Twenty years ago, when the Sahato Benibana, Kahoku Civic Cultural Center in Kahoku-cho Japan opened, the only way to put dramatic, colorful, animated images onto a planetarium dome was to use large format film running through an oversized cinema projector with a special lens. But today, high-cost, high-maintenance film is essentially a “dead” technology. Video is able to replace much of what the old large format projectors used to do. The Kahoku-cho staff knew that it was time to replace the obsolete large format film projector with fulldome video.

However, the Kahoku-cho staff also knew that video does a very poor job of reproducing the pin-sharp, bright starry sky of an opto-mechanical planetarium projector. So for their renovation technology, they chose a GOTO PANDIA II HYBRID system. The stars are created by the very compact PANDIA II. This LED-powered 19 inch starball shows a gorgeous sky in the tilted, 15 meter dome, including a Milky Way made up of 40,000,000 micro-stars.

Synchronized with the motions of the PANDIA II is GOTO’s own VIRTUARIUM X fulldome video system. And the entire system is controlled by GOTO’s unique HYBRID control console, which enables everything from simple cueing of automated movie playback to rich, yet effortless live programming.

Finally with the turnkey equipment package installed, the planetarium’s original “safflower city” movie was cleaned, scratches were removed, and the movie was digitally enhanced for optimal color reproduction and stability on the dome. So the large format film that ran when the theater opened in 1995, now digitized, can be seen better than ever before. The total conversion from large-format film theater to modern GOTO PANDIA II HYBRID Planetarium is now complete. And the public loves it.

Note: PANDIA II is called PANDORA II in Japan.
Articles

8 Outcomes of immersive learning: Comprehension and retention of science content
Jon Elvert
10 Blueprint to Blastoff: Free engineering materials for the planetarium or classroom
Talia Sepersky
16 The world's first downloadable, full-length fulldome show. For free.
Lars Lindberg Christensen, Theofanis N. Matsopoulos, Max. R. Rößner
20 I am the Doorway
Thomas Kraupe
22 Thirty years of spinning the stars
Rob Walrecht
28 Astronomy at the Top of the World: Educators experience why Chile is vital to astronomy
Pete Detterline, Renae Kerrigan, Sarah Komperud, Jim O'Leary, Mike Prokosch, Shannon Schmoll
34 The story of a layman planetarian: A determination to share the universe
Ido Bareket
39 Under One Dome: Sharjah Center for Astronomy and Space Sciences
Cecilia Öhrner
52 How we do it: Low-cost multi-language audio
Hari Nandakumar, N.A.V. Krishnam Raju
68 My exceptional experience as the American Planetarium Operator in Italy
ShiAnne Kattner
80 Tales from Dome Under: Spooked
Tom Callen
84 Tribute: Robert Andress

Columns

76 Book Reviews
April S. Whitt
86 Calendar of Events
Loris Ramponi
47 Fulldome Matters
Carolyn Collins Petersen
42 From the Classroom
Jack L. Northrup
4 In Front of the Console
Sharon Shanks
56 International News
Lars Petersen
88 Last Light
April S. Whitt
66 Mobile News
Susan Reynolds Button
73 Partycyles
Alex Cherman
6 President’s Message
Joanne Bishop
70 Seeking What Works
Jeanne Bishop
74 Sound Advice
Jeff Bowen, Mark Trotter
84 Waxing New
Sharon Shanks

Index of Advertisers

Astro-Tec .......................................................... 51
Audio Visual Imagineering ................................. 37
California Academy of Sciences ....................... 83
ChromaCove ...................................................... 84
Clark Planetarium/Hansen Dome .................... 33
Digitalis Education Solutions, Inc. .................. 19
The Elumenati ................................................. 38
Evans & Sutherland .........................................61, 65, Inside back cover
GOTO Inc. ........................................................... 15
IPS Fulldome Festival Brno ............................ 19
Konica Minolta Planetarium Co. Ltd ................ 53
Loch Ness Productions ..................................... 7
Magna-Tech Electronic Company .................... 77
Metaspace .......................................................... 81
Mirage3d ............................................................ 31, 75
NSC Creative ...................................................... 63
R.S.A. Cosmos .................................................. 5
SCISS ................................................................. 5
Sky-Skan, Inc ................................................... 43-46
Softmachine ....................................................... 27, 55
Spitz, Inc. ........................................................... 25, 79
Spitz Creative Media ........................................ 13, 36, 85, 87
You Can Do Astronomy ..................................... 54
Zeiss, Inc. ........................................................... 49

Fulldome Matters
Carolyn Collins Petersen

Last Light
April S. Whitt

Mobile News
Susan Reynolds Button

Partycyles
Alex Cherman

President’s Message
Joanne Bishop

Sound Advice
Jeff Bowen, Mark Trotter

Waxing New
Sharon Shanks

On the Cover: Mami artist Radim Vizváry with camera on his body to film the action for the new fulldome program based on Stephen King’s short story “I Am the Doorway.” Read more about this innovative program on Page 20. Photo by Nina Zardalishvili.

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In Front of the Console

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There’s a saying that goes “Be careful what you wish for.” In June I asked for more material to share with Planetarian readers, and I got my wish. Thank you to everyone for sharing your fun stories, experiences, and tips for this issue.

I also mentioned in June that I had to hold two stories and promised they would appear in this issue. I kept my promise to Rob Walrecht (see Page 22), but I once again had to break it to Jean-Michel Faidit. His story about the history of telescopes is all ready to go for the December issue.

Quite a while ago Tom Callen sent some articles to consider for publication. Tom, who’s been in, under, and around domes since 1972, both in the United States and Sweden, said “They are from the golden days of the biz, before there was little digital anything, and so they are not of the ‘the day our render farm died’ variety, but from the days when one had to actually do more physical things when it came to the profession. And they’re quirky enough that someone might find them amusing.”

I found them amusing, and I’m sure many readers will as well. He calls them “Tales from Dome Under.” I’m considering asking for more articles to run under a regular “Dome Under” column, depending on the reaction from you, the Planetarian reader. What do you think?

My email is above to let me know.

Tom’s first article is set in a cemetery, and he titled it “spooky.” When I think of spooky, the first thing that comes to mind is my favorite author, Stephen King. You can imagine my excitement when Thomas Kraupe sent his article about a planetarium program being produced based on a King short story.

Not only is it “King on the dome,” but it is being filmed in first person and the actor is a mime. Can you say envelope pushing? Intrigued? Read more starting on Page 20.

Retired, not retired

Many of you already know that I retired from my paying job under the dome as of June 30 this year.

And, because you’re reading this, you also now know that I have not retired as editor, which always has been my labor of love.

During my last days at Ward Beecher Planetarium (Youngstown State University, Youngstown, Ohio, USA) it was feared that constant budget woes might mean my position would go unfilled. But, on my next-to-the-last day at work, we heard that the provost had approved it and the search for a replacement could begin.

I wish good things for the person who fills my job, and preemptively apologize for the amount of teaching demos and educational material I left behind. Have fun with my neon sock puppets!

You’ll be working with a small but great crew: Curt Spivey, the planetarium engineer (a vague title that means he keeps everything running and also produces programs), and Pat Durrell, the director.

Changes are on the agenda

Be sure to read President Joanne Young’s message in this issue (Page 6). She reviews the IPS Council meeting held earlier this month and the positivity she felt as a result.

In the months to come, we hope to spread this positivity to IPS as a whole as we strive to be more responsive to our members—our friends—needs.

From Pluto, with love

About the comic: I posted this on the IPS Facebook page to help celebrate the New Horizons arrival at Pluto, but I decided to share also with those who don’t FB. It’s from xkcd.com, “A webcomic of romance, sarcasm, math, and language” By Randall Munroe.

It’s large so you can cut it out and post it on your door with all your other space comics. It also means I don’t have to write as much to fill my space this time.

You’ll see there’s one part of Pluto that is called “full text of Wikipedia article on pareidolia. Don’t know what pareidolia is? Look it up on Wikipedia: en.wikipedia.org/wiki/Pareidolia. It’s perfect.

☆
Beyond your dreams...

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I then realized:
one of 5 copies prepared for all of the officers.
secretary, handed me a big white notebook,
oficers. When I sat down, Lee Ann Hennig, IPS
...ing, I took nothing for granted and came
...ing to IPS 2018.
...senters who were proposing to host IPS 2018.
big white notebook filled with the council
read Robert’s Rules of Order twice, prepared a
...ating lunches. I watched him move tables and
room, all equipment, and organized our work-
Combe, our facility host, set up the meeting
the IPS Council meeting to order. Pierre La-
...es the new, very successful Planétarium Rio
Tinto Alcan, Espace pour la vie Montréal?
#2 IPS members humbly serve one an-
other without regard to status.
Dr. Jin Zhu was present to give his final re-
port on IPS 2014 in Beijing, followed by a very
appreciative response from the entire council.
Jin’s presentation was followed by Maciej Li-
gowski and Monica Malinowska with updates
on the IPS 2016 Conference in Warsaw, Po-
land. You will be receiving information soon
about the wonderful surprises and plans for
this extraordinary conference.
Later that morning we heard from our four
presenters to host IPS 2018:
               • Celso Cunha, Planetarium Foundation
                president and Alex Chern, astrono-
                mer, both of the Rio de Janeiro Planetar-
                ium presented for Rio de Janeiro, Brazil;
               • Alan Nursall, president and CEO, Telus
                World of Science, introduced by Ian
                McLennan, representing the Canadian
                Association of Science Centers, for Ed-
                monton Alberta, Canada;
               • Marc Moutin, director of expositions,
                Cité de l’espace and Mrs. Rouillon-Val-
                digue, Toulouse Deputy Mayor for Tou-
                louse, France;
               • Levent Gurdemir, director, Planetarium
                University of Texas Arlington for Arling-
                ton, Texas, USA.
The winning bid proposal to host IPS 2018
was awarded to Toulouse, France. We are sin-
cerely grateful to all of our presenters for gen-
erously opening their hearts to invite IPS
members to their home institutions and cities.
To be present in a room with the past con-
ference host, the present conference host, and
the future conference host was a momentous
occasion.
#3. IPS conference hosts work for years
with their host cities to provide the very
best offerings and experiences for you.
Each conference promises to build upon
one another with innovative and enrich-
ing programs. It should not be a surprise
that IPS’s key benefit to membership is
our truly remarkable and unforgettable
(Continues on page 14)
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In 2009, a NASA grant was awarded to the Louisiana Art and Science Museum, the Houston Museum of Natural Science, and Rice University for the purpose of developing two planetarium shows and interactive games for a portable Discovery Dome.

We Choose Space (2012) and The Great Planet Adventures (2014) were produced and created by HMNS, Home Run Pictures, Tietronis, and LASM to enable the general public to envision the future following the space shuttle program. The two shows address the possibility and feasibility of returning to the moon, as well as possible future missions to solar system destinations and what astronauts' work/play on these other worlds might look like.

A provision of the grant was to assess and evaluate comprehension and retention of the primary scientific content in We Choose Space.

This paper is the summary of the external evaluation of student assessment conducted by Laurie Zimmerman and Stacia Spillane (both from the Houston Independent School District) and research performed by Dr. Carolyn Summers (HMNS) and Dr. Patricia Reiff (Rice University).

The outcomes compare student learning about space in digital and computer environments. Show content was reviewed by NASA scientists and engineers. Questionnaires were developed both by the production team and by teachers at Rice University using science standards.

Multiple-choice questionnaire instruments were administrated to students in both formal (public school) and informal (museum/planetarium) settings. The formal presentations were made via computer; the informal, in the dome.

A total of 370 students ages 11-17 from both formal and informal settings participated by taking pre and post tests and viewing the show We Choose Space. The informal group consisted of 104 students, while the formal group consisted of 200 students.

The evaluation instrument had 16 multiple-choice questions. Each student completed the test prior to viewing the show, and again afterwards, both on the same day.

The middle school students who participated were primarily underserved minorities (African American, American Indian, Asian, Hispanic, and White).

Overall results from the informal and formal educational settings indicated that there was a statistically significant increase test scores for students who viewed We Choose Space in both delivery systems. However, the mean gain of these test scores was higher for the students who watched the show in the planetarium.

To evaluate long-term retention of concepts presented in the show, the identical post test questionnaire was given to both groups of the same students six weeks after viewing the show. The mean gain results of the post test was higher for the students who watched the show in the planetarium rather than on the computer. In general, test score improvement six weeks after learning in the dome was essentially the same as the post-test immediately after viewing the show, demonstrating virtually no loss of gained information in the six week interval. Students who viewed the show on a computer scored lower six weeks after viewing the show. Numbers in the chart are based on a score of 100. Statistical significance with t- and p-values are not discussed in this presentation, but are given in the handout, or upon request.

Test results show that the mean increase in test scores for learning in the informal environment was 10.47, indicating a significant retention of show material.

In conclusion

There was a statistically significant increase in post-test scores for students who viewed the show in both formal (school lab) and informal (dome environment) settings. (9.2%) Long-term retention of science concepts by
students who viewed the show in the immersive environment had a statistically significant increase in test scores over those who viewed the show on a computer. (7.34%)

Test results were virtually the same after six weeks as they were just after viewing the show in the dome; students who watched the show on a computer retained less after the six week interval.

The planetarium experience is more memorable and better remembered than a comparable classroom experience.

To assess their attitude about the experience of watching the show, students were asked to respond to the following questions.

The bar chart summarizes what students liked best about the show based on a 4-point scale where 1 was Little and 4 was Great.

NASA identified space science education as a method for engaging students in the pursuit of STEM careers with astronauts as role models for students of all ages. They recognized that career choices would be built on experiences that could only happen if students became aware of the programs available and engaged in explorations, either real or virtual. Both these shows were designed to motivate youth to wanting to become astronauts and/or solving challenges for the next generation of scientists and engineers.

About half the students who viewed the show were asked what career they were most interested in pursuing. Out of 198 responses, 102 selected STEM-related careers; 68 selected nonSTEM careers (musicians, professional athletes, law enforcement, and lawyers), and 28 students had no preference.

