, each one actively reconstructs the story-experience — each according to his measure, knowledge, gifts. And charity.”

Here’s another way to think of your work and the role that your scripts fulfill. Because our stories are interpreted visually for the audience, think of our work as a cosmic play, or even a unique kind of astronomy screenplay. We may not always have characters to create or portray in our scripts, but we do write about compelling things and interesting processes that engage people’s interest. I think that in a way, we’re really very unique dramaturgs. Planetarium dramaturgs.

I first ran across that term “dramaturg” in high school when I thought I wanted to be an actor. I joined the student thespian troop and was assigned to work with the dramaturg. She was a lady who took the script and researched the history, literature, and art of the period the play was set in. She worked with the director to make sure the actors’ lines were delivered correctly. She advised the scenery and props people on making the sets as accurate as possible. She was, actually, what playwright Mark Turvin calls the Director of the Text. The Dramaturg ensures that the words and intentions of the scriptwriter are being served in the presentation of the show.

Not only do we as planetarians get to write our scripts, but we have to be our own dramaturgs/director/producer. We work with the visual designers to get the images right, and we think about how the narration will sound in the mouths of various narrators. We select the music and coordinate the final production. And all of this is to create an educational and entertaining story to present in our domes. Which brings us back to those folks in the seats, waiting to see your show.

Whether they are students awaiting an interactive lesson or a fully produced program, or members of the general public expecting to be told a cool story about something neat in the universe — they are the mass audience we are here to inform, entertain, and amaze. But they also bring something to the show too. We can’t forget that when we write. We’re their storytellers and we owe them something good to work with!

**Philip Groce**

Philip Groce currently serves as Senior VP for design and development at MegaSystems, Inc. and is President of Helping Planetariums Succeed. Mr. Groce has been an active member of IPS since 1974 and an IPS Fellow since 1986. Over the last 34 years, he has been employed at five different planetariums, three of which he served as director. During this period Phil has written more than 100 planetarium shows, many of which have played at hundreds of other facilities across the US, in Europe, and Japan. He has served as a scriptwriter for both Bowen Productions and Sudekum Planetarium. From 1982 to 1987, Phil also wrote for television news as Science Analyst for WJXT-TV and the Florida News Network. Currently, Mr. Groce serves as a design consultant for new and renovated planetariums and limits his scriptwriting and producing to grand-opening programs for these facilities.
Thank you Carolyn for inviting me to participate in this panel discussion. First I want to state that for the moment I am limiting my remarks to scripts for prerecorded public programs. Live lecture presentations and interactive school presentations require more time than I can give in these opening remarks.

There is a lamentable trend in planetarium shows that I fear will get worse before its gets better. It is a trend that I regret I may have helped along the way. With the advent of multimedia, video and full-dome video in planetariums there is a tendency to write scripts toward the visual, rather than for the spoken word. Unfortunately, you may see examples of this approach during this IPS conference presented as the “future of planetariums.” When I worked in television news, I was always told “if we can’t show it, we can’t do the story. This is television, not radio, and not the newspaper”. Sadly, this same philosophy of show production and script writing is starting to permeate planetariums. This approach will either drive up the cost of productions to the point where only a few facilities can afford it or it will limit the content of scripts to that which can only be easily or inexpensively visualized. Worse, I think this philosophy will deny our audiences the very reason why they came to the planetarium to begin with: to be inspired by the cosmos...to be lost and found again in the stars.

Another worrisome trend is the amount of audience multi-tasking taking place in the name of “participatory “ programs. Before I offend all of the purveyors of this technology, I will admit that for many student classes, this audience response system has value, especially as a game show device. In many programs, however, it is often another opportunity for an audience to get sidetracked or derailed by the distracting process of pushing buttons or participating in a survey. When the majority of the audience votes to go to Mars and I vote to go to Jupiter, I can’t help but feel, at least momentarily, disenfranchised from the program process. In some planetariums, the audience seems to be always aware of the audience response system, forcing them to multi-task throughout the program. Today, we are constantly multi-tasking. Whether it’s talking on our cell phones while driving, answering emails while on a conference call or watching television during a family discussion, this multi-tasking is detrimental to all of the tasks at hand. Today more people are going to movie theaters then ever before, in spite of the ability to watch movies at home. One of the reasons is that in a movie theater we are free of distractions and multi-tasking. We are free to concentrate on one task and to get completely immersed in the story at hand. So it should be with planetariums.

I have had many mentors in my scriptwriting career. Jack Horkheimer taught me how to apply the fundamentals of theatre and playwriting techniques to planetariums. Planetariums are, after all, theatres. Behind the mask of every great planetarium teacher and presenter is an accomplished thespian.

I have learned that everyone needs to be edited, whether self-imposed or by a respected colleague. Editors have taught me that less is almost always more. Many shows I see today are over-scripted, with too many words and way too much narration. Most beginning planetarians make the fatal mistake of trying to tell their audiences everything they know about a subject rather than trying to share the essence of their excitement about a subject. Music alone and even silence can be very powerful communication tools. In production, it has always been my experience that you should err on the side of longer pauses and more music and environmental sound effects.

While many would argue that a picture is worth a thousand words, I often find that a few well-chosen words are far more cost effective than a thousand frames of animation.

From the writers Edgar Allan Poe, Charles Dickens, Mark Twain and Ray Bradbury I learned...
how to tell a story and to paint a scene with just a few words. For example, in the preface to his short story collection October Country, Ray Bradbury paints a dark and melancholy world.

“October Country, that country where it is always turning late in the year. That country where the hills are fog, the rivers are mist; where nouns go quickly, dusks and twilights linger, and midnights stay. That country composed in the main of cellars, sub-cellars, coal bins, closets, attics and pantries faced away from the sun. That country whose people are autumn people, thinking only autumn thoughts. Whose people passing in the night on empty walks sound like rain.”

These 78 words are much more powerful than a thousand computer visualizations, especially when read in the dark under the stars. A good scriptwriter knows the value of both sight and sound and writes to the strengths of each.

Every writer has his own special method for getting words on to paper. For me it is writing the ending first. The ending will likely be the last thing that your audience will remember. It is your last chance to inspire your audience to go out and look at the real night sky or visit an observatory or read a book on the subject. The ending gives me focus and allows me to shape and point every sentence in the beginning and the middle of the script toward those last words.

Finally, when I get there, I often rewrite or refine the ending to reflect the knowledge, energy and mood I have attained along the way.

I would like to share with you the ending of a show I wrote as the inaugural program for the new Pennington Planetarium in Baton Rouge, Louisiana. This planetarium is just 50 paces from the Mississippi River and the place where Mark Twain boarded the steamboat “The City of Baton Rouge “ doing research for his book Life Along the Mississippi. So it seemed only natural that I would start my scripting process by writing this ending.

“Long before the written word and the science of astronomy, there was the wonder of the stars.

On some clear night, I challenge you to travel on to a Louisiana country road and stop at a point free of streetlights, porch lights and road signs.

There I ask you to share with a friend or a son or a daughter or a wife or husband, the starlight that binds us all together.

Among these stars you may see the Milky Way. This River of Light which runs through our thoughts and courses through our imagination has always challenged us. For nearly every civilization it has been a source of stories and myths...a mystery best seen on dark moonless nights.

Unraveling this mystery greatly enlarged our view of the stars and the size of the universe.

Just as the Mississippi River divides the land, the Milky Way divides the sky. Like Twain’s Huckleberry Finn, we are adrift in this River of Light on a raft called the Earth, sailing in a whirlpool of stars through a universe more vast and beautiful than we can ever imagine. And like Huck, we are all very young and only beginning our great adventure, not knowing what new discovery awaits us around the bend.”

William A. Gutsch

As Staff Astronomer at the Strasenburgh Planetarium and Chairman of the American Museum-Hayden Planetarium, Bill Gutsch spent over 2 decades writing school and public planetarium shows seen around the world. He has also been a syndicated newspaper columnist for Gannett, Science Editor for WABC-TV in New York, and Special Science Correspondent for ABC’s World News This Morning and Good Morning America. For the
past 7 years, Bill has continued to write and produce planetarium shows and serves as President of Great Ideas which has provided consulting, planning, fund raising, and educational production services to science centers, local and national governments, schools, universities, and educational television in North America, Europe, and Asia.

While I usually enjoy “having written” far more than I enjoy “writing”, I have spent quite a bit of my life writing - planetarium shows, books, articles, and syndicated newspaper columns, as well as television news, features, specials, and series for local and network commercial stations as well as PBS and cable. And, within planetariums, I have written and produced standard documentaries as well as science fiction and fantasy, comedy, shows that have incorporated poetry, interactive shows, non-interactive shows, stage plays, and even corporate special events. From this 30+ years at the yellow pad, typewriter, and computer, I feel experienced enough to say that writing for different media requires different mind sets and different processes.

In short, the most important point I can make is that planetariums are visual media. And so, in writing for a planetarium, you have to write for a visual medium and know the difference between writing for a visual medium and writing for nonvisual media.

When you are writing a book, an article, or a newspaper column, with the exception of a photograph or illustration here and there, the writer must carry much of the weight of conjuring the needed imagery in the mind of the reader. The words must get the reader to understand the story or the information but also must get the reader to see what is in the mind’s eye of the writer, or coming down the telescope tube, or out of the supercomputer. But having said that, given sufficient skill, the writer can take the reader anywhere in time or space and help the reader experience anything. Furthermore, at least within the context of a book or series of articles, the writer has quite a bit of freedom to develop topics and scenarios at a relatively leisurely pace placing several paragraphs or even pages between the introduction of a topic or question and the final “ah-hah!

In visual media, the tables are frequently turned. Now the visuals and how they are edited usually dictate topic, direction, flow, and pace. The goal is still to tell a story but now the visuals carry more of the task. And so, a good planetarium writer must not only be able to think visually but must know how to write for visuals and support them (and the accompanying music) with words. Don Hall once said, “A good planetarium script writer knows how to tell a story but also how to do so by writing what are essentially captions for visuals.” And, by and large, I think he is right. A good planetarium script needs to know when to “speak” and when not to speak but rather let the visuals and music carry the experience and also inspire the audience.

And so, as a planetarium writer, I may start with an idea for a show but, before I get much past a concept and, maybe, an outline, I am asking myself, what is the audience seeing now … and now … and now, scene by scene throughout the show? Even after a show idea with a good premise, treatment, and story has been evolved, a good script cannot follow unless the writer has a good understanding (a good “gut feel”) for what the audience is looking at, moment by moment, and how long each scene will sustain the audience’s interest and attention. The script then follows from this story boarding process and the pacing it dictates. And, unlike the pacing afforded the writer by many written media, visual media move fast and seem to be accelerating all the time.
In my opinion, two main reasons why particular planetarium shows fail with the audience is because the writer chose to tell the audience more than they ever wanted to know about a particular topic and/or because the writer tried to cram too many words into too little visual stimulation. And both mistakes stem from not understanding the medium. If you are writing a planetarium script and you don’t have a new scene for every 3 or 4 sentences (or less), it’s usually time to either conjure up more interesting visuals or rip script. If you are in love with what you have written, save it for your next book or feature article but don’t put it all in the planetarium show.

Finally, I have been asked if the style of writing for planetariums has evolved or is dependent upon the technology in the theater. The answer to both questions is “yes”. In my opinion, “one size fits all” planetarium scripts are a compromise. When I am approached by a planetarium or a consortium of planetariums to write a show, the first question I ask is “What equipment do you have?” For example, if the planetarium client has a Digistar II, or an Omnisca, or full-dome color video, I would be remiss if I didn’t specifically write for that technology. With certain types of technology, you can simply do things you can’t do without them and script and soundtrack should follow suit.

As noted above, pacing has also changed. It has quickened. And so, writing styles have evolved as the planetarium has evolved with, in general, fewer words per scene (as shows, in turn, have taken on more scenes per show). But it would be unrealistic to think that these general writing style changes for planetariums have occurred because of, or have been led by, planetariums. Television and IMAX films and the visual density, pacing, and dynamic dome coverage they demonstrate have proceeded such evolution in planetariums by years if not decades. Indeed with the visual density and sophistication of many planetarium shows currently still behind what lots of kids see on their home computers and Play Stations, I think we will be following the trend for a long time to come.