The second show produced, The Great Planet Adventures, was completed in late 2014. Unlike We Choose Space, the show did not have an external evaluation to compare student learning. Instead, Dr. Sumners delivered an evaluation instrument to students viewing the show in 2015.

The GPA learning objective is to immerse students in 10 environments, with habitats, weather, surface features, and activities consistent with what astronauts would experience on each world. Students also watched astronauts engage in a favorite sport at each destination. Of the 12 destinations in the show that students were asked to respond to, three of the destinations, represented in screen shots below, depict off-world environments: Venus, Uranus, and Mercury.

All pre- and post-questions asked regarding the GPA focused on what students learned in the planetarium environment. The results are highly significant for the whole test with correct answers correlated with the time spent in each environment (indicated on each image).


More information
Both programs are available for sale through Space Update, Inc., a partner of MTPE, Inc., which does business as ePlanetarium®. For the sake of transparency, please note that paper co-author Dr. Patricia Reiff, Rice University (Houston, Texas) formed and leads both MTPE, Inc. and Space Update as a way to market shows, software, and planetarium technology created by the NASA-funded Immersive Earth project and its partners.

Dr. Reiff is professor of Physics and Astronomy and associate director of Outreach Programs at Rice Space Institute.

We Choose Space: Covers microgravity and low lunar gravity technology, living and working in space and on the moon habitats. Available in English, Hindi, Spanish, and Telugi; 24 minutes.

The Great Planet Adventure: Go along on the adventure on the visit to all the planets and more. Includes 2 free immersive fulldome games: Monster Trucks On The Moon and Mars Flyer. Running time: 24 minutes, with a shorter kids version available. English.

Both program have educator guides and are available in portable, 2k, 3k, 4k, and dvd (for personal and classroom use); general audience, grades 2-12. spaceupdate.com/store/shows_hmns.html ∗
Putting the “E” back in “STEM”

When it comes to STEM, planetarium shows tend to be very good at covering the science and technology, and even the math portions, but engineering often gets left out. To help fill this void, in 2013 we, the staff of the Charles Hayden Planetarium at the Museum of Science, Boston, teamed up with NASA to make a planetarium show about spacecraft engineering.

The result of this partnership is the show From Dream to Discovery: Inside NASA, which explores what it takes to design, test, build, and fly a successful space mission.

As much as we would have liked to, we could not talk in detail about every part of spacecraft engineering during the show. However, through the partnership with NASA, we were able to expand on a few engineering topics from the show in three separate, supplementary education modules. We are extremely pleased to be able to offer these modules to anyone who wants to use them completely free of charge.

The modules themselves have three very different lengths, styles, and topics, and are designed to be presented in different ways. They can be used on a planetarium dome, and a flatscreen version permits their use on a conventional screen as well. Although each goes into depth on topics that are raised in From Dream to Discovery: Inside NASA, they all stand on their own and require no knowledge of the show itself. The three modules are: Fixing the Hubble Space Telescope, Gravity and Space Travel, and Design a Mission.

Fixing the HST

We’ve found that many people in our audiences know that there was something wrong with Hubble when it launched, and that it was eventually fixed. However, few people tend to be aware of the details.

The first of our modules, Fixing the Hubble Space Telescope, goes into some of those details. It’s the most straightforward of the three modules, consisting of a single video approximately eight minutes long. Large portions of
the narration are undertaken by Dr. Jeffrey Hoffman, a former astronaut who flew on the first Hubble servicing mission.

With this module we wanted to focus on a specific case of spacecraft engineering, and Hubble Servicing Mission 1 provides a fantastic real life example. We also wanted to bring in the idea that failures can be instructive.

This module starts by introducing Hubble in space, and then describing how astronomers realized the telescope had a flaw, using some of Hubble’s earliest observations to make the point. It then takes Hubble apart to show the primary mirror and allow Dr. Hoffman to describe exactly what went wrong with making it.

While still looking at a cutaway view of Hubble, Dr. Hoffman goes on to explain the “fix" designed by engineers to repair Hubble, describing the arrangement of mirrors that allowed light entering Hubble’s tube to be refocused before landing on the detection instruments. While he is providing the narration, the visuals show this in action, following a light path all the way through Hubble to the instruments.

The module then moves on to the installation of the new optics on Hubble, with Dr. Hoffman talking about the work on the shuttle mission. This is accompanied by visuals of Hubble and the space shuttle in space, as well as actual video clips from the mission.

In one of our favorite parts of this module, Dr. Hoffman shares his story of receiving the phone call that let him know the fix had worked, as well as some thoughts on what it felt like to actually touch Hubble. Some of the visuals for this portion include Hubble images for comparing pictures of the same objects before and after the repair.

The module concludes with the idea that we can learn from failures like Hubble’s. To quote Dr. Hoffman at the module’s end, “The important thing, though, is if you do have a failure, you really need to be able to learn from it. To have a failure that you don’t learn anything from, that’s tragic.”

Gravity and space travel

It turns out that describing what goes on during a gravity assist can be tricky business. This module introduces some of the mechanics of the momentum transfer that happens during a gravity assist maneuver through Earth-based and space-based examples, as well as describing some of the various ways gravity assists can be used in a space mission.

Since gravity assists can be a tough subject to teach and the depth a presenter goes into will vary widely with different audiences, we designed this module to be as flexible as possible. It is broken up into five segments, each about 1-2 minutes in length (for a total of about 7 minutes of video). Each segment can be presented independently if the presenter only wants to use some but not all. They can also follow after each other, with each segment building on the one before.

We created this format with the idea of using live interpretations in between each of the segments, to reiterate or emphasize the content covered in the previous segment and set up for the next one. However—maximum flexibility!—they can also be strung together to create one unbroken video, depending on the presenter’s preferred style.

The core ideas behind momentum transfer and gravity assists are presented in segments 2 and 3, so our recommendation is that at least these two be used.

Segment 1 is relatively straightforward. It starts with the idea that spacecraft travel often is not as easy as pointing the spacecraft at its destination and giving it a push. It introduces the terms “gravity assist" and “momentum transfer" and also defines the word “momentum.”

Segment 2’s purpose is to help the audience gain a better understanding of the transfer of momentum using an Earth-based example. To this end, we enlisted the help of a local roller derby team. We wanted to emphasize the idea that gravity assists work not just because the planets are large (i.e. have a lot of gravity) but because they are also moving (i.e. have a lot of momentum).

For this, we had one skater (designated Skater One) hold still and whip her teammates around her as they approach. While her teammates’ paths change, their speed remains more or less the same. We then recreated the same scenario with Skater One also in motion. This time, when she whips her teammates around, their speed increases noticeably even as Skater One’s decreases, due to the momentum transfer between them.

Segment 3 builds on the Earth-based example with a space-based one, specifically the New Horizons gravity assist flyby of Jupiter in February 2007. It starts by looking at what would have happened if New Horizons had gone directly from Earth to Pluto, then looks at the Jupiter flyby. The visuals show an overhead view of New Horizons approaching Jupiter and then visibly increasing its speed as it flies past.

This segment uses some actual numbers to get across how much momentum Jupiter has to spare and to emphasize the fact that the
Design a mission

The “Design a Mission” module is the most interactive of the three and requires a live presentation. In this activity the audience, using information provided to them by the presenter, designs a spacecraft to search for signs of water in the solar system. They have to choose a destination and then, based on that destination, a power source and whether their spacecraft will be a lander or orbiter.

If they design their spacecraft well to suit their destination, the mission will succeed. If they do not, the mission will fail (and how it fails depends on the spacecraft design).

The module itself is made up of thirteen video clips to incorporate all the possible outcomes of the audience’s decisions. In total, the video clips make up about 35 minutes of footage, but a presenter should only need a fraction of that during any given presentation.

The first clip represents the audience’s first decision: will their spacecraft travel to Mars or Saturn in search of evidence of water? The visual for this clip is fairly basic, with images of both of those planets on the screen.

Once they’ve chosen the destination, the second clip represents the audience’s next decision: will the spacecraft be an orbiter or a lander? The presenter may want to provide the audience with some of the benefits and disadvantages of each, or ask the audience to come up with some on their own. The visual is of the two different styles of spacecraft. The “lander” option is based roughly on Cassini with a Huygens-style lander attached to its side.

Decisions, decisions

The third decision is whether to make the spacecraft solar or nuclear-powered, and there are two clips that can potentially be used depending on whether the audience chose an orbiter or a lander. If they chose “lander,” the corresponding clip shows two versions of the lander-style spacecraft, one with solar panels and one without (the nuclear reactor is visible on the bottom edge of the nuclear-powered spacecraft, but is small and not immediately obvious like the solar panels).

If they chose “orbiter” the visual is the same, with the orbiter-style spacecraft instead. Again, the presenter may want to make sure the audience knows the benefits and drawbacks of each choice.

Now that they have designed their spacecraft, it’s time to send it to the chosen planet and see if it succeeds. There are eight different clips to represent the eight possible outcomes of the audience’s choices. All start with a lift-off from Earth and a view of the spacecraft moving towards its destination. What happens once it starts moving depends on how well the spacecraft was designed.

The four Mars scenarios (nuclear orbiter, nuclear lander, solar orbiter, and solar lander) all succeed. The two lander scenarios make use of the landing sequence of the Curiosity rover for visuals. The landers will find evidence for water in the form of “blueberries,” frost, and silica deposits. The orbiters will find evidence of water from seeing river channels, hydrogen deposits, and rampart craters.

It’s much harder to succeed at Saturn, and only one scenario, the nuclear-powered orbiter, will lead to success. If the audience chose a solar-powered spacecraft, then as it moves through space towards Saturn the picture will turn to static to represent the spacecraft losing power and shutting down.

If they chose a nuclear-powered lander, they will see a rather stunning sequence of their lander entering the atmosphere, heating up, and exploding. If they chose a nuclear-powered orbiter, they will find evidence of water in the geysers on Enceladus and in Saturn’s E Ring.

Since not all of the mission designs succeed, the presenter may wish to talk about failure in spacecraft engineering. To this end, we wanted to show audiences that the professionals

(Continues on page 14)
DYNAMIC
EARTH
Exploring Earth's Climate Engine
NARRATED BY LIAM NEESON
also sometimes don’t get it right. The final clip shows images from four real life failed missions from different countries, specifically the Vanguard rocket, the Mars Climate Orbiter, the Phobos-Grunt mission, and the Akatsuki mission. As with the end of the “Fixing Hubble” module, the idea is to emphasize that failures happen, and that the important thing is to learn from them when they do.

Guides
Between them, these three modules present a lot of information, some of it very specific. To make them as easy as possible for a large variety of institutions to use, we’ve also created planetarian guides to go with each. Our hope is that a presenter with no background in any of these three topics can make an effective presentation on any or all of them using just the material found in the corresponding planetarian guide. In addition to the script for the module, a set of FAQs, and a glossary, each guide contains copious background information as well as some suggestions for presentation.

The Fixing Hubble guide includes a layout of Hubble’s optics, even more detail about the flaw and how it was fixed, a brief breakdown of each of NASA’s Hubble servicing missions, and a list of Hubble specifications.

The Gravity and Space Travel guide goes into greater detail about the mechanics of gravity assists, how momentum is transferred, and why the spacecraft’s trajectory changes. It also looks at the usefulness of gravity assists on specific missions and provides a list of missions that have made notable uses of gravity assists.

In the script section, it provides some guidelines for live interpretation in between the video segments as well instructions on how to recreate the roller skater demo from Segment 2 in house, using either staff or audience members.

The Design a Mission guide includes specific descriptions of each of the visuals in the clips and what they are designed to represent. There is an outline for the progression of the module, with some guidelines for discussion, background information on the pros and cons of landers, orbiters, solar power, and nuclear power, and a description of why each mission succeeds or fails. There is also a list of all of the video clips included with this module.

Separate from the planetarian guides, there is a set of educator guides for teachers using the modules in a standard classroom setting. The educator guides are geared more towards using the modules as part of a lesson in a school environment rather than a presentation in a planetarium show, and the information they include is not as detailed as that in the planetarian guides.

There are also educator guides for topics not included in the modules, including Waves and Information Transfer, and Infrared Astronomy, which also expand a bit on topics raised in the show From Dream to Discovery.

Acquiring the modules and guides
To ensure that many different institutions, classrooms, and other settings can make use of our modules, we are offering them in a variety of formats. The modules are all available in 1K, 2K, and 4K fulldome versions for planetarium domes. There are also flat versions available for use in standard classrooms or for anyone using a flatscreen projector.

Anyone interested in the flatscreen format (in the form of an mp4, complete with captions) or 1K dome format (in the form of a Quicktime movie) can find them online at www.mos.org/fulldome/modules. We ask that anyone downloading from the website fill out a brief survey to help us understand how the modules are being used in different settings.

Teacher and planetarium bundles
The Teacher Bundles for Fixing Hubble and Gravity Assist include the flatscreen captioned versions of the modules as well as the educator guides. The classroom version of Design a Mission is web-based, so the Teacher Bundle for that module includes the educator guide and link to the web-based activity. The modules page also includes a Teacher Bundle with the Waves and Information Transfer and Infrared Astronomy educator guides.

The Planetarian Bundles for all three modules include the 1K Quicktime dome movie and the planetarian guides. Anyone interested in 2K or 4K domemasters or the flatscreen version without captions should contact full-dome@mos.org for details.

Engineering in the dome
In covering some of the nitty-gritty details of designing a space mission, these modules can serve as a good foundation for introducing engineering in the dome or classroom. We anticipate that different venues will find diverse creative ways of using these resources (and we’d love to hear how they’re being used!). It is our hope that many different institutions will find our modules helpful, and that they will help engineering take its rightful place in the planetarium space.

Talia Sepersky is a planetarium educator in the Charles Hayden Planetarium at the Museum of Science, Boston, where she has worked for the past four years. You can contact her at tsepersky@mos.org.