Thomas Kraupe

Thomas Kraupe is presently director of the Planetarium Hamburg in Germany and is also working with the Planetarium Munich to reopen in fall 2002. He is a longtime member of IPS and served as its president in 1997-1998. His academic background is in astrophysics and he earned his diploma in 1983 at the Max-Planck-Institut for Extraterrestrial Physics in Garching. He has served as astronomer and assistant director at Stuttgart’s Carl-Zeiss-Planetarium, and director of the Interactive Multimedia Planetarium at Forum der Technik - Deutsches Museum in Munich. Thomas is also a consultant, author and multimedia-producer for leisure Education and entertainment attractions and new media for science museums, planetariums and other immersive and interactive theaters. In 1996-2000 he served as a primary consultant for the American Museum of Natural History’s New Hayden Planetarium. Besides many dozens shows for his home base theatres, Thomas written premiere shows for the opening of new planetarium theatres around the globe. He is also member of the TIE Committee (Trends in Leisure and Entertainment), chair of Working Group TEACHING THE PUBLIC of the “European Association for Astronomy Education” (EAAE) and chair of the IPS Media Distribution Committee.

Planetariums have always been immersive simulators and with the stunning advances of space exploration we are no longer earthbound in our perspective. The planetarium is about perspectives and changes of perspectives in space, time and cultural perception.

The upcoming space missions and new generations of giant telescopes give us plenty of themes for new scripts. It is not a lack of topics we suffer, it is our lack of creativity in using what science and technology offer to us — even for smaller domes.
Planetariums have diversified and overall serve audiences in two categories - groups who expect our shows to be educational and others, who want us to entertain them within a hip space travel environment.

Yes, we are competing for time with other leisure attractions, but we still have a unique medium, which is currently reinventing itself with bright prospects for the future. We have a theatrical space where we present the ultimate story — the story of us, life, and the universe and just about everything.

Be aware: People live in different universes — universes of their own perception and we can categorize their attitude as “watcher”, “thinker”, “toucher”, “feeler” through which they filter the environments we present to them. In large groups, meaning in larger domes, we cannot expect that interactivity will work the way we expect — some people have fun just watching and only a fraction will want to deal with tactile devices as touchers.

I see a bright future for all-dome shows, if we manage to create immersive experiences, which will not be “another type of movie”. We should not try to imitate a movie, but also not refuse learning from experiences in the field of movie and TV productions. Let us be open to incorporate a variety of elements from the entertainment world to awaken the curiosity and senses for detection. And give our audiences time to breathe, to feel comfortable — and time to play mind games.

Introspective learning - “Where am I and what does that mean for me/us?” - that is ultimately what people want to understand.

I understand scriptwriting for the planetarium as the overall art of being able to create a story which takes the audience into an immersive scenery and guides them along a joint flight path. A planetarium show is not a radio show — the narration needs to invite you to accompany the visual environment — and not the opposite! Well, certainly we can argue about that, but I believe we are no longer in a “chicken or egg” type situation, because we all should agree that we first need the key idea, a theme or even a 1-2 sentence long message and answer to the question of “Why should an audience see the show? What is the essential message of the show?”

Indeed, we are dealing with immersive scenery, which will present strong visual impressions for the brain. With the advance of all dome effects, any choreography of a story needs to take into account the psychophysics of the human audiovisual systems. On the small screen it is no problem to cut, but from one scene to the next or from a total to a close-up — it is not perceived as a discontinuity. But the Big Screen — I mean here the immersive screen — does not work the same way. Whereas TV programs and even wide-screen movies affect only the central area of our field of view, immersive screens like planetarium domes work specifically with effects of peripheral vision. Any motion or changes presented in these areas, may signal “danger” to our brain so that the spectator is inclined to turn his head and feels distracted from the main storyline. In TV you cut from the total to a close-up without trouble. But dissolving complete sceneries and full dome projections has the potential for losing the audience. Hence do not throw facts at the audience members like stones, before they have a chance to get oriented and digest where they are.

With the advent of digital all-dome we now have a medium where we can indeed completely avoid any discontinuity along our flight paths (except cases where we do it on purpose), but we still have to avoid the distraction. Selecting a “flight path” — you may call it storyline in the more classical theaters — and pacing the show properly is what I see as the cornerstones for creating a good script and show.
Do not lose the audience by using audio or visual clues, which are in conflict or competing with the storyline! Less is more and this is sometimes also true for the visual sceneries, but mainly this is true for the narration. Yes, there need to be enough places where we should step back and let the brains of our audience do the magic!

In the early stages of the project of the new Hayden Planetarium, when we discussed how much narration is necessary, I tried to stir discussions by claiming that — given this stunning potential of immersing the audience in 3D digital model of the entire universe and taking the audience for a show which works like an all dome version of the acclaimed “Powers of Ten” film, from the Earth to the edge of the observable universe and back, we may not even need any narration, because the continuous flight without any miraculous cuts through the universe and back is strong enough when a good musical score kicks in. Why not provoke questions like that?

In a sense I am saying that scripts are no longer as important as they were in the “good old” Radio Days, but that’s not the whole situation — the script can no longer be separated from the visual flow of the show, and each word less or more in your script can and will be more decisive than ever for keeping or losing the audiences attention. The same is certainly true with the visuals, but since we now have much more visual stimulus than we used to have in the early days — with just a few thousand dots, we have to balance them much more carefully.

The flow of the show is vital — and I see the visual storyboard (with all the remarks) as ground zero where all the other elements have to plug in. It all comes down to a good story. The question you have to ask is: “For whom am I writing this script?” — who is the client and who will be the audience?” The review committee, the boss? The scientific community?

There have been shows where, in a tedious process, every word was discussed at length, whereas the choreography did not get the same attention. I believe that a script should not be the work of a committee, you need the artistic freedom and vision of a good writer-producer (or at least a writer who is able to understand/ cooperate with the choreographer/producer).

**Steps as I see them**
1. Idea and Theming
2. Visual storyboard
3. Raw Script
4. Flightpath
5. Pace (“time to breathe”)
6. Adapted Script
7. Visuals
8. Iterations
9. Final Script

**Trends**

**Up-to-date or even Real Time**

Future shows will benefit even more from digital technologies, since these allow us to incorporate up-to-date elements and even show modules that update automatically (Earth globe live from space etc.) The challenge is that these modules need clever integration into a storyline unless they are only meant to be an exhibit. I believe that it should always be our highest goal to “take our audiences there” — right now! The current night sky, the latest images and real-time imagery.

**Audience Participation**

Detective stories and gaming within shows using more elements of audience participation - not necessarily Interactivity - will become more common. This will also see a rebirth of live presenters in a virtual real-time environment.
Hybrid Shows

Shows produced in collaboration with the entertainment and music industry, which use characters or real figures from the big and small screen (see Bill Gutsch’s work and other examples, like Munich). I believe that it should always be our highest goal to “take our audiences there” right now! The current night sky, the latest images and real-time imagery.

Cross-Platform Networks

We have seen shows co-produced between planetariums — and sometimes external freelance artists and I think we will see more of that, because this will help us to produce better shows for the same amount of money per institution.

Production work increasingly makes use of the Internet and is no longer location based. Digital technologies will make the planetarium market a cross-platform market, where all is based on “all-dome-originals.” Linking whole theaters online is the ultimate challenge and will give us new mission profiles for explorations by whole audience groups.

Outsiders

There have been examples where writers who have never dealt with planetariums or astronomy before have been asked to come up with a script, which then, in a next step was transformed into a planetarium show. I do believe that we should indeed be more open and embrace also creativity from outside the planetarium field, but this can be a very tedious process.

Hopes and Dreams

There are gifted writer-producer-directors who can pull off the whole show, not just the script, but this is a rare talent, which they need to pass on to the next generation of planetarians. I hope we can manage to set up something like a planetarium academy for script and show production, which will invite also scriptwriters from the big and small screen. (Please remember, that most of our gifted folks themselves were inspired and trained by courses, internships etc. mainly at Strasenburgh Planetarium in Rochester. We no longer have such “Makes” for planetariums.

That’s my dream for the future - and has already been my vision since I started the new Munich planetarium in 1993. I do hope that I can help to contribute now to launch such an initiative at least for Europe, but hopefully keeping it open for the rest of the IPS community.

James Manning

Jim Manning has been toiling in the planetarium vineyard for 27 years, engaged in planetarium development, astronomy education, and show production—including scriptwriting. He’s written about 30 major scripts for his facilities and others as well as numerous smaller bits, and is a frequent contributor to planetarium-related publications. He writes the “What’s New” column for The Planetarian and an astronomy column for a local outdoor magazine, and is a former president of IPS. He likes his steaks medium-well, and his favorite color is green.

Four minutes provides time to crystallize perhaps two or three points about scriptwriting—so I’ll make four.

First, we’re talking about one species of planetarium program, I think: the scripted and taped show versus the less-scripted and live show. In the case of the scripted show, the script is everything because it’s the first thing. As those in the theater sometimes say: “if it ain’t on the page, it ain’t on the stage.” You have to start with a strong base.
Second, I don’t subscribe to the notion that the advent of the 21st century with increasingly sophisticated technologies and increasing shortened attention spans means epic changes in scriptwriting — at least not for the good stuff. Good scriptwriting has always been about good storytelling, and virtually all of the important rules for both transcend technology and topic. Special effects can serve a good story, but they can’t substitute for a bad one. If you don’t believe me, just watch Jurassic Park 3 again or any number of other movies I could name.

Third, you’ve still got to write for the medium — and it’s an audiovisual medium. You have to write words for the ear, but you’ve got to craft the script also for the eye. It makes no sense to write a page for a single slide, and a phrase for a great special effect. You’ve got to know the audiovisual capabilities for which you’re writing and to let a little movie of the show run in your head as you write, adjusting as you go. I call it having a vision for the show. And I have found, over the years, that the key to a good script is more often what you leave out than what you leave in. Spare and vivid wins the day, and never use a fifty-cent word where a twenty-five-center will do.

And by the way, we’ve always written for an all-dome technology. Just because it’s getting fancier doesn’t mean the rules of good writing or storytelling change.

Fourth, scriptwriting is hard; that and passing a kidney stone are probably the closest I’ll ever come to childbirth. Some days you beat the hell out of your muse, and some days your muse beats the hell out of you. But it does get easier with practice, age, and perhaps drink. And so long as you’re never completely satisfied (which means you can still get better), it can be immensely satisfying both in the process and the result.

Kris McCall

Kris McCall has been with the Sudekum Planetarium in Nashville, Tennessee since 1987. She has spent 26 years of her life under the dome, beginning as a high-school volunteer at the Alexander Brest Planetarium in Jacksonville, Florida. She eventually worked her way up to educator and producer and says that she has Phil Groce to thank/blame for her being in the profession. Kris has collaborated on a number of scripts, and began her solo writing career in the early 1990s. She credits her production team for helping her develop ideas and edit her work. Several of Kris’s scripts have won awards from the Tennessee Association of Museums and in the Eugenides International Planetarium Script competition. Her credits include “Worlds in Motion,” “Our Place in Space,” “Rusty Rocket’s Last Blast” and “The Planet Patrol Solar System Stakeout.

When Carolyn asked me to sit on this panel, my first thought was “that sounds like fun.” Then I found who the other panelists were — many of whose work I have admired since long before I ever wrote my first script.

When one sits down to write a script, or consider purchasing a show for that matter, it is because you need something. It could be a specific topic or a curriculum requirement or a way to tie into that next big blockbuster exhibit. Whatever the reason, you need a show.

First, you need to develop some clearly defined and measurable objectives. What do you want the audience to take away from your program? And remember, the objectives don’t all have to be educational.

Second, you need a reason for the audience to even be interested in watching your show. Disney called it the “wienie.” I attended an exhibit design workshop some years ago, and the presenter talked about grabbing the visitor from the very beginning. The difficult example he gave was an exhibit he had worked on that
would explore racism and segregation in the United States. Talk about a challenge: not to mention that the exhibition was to be mostly text and artifacts. The solution, which has stayed with me over these many years, is how they designed the entrance. You see, there were two doorways leading into the exhibit. One was labeled “white”. The other was labeled “colored.” It was fascinating to see people stop and think about which door they should enter. They were actively engaged before they had even made the decision of which door to choose.