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Open a window to the fulldome world!

www.fulldomefestivalbrno.com
The world’s first downloadable, full-length fulldome show.
For free.

The European Southern Observatory (ESO) is a driving force behind ground-based astronomy throughout the world and also is arguably the most productive ground-based observatory as well. As part of its mission, it has provided a wealth of free outreach and educational material for many years.

ESO's education and outreach department (ePOD) also is responsible for the European Space Agency (ESA)'s outreach for the Hubble Space Telescope and for the International Astronomical Union (IAU) outreach on contracts.

Over the last few years ESO has been expanding its educational mission to deliver increasingly high quality content in the form of visuals and texts. For the visuals, the production line was upgraded from standard definition (SD) to high definition (HD) in 2007, and then to ultra high definition in 2013 by delivering free videos in 4k resolution (so far more than 300 are available for free in the ESO and ESA/Hubble video archives).

In 2014, fulldome visuals in 4k resolution were introduced to support the planetarium community. So far this collection consists of more than 100 free fulldome clips and movies, which are partly based on original images taken through ESO's telescopes.

The telescopes, distributed over three sites in Chile, include the four colossal 8-m Unit Telescopes that makeup the Very Large Telescope (VLT) and the Atacama Large Millimeter/submillimeter Array (ALMA). Earlier collaborations for commercial fulldome productions were also made with the Association of French-speaking Planetariums (APLF) and the Hamburg planetarium.

Support for planetariums
Our work with the planetarium community follows explicitly from requests made by the outreach community at conferences and in reports (for example, via ASTRONET and CAP conferences). ESO strongly supports the idea that planetariums are places where scientific knowledge can be disseminated in an attractive and entertaining way. Our focus is on providing “raw” fulldome material for free, in an effort to support producers and planetariums in producing their own astronomical educational shows on low budgets.

The seed for this work was already in place, when, in 2013, by a remarkable coincidence, it became clear that the Klaus Tschira Stiftung would fund the construction of a planetarium and visitor centre at ESO’s Headquarters in Garching bei München, Germany. This
gave the fulldome project its critical initial impetus (in a staffing-limited operation there are many competing requests for talented in-house motion graphics artists) and work began on developing the material in earnest.

The ESO Supernova Planetarium & Visitor Centre will be a showcase for astronomy for the public. It is made possible by a donation from the Klaus Tschira Stiftung (KTS), a German foundation that supports the natural sciences, mathematics, and computer science, and by a collaboration between the Heidelberg Institute for Theoretical Studies (HITS) and ESO.

This new facility will provide visitors with an immersive experience of astronomy and ESO’s scientific results, projects, and technological breakthroughs. It will include a fulldome planetarium and more than 2000 square metres of permanent and temporary exhibitions. Further rooms housing conference facilities will also host a variety of lectures, workshops and conferences. All content will be provided in both English and German.

Sadly, Dr. Klaus Tschira passed away unexpectedly on 31 March 2015 in Heidelberg at the age of 74. Klaus Tschira was a devoted supporter of science education and astronomy, and we have pledged to make his dream of broadly communicating astronomy come true. We aim to make a difference to pupils, laypeople and the outreach and planetarium community worldwide.

Once the new facility was approved, the natural next step for ESO’s outreach was to start producing complete educational fulldome documentaries for the ESO Supernova itself, and in turn, due to ESO’s obligation to its Member States and beyond, also for the planetarium community.

Two shows are born

In 2014 ESO produced a free seven-minute fulldome mini-show titled Journey to the Centre of the Milky Way enhanced by the epic Sacred Sites soundtrack from Michael Stearns. The show was accepted by the community with enthusiasm, encouraging us work on more ambitious material.

Almost a year later, in June 2016, ESO’s ePOD and the Supernova Planetarium proudly released their first complete full-length 4K fulldome documentary under the title From Earth to the Universe.

This simple, but visually impressive, 30-minute voyage through time and space conveys, through an arresting combination of sights and sounds, the universe revealed to us by science.

It is directed by the promising 23-year-old Greek filmmaker Theofanis N. Matsopoulos, and features a sweeping soundtrack from the Norwegian composer Johan B. Monell. Viewers can revel in the splendour of the various worlds in the solar system and the ferocity of the scorching sun.

We leave Earth to take the audience out to the colorful birthplaces and burial grounds of stars, and still further out, beyond the Milky Way, to the immensity of myriad galaxies. Along the way, the audience learns about the history of astronomy, the invention of the telescope, and today’s giant telescope arrays that allow us continue to probe ever deeper into the universe.

The movie is based on visualizations from data captured by the largest telescopes in the world, such as the Hubble Space Telescope and the giant ground-based VLT in Chile. It is suitable for primary and secondary students, as well as families.

Premieres in Greece and Germany

The show had its world premiere at the New Digital Planetarium of the Eugenides Foundation in Athens, Greece, and at the Hamburg Planetarium in Germany, on 22 June 2015. It has since been downloaded by, and shown in, planetariums worldwide.

Thanks to the hard work of our partners in Hamburg and Athens, the planetarium soundtracks are available in German and Greek. Soundtracks or scripts are available in numerous other languages as well. The show is available in various formats for direct download: 4K, 2K, 1.5K, and preview.

From Earth to the Universe is the world’s first freely downloadable full-length fulldome show. There are other free full-length shows, like Two Small Pieces of Glass, but none are directly accessible for download, something that we believe will be increasingly important in the future.

We believe there is a need also for free clips and shows, especially for small domes with budgets so small that the procurement of shows becomes a financial or even practical impossibility. We are aware of the needs of the fulldome industry and do not wish to undermine their profitability, but aim to expand the available material in a particular part of the astronomy show spectrum.

A 30-minute full-length fulldome movie can reach 400 gigabytes in size, depending on the format, which stretches the ability of most internet connections. However since internet connection speeds generally increase with time, we believe that if we provide excellent access to the material the community will eventually be able to access the show.

To demonstrate the feasibility of distributing these extremely large files online—assuming excellent connectivity—the table shows the download times for different typical internet connection speeds for planetarium clips and shows.

The throughputs of the connections quoted are the ideal ones with little latency, packet loss, network outages, and inter-network friction. Even on relatively modest internet connections (similar to a good private 16 Mbit/s internet connection) with a bit of patience and a full night or weekend at your disposal downloading the material is a practical proposition.

However, providing excellent access to material on our side has proved to be a slightly more complex issue than anticipated. Inherent limitations in the internet’s architecture make it difficult to achieve the desired levels of performance reliably.

The internet has grown organically, achieving a best-effort network design and so provides no guarantees for either end-to-end
reliability or performance. Most internet connections are occasionally subject to a number of bottlenecks that adversely impact performance, including latency, packet loss and inter-network friction (Nygren, 2010).

Because receiver acknowledgements are needed for every window of data packets sent, throughput is inversely related to network latency or round trip time. The distance between server and end user can become the overriding bottleneck in throughput (download speed) and video viewing quality. In the real world this means that downloading files fast or streaming HD video is not possible unless the server is relatively close by.

Content Delivery Networks (CDNs) can be a solution to all of the above-mentioned problems, where a company provides a distributed system of servers deployed in multiple data centers across the globe to more widely available and with high performance in many locations. Internal checks in the network can ensure that all content is synchronised and available from all the servers.

Since February 2015, ESO and ESA/Hubble have made use of the advantages of a CDN. As part of a collaboration, the CDN provider CDN77 has now placed all ESO’s and ESA/Hubble’s images and videos on 28 servers throughout the world. They are distributed in 23 different countries and cover all continents except Africa (and Antarctica).

This gives users, particularly in the Americas, Asia and Australia, significantly faster access to the content and allows them to play back videos live on screen, and download even the largest videos and images in a reasonable time.

So far the distribution has been going very well, with between 100 and 200 packages of this show distributed and 0.005% downtime on our side. The only reported problems have been of slow internet connections in need of an upgrade (we have heard of down to 4 Mbit/s connections) and some curious problems in unzipping otherwise fine zip files.

As an odd fact, it is worth noting that due to the system of CDN distribution we actually pay a few euros every time the show is downloaded. We are not forced to distribute fulldome material for free, but we are deeply committed to the planetarium community and to providing content to those who cannot afford licenses or even the administration and accounting work associated with this.

A way forward for the community

We believe that electronic distribution of fulldome clips and even full shows is a way forward for the community to be swifter and more responsible towards news and hope that we can contribute to shifting the delivery mechanism for fulldome shows in this direction, while at the same time making a case for the standardisation of the fulldome format (which de facto is 4k/30 fps).

One of our big projects for the ESO Supernova is an “astronomical weatherman” system which—with the help of the community, especially the vendors—will become the first real-time, data-driven distribution system for planetariums worldwide. Every morning, planetarium presenters around the world will be able to select interesting news and dataset previews downloaded overnight—planetary maps, images of sky objects, tabular data, event data—and mark the full datasets and metadata for download and for possible inclusion in live show segments during the day. We will hopefully be able to present the plans for this in an upcoming article in Planetarian.

We encourage anyone interested to subscribe to the fulldome RSS feeds and get notified whenever there is new content. And keep scanning the IPS web page that acts as a portal for interesting new materials.

Experience beauty and mystery

To conclude with an excerpt from the From Earth to the Universe promotional material:

The night sky, both beautiful and mysterious, has been the subject of campfire stories, ancient myths and awe for as long as there have been people. A desire to comprehend the Universe may well be humanity’s oldest shared intellectual experience. Yet only recently have we truly begun to grasp our place in the immensity of the cosmos. To learn about this journey of celestial discovery, from the theories of the ancient Greek astronomers to today’s grandest telescopes, we invite you to experience From Earth to the Universe.

We are proud to be able to help you show just how far humanity’s ambition has taken us in terms of observing and understanding the universe.

References


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Theofanis was born in Athens, Greece, in 1991, and specialises in astrophotography, digital image and video processing, 3D animation, and video production for digital planetariums. He has directed and produced documentary series for local television, promotional videos and documentaries for the Visitor Centre of the National Observatory of Athens and for the Greek GEO (Group on Earth Observations) Office. He has presented two photography and astrophotography exhibitions titled The Greece of the Stars and Between Heaven and Earth at the Eugenides Foundation in Athens and elsewhere in Greece.

Max R. Rößner

Max is a PhD candidate and has an engineering degree from the Technische Universität München. He has worked in the planetarium field since 1996. His research interests are in fiber optics, planetarium display systems, and space engineering. At the moment his focus is on doing research and development into various issues concerning innovation for planetariums worldwide and in particular for the planetarium at ESO’s upcoming Supernova Planetarium and Visitor Centre, with special emphasis on the production and integration of a system for providing all planetarium presenters globally with daily information via the internet.

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A unique fulldome experiment is soon to be finished at Brno Observatory and Planetarium in the Czech Republic, where film director Robin Kašpářík is finalizing his first full-dome film based on a story by Stephen King. Yes, that Stephen King!

The bestselling author gave him permission to direct his short story “I Am the Doorway” for a symbolic price of one dollar, under the restriction that it will be a non-profit project.

“The name of the story piqued my interest: ‘I Am the Doorway.’ Strange title resonating with the unconscious. Just as the story. After the first reading it seemed to be a sci-fi horror, but there was something much deeper and darker in it. I wanted to capture ‘it’ in a film and immediately became fascinated,” explains Kašpářík.

“I Am the Doorway” is a story of an astronaut held in quarantine on a spaceship because of a strange otherworldly disease. The astronaut soon learns that the disease is gradually taking control of him and the time to act against it is nearly over.

During preparation for the film, Kašpářík visited Zeiss-Planetarium in Jena, Germany, for consultation. This was his first opportunity to see fulldome technology.

“It was fascinating, completely different experience from a cinema. It immediately connected with ‘I Am the Doorway,’ which expanded to another dimension. Fulldome resembled to me the inside of a giant human skull. That is why I decided the whole film in fulldome, in the point of view of the main character. The spectator enters the dome and astronaut’s head at the same time, watches, and experiences everything together with the astronaut.”

“It was a challenge”

Kašpářík asked French cinematographer Nicolas Bordier for cooperation. “When I told him it is a low-budget film without any royalties, he dismissively waved his hand and said it was a challenge. I found a right hand.”

Bordier talked to Ivo Marák, technological director of UPP, a post-production company, and to Jaromír Čedina, a specialist in the field of camera-stabilizing technology who worked on the James Bond movie Casi-no Royale. Together they designed a construction tailored to the human body, holding a Red Dragon camera and a special lens.

Now an actor was needed who would move naturally with this equipment and at the same time could express emotions only with his hands. “His hands will be the only thing that the spectator will see from the point of view of the main character. I thought a mime would be best in such role.”

Thomas W. Kraupe
Planetarium Hamburg
Hamburg, Deutschland
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Robin Kašpářík
The director found Radim Vizváry. “I saw his performance. It was a completely different kind of pantomime than what I have seen. He was able to express memories, traumas and fragility of a human psyche. He was the man for our film. He read the script, asked about the schedule, took his diary and crossed out his scheduled performances. Mimes really don’t waste their time with chit-chat.”

That is how the foundation of the team came to existence. Later it contained people from eight countries. “I had the right people: talented, friendly and excited,” says the director.

The creative team built the interior of a spaceship. “People discouraged us from such construction saying we should create everything on a PC. I refused that. I wanted real sets that would provide the film with authenticity. Every millimeter had to be perfect,” says Kasparík.

**The actor as camera**

Then they mounted the support structure on main actor Radim Vizváry and turned the screws. Then they fitted him with a camera with a special lens allowing you to watch the film in a planetarium through the eyes of the main character. After locking him in quarantine on the spaceship, the team waited to see if his body would merge with the gear—and the wait was totally worth it! Just have look at the cover of this issue.

The film was shot twice: one version for the fulldome technology that will be projected to viewers at planetariums and other domed venues, and the other for classic cinemas. It was an experiment even for a skilled cinematographer.

“Fulldome requires a completely different approach to filming. The special lens covers entire surroundings, so the actor had to be in the set on his own. We controlled everything, including lighting and camera zoom, with a remote control,” explains Bordier.