Of course, there are other ways to capture peoples’ imagination. It could be a mystery, humor, a game show, or some other clever plot device. And sometimes you can reach them intellectually through well-crafted inspiration which in turn leads to the meat of the content. It is also OK to be enthusiastic about a specific subject and share it simply because it is cool or beautiful.

If the scriptwriter has done her or his job, the show will engage the audience, sometimes on many levels, while fulfilling the objectives that were devised at the start of the process.

Whether celebrity-narrated or not, the right voice, directed and well read, can add even more impact to a well-written script. Now, close your eyes and imagine any script by the panelists narrated by Bobcat Goldthwait.

It seems obvious, but is frequently ignored, that the narrator should be allowed to pause and catch his breath during the reading. Allowing for dramatic delivery and pauses for reflection give the listener a chance to think about what they have just heard.

Music can further enhance the aural experience by building emotion or drama, accentuating salient points, or allowing for simple enjoyment.

But half of the audiovisual qualities of the planetarium show are visual; not 60 or 70 or 90 percent. There can and should be audio high points and visual crescendos, but all flash and no substance makes for a weaker program.

Even with all the visual firepower we are seeing at this conference, image just for image sake could result in nothing more than a 25 minute thrill ride. That is not to say that visual interludes, diversions, or truly majestic elements are BAD, but if image is everything, what about subjects which can be described and illustrated but do not lend themselves to flashy visualization?

One of Carolyn’s questions for us ahead of time was “What is the nature of production in this new century?” This question diverts us a bit from the main focus on scriptwriting, but it is certainly relevant.

Production is changing at breakneck speed. There is so much new technology, capability, and capacity; it’s almost reached a point where “if you can dream it, you can do it.” That’s very liberating. All these advancements in production experience and technology are removing many of the obstacles to creative visualization. However, it comes back to the people who are producing the show, from the scriptwriter to the animator. A trumpet can make beautiful music, or not, depending on the person who is playing the instrument.

So we have come back to the quandary of writing scripts in this age of burgeoning technology. I have heard more than one person espouse the philosophy that a script should be written to take full advantage of the available technology. That is true: especially if the show is being developed for a particular theater or group of theaters. However, if a program is being produced for wider distribution, it helps if there are opportunities for workarounds or alternate visual interpretations. It will be some time before everyone has the same video capabilities; the same way that not everyone acquired automation or their first video projector at the same time.
The technology is truly awesome. But unless we make the experience more meaningful, it will be no better than watching the *iTunes* patterns on my computer monitor at home. The script, whether an astronomer’s personal journey, the latest discoveries from HST, or mythological drama, is the heart, the very foundation, of the planetarium experience. It can be educational, entertaining, or deeply inspirational: touching the visitor and giving them a personal connection to the universe.

**Isshi Tabe**

Isshi Tabe worked at Goto Optical MFG in the sales and planning department for a number of years before leaving in 1995 to establish LIBRA Corporation. His company creates planetarium shows (scripts, narrations, artwork, music, etc.) and distributes them throughout the whole of Japan.

On a rainy Sunday about 30 years ago, when I was 10 years old, my father and my uncle took me to the Gotoh Planetarium in Shibuya (near Tokyo), Japan. In the theater stood the Zeiss IV star projector. Until this point in my life, I had only seen pictures of planetariums in books and so this first visit was extraordinary for me. The stars appeared so small and bright; I had a hard time believing that they weren’t real. The live lecturer also held my attention with his words as he showed us the constellations and, like magic, made the bright moon conveniently disappear at one point so we could more easily see the relatively faint stars of Corona Borealis and Coma Berenices. I left the planetarium totally enchanted with astronomy.

A few years later as a junior high school student, classmates and I again visited a planetarium. This time, however, I was far less spellbound. The stars seemed artificial and the lecturer’s words uninteresting. Maybe it was the planetarium. Maybe I had become a teenager. Maybe something was indeed lacking in the planetarium experience.

For better or worse, I lost my interest in planetariums for a while but, fortunately, I remained intrigued with astronomy and became an active amateur astronomer. Of special interest to me were planets, comets, and meteors and I logged many hours of observing time studying them. The incredible experience of a total solar eclipse also fascinated me and lured me on trips to Okinawa in the south of Japan as well as abroad to Java, Hawaii, Borneo, Mongolia, and Hungary. In addition, a desire to see Halley’s Comet at its best brought me to Australia in 1986. And so my interest in astronomy remained high and continues to this day.

Gradually, however, I returned to planetariums. This time, ironically, as someone who, along with a talented team of artists, musicians, and others, creates planetarium shows seen throughout Japan — a country with over 250 functioning planetariums. However, in spite of the large number of planetariums in my home country, I believe the overall current state of Japanese planetarium programs leaves much to be desired.

Japanese planetarium shows, for better or worse, have become products of a rather rigid formula. There is some science discussed here and there, but large section of most shows are given over to repetitions of the same constellation identification and mythologies. In addition, storytelling with little science content is also a common occurrence. As a result, adults frequently find the experience boring and interpret the planetarium visit as being primarily for children (though, I believe, the children are also frequently quite bored themselves.) As a result, public attendance is down and amateur and professional astronomical interest in planetariums is virtually nonexistent. In short, new experimentation in planetarium programming in Japan is very much needed.
While storytelling should remain a critical part of planetarium shows, my feeling, and that of others in my county, is that more science needs to be infused into the shows in an interesting and exciting way. Doing shows on timely topics may also help sagging attendance since it may be assisted by news coverage of the same events.

Last year, for example, we created a show on the anticipated spectacular Leonid meteor shower of 2001. We included an interview with Dr. David Asher of the Armagh Observatory in Northern Ireland who accurately predicted the swarm observed over Japan and elsewhere. And, as part an historical element to the show, we also included an interview Jose Alvarez; formerly of the Chabot Space and Science Center in California who was a witness to the last major Leonid swarm in the western United States in 1966. For the coming year, new missions headed to Mars are inspiring us to create a show about the “Red Planet”. New and recent discoveries will, of course, be featured in the program. But, in addition, historical figures such as Lowell and Antoniadi are likely to also find their place. Some years ago, in a show I saw in Paris, puppet figures of these two gentlemen enthusiastically debated the existence of the canals of Mars. In our planned show, such personalities may be “brought to life” via animation or at least voiceovers during the program.

All in all, however, our mission remains the same — to inspire in people an enjoyment of astronomy and, in the process, correct misconceptions and help people better understand how science is done. We simply hope to now do it in a more interesting and scientifically credible way. In that, I think our script writing goals are universal.

Discussion Recap

A common theme among the panelists was that all the panelists is that the show needs to start with a good story idea and that idea should remain paramount throughout the script. Questions were raised about the pacing of shows and why planetarium shows continue to run at a leisurely and slow pace while television and video programs are more quickly paced. Panelists’ responses pointed out that moving to a more frenetic pace is not necessarily a good thing. Planetarium shows are still (to a large extent) governed by the motions of the star projector and the auxiliary slide systems. Those mechanical systems need time to operate during a show. However, an important thing to remember is that we are often presenting complex information — and that Slow pacing is not a bad thing if it allows audience members to absorb this information. Audiences don’t come to planetarium shows to multi-task and we should allow them time and space to enjoy and be inspired. Certainly we can use elements of pacing and production from other media to influence our shows — but those are elements we should use with wisdom and attention to how they enhance our shows, not detract from them.

One very important point that was made repeatedly was that we as writers need to let the visuals carry more of the load in a story. We should write less per visual (i.e. don’t describe something as large and red if it’s obvious from the accompanying visual). This is very important because it frees us to make the words we DO use count for more.

In a related question, an attendee asked the panelists to comment on the best way to focus audience attention on some really important points in a show. One answer was that we should put ourselves in the place of the audience and see how WE (as planetarians) would feel about the pacing of a show. One panelist suggested that the time-honored method of bringing up the stars and letting them roll for a bit (if allowed in the script) remains a good way to bring an audience member’s focus to the point immediately before or after the stars. This “visual breathing space” is a sort of punctuation that sets off important ideas in the mind of the viewer.
Part of the discussion turned to the use of the planetarium as a “virtual reality” simulator to bring not just the sights of the night sky, but the sounds – the crickets, birds, etc. that we would hear outdoors as we observe. The final discussion focused on determining the best narration method for a show, and touched on “voice of god” omniscient narrators, as well as the relative merits of male vs. female voices, and whether to use more than one. In most all cases, the panelists agreed that the content really gives a clue to what sort of narration works best. One audience member pointed out that there have been studies that people respond more positively to a female voice talking about complex issues, and when a soundtrack is mixed with music, most times a woman’s voice rises above music more easily than a male voice. Still, it remains a final judgment call for the writer/producer.

About 100 members attended this session.
Charting New Courses in the Planetarium World

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Abstract

The planetarium was conceived less than a century ago. In the 1960s it flourished and hundreds were built around the world. Today the planetarium world is in a state of transition. What can we learn from this changing landscape? How can we chart new courses for the future? Three very experienced leaders will review the lessons they have learned, and identify the challenges which today’s planetarian’s must traverse to achieve success.

One directs a major planetarium. One was involved with the development of the most northerly planetarium in North America. One is an international consultant. What they have in common is a broad understanding of the planetarium field and interesting and at times controversial views on the future of the planetarium.

JOHN DICKENSON’S STATEMENT

Our cultural and educational facilities and services are not, as some might think, “natural” or based on common sense. If either were true then all communities and societies would have evolved along similar natural or common sense lines. There would have been no battles between communism and capitalism, between Protestant and Catholic, between creationists and evolutionists. Instead, they are very much a product of a specific set of historical, cultural and economic determinants.

Our ideas of science are peculiar to Western culture and first appeared in the 17th century. The success of the capitalist system and its imperial military framework has validated this idea’s underlying philosophy to the point where some feel that only a fool could not perceive it as a self-evident truth. Were it not for the launch by the Russians of Sputnik in 1958, the first man in space in 1961, and a variety of other space firsts in the 1960s, I doubt very much that the planetarium would have become as commonplace as it was by the early 1970s. After all, since its initial development in 1923, it had achieved only a very modest, growth by 1960, but later that decade it became a product that would ably meet the perceived needs of engaging the public’s interest in space and helping to educate its children. It offered a unique experience—a simulation of the night sky—complete with expert interpreters and visually interesting technology. It could handle a large number of people at the same time and deliver a similar experience to them all. It was seen by both communists and capitalists as a useful tool to keep us ahead of each other’s “evil empire”.

Through the 1970s, 80s and 90s, the environment changed and the pace of that change picked up speed. Simply put, the media world became ever more sophisticated and diversified. Colour TV, IMAX, special effects, computers and computer graphics all brought new and engaging media experiences to the
masses. The planetarium changed as well, leaving its live night sky star show format behind and adopting many of the techniques and technologies of the wider media world. Soon, for many, it became just another wide-screen “movie” experience, an experience which, in many cases, could not match the production values of the conventional movies. Particularly in facilities which also offered IMAX theatres, it fell behind both in its popularity with audiences and in the economics of its production and presentation.

Led by the USA, the planetarium field has developed into an increasingly market-driven industry, with the client as a “consumer” of its fee-for-service “products”. Those products too have changed, increasingly being focussed on entertaining rather than educating the client. This curious hybrid institution, with one foot in the marketplace and one in the hard-to-define not-for profit sector, with its requirements for government, corporate or individual philanthropic support, has not been an unqualified success. Its future appears uncertain unless it can be carefully restructured and its governance and staff retrained to deal with the new reality. While few in North America would argue that market capitalism has not justifiably defeated communism, few in our profession would also embrace that same marketplace as the sole determinant of our operations. A world with no NSF, no federal, state, provincial or municipal grant programs. A world in which ability to pay - and pay much more than at present - would be the sole determinant of who can enjoy our programs. In most planetariums, admission charges make up only 15 to 50% of the cost of operating the facility, with a large part of the balance comprising direct or indirect grants from government.

Does this mean that the planetarium will not survive to 2050? Well, I hate to prevaricate, but I think a truthful answer must be dependent on the strategies which we adopt as we navigate through this changing environment. Like it or not, we are the leaders of our industry, and the actions which we take, or do not take, will have a critical impact on the future of our sector. Let me briefly outline some of the responses which I think must be made if we are to reach 2050 as a viable and well-defined group.