**Now in postproduction**

Currently the team is working on postproduction at Brno Observatory and Planetarium. After they complete the movie, they are looking forward to presenting it at fulldome festivals and shows all over the world, along with a documentary film about making the movie.

The reactions by planetarium directors and fulldome producers from around the world were very promising after the presentation of the first trailer at the Central European Fulldome Festival in Brno. The director of the film was already offered the chance to present the film in several key planetariums in Warsaw and Łódź (Poland), Hamburg (Germany), and San Francisco (USA), so you might be able to see this unique production very soon at a fulldome festival and venue near you!

If you would you like to show the film in your planetarium, contact the director himself at Robinkasparik@gmail.com. News about the film can be found on Facebook: www.facebook.com/IAMTHEDOORWAYMOVIE.

Robin Kasparík was born in the Czech Republic in 1986. He has been fascinated by film since his childhood and analyzing films by his favorite directors taught him the most. His short film Séance (2009) was awarded as the best short film at the Dark Carnival festival in the US. His girlfriend, Veronika Poláková participates on “I Am the Doorway” as a co-producer.

Thomas W. Kraupe:
Born in Bavaria, Germany, in 1956, Kraupe is an astrophysicist, director of Hamburg Planetarium, and IPS officer (past president). He met Robin in April this year in Brno and both quickly found common grounds in their fascination for sci-fi film and their passion for immersing themselves in many facets of culture. He offered Robin his full support for this unique film project.

Facing page: Set design of quarantine on space ship. Photo by Pavel Gabzdyl.

This page, top: Special fx makeup of strange disease. Photo by Ondřej Kramář. Center: Film director Robin Kasparík with mime Radim Vizváry. Photo by Ondřej Kramář. Bottom: Director of photography Nicolas Bordier; photo by Pavel Gabzdyl.
In Amersfoort, The Netherlands, there is a small company that exports stars. Since 15 June 1985, Rob Walrecht Productions has designed, produced, and published planispheres. These planispheres are sold to private and commercial customers all over the world, in many different versions, in 14 languages, and 10 latitude zones, together covering the entire populated world.

Your guide to the stars

You surely know the planisphere. It is a wonderfully enjoyable instrument that helps the user learn how to recognize constellations and stars and to find deep-sky objects. Of course, there are popular phone apps available these days, but they really don't give the user the same feeling that a planisphere does. The modern digital tool is great for people who are familiar with the sky and just want a quick update; for the layman, however, it's another one of those fast but superficial gadgets. The user can quickly establish that a certain bright star is Arcturus in a constellation called Boötes, but if you ask a day or even an hour later, he will have forgotten the name and the constellation.

A planisphere invites the user to go on a fun exploration of the heavens, together with friends and family. Once you have learned to follow the shape of Draco, the chances are that you will remember names like Thuban and Etamin, and you will certainly remember that it is close to Ursa Minor and the famous star that belongs to it.

About me

I was born on 16 June 1959. I have three older brothers and a younger sister. My parents instilled in all five of us a love of nature and they stimulated us to develop our creativity. Two brothers are teachers.

Following these two brothers, I became a member of the local astronomy club in 1976. Soon the three of us were producing exposures and all kinds of other events, but I was also the “media officer” and created a club library, plus a small “book shop” to help fund it. It was here that I developed my writing, graphical, and presentation skills.

With a separate non-profit foundation we published over 90 different slide sets about space and solar system exploration (with images from Voyager, Viking, Space Shuttle missions, and much more). They were very popular in the Low Countries and we sold some 300,000 slides.

I assembled a huge archive of pictures, chose the subjects, and was the author, editor, and graphical designer for the accompanying booklets.

I let my active career as an astronomy edu-
On to a planetarium

In 1982 I got in touch with the director/founder of the then new Zeiss Planetarium Amsterdam (nowadays the Artis Zoo Planetarium) to see if he would be interested in selling our slide sets. Of course, the real reason for my visit was that I wanted to be part of the planetarium, and thus became a member of the small staff of four. We had to learn and invent everything ourselves, as there was no internet and we didn’t know about Planetarian to learn from veterans.

Unaware of any planetarium rules, we were therefore unbounded by any. We made some wonderful programs, for which I prepared all the slides, and gradually I did the sound, co-production, and more.

Another one of my many responsibilities was, not surprisingly, the gift shop. One idea that came forward was to publish a Zeiss Planetarium planisphere. After a miserable first try, our astronomer provided a computer list of star positions. I set to work in the projector room of the auditorium, under a metal roof, in the hot summer of 1982. Drawing was done with pen and ink, while the text was done with rub-off letters. A couple of times I damaged my design with a sweaty arm, rubbing off text parts. However, in between doing hundreds of planetarium shows, I finished the design and the planisphere was published later in 1982. It was made mostly of plastic and the paper star chart being covered in a thick layer of PVC.

Apollo Mobile Planetarium

The Zeiss Planetarium Amsterdam didn’t do well, however, and in 1983 I was one of the people who had to go. That was a huge blow, but my friend and former Zeiss Planetarium colleague Ruud Schornagel and I were soon planning our own planetarium. A real large planetarium. Far too ambitious.

Reading about mobile planetariums in a well-known American astronomy magazine, it struck me that such a planetarium could be used to travel through the country, to give planetarium lessons in the schools. This wouldn’t require classes to travel to a planetarium, therefore saving them the time and money for such journeys.

This was a planetarium that was within our reach. I have long thought that I was the first person to think of this, but some years ago I was told that possibly one or two Americans had the same idea in about the same time.

Our Apollo Mobile Planetarium was established as a company on 15 June 1985, on the same day that I started my planisphere publishing business. The planetarium was meant to provide us both with an income; the planispheres were just extra for me.

The 1980’s was a period of numerous education budget cuts, but still we had a very good first half of 1986, thanks to the enthusiastic response of the media. After the summer holidays orders dropped, however, to only four the rest of that year.

We tried for more than a year to remedy the situation in any way we could, but at the end of 1987 we decided to split, Ruud continuing the planetarium, hoping that one of us at least could make a living with our dream.

I went into what you would now call IT, started to pay my part of our debt to the bank, and my planisphere project gradually disappeared from view. With stock running low and sales not worth mentioning there was no need, nor intention, to produce new planispheres.

I still did the odd planetarium lesson on schools now and then. But back to 1984 first.

The “Planisfeer”

My own planisphere design was an improved version of the Zeiss Planetarium Amsterdam version, using the same computer data of the celestial coordinates of over 700 stars. I started work in 1984 and, being a veteran now, thought of some features that were quite new at the time (some of them having been copied by others since).

One of them was the ecliptic, which was made so that the dots were not simply part of a dotted line, but actually the daily positions of the sun at noon. This allows the user to determine the times of sunrise and sunset to within minutes and, of course, added to the need for a very accurate planisphere.

Double stars and variables were on the list of some 300 other object for binoculars, like nebulae and galaxies. In 1985 my Dutch Planisfeer was printed. My grandma funded it, for which I still thank her, although she died in 1991, with a special code on all my own publications.
Using the same list of celestial coordinates had a problem, as my more famous colleague astrocartographer and friend Wil Tirion kindly pointed out. Both the first planispheres had exactly the same errors in the positions of a few dimmer stars. He spots stars that are in the wrong position in a star chart with humiliating ease.

A second life
At first there was just one Dutch planisphere. Some 3000 were produced of this plastic version, a thousand of which were for the new Omnimax theatre Omniversum in The Hague. That was thus my first customised planisphere.

I have already mentioned that my planisphere project seemed to die a gradual and quiet death. However, in 1993 Marja and I wanted to get married and needed money. I decided to dust off the planisphere design.

An all-plastic design would now cost too much to keep the price at a reasonable level, so the new printer and I settled on a laminated thick paper star chart with a PVC upper disc from a silk screen printing company we still work with.

The new material of the star chart allowed for a completely new design, one with a rectangular shape and folded, leading to four square pages. One of them was the star chart, one contained instructions and tips, and the two pages inside contained a concise introduction to astronomy.

But how to pay for it? An IT colleague loaned me the money to produce 3000 planispheres, and the Omniversum added 1100 customised planispheres to that number (a few months later we received an order for 3000 copies from the Artis Planetarium). A renewed and again very successful press campaign led to many enthusiastic articles in the Dutch newspapers. Sales were wonderful and enabled the loan to be paid back quickly and for us to have a great wedding party in September of that year. Of this first design, still our bestseller, some 100,000 copies were produced.

Other planispheres
After this success I started thinking of other versions. The design of the mother star chart allowed the publication of planispheres for any latitude down to 30° north. For each version I needed to have a design containing the required portion of the main star chart, correctly reduced, and the basic layout of the star chart (with the outer rings). I made all designs at 200% for better accuracy.

Remember that this was before the age of digital files. Copies at any scale of the original designs could only be produced by companies with special photographic equipment, and I had to glue the huge black and white photographic prints accurately to a print for the basis of the star chart. The text and lines layer of new language versions had to be made from scratch each time, but for new upper disc designs I could also use a photographic print for all except the horizon and meridians, and the text of course.

In August 1995 three English planispheres came out, for 30, 40 and 50° north. A year later, an English planisphere for 60° north followed, together with Dutch planispheres for 40, 50 and 60° north. In 1997 I was able to add a French Planisphère and a German Planisphäre, with the help of two people from ESA’s Estec site here in the Netherlands, who provided the required translations.

In the meantime, orders kept coming for customised planispheres from all over Western Europe, including (in 1998) Norwegian and Danish planispheres.

Modern times
A major problem with hand-drawn designs is that they are made on paper and the size of a large sheet of paper (even professional paper) changes over time. My planispheres were getting oval. That was particularly nasty, as my design depended so much on accuracy. The declination circles (for 60°, 30°, 0° etc.) on the star chart should correspond with the correct marks on the declination line (celestial meridian) of the upper disc. And that was increasingly less the case.

In the winter of 1999-2000 Wil Tirion invited me to his house and he showed me how Adobe Illustrator works. It was a revelation. Using Illustrator, I could make designs that would never change in shape. It was also much easier to create other versions. However, I had to do make all designs all over again. It took me almost a year.

An extra advantage was that I could now first make two complete designs, one based on the northern and one based on the southern celestial pole. I designed all upper discs from 60° north to 40° south, with intervals of 5° (plus some special latitudes, like 52° north for the Dutch and 47° north for the French planisphere). I corrected and improved the list of deep-sky objects. The Milky Way was done in two shades.

It was now easy to produce any design, for (Continues on page 26)
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any latitude and in any language. The object numbers (M, NGC, IC), the circles and lines, and the names are all in separate layers. In another language it is just a matter of changing the names of constellation and a few stars.

That same year my first English planispheres for the southern hemisphere came out (20°, 30° and 40° south), and later one for 20° north. Then there was just one more English planisphere that I wanted to make: one for the equator.

The horizon of a planisphere designed for 0° is shaped as a half circle, with two right angles. That’s quite disgusting, of course, so I made upper discs for 10° north and 10° south, and a star chart based on the Dutch planisfeer, but with two star charts: when you look to the north you use the planisphere for 10° north and vice versa. This one is very popular all over the world, so I guess there not many competitors.

Gradually other versions came out: a Italian Planisfero, a Spanish Planisfero for 40° north and one for 30° south (for South America), a Frisian Planisfeer (Frisian is the other language of the Netherlands, with ancient roots), and a a Turkish err... Düzlemküre. We also did customised planispheres in Swedish, Finnish, Inuit, and Romanian. Hopefully many more will follow because it is great fun to do planispheres in other languages.

Among our customers are many well-known organisations: universities, planetariums, museums, professional and amateur observatories, and large stores (like WalMart).

Since 1985 we have sold some 300,000 planispheres in total. Before the crisis we sold some 25,000 per year.

Other work

Writing about planispheres, I almost forget that I have done much more. I have kept writing and teaching/lecturing all my life. Although schoolchildren are the most wonderful audience I can imagine, I had to stop with that, as a cheap build-it-yourself cardboard kit, for youngsters. That started in 1986, when I made upper discs for 10° north and 10° south, and a star chart based on the Dutch planisphere, but with two star charts: when you look to the north you use the planisphere for 10° north and vice versa. This one is very popular all over the world, so I guess there are not many competitors.

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Other work

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However, young people remained high on my list and I kept producing special products for youngsters. That started in 1986, when I produced a simple version of my planisphere as a cheap build-it-yourself cardboard kit, which I named the Star Wheel. In 1987 a BIY sundial followed.

Around 2001 I designed a whole range of BIY products, but I lacked the funds to publish them all. Three were published, however, in 2003. Apart from new versions of the Star Wheel and sundial, I came out with a unique solar system scale model (at scale 1:100 billion). It consists of sixteen cards (for the sun, the planets, and more). These cards contain the size and distance to the sun at scale, but also a table of general information and, on the back, a narrative of the planet or other object. The product was based on one of my 3D mod-
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Astronomy at the Top of the World: Educators experience why Chile is vital to astronomy

Pete Detterline
Boyertown Planetarium, Pennsylvania
Renae Kerrigan
Peoria Riverfront Museum, Illinois
Sarah Komperud, Bell Museum of Natural History, Minnesota
Jim O’Leary, Maryland Science Center, Maryland
Mike Prokosch, Sam Houston State University, Texas
Shannon Schmoll, Abrams Planetarium, Michigan

Those of us working in astronomy education know the great observatories of the world: Kitt Peak, Mauna Kea, and the mountains of Chile. And many of us have visited these remote locations to see the great instruments used to explore the universe.

Earlier this year, a new National Science Foundation-funded program brought nine U.S. astronomy educators to Chile to visit U.S.-supported observatories and to hear from Chilean-based astronomers and educators about their work. Known as the Astronomy in Chile Educator Ambassador Program (ACEAP), the initiative looks to spread the word about U.S. astronomy efforts in Chile and forge lasting links between the American and Chilean astronomy education communities.