Firstly, I think we need to figuratively open the doors of our facilities and keep them open. Insularity, a lack of awareness of what those curious and expensive people do in that planetarium, of what contributions they make to our programming, can create a tremendous threat, particularly when the planetarium is part of some larger organization which perhaps has other agendas. I will say Toronto’s McLaughlin Planetarium is a good example of this. It no longer exists.

Secondly, program content is critical. We must again be searching for unique and engaging experiences to provide to our clients, and for me the new mantras for the 21st Century are LIVE and IMMERSIVE. We are fortunate here in having two options, one for those who cannot afford the capital and programming costs of all-dome Immersive video systems, and one for the poorer facilities which can offer contact with a real live “expert” or performer, rather than cheesy grade B documentaries.

Thirdly, critical mass is a critical factor. Without it the facility does not have sufficient activities to engage the family for the requisite two or three hours. It is unlikely to be an attraction for tourists and visitors, and it is unlikely to be able to operate in a cost effective manner, or produce or share in the production of engaging programs with high production values. It is also not likely to engage strong community
Finally, it sure makes a difference if one has a “sugar daddy”. A number of our facilities were originally constructed through grants from local businesses and business leaders. Fortunate are those among us whose operations were also endowed at the same time. And even more fortunate are those who have been able to maintain close philanthropic links with the families of our founding donors.

If we think and act strategically, I believe we can greatly improve the odds of our survival. I think we would all like to be remembered as the planetarium leaders who made a difference.

DAVID LEVERTON’S STATEMENT

The planetarium world is in a constant state of evolution. Unlike the automobile industry which seems to thrive for the most part on bland similarity, the planetarium world is as diverse as the number of different boat designs floating placidly in a marina. Different shapes and sizes. Different types of equipment. Different types of presentations. Unlike the movie industry which features a single projector, a flat screen and unidirectional seating arrangement, the planetarium is a diverse viewing experience. Planetarium Theatres may have concentric seating, unidirectional and/or no seating at all.

What is unique about the planetarium community? What is unique is that it doesn’t conform to a standard model. Rather than celebrating our differences there seems to a drive toward all becoming the same. Would the experience be better for our visitors if we all looked alike? If we all sounded alike? If we all shared the exact same shows and visual experiences?

The planetarium should be recognized as an “art gallery of the cosmos”. We should celebrate our differences. We should recognize that visiting a planetarium is a unique visual learning experience. Not all experiences will be memorable but when you think about it - are all visits to art galleries memorable?

The planetarium community has more space-related information and images at its disposal than at any other time in history. We have a fabulous opportunity to tell the world our story. Visitors should view our facilities as a beacon of hope for the future. When the first sailing ships left the Old World on their voyage of discovery they were heralded as the great adventurers of their time. The Apollo missions, Hubble discoveries, the Mars missions, the ISS project to name a view, all bring a sense of hope to humankind. An appreciation of the great beyond and a deeper sense of meaning to life and our place in the universe. It is a tremendous story and we are only in the opening chapter of the book. Planetariums have a very important role to play in helping the public understand this ongoing astronomical story.

The advent of light pollution in recent years has led to a great “cosmic disconnect” for large segments of civilization. We no longer have a direct visual connection to the stars and the universe. It is the challenge of all planetariums to provide civilization with a link to the cosmos. The future survival of spaceship earth may depend on the planetarium as our life raft.

So what is the future of the planetarium? The future of the planetarium is largely dependent on our ability to define our customer and to meet their needs. How much do most facilities know about their customers and their wants and needs? Do we always produce shows and design exhibits for the end user or what we
think the end user is interested in?

The survival of the planetarium will largely depend on our ability to engage the audience in a fun and entertaining way. The educational message should not be mixed between the interests of our educators and the general public. Often times show productions are developed for the public and school groups alike and end up not satisfying either.

Bigger is not always better. A live presenter can often be more effective than all the best special effects. The combination of a lively presenter and state of the art technology may be the best of both worlds but all is lost without the support of a compelling story.

If planetariums are to remain relevant in this century, we must begin to redefine who we are and what message we are trying to send. Anyone interested in the survival of our planet, the future exploration of the solar system and a desire to learn more about deep space should look to us for leadership. It doesn’t matter whether you are a small or large planetarium. The survival of the planetarium will depend on a shift of public attitude about who we are. The only similarity between our facilities should be the quality of the science in our message. We should celebrate our uniqueness and the innovative methods we use to deliver our information.

We are as culturally significant today as we were to Greek society thousands of years ago. Our challenge is to work harder to ensure that as a communicator of cosmic information, we are recognized by the public and our political leaders as an important messenger. The important question is are we capable of rising to this challenge?

IAN McLENNAN’S STATEMENT

This is my fortieth year in this and related institutions, and I am well aware that some of the audience isn’t even that old. What is as old (and constant) is the perennial question of the proper role, purpose, place and viability of the planetarium as a teaching tool and communications medium. One of the consistent things I have noted is that people in the business are often fixated on particular solutions which reflect their own backgrounds, perspectives and fields of study. That is fine as far as it goes, however, it leaves out the most important consideration the target audience.

Over the years, I have been alternately intrigued and dismayed that whilst we in the planetarium business have fretted over this technology versus that one (the toys), or the crushingly introspective, boring, and winless argument about entertainment versus education, the rest of the world has gone on, and some would say, passed us by.

Major film events have helped shape the public’s awareness and attitudes towards space and astronomy; astrology columns command greater newspaper space and readership than astronomy and space adventures, while the odd TV special and colour magazines have opened the public’s imagination to the splendours of the Universe. Gigantic, contrived events in sports and entertainment, the advertising industry, theme parks, shopping malls, sex, food, the Internet, issue-oriented politics and causes - often promoted by celebrities - command disproportionate public attention compared with the tiny blip we make on the public’s collective “radar screen.”

We must grapple with our own definition and measurements of success - and of primary importance, we must craft strategies which are related to those qualitative and quantitative yardsticks. If it is soap or cars you are selling,
the first thing you do is hire an ad agency that helps you define the target audience, then an expert team gets to work crafting images and messages that will move the product. If it doesn’t work, you fire the agency, or retool the product. More and more, though, it has become a real science - with years of backup data on what works, what doesn’t, and why.

Although we’re not selling soap or cars, we have a message, and more often than not (there are some notable exceptions) the message doesn’t punch through. The reasons may be complex, but I believe a common problem is that we haven’t defined the audiences, crafted the message accordingly, or hired the right people to help us deliver (and measure) it. We have to get out of our ivory domes.

I will expand upon these thoughts as part of the panel discussion.
Visual Impressions of IPS 2002

Martin Ratcliffe, IPS President and conference host

Lee Anne Hennig, IPS Secretary

Davin Flateau, Exploration Place

Shawn Laatsch, IPS Treasurer
with Undine Concanon,
IPS 1998 conference host (London)
Sunday, July 28, 2002—NASA Workshops

Cherilynn Morrow

Isabel Hawkins, Jeff Rosendhal, Cherilynn Morrow

Ramon Lopez

Anita Sohus
Sunday, July 28, 2002—Reception

Al DeSena, President of Exploration Place

Jonn Serrie

The Bird
Monday July 27, 2002

Invited Speaker: Dr. Jeffrey D. Rosendhal (NASA)
*Planetariums and NASA: A Natural Alliance*
Lunch on Monday July 27, 2002

Opening Lecture:
Dr. Seth Shostak (SETI Institute)
*Life in the Universe*
Exhibits at Exploration Place
Jazz Band entertainment

Weather Broadcast from Exploration Place
Invited Speaker at Lunch, Tuesday, July 30, 2002:
Dr. Carolyn Porco—*Cassini at Saturn*

Tuesday Afternoon, July 30, 2002:
Field Trip to Cosmosphere in Hutchinson, Kansas

For many more images of Cosmosphere, see Cosmosphere Images file in Supplemental Material folder on the IPS 2002 Proceedings CD-ROM
Paper Plate Astronomy—Chuck Beuter
Exhibitors—Images

Minolta MediaGlobe

Rose Center

Laser Fantasy

SGI

STARLAB’s new star projector

StarDate Cards
Art on the walls of the banquet room

Jon Bell, organizer of the Constellation Shootout
Society Banquet Keynote Speaker was Dr. Alan Dressler

The “Hat” goes to Tony Fairall

Closing Lecture: T.C. Samaranayaka
The IPS Conference Bird is handed on for the IPS 2004 Conference in Spain

New IPS Fellows

Candidates for next IPS President
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In Wichita, planetarium experts see latest gadgets

Ken Miller, with Goto Manufacturing Co., demonstrates the Chronos projector during the International Planetarium Society's convention at the Hyatt Regency Wichita on Monday. About 450 people from 20 countries are attending the convention.

Photos by Jaime Oppenheimer/The Wichita Eagle

For sale: space adventures

Ki-hung Chen, assistant curator at the Hong Kong Space Museum, looks through a star spectrometer Monday at the International Planetarium Society convention in Wichita.

By Suzanne Perez Tobias
The Wichita Eagle

Jeffrey Rosendhal can see the future, and it rocks. On Monday, he described it to members of the International Planetarium Society, which is holding its conference in Wichita this week.

The NASA astrophysicist envisions people sitting in their local planetarium, or perhaps even at their home computers, watching live feeds from the latest mission to Mars.

As the rover moves, it sends back information and pipes it through the Internet. Whatever the rover sees, we see. When it reaches the summit of a new hill, we all crane our necks to see what's on the other side.

We're not just hearing about this space mission on the news. We're driving.

"We want to take the public and make them participants in the adventure of exploring another planet," said Rosendhal, director of NASA's division of education and public outreach.

Please see SPACE, Page 5A
“There’s an amazing undercurrent of interest in space and astronomy. If it’s a good story, the science comes across in an interesting way.”

Carolyn Collins Petersen, vice president of Loch Ness Productions

“We need to find ways to make them a part of it.”

That’s a primary mission for Planetarium Society members, who hail from all, over the world. About 450 delegates spent Monday at the Hyatt Regency Wichita and Exploration Place, seeing the latest space technology, playing with state-of-the-art toys and discussing how to inspire the next generation of

People want to learn, but they also want to have a little fun,” said Darryl Davis, systems coordinator for the Boston Museum of Science. He and two colleagues from that museum were looking forward to seeing the new hardware and programs available to planetariums.

“We’re seeing more and more things happening all the time,” he said. “it’s exciting.”

Take, for example, Minolta’s Mediaglobe, the world’s first full color, full-dome, computer-generated planetarium system with a database of seemingly countless planets, stars and galaxies. (They’ve counted those stars, though. There are 61000.)

Consultant Philip Groce led conventiongoers through a demonstration of the system which sells for about $200,000 and is being marketed to schools, universities and small museums.

Groce’s demo was part science, part infomercial, as he led the group on a tour of constellations, a mission to the moon and a trip back in time.

“Literally anything you can dream and render, you can show,” he said. “And a at the touch of a button.”

Elsewhere in the Hyatt exhibition hall were booths for companies that make star projectors, planetarium software and even an inflatable planetarium that can be set up in a gymnasium or large classroom.

The name of the game, manufacturers said, is bringing science to the masses.

Lynne Talbot, a volunteer with the Fort Worth Museum of Science and History, was especially excited about “Starry Night” software that let her travel the galaxy.

“Something like this would help me answer the tough questions third-graders ask,” she said

Another company, Loch Ness Productions showed off ft-plan-4tadwri programs which combine science, computer animation and music as well as voice-overs by such well-known stars as

Patrick Stewart. One new program, “MarsQuest,” explains what we know about the Red Planet and imagines a time when humans will inhabit it. “There’s an amazing undercurrent of interest in space and astronomy,” said Carolyn Collins Petersen, the company’s vice president. “If it’s a good story, the science comes across in an interesting way.”

While most of this week’s conference is not open to the public, Wichitans can still see some of the technology the planetarium types are raving about.

“Infinity Express,” a program previously shown at the Smithsonian Institution in Washington, D.C., will run hourly at Exploration Place’s CyberDome from today through Monday. It gives a look at the history of celestial exploration, from ancients who saw patterns in the stars to the latest views from the Hubble telescope. Admission is $5.

If history is any indication, said Rosendhal, the NASA director, some curious boy or girl will see that show and decide to become a scientist or astronomer.

“Hearing someone say, ‘He’s a whole universe out there, and by God, I want to know what makes it tick,’” he said. “What could be a better adventure?”

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