Representing planetariums, schools, universities, and astronomy organizations, the nine of us visited the major NSF-supported observatories along the Chilean Andes: Cerro Tololo, Gemini South, the Southern Astrophysical Research Observatory, and the Atacama Large Millimeter Array.

The authors represent the planetarium field and include Pete Detterline (Boyertown Planetarium, Pennsylvania), Renae Kerrigan (Peoria Riverfront Museum, Illinois), Sarah Komperud (Bell Museum of Natural History, Minnesota), Jim O’Leary (Maryland Science Center, Maryland), Mike Prokosch (Sam Houston State University, Texas), and Shannon Schmoll (Abrams Planetarium, Michigan).

Other astronomy educators rounded out the group: Ryan Hannahoe (Monforton School, Montana), Brian Koberlein (Rochester Institute of Technology, New York), and Vivian White (Astronomical Society of the Pacific, California).

Why Chile?

Chile is one of the prime locations on the planet for astronomy research. The combination of climate, high mountains, dry air, clear skies, and stable government make it a mecca for ground-breaking research, new observing sites, and even a burgeoning astro-tourism business that brings thousands of visitors a year to this southern hemisphere nation.

Located along the western coast of South America, Chile is unique in shape. More than 2,600 miles north to south but only 215 miles at its widest east-west, it spans a wide variety of environments from the arid Atacama Desert to the rugged Andes Mountains and the Patagonian uplands.
of climates, landscapes, and ecosystems.

The regions that attract astronomical interest range from the area around La Serena in central Chile to the vast and arid Atacama Desert in the north. This is where the world’s astronomy community has looked to build the largest and most innovative observatories.

Chile is home to more than 40% of the world’s astronomy infrastructure, and by 2022 this number is expected to swell to 70%.

Chile experiences more than 300 clear nights a year on average, thanks to its geography. It’s free from the atmospheric moisture surrounding it on both sides. The towering Andes Mountains to the east block moist Amazon air, and persistent high pressure over the Pacific Ocean and cold ocean currents prevent clouds and rain coming in from the west. The Andes are the world’s longest continental mountain range, averaging about 13,000 feet in height, providing the ideal lofty setting for observatories.

The region from La Serena north leads into the harsh Atacama Desert, considered the driest non-polar desert in the world. Average rainfall across the Atacama is about 15 mm (0.6 in) per year, and some weather stations have never recorded rain. Records show that the Atacama may not have had any significant rainfall for 400 years prior to 1971. Dry air is ideal for astronomy research since water vapor in the atmosphere absorbs critical wavelengths of incoming light.

Away from major population centers, these sites offer the darkest skies possible. While population and development continue to grow and light domes are visible from some observatories, the government is working to reduce light pollution.

The Chilean government is another reason for the abundance of Chilean astronomy. Among the dozen countries on the continent, Chile is one of the most stable and prosperous nations and welcomes the international astronomical community.

Cerro Pachon

The first peak our ACEAP team visited was Cerro Pachon, home of Gemini South and the Southern Astrophysical Research Observatory (SOAR). It is also the future home of the Large Synoptic Survey Telescope (LSST).

Gemini South

The only thing better than one great telescope is two, especially if the second one is located in the opposite hemisphere. This is the story of the Gemini twins, Gemini North on Mauna Kea in Hawaii and the twin we visited, Gemini South on Cerro Pachon. As we walked around the cavernous dome that houses the 8.1-meter telescope we were immediately impressed with the magnitude of the instrument and the cutting-edge technology it employs.

Huge segments of the dome’s walls can open to help stabilize the inside of the dome with the outside air temperature. It uses the most advanced adaptive optics system of any telescope in the world. There are 120 hydraulic actuators changing the shape of the 20-cm-thick mirror to cancel out the effects of air turbulence. The adjustments to the mirror made by the actuators can be as fine as 1/1000th the thickness of a human hair, providing razor sharp images.

Three different camera systems are used, with the Gemini Multi-Object Spectrograph (GMOS) being the workhorse. The Gemini Planet Imager (GPI), an adaptive-optics imaging spectrometer, and FLAMINGOS-2, a wide-field imager and multi-object spectrometer, complete the instrument package.

Notice the word “spectrometer” in all of the cameras. This is because Gemini South sees the universe by looking at heat signatures in the near-infrared rather than visible light. The mirror has a coating of silver, which gives it a much better sensitivity to heat. There is more of this precious metal in two silver dollars than what is found on the Gemini mirror.

The universe in these wavelengths allows us to see what is hiding behind those curtains of gas and dust in star-forming regions or permits us to reveal black holes at the centers of galaxies, but that is just the beginning. Observations with the Gemini telescopes can give us key insights into the history, structure, and evolution of the universe.

Interested in observing with Gemini? A successful online application for research is put into a scheduling queue. Your observing request is then programmed for time by the Gemini staff by matching conditions optimal for your research.

The days of having an astronomer travel to the facility with a set observing time only to discover that there is a problem with the weather or a camera are over at Gemini. The astronomer stays at home and collects the data when it is completed. This new philosophy of doing astronomy at a major observatory is now standard rather than the exception.

SOAR

Just a jaunt down the road from Gemini South is SOAR. At 4.1 meters it is half the diameter of Gemini South, but still impressive. This telescope is a collaboration of the National Optical Astronomy Observatory, Ministerio da Ciencia e Tecnologia of the Federal Republic of Brazil, the University of North Carolina at Chapel Hill (UNC), and Michigan State University (MSU).

SOAR can have up to nine instruments
mounted at a time and observes in optical to infrared bands, requiring the high dry location of Cerro Pachon.

SOAR has public time, though astronomers from UNC, MSU, Chile, and Brazil do have guaranteed time on the telescope. The advantage of this is that astronomers from those locations are able to use their time on longer-term projects that require monitoring or scanning the sky.

For instance, Megan Donahue, a professor at MSU, and her student Tom Connor use SOAR to study the gas in the brightest galaxies in giant clusters. They are studying how active galaxies turn “on” and “off.” Their time allows for many observations to show what is happening across multiple galactic clusters at different levels of activity.

Observers either travel to Cerro Pachon and work from the control room on site, or work remotely from several locations. These remote sites have identical set ups to the one in Cerro Pachon, but allow observers to skip the travel. That might seem baffling to those of us who want to visit these telescopes, but for those with guaranteed time, traveling monthly can get a bit tiring.

LSST

The Large Synoptic Survey Telescope (LSST) is the next major survey project by astronomers and will change the way we do science. It will have a 3.2-gigapixel camera that will take an image of the sky every 60 seconds while in operation. That equals nearly 15 to 18 terabytes of data each night. LSST will cover the entire visible sky from Cerro Pachon every three nights. All collected data will be freely available for anyone in the world to use.

Up until now, most astronomy has been driven by astronomers proposing observations they want to make to help answer a specific question. They collect the data they need to answer that question. In short, the question often precedes the data.

This is not so with LSST. The data will be collected, and it is up to astronomers to mine the data to find what is interesting. This requires new skills in computer science, physics, and mathematics to figure out how to meaningfully sift through so much information. LSST will not be fully operational until 2023, but current students are already starting to train and develop new skills and techniques required to deal with the science LSST will be bringing us.

Cerro Tololo

There is something indescribable about Cerro Tololo. It is a smell in the air—wind, dust, and the aroma of an herb that grows all over the mountain. It is the way telescope domes shine at the top of the mountain and the grasses seem to glow in the bright sunlight. It is the people who live and work on the mountain, and the foxes who gather around, hoping for a treat. It is the velvety dark night, the stars that glimmer brightly and the Milky Way leading you across the night sky. It is sunsets, scenery, and science. All of these things add up, until Cerro Tololo has imbedded itself in your heart.

The ACEAP team spent two nights at the NSF-funded Cerro Tololo Inter-American Observatory (CTIO) campus, which houses many telescopes. There are so many domes clustered together on the hill that it is affectionately called the “mushroom farm.” CTIO is part of the National Optical Astronomy Observatory (NOAO), and NOAO is managed by Association of Universities for Research in Astronomy (AURA).

Beginning in 1963, construction of CTIO was managed by AURA in partnership with the University of Chile. Work on the complex was completed in 1974 with the installation of the 4-meter Blanco Telescope.

Part of the charm of CTIO is the contrast between the vintage and modern. The furnishings and appliances are mostly original, but the equipment is about as high-tech as you can get.

The star of CTIO is the Victor M. Blanco 4-meter Telescope. This optical telescope has often been used for sky surveys, thanks to its wide field of view. In the mid 1990s, two teams of astronomers used the Blanco telescope to look for supernovae to try to prove that the expansion of the universe was decelerating.

However, both teams found that the data proved the opposite: the expansion of the universe was accelerating! In 2011, members of both teams received the Nobel Prize in Physics for the groundbreaking discovery.

The Blanco currently is outfitted with the Dark Energy Camera (DECam), a high-performance, wide-field CCD imager that photographs a large portions of the sky with a single image. This high-resolution survey allows astronomers to identify supernovae, weak gravitational lensing, galaxy clusters, and other evidence to probe dark energy.

While the study of the large-scale structure of the universe is the primary mission of the DECam, the images it takes are such high resolution that astronomers will be able to use the data it gathers for many other projects. The ACEAP team had the privilege of being inside the Blanco’s dome while it was observing, and hearing about the project from Dr. Chris Smith, astronomer and AURA head of mission in Chile and a member of one of the teams that discovered the expansion of the universe was accelerating.

The Blanco is in good company. There are about 13 telescopes on the top of the mountain. Astronomers and students from all over the world operate many of the scopes remotely. It was thrilling and slightly spooky to be out at night observing, and suddenly have a dome start rotating; you knew science was happening at that very moment!

ALMA

All along our journey we were allowed unbelievably and unparalleled access to the observatories and the people behind them. But nothing topped the access we were granted at (Continues on page 32)
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the Atacama Large Millimeter Array (ALMA).

After a few days of acclimating to sites at approximately 8,000 feet, ALMA’s Operation Support Facility tour, at 10,000 feet, felt easy. But the test was the high site. In order to be allowed to visit the high site at 16,404 feet, we had to pass a basic physical.

Although blood oxygen levels aren’t something we typically worry about in our day-to-day lives, we do pay attention at 16,000 feet, where blood oxygen levels drop fast while blood pressure rises.

Those of us used to moving fast found that our bodies and brains didn’t quite work the way we were used to. Asking questions and taking notes while on a tour of the second fastest supercomputer in the world, the ALMA Correlator, was like dredging through the shallows on a beach: able to be done, but slow work.

All that effort paid off once we got outside and were able to walk around the antennas. Scattered amongst the 12-meter antennas, the 7-meter antennas form a compact array. The limited snow sublimates at this altitude, and the reddish mountains make the scenery look like what you’d picture on the planet Mars. The sheer wow factor can’t even be described.

The antennas can be transported around the plateau with giant vehicles named Otto and Lore to change resolution for various research projects. At a maximum baseline of 16 kilometers, this gives ALMA the same resolution as the Hubble Space Telescope when all 66 antennas are working together as a single telescope.

This is easier said than done, since there are three different designs to the antennas, themselves each from partner country.

That’s where the supercomputing correlator comes in, with its 32,768 chips performing 17,000,000,000,000 operations every second, equivalent to three million laptops. This combines the pairs of signals into data that can be used to study the universe in a whole new way.

The process of observing at ALMA is somewhat similar to that at an optical observatory. You fill out an online application and it goes through a peer review and selection process. If accepted, then a member of the software team writes a script for telescopes to collect your data based on the antenna configuration you need.

The software team oversees the observing run, making certain that everything goes according to plan. The astronomer can be present at ALMA during the observing run or can collect the data remotely.

Due to its sensitivity, ALMA can image galaxies in minutes, rather than hours. ALMA’s targets include studies in astrochemistry, with astronomers looking for carbon and carbon monoxide in Milky Way-type galaxies. They can also do cosmological studies to calculate the high redshift of galaxies or observe galaxies being formed in the early universe.

ALMA does a lot in helping our understanding of star formation and viewing protoplanetary disks around newly-forming stars. A good example is HL TAU, a young star in the throes of planet building. In the image, we see these future worlds sweep out their orbits leaving dark lanes behind. This is the highest resolution image ever taken of a planet forming disk, and images like this show that ALMA is truly a revolution in astronomy. It is the case study model of where science is going.

Futures

So, where do we go from here? As fellow ACEPA ambassador Dr. Brian Koberlein put it, when we first met we were strangers, but now we are a family. We would like to see that family grow and prosper, but how?

First, we plan to get the word out and share it with others. ACEAP team members belong to GLPA, SEPA, MAPS, and IPS, and we will be presenting at upcoming conferences.

We also plan to create a planetarium show documenting our experience. We will use the hundreds of photos taken by all the members of the ACEAP family. This includes photospheres and ones taken with a macro fish-eye lens to give images a natural curve. These images will also be made freely available for planetarians to use.

One of the many take aways for us from this trip was learning about the vast content available from the observatories we visited. For instance, ESO hosts a large library of full-dome images and video sequences on their website, including footage shot on location at La Silla, Paranal, and ALMA as well as some

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Star Trails taken at CTIO with the Victor M. Blanco Telescope in the foreground. Photo by Peter Detterline.
Explore the Earth, Sun, and Moon systems with Annie, Cy, their dog Armstrong, and a wise-cracking starship computer. The Accidental Astronauts is a space adventure for all ages, designed to cover astronomy curriculum subjects in the low-to-mid elementary school levels.

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The story of a layman planetarian
A determination to share the universe

Ido Bareket
Bareket Observatory
Modi’in-Maccabim-Re’ut, Israel
info@bareket-astro.com

It was December 2010 when I was fortunate to meet Dayle Brown, a fellow planetarian, after posting a message on the Dome-L group. I was interested in creating a portable planetarium program as an addition to the Bareket Observatory’s global outreach activities.

(The observatory is family owned and operated. We are located near Modiin in Israel.)

We received at that time an old inflatable planetarium dome, which was in fairly bad shape. We tried to bring it back to life and start a modest planetarium program.

Dayle was on the last days of her vacation in Israel and was kind enough to offer her assistance and visit us at the observatory. It was great talking to a fellow from the planetarium community in person and I found Dayle’s inputs of a great value.

We did some more research and were able to renovate the inflatable dome, and then started to search for a dedicated digital projection system. The prices of the digital planetarium projectors were way beyond our budget, with a price tag of over $20K at that time for a moderate system (without a dome).

After the consideration for variety of solutions, we built a spherical mirror system, using a first surface mirror and a full HD projector. This setup enabled us to start running the planetarium program, bringing the stars to literally thousands of young students from different sectors in Israel.

Although the mirror setup was simple to maintain and fairly easy to produce, I was not completely happy with the results. The feeling was that the projected image could be sharper and the overall performance of the mirror, such as reflections and sweet spots, damaged the enjoyment from a truly immersive feeling of the night sky.

We wanted students to see the skies as realistically as possible and in its full glory. We continued our journey for a better solution: the search for a better planetarium.

The passion
In order to have a better understanding of what follows, it’s important to get a glimpse of our astronomical outreach activities. The Bareket Observatory is located in Israel. Our mission is to act as an educator’s resource for schools and educational institutions. We maintain many astronomy courses and classes as an integral part of the observatory’s activities.

The team at the Bareket Observatory is a unique combination of people with technical expertise, along with aerospace and education backgrounds. We all share the same passion: to light that “intuitive spark” by presenting the heavens to those students who represent the next generation of researchers. We are committed to introducing the universe to everyone, no matter where they live or from where they come.

Over the years we have developed unique and sophisticated tools for astronomy education and research, like a remote telescope accessible via the web, a Mars diorama with rover robot that can be controlled through the observatory’s website, and more.

As a part of our global outreach program we conduct live webcasts from our internet-accessible telescope. One of our most popular efforts in this respect is the NASA’s Deep Space Webcam.

It was a truly global effort, coordinated simultaneously by different organizations...
The flame nebula, taken using the Bareket Internet telescope.

The solution

The observatory’s team innovation capabilities are our biggest strengths and source of pride. We used the team’s aerospace engineering and education experience in order to create a new digital fulldome projection system.

Emerald™ planetariums - was born. (The name Emerald is the English translation for the Hebrew word Bareket.)

We started by making a 3D virtual design of the system, based on numerous mechanical, electronic, ergonomic, and esthetical features we found important for the planetarium operator.

We took great care on the details and it took many hours of hard labor until we were completely satisfied with the new “baby.”

The actual unit is made of laser cut aluminum and computer numerical control parts for great accuracy and performance, while keeping the overall weight as low as possible. When our hardware department finished working on the first unit we were all thrilled—it looked so darn good!

We design and build our hardware locally, including the internal SSD fanless computer as well as the optical system. This ensures optimal results with the specific projector and dome. This also allows us to supply custom solutions.

For instance: a school contacted us for supplying a projection system for their dome, which was placed (spring line) about 6 feet above the floor and tilted at an angle of about 25 degrees. We made a system that projected correctly onto the dome while still being placed on the ground.

All the school teacher had to do is open the dust cup and press on. The school had a fulldome system custom fitted to their current dome with no hassle and with money to spare on other educational projects.

We place 2 USB3 external ports on the units to let the user conveniently connect external hardware with ease. We provide further AUX ports for special uses if needed.

Using high-performance projectors combined with Emerald’s amazing optics, these systems produce seamless, sharp, and color-rich planetarium images.

Controlling the system is done via the Remote Dome Console, an intuitive and gesture-friendly user Interface. The operator can walk all around the dome while controlling the Emerald computer’s features with the tip of the finger.

We made sure that the learning process would be as simple as it gets, and we are getting great feedbacks from schools that brag about their students who are operating their entire planetarium for their own classmates. This is a real learning process right there.

For us, every system is a work of art. Thus we even include a true emerald gem in every projection system.

(Emerald planetariums are currently looking for an agent at the United States, Russia, Australia and East Asia. Relevant nominees are encouraged to contact the Emerald team via their website.)
Narrated by Benedict Cumberbatch

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“The Elumenati Evolver has redefined astronomy education for us. Teaching concepts that were once out of reach are now an everyday lesson plan. Teachers and the general public marvel at what we can show and teach them, and we are constantly discovering more that we can do.”

- Matt Linke, University of Michigan Museum of Natural History Planetarium

“The GeoDome Evolver system from Elumenati is the ultimate system for the 21st century planetarium. The combination of top of the line projection and software gives the planetarium a plethora of resources to customize and immerse their audience into a truly out-of-this-world experience. You will not be displeased!”

- Derek Demeter, Director, Seminole State College Planetarium, Sanford, FL
The Golden Dome

As the golden cupola rose from the deserts of the Emirate of Sharjah, many citizens and by-passers probably wondered what this new marvel was to become. The expansive campus of the Sharjah University nearby might have offered some clue, as well as the eight circles orbiting the golden sunlit dome in the center.

The United Arab Emirates (UAE) has more than its fair share of modern wonders, from the world’s tallest building to the world’s largest mall. Now, located just 30 minutes from the Dubai International Airport, the UAE are also hosting the largest digital—and hybrid—planetarium in the Gulf region.

From a vision and project initiated directly by His Highness Dr. Sultan bin Mohamed Al-Qasimi, the ruler of Sharjah, full-dome company Sciss had the honor to design and commission the next modern wonder in the area.

To paint you a picture of the spectacular surroundings, the Sharjah Center for Astronomy and Space Sciences (SCASS) is a circular planetarium building surrounded by gardens covering not less than 40,000 square meters. Together, the garden and the planetarium represents the solar system, where the planetarium building with its golden ceramic roof symbolizes the sun in the center. The garden is located within the University City area of Sharjah.

The planetarium also lies in the center of an interactive gallery, designed and fabricated by German company Hüttinger.

The whole project is part of an increased focus on education and research within the Sharjah emirate, the third largest in the United Arab Emirates after Dubai and Abu Dhabi. The initial vision for the planetarium was literally scribbled down on a napkin by His Highness Dr. Sultan bin Mohamed Al-Qasimi and the project’s shepherd, Dr. Hamid M.K. Al-Naimiy, professor of Space Astrophysics at University of Sharjah.

After two years, SCASS and its new Colorspace planetarium, alongside a brand new observatory, interactive gallery, several astronomy labs, lecture halls and study rooms, had its opening on May 7, 2015. The opening, hosted by His Highness, comprised of an engaging live Uniview presentation by Planetarium Manager Marwan Shwaiki, and a specially-made fulldome film by NSC Creative (that moved the audience to tears—true story). It was a very special day that summarized an exciting project.

Designing a dome theater

The planetarium design scope included the build of a full Colorspace theater: a digital display system, star projector system, audio, lighting, dome screen, seating, and software. 18 meter in diameter, with 200 seats and a comfortable 10-degree tilt, this hybrid of the innovative and the traditional is a truly unique planetarium.

All planetarium projects are rare and special projects, and new builds are even more so. No matter how great the architect, how experienced the civil contractor, planetariums are complex spaces not really comparable to other types of theaters. The placement and size of entry and exit points, seating layout and raking, and access and location of technical areas,
are just a few examples of details that can have large consequences if you don’t liaise with an experienced planetarium design team at an early stage.

That being said, we as dome specialists also need to be communicative and set up a good dialog with all stakeholders in a project when we get involved. Making time and space to revise and design the planetarium together with the client, the civil contractor, the architect, and the planetarium specialists are key so there are no misunderstandings or unpleasant surprises in the end. For the SCASS project, this need resulted in a steering group that included all stakeholders which met continuously, face to face, throughout the project and received monthly status reports from all subcontractors throughout the project.

Local representation

The world has many corners, and as a fulldome company, you oftentimes commission projects in places where you cannot be present every day. To have local partners that are not merely sales agents, but actual engineers certified on your products, is essential.

In Sharjah, our local representative Wesam Al Mofty, chief executive officer of Visuals Attractions LCC, was vital to ensure the quality throughout the construction project. With regular site visits he could be the guiding hand the civil contractor needed, and ensured that designs were followed and requirements met.

Skilled and regional on-site support helped not only to ensure a good working relationship with all sub-contractors, but also guaranteed a solution that could be understood and easily supported after the commissioning stage. When the spreadsheets were finished and the calculations done, it was easy to prove that the increased cost of having the planetarium specialist so present throughout the construction project was an excellent investment.

For example, we were able to avoid holes cut in the dome screen, structures shadowing light from the projectors, highly reflective surface materials inside the theater, and many other details that may seem small for a construction company but are essential to us planetarium professionals.

Every detail is important

The planetarium dome screen is designed with a 10-degree tilt and a low spring line, a carefully-made design choice. The slight tilt increases the immersive audience experience, while at the same time it keeps the similarities of being outdoors under a real night sky.

“When we design a dome theater, we approach each with a fresh perspective considering the region and its specific use case, along with universal factors such as capacity, comfort, and the immersive experience as a whole. We also make use of reference data relative to the tasks at hand, although reference data alone is not always appropriate or in some cases even applicable within dome environments. All these aspects and many more not only help to shape the layout of the theater itself, but also the supporting engineering solutions,” says Jack Langley, senior project engineer at Sciss.

An example of a design choice like this is the distance between seating rows. Most guidelines and fire regulations for auditoriums and theaters would require a minimum of 330 mm between rows, dependent on capacity and exit

Top: The Megastar II-A used in the dome’s hybrid system. Middle, bottom: His Highness Dr. Sultan bin Mohamed Al-Qasimi hosted the grand opening of the Sharjah Center for Astronomy and Space Sciences on May 7, 2015.
paths. For this dome we increased the distance to a minimum of 500 mm, which allows for greater recline and audience flow through the theater.

Additionally, with the theater catering predominantly to local audiences (with shows in Arabic and support for additional language tracks), the seats themselves were adjusted slightly at the manufacturing stage to favor ergonomic data representative of the audience.

To emphasize flexible design, the two front rows also are removable to allow an expanded stage area for special events as well as to make room for additional wheelchair spaces.

The hybrid system

The SCASS planetarium has a hybrid system with a notable capacity. The digital system is fully integrated with both an optomechanical star projector as well as the three telescopes from the nearby SCASS observatory. This solution allows teaching and inspiration of new topics taught in completely new ways, which was an important driving force in developing the integrated system.

The star projector, placed in the center of the dome, is a Megastar II-A model manufactured by Ohira Tech from Japan. It is as much of a tribute to countless hours of engineering marvel as it is to the accurate depiction of the night sky.

The projector provides a brilliant star field with over 10 million individual stars. By the press of a button you synchronize the star projector with the digital star field, and the transitions between the two systems are fully automated throughout your flight. Flying around the International Space Station while the star projector is kept in sync, or observing the night sky from Mars, are key examples of this hybrid experience.

SCASS lies in connection to a brand new observatory, designed and built by the German company Baader Planetarium. The observatory is equipped with three different telescopes that are integrated with the planetarium, meaning that you can stream high resolution imagery from it straight onto the dome, in real-time.

“In a modern planetarium, digital projectors are used to stitch together a seamless projection covering the full dome, opening up the planetarium for much more than projection of the night sky. A holy grail of planetariums, at least over the last decade, has been to find a way to combine the classical planetarium with the modern. To find the right niche between education and inspiration. With the solution made for SCASS, we’ve retained that balance and opened up to many types of experiences that a planetarium can offer,” says Staffan Klashed, CEO at Sciss.

The digital display

The digital display system comprises a 7-channel solution with F35 projectors from Barco. The native resolution per projector is 2,560 x 1,600 pixels. Blended together, the 7 images appear as a single seamless 15.8 million pixel image, corresponding to close to 5,000 pixels across the meridian of the dome.

The 8-server cluster allows for one server per projector, plus a back-up. The cluster is synchronized to millisecond precision by using the Nvidia Quadro sync approach, a combination of hardware and software that ensures that all nodes in the system swap frames at exactly the same millisecond, thus making sure that all computers are using the same clock for its rendering and simulation.

Combining solid state drives (SSD) with the optimized hardware allows for extremely fast transfer of images across the network. With the SSD’s enabling faster reading of data—a traditional bottleneck in many planetariums—you ensure smooth playback on the system without having to slice videos for each channel.

Last but not least, the software

The fine-tuned hardware and software enables the SCASS Planetarium to depict an interactive model of the entire observable universe, extending beyond 137 billion light years from Earth, as seen from any vantage point and at any point in time.

With Uniview 2.0, they can pull data from NASA satellites taken the very same day, visualizing volcanic eruptions in the dome just hours after it happens. A universe of data becomes accessible from across multiple disciplines. They can, for example, offer tours inside the human brain through “Neurotours,” a live presentation based on real neurological data.

Through the domecasting capability in Uniview, the SCASS planetarium can also connect and control (or be controlled by) other planetariums with the same software platform, essentially connecting planetariums across the world into a giant network, sharing live presentations and content for their audiences.

With so much information being available online today, and with the visuals of digital cinemas, SCASS has succeeded to niche themselves from other attractions by offering experiences that are educational, often presented live, and that are visually stunning. It is a place where both children and grown-ups can explore and get motivated to pursue more knowledge. The golden dome of Sharjah is becoming a hub for inspirational education. Marwan Shwaiki, planetarium manager at SCASS, explains the planetarium experience beautifully:

“When I take the audience to the edge of the known universe in Uniview, it challenges their perspectives and changes their idea of ‘home.’ From billions of light years away, the entire Earth becomes their home, and countries and borders disappear. In a larger picture, I like to believe that exploring space makes new generations understand their place in the universe better, and that this can contribute to a better and more peaceful future.”

About Sciss

Sciss is a fulldome company from Sweden that realizes complete dome theater solutions for planetariums, science centers, museums, and educational institutions all over the world. Introducing the groundbreaking Uniview visualization software in the early 2000s, we have since grown to over 150 installations worldwide. Today we are a world leading supplier of dome theaters and dome theater systems. Our Colorspace theater system is a fine-tuned package of servers, display systems, theater control, and software. We work through all the stages of the theater commissioning: from designing and building, to lifetime support and continuous development. For more information, please visit www.sciss.se.
Summer break can mean a lot of things to different people. Some see their annual vacation, others see an upswing in their public shows, and some go back to school. This year I did not have any summer groups; this was the first full summer I have had off in 10+ years. I thought I would go nuts.

Instead, I was approached to teach at some summer camps and lead some workshops around the midwestern United States. The workshops were animation classes and a course on updating logos.

The other part of my summer was spent rewriting my distance learning astronomy course by taking quite a few workshops.

Over the last few years my school and the planetarium have offered a middle school astronomy course through the state’s distance learning system. While ideally I would like the students to be able to watch the presentations in the planetarium, I knew that wasn’t going to work when they are 200 miles away.

I had to find other techniques to provide the core content, so I decided not to require a textbook. The standards that I wanted cover used a “near to far” model.

Not using a textbook meant that while I would have to research reliable sources, I also would be able to adapt quickly to new findings and discoveries. As I was developing the curriculum I decided that I didn’t want it to be an 18-week web quest, and wanted to make sure I included instructional best practices.

There are five major types of blended and distance learning philosophies that could be implemented for instruction. I explored each type and discovered they all have strengths and weaknesses. It is best to not buy into only one; treat them like a buffet and mix & match.

Distance

This model was one of the first on the scene and involves using a video camera and broadcasting your lesson with varying amounts of interaction. For no interaction, you could record to VHS/DVD/YouTube and a person just watched and took a concept quiz at the end.

Moderately interactive allowed for you to broadcast from a central location and your students were at remote studios that had cameras that you watch them and hear their questions. This allowed for more interaction and better depth of knowledge, but you were limited to the sites that could be used, and the teacher controlled what was shown (such as bringing up a remote site).

A high interaction option that has more recently come into use ties Skype’s ability to do video and screen sharing. From any place with a network connection you can transmit and your distance students call into the video conference call. They can see my PowerPoint and, when necessary, they can see me on the video. The students also can see each other, so they are able to develop collegiality with the others in the group.

The problem I discovered after using this method for a year, despite the fact that I found the discussions were great and the student projects they could share through screen share were good, was that I wasn’t happy with the lack of a way to check for knowledge as we were going.

Flipped

I have discussed this before in the Classdome, but here is a quick refresher: low interaction parts of the lesson are done at home as homework (guided readings, instructional videos, and simulations), while high interaction lesson parts are done during scheduled lesson time. These portions include labs, discussions, group collaborations, and practice/mastery.

I recorded my “lectures” and presentations and uploaded them to the state’s learning management system so the students could watch them. I also synced the videos to palm units for the students who didn’t have reliable internet connections.

I liked that the students were able to spend their digital time with me not just going over a PowerPoint or a webcast, but actually it was harder to convince the parents that it was going to work. Parents are certain that the non-class time should be spent on homework. One found it very frustrating that instead of homework they could check over, they had a video to watch together.

Lab

This model is easier for me to use when the students are in a more traditional school setting that allowed them to work in a computer lab on my curriculum with other students who were participating in distance learning. There could be five or six different courses going on in the same space.

The biggest adjustment to this model was the chunking into modules and sessions. A unit of study, like the solar system, would be broken into three modules: the sun, inner planets, and outer planets. These modules then are broken into 4-5 sessions of about 42 minutes each.

The best practices model for a session is a vocabulary pre-test (5 minutes), skills section (25 minutes), and concept post-test (10 minutes). Normally this style of instruction uses a learning management system in the background for the students to take the tests, which gives you quick feedback to use to adapt the skills instruction. This model is one that I used when I was working with a very small school district with several grades of students in the same class.

Station

I have used this model the least because part of it is very similar to the lab model, but it wants to use grouping strategies that may not be available to the students at the remote sites. It also mixes online and offline instruction within a single lesson.

This mix of strategies I found difficult to implement with the students. We would start online with instruction to the whole group, then move to group activities (with some support from me), and finally transition to individual activities offline. Then they go back to whole group, which was the difficult part because the students were working at different paces and were often not ready to stop their work to go back to whole group when I logged in.

Flex

This style is one that I use in my classroom and it uses many traits from the others. The students are able to self-pace through parts of the lesson. Instead of whole group teacher-led instruction, it is provided at the time small groups of students are ready for it. It means that they are independently completing some of the lesson and when they reach the portion of the session (remember that from lab) where they need the teacher instruction, they signal or move to planetarium seating.

Our class’s magic number is six; as soon as we have six students ready, I do my part of the lesson. They return to their computer/station/lab for the next part of the session as the next group starts to build.

I selected this model because it was the most “flexible” to my needs, especially with some students needing more vocabulary support and others needing concept application.
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The Franklin Institute
The world of immersive content continues to grow as new technologies, shows, and presentation methods evolve. Here’s a snapshot of fulldome immersive activities from the past few months.

Featured fulldome facility and fulldome workshop

Immersive facilities are finding favor beyond the traditional planetarium venues we all know and love. For example, the Digital Dome at the Institute for American Indian Arts (part of the College of Contemporary Native Arts in Santa Fe, New Mexico), is a unique installation with an articulating dome and a Sky-Skan Definiti system. IAIA is making waves as an innovative space where many different kinds of artists—particularly Native American producers—can learn their craft and link its programming and knowledge formation with others across the country and the world.

Mats Reinlusson, director of the Digital Dome and internationally acclaimed artist, is offering a Dome Workshop at his site from October 9-11, 2015. Attendees will explore the dome creative space and technology in order to learn about creating for the immersive environment. For more information, visit the workshop web page at www.myiaiaonline.com/digitaldome.

Innovations in content delivery

Today we have tremendously vibrant tools that allow planetarians and fulldome producers amazing leeway in presenting both live and fully produced content. Each major equipment vendor is continually adding features to enhance a range of content delivery, from the newly announced Cloud by Evans & Sutherland (www.es.com) and the enhanced Dark Matter product from Sky-Skan Inc. (www.skyskan.com), to the continued database additions to the Spitz SciDome (www.spitzinc.com) product and the strong emphasis on live presentations by Digitalis Education Solutions (www.digitaliseducation.com/).

This past spring, SCISS (sciss.se) unveiled the ability of their platform to link planetarium domes together for content sharing and data exploration. This Domecasting enables remote collaboration between display venues.

Exploration and presentation of data are also at the heart of the open-source OpenSpace Project, spearheaded by Carter Emmart, released to domes in mid-summer. Among other feats of visualization, it lets users of both multi-projector and fisheye projection systems do real-time plotting of such events as the New Horizons flyby of Pluto and the Rosetta flyby of Comet 67P/Churyumov-Gerasimenko, and allows users to pull in imagery as it becomes available. (Learn more at openspaceinlu.se)

At my company, to bring more fulldome shows to small-to-medium range domes (including portables), we have started a new service called FULLDOME OnDemand which offers a new paradigm: online rentals of fulldome shows to theaters that can stream web videos to their projectors.

Launched in August, we hope the service appeals to budget-conscious planetarians, dome club operators, and those wishing to preview content on their domes before buying traditional licenses. For more information, see www.FulldomeOnDemand.com.

Shows in production

At least two new shows are slated for release later this year. The first is Asteroid: Mission Extreme, a joint production between Sky-Skan and National Geographic. Look for it in November, with a 3D version coming in 2016. The show focuses on asteroids, and how they can be both a danger and an opportunity for space exploration. More information is available at skyskan.com/shows/shows/Asteroids.html.

Evans & Sutherland is in production for Edge of Darkness, a look at the ongoing exploration of Pluto, Ceres, Comet 67P, and the other small denizens of the solar system. I wrote the script and visualizations are by space artist Don Davis. The show is scheduled for release in late fall, 2015.

Recent releases

The power of the sun is the focus of Solar Superstorms, from Spitz Creative Media, in cooperation with NCSA’s Advanced Visualization Lab, Thomas Lucas Productions, and in association with Fiske Planetarium at the University of Colorado in Boulder. The show uses spectacular visualizations to explore the fiery storms that erupt from the surface of our star. Narrated by actor Benedict Cumberbatch. For more information: solarsuperstorms.spitzcreative.com.

From NSC Creative comes We Are Stars, narrated by actor Andy Serkis (the genius behind the character “Gollum” in the Lord of the Rings). The show explores stars and the role they play in the universe. It was released in July, and will soon be available in 8k 60fps. See the show web page at wearestars360.com.

The Museum of Science in Boston recently released From Dream to Discovery: Inside NASA, which was featured at the IMERSA Summit this past March. The show focuses on the creation of space exploration vehicles such as the James Webb Space Telescope and the New Horizons spacecraft. It features an immersive visit to Goddard Space Flight Center and highlights the engineering talent needed to explore space. For more information, visit www.mos.org/fulldome/dream.

(See page 10 to learn about free educational modules connected with the program.)

The University of Alaska-Fairbanks has created a lovely 11-minute exploration of the aurora borealis in a show called Aurora Storm. Funded by a NASA grant, this show is available from Loch Ness Productions for the cost of encoding. It combines a scientific look at aurorae and a native viewpoint about these beautiful geomagnetic storms that light up the skies over our planet’s poles. Go to www.lochnessproductions.com/shows/uaf/aurora.html for more information.

Two free shows made their debuts this year. Cosmic Origins Spectrograph (Fiske Planetarium, University of Colorado) was released on April 25, 2015. It’s an exploration of the universe as seen through one of Hubble Space Telescope’s instruments. Frames can be downloaded from Fiske (contact Chris Maytag at maytag@colorado.edu for details), or you can order an encoded video from Loch Ness Productions (www.lochnessproductions.com/shows/fiske/cos.html).

From Earth to the Universe (produced by the European Southern Observatory Supernova Planetarium), released in early May, looks deeply into the night sky through the eyes of one of the most advanced ground-based telescopes on the planet. It is available for download. For more information see supernova.eso.org/programme/planetarium-shows/fettu. (Read more on page 16.)

Not a new show, but definitely a popular one, Mirage3D’s production of Natural Selection, about the life of Charles Darwin and the development of his famous theory, continues to be a dome favorite. Producer Robin Sip reports that it is now playing in more than 100 theaters world-wide, providing more viewers with a scientific look at how life on Earth formed and evolved.

Fulldome in festivals and beyond

Summer season was a busy one for the im-
imersive fulldome world. In particular, fes-
tivals and meetings lit up domes in Europe,
Russia, India, and the United States. The 9th
annual Jena Fulldome Festival—which at-
tracts producers and attendees from around
the world—was held May 27 to 30 in Jena, Ger-
many, and featured 94 fulldome show submis-
sions.

The festival began with a live performance
piece called Hotel zur Blauen Blume, presented
by the ZoManer group, augmented with digi-
tal fulldome projection and immersive sound.

Three days of fulldome presentations and
workshops followed, culminating in a Gala
awards evening for the best shows. Jena Fulldome Festival Awardees:
The Creative Award: Jalousien, Aljoscha Se-
us, producer
Performance Award: Am Ende eines langen
Tages, Christian Öhl and Philipp Boß, pro-
ducers
Audience Award: Ein abnormes Liebeserleben,
Deike Schwarz, Jonas Eichhorn, Perschya
Chehrazi, producers
The First Year Students’ Award: Απειρο, Kelly
Spanou, Camilo Zúñiga
The Blaue Blume award: Obscure Path (The
Flower of Afterimage), Fusako Baba

Emphasis on Emotion Awards: Walls Have
Ears, Mohammad Jaradat, producer; and
Green Grass and Pretty Girls, produced by
Bigyan Mani Dixit

The Best Fulldome Short Film Award: My Lit-
tle Brother Jimmy, created by Thomas Ban-
nier (Hochschule für Gestaltung Offenbach,
Germany)

Use of Innovative Production Technolo-
gies Award: Fermentation, by Masahige Iida
(Moriya, Japan)

The Directors Awards: Habitat Earth (Cal-
ifornia Academy of Sciences) and Starlight
(Melbourne Planetarium)

The Jena festival also included the “first
light” for the new Zeiss VR One virtual real-
ity headset. VR is a big topic in fulldome cir-
cles, making inroads into the dome, as well as
in the production studio, where headsets are
used for viewing quick renders.

The second annual IX Immersion Experi-
ence Symposium occurred at the Satosphere
in Montreal, Canada, May 20-24. Present-
ers explored expansion, hybridization, emer-
gence, and transcaling of the immersive me-
dium.

Live performances in the 18-m hyperdome
included Lost, by Ulf Langheinrich (Germa-
ny); Lumophore II, by Paul Prudence (Unit-
ed Kingdom); Quintesence, by Florence To
(United Kingdom) and Ricardo Donoso (Unit-
ed States); Entropia, (pictured in the Sato-
sphere) by Eric Raynaud and Aurélien Lafar-
gue (France) and LP St-Arnault (Canada).

The Russian Fulldome Festival in Yaro-
slavl, Russia, was held June 16-18, 2015, at-
tracting fulldome professionals from across
Europe, Russia, and the Far East. Elena Teresh-
kova, daughter of cosmonaut Valentina
Tereshkova, was a special guest.

The organizers screened 50 shows and gave
awards to Polaris, The Space Submarine and the
Mystery of the Polar Night (Planetarium de St.
Etienne, France); MUSICA: Why is the Universe
Beautiful? (Live Company, LTD); Journey to the
Solar System (Donesk Planetarium, Ukraine
and the Fulldome Film Society); Dream to Fly,
(Heavens of Copernicus Planetarium, Poland);
and A Starry Tale (Kagaya Studios, Japan).

The 2015 Western Alliance Meeting
(WAC), held in Albuquerque July 28-August 2
at the New Mexico Museum of Natural Histo-
ry, was something of a mini-fulldome festival
in addition to being a regional meeting.

More than 90 participants experienced a
dozen fulldome shows—including Accidental
Astronauts (Clark Planetarium), Discover the
Stars (Bays Mountain Planetarium), Exoplan-
ets (Casper Planetarium), Habitat Earth (Cal-
ifornia Academy of Sciences), Solar Superstorms
(Spitz Creative Media), Space Aliens (Milwau-
kee Public Museum), Space School (Sky-Skan),
Skywatchers of Africa and STARS (both by
Sudekum Planetarium), and a special showing
of First Friday Fractals, sponsored by the Frac-
tal Foundation (fractalfoundation.org/fractal-
shows/first-friday-fractals.)

The India Fulldome Planetarium Festi-
val, held in Surat, was the first-ever such event
in India. Sponsored by Astral, Inc. and Evans
Sutherland, in association with the Nehru
Planetarium (Mumbai), and Infovision, India
Fulldome Planetarium Festival showed at-
tendees the tremendous breadth of content
available. A special version of the E&S show
Wonders of the Universe was shown for deaf
children in attendance. Signing was provid-
ed by Infovision India and supported by Astral,
Inc.

The Fiske Fulldome Festival, held at Fiske
Planetarium in Boulder, Colorado, Aug-
gust 6-20, had more than 70 show entries, all
shown as part of a public festival and as well as
to attendees of the professional festival.

There were a number of premiers, includ-
ing We are Stars (NSC Creative) and Solar Su-
perstorms (Spitz), plus several North American
Festival premiers, including SpacePark360:
Infinity (Dome3D, featuring a Geodesium
(Continues on page 50)
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soundtrack), *Habitat Earth* (California Academy of Sciences), *Vera Rubin: Bringing the Dark to Light* (Fiske Planetarium and the Boulder Ensemble Theater Company), and *Deen Al Qayyima* (NSC Creative). The festival also featured live performances by Kenji Williams in *Bella Gaia: Live and Spontaneous Fantasia* by J. Walt Adamczyk.

**SIGGRAPH** featured a significant full-dome presence at this year’s Los Angeles event. Organizer Ed Lantz presented the full-length shows *Chaos and Order* (courtesy of Loch Ness Productions, created by Rocco Helmchen and Johannes Kraas) and *Waiting Far Away* (Museum of Science, Boston). Showings were held at the Vortex Immersion Dome in the SIGGRAPH VR Village, and included excerpts from *Dark Universe* (American Museum of Natural History), *Dynamic Earth* (Spitz Creative Media), *Immersive Spaces* (NSC Creative), selected visualizations from the California Academy of Sciences, and a collection of other short immersive content.

The **Giant Screen Cinema Association**, a group with dome theater interests, held its annual meeting September 9-11 in San Francisco. This organization is taking special interest in the rise of 8K theaters, following on the heels of last year’s successful “shoot out” between 8K and 15/70 at their annual meeting in Richmond, Virginia. This year, the group invited Evans & Sutherland to showcase its 8K system at their GSCA Dome Day, held at the Tech Museum in San Jose, California.

**IMERSA News**

Since the March 2015 IMERSA Summit, the organization has been developing a robust outreach to fulldome professionals. The newly revised and updated Web site at www.imersa.org now features videos of Summit sessions hosted on the group’s Vimeo channel. You can watch talks, workshops, the IMERSA Sizzle Reel, and much more, at the click of a mouse.

IMERSA has a Facebook presence at www.facebook.com/imersa.org. Fulldomers use the page to share production news, talk about technology, and more.

The organization is currently affiliated with such prestigious groups as the Giant Screen Cinema Association, IPS, GLPA, the Themed Entertainment Association (TEA), and several others, to draw together all aspects of filmmaking and production and focus them on specific needs in immersive media. Plans are already underway for the 2016 IMERSA Summit, scheduled for March 15-20 at the Denver Museum of Science and Nature.

Send Me Your News!

Fulldomers! This column covers all things immersive—and I depend on news from you! Creating a new show? Won an award? Have a new immersive technology you’d like to share? I’m always interested in what matters in the immersive world we all inhabit! Drop me a line!

ACEAP is a project of Associated Universities, Inc. (AUI), the National Radio Astronomy Observatory (NRAO), the National Optical Astronomy Observatory (NOAO) and the Gemini Observatory, both which are managed by Associated Universities for Research in Astronomy (AURA), and the project is funded by the National Science Foundation. Tim Spuck, AUI’s STEM Education Development Officer, serves as PI on the project.

Carolyn Collins Petersen is Communications Coordinator for IMERSA and CEO of Loch Ness Productions. She writes and edits this column with input from fulldome pros around the world. Carolyn can be reached at carolyn@imersa.org or carolyn@lochnessproductions.com.
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Audience, some of them with headphones.

Hari Nandakumar, Senior Manager
N. A. V. Krishnam Raju, Deputy Manager
Sri Sathya Sai Space Theatre
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Andhra Pradesh, AP-515134, India
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The problem

Our 180-seat planetarium has a very diverse visitor profile, since it is located at a pilgrimage centre devoted to Bhagawan Sri Sathya Sai Baba. Visitors from different parts of the country speak different languages, and so we present regular planetarium shows in three languages—English, Hindi, and Telugu—on different days of the week.

In spite of this, we often have visitors who would prefer the voice-over to be in a language other than the language scheduled for that day. When only a handful of visitors prefer different languages, scheduling separate shows for them becomes difficult, especially since we do not charge any entry fee.

Hence, we explored the possibility of making multiple language voice-overs available using headphones.

Possible solutions

Airline-style plug-in headphones was one possibility. But many of our visitors are from rural areas and are not tech-savvy enough to choose the appropriate language option, plug in the headphone to the appropriate language audio socket, and so on. Wiring also would be a significant challenge, since our seats are currently very basic plastic moulded chairs.

Wireless was the next option we examined. Wireless headphones for home use are commonly available for low prices—less than $10 each. Many models use FM radio transmission for operation, and can be tuned to multiple frequencies. This would help us in making available more than one language voice-over, using the same wireless headsets as receivers.

But would the audio coming over the headsets be audible, or would it be drowned by the audio coming over the speakers of the planetarium sound system? We did a test run, and found that if the sound delivered on the headset is slightly higher than the volume of the sound from the speakers, intelligibility is assured. We only had to reduce the speaker volume by 3 dB or so from our normal operating levels for the headphones to be viable throughout our seating area.

Sourcing the multi-channel audio

Next was the issue of how to interleave the multiple voice-overs in a single file suitable for playout on our system. We have a single projector spherical mirror-based system with stereo audio sound in our planetarium and use a Blu-ray player for playout.

The easiest implementation seemed to be to use a commonly used multi-track sound codec, Dolby AC3, using the surround tracks of a 3/2 AC-3 surround mix to deliver the extra voice-overs, retaining the main left and right tracks to feed the stereo speakers in the theatre.

We used multi-track audio software Reap.

We have implemented a multi-language audio voice-over system on headphones at our planetarium using off-the-shelf components and open-source software. The low cost of the system makes this an attractive option for venues in areas where multiple languages are spoken.
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er4 to make mono wav files of each language voice-over track and used WAV to AC3 Encoder5 to splice together all the mono files to a single multi-channel AC3 file. Avidemux6 was used to multiplex the audio and video files. (We are not affiliated with these software providers in any way, just happy users!)

This file was played back on our Blu-ray player, with audio being routed through an AC3 decoder, which gave 6 analog outputs for 5.1 Dolby Digital audio.

Hardware tweaks

For the implementation of this project, we used “Intex” branded wireless headsets7 and a generic AC3 decoder. Each wireless headset came with its own transmitter, which was set to 86 MHz at the factory for this product.

For making a single language available over headsets, a single transmitter would have been enough. For simultaneous transmission of four languages, we needed four transmitters at four different frequencies.

We opened up the transmitters and used a screwdriver to adjust the variable inductor by scraping away its protective wax cover. An FM radio was used to monitor the frequency obtained by varying the inductor, arriving at appropriately spaced frequencies by trial and error.

The transmitter frequencies had to be spaced by around 1 MHz for the automatic signal scan of the receiver to work reliably. Once the tuning was done, we replaced the protective wax covering on the inductor by using a candle to prevent accidental changes.

Logistics

Currently we use a simple show of hands to decide the majority preferred language and the number of other language headsets needed when the audience assembles in the lobby before the show. We tune the headsets before the audience enters the dome.

As the visitors enter, we hand over headsets to those who need them. We run a filler video in the dome during this process, which can take ten minutes or more if a large number of headsets are required.

We have used rechargeable NiMH AAA cells in our implementation. We can run 15 half-hour shows before we need to recharge the batteries. With our set of 100 headsets, it takes about an hour for one person to take out all the cells in pairs and insert them in the chargers, and after charging, to replace them in the headsets.

Conclusion

Our audience is happy with the headsets. There are requests to add more languages to the shows. We have added Malayalam language to our current show, and plan to add Tamil and Kannada options for groups who wish to listen in those languages.

We express our gratitude to Bhagawan Sri Sathya Sai Baba for inspiring this project, and to Sri Sathya Sai Central Trust for funding it.

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**Nordic Planetarium Association**

**Estonia.** The AHHAA Science Centre in Tartu has become more serious about astronomy. Since the beginning of this year, it has its own observatory on the roof of the building. A 150-mm achromatic refractor is permanently installed. The telescope is mostly used for public observations and special events.

During the first public night, the observatory had about 60 visitors and everyone could see Venus, Jupiter, and the moon. More public observations were carried out in August and September.

The telescope also was essential in the astrophotography learning course during 2-5 June. Eighteen high school students gathered in the AHHAA Centre to learn more about taking an astrophoto, processing it, and learning what kind of equipment is needed. Students spent two nights and had clear skies, so everyone was able to make their own first astrophoto.

Besides practical work, the program included lectures by AHHAA planetarium Margus Aru, astrophysicist Tõnis Eenmaä, and Tartu Old Observatory tour guide Kadri Tinn. Students provided excellent results and discovered that it is really possible to make nice astrophotos with a smartphone. The course was very successful and will most likely be repeated next year.

The AHHAA planetarium remains popular, and after being open now for four years it still receives about 50,000 visitors annually.

**Norway.** The planetarium in Vienfabrikken at Jærnmuseet in Sandnes has run six to seven shows daily during the summer season, including *The girl who walked upside down, Back to the Moon, Polaris,* and *Is there life out there?* and also given live presentations of the night sky and the planets. The newest show, Polaris, was premiered in June.

**Denmark.** The Orion Planetarium in Jels is producing a new show on exoplanets and discoveries from the Kepler Mission. It is scheduled to have its premiere in the autumn school break in October.

**Russian Planetarium Association**

**Irkutsk.** On 21 April, Major-General Zhügerdemidiy Güngragcha, the 101st person in space, the first Mongolian cosmonaut, and Hero of MPR and the Soviet Union, together with the head of the Institute of Astronomy and Geophysics of Mongolian Academy of Sciences Demberel Sodnomsambuu, visited the planetarium of Irkutsk. The guests showed great interest for the exhibition.

A collection of press cuttings dedicated to his space flight to the Salyut 6 space station as a crewmember of the Soyuz-39 spacecraft in March 1981 became a huge surprise for the Mongolian cosmonaut. The guests enjoyed the starry sky of Pribaikalye and fulldome planetarium shows.

Kazan. From 4-7 June, youth school Space Science took place in the facilities of Kazan Federal University. The main items on the agenda were recent research and the educational programs of Russia's leading planetariums. Participants were young scientists, students, and planetarium engineers and lecturers from Russia and Ukraine.

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the 70th anniversary of the victory in World War II, an exhibition of photographs, postcards, and stamps of the wartime opened in the planetarium of Nizhny Novgorod.

On June 24, the premiere of the Planet of Violin musical performance took place. This is the result of cooperation between the planetarium and the Solisty Nizhneho chamber orchestra. Unconventional concerts which combine live musical performance and full-dome visualization have become popular among the citizens of Nizhny Novgorod. Each full-dome installation is specifically designed for a concrete musical composition.

Yaroslavl. On April 18, the IV Interregional student conference Way to the stars took place in the facilities of V. Tereshkova’s educational center. The conference was dedicated to the 55th anniversary of the establishment of the Cosmonaut training center and the first cosmonaut corps.

Commemorative plaques (in the form of stars) honouring the cosmonauts V. Dzhanibekov and Yu. Louchakov were embedded in the Cosmonaut Alley. Participants of the conference, famous Russian cosmonauts, and the governor of the Yaroslavl region took part in the ceremony.

16-19 June, the second international festival of popular scientific full-dome films Reflection of the Universe took place in the facilities of the planetarium of this educational center. In total there were 98 participants, and more than 50 films from Russia, France, Poland, Germany, the Netherlands, Spain, Great Britain, India, Thailand, Taiwan, South Korea, the United States, and Japan were presented in the main competition. Workshops and master classes in the creation of full-dome content were conducted within the framework of the festival.

The list of festival winners can be found here: www.apr.planetariums.ru/images/pages/main/Award_2015.pdf. (See also Fulldome Matters on page 47.)

Society of the German-Speaking Planetariums

Potsdam. The annual GDP conference took place in the city of Potsdam from 2–4 May. Most presentations were held in the lecture halls of Fachhochschule Potsdam (University of Applied Sciences), with some key presentations offered in the 8-m dome of Urania Planetarium. A focus during the conference was on the full-dome visualization projects of Fachhochschule Potsdam students and faculty.

During the conference, a new board of the GDP was elected. It is now led by Björn Voss, former vice president of the society. The next GDP conference will be hosted by the planetarium in the city of Münster, in early May 2016.

Göttingen. After long-lasting efforts to establish a planetarium in the region of the famous university city of Göttingen, this initiative of a group of university astrophysicists finally succeeded: On 9 May, a 6-m dome with 32 seats was inaugurated in Uslar, a small town near Göttingen. This is the first planetarium in the south of the German state of Lower Saxony.

The new planetarium is equipped with a one-channel fisheye WXUGA video projection system. The planetarium will offer live presentations and full-dome shows on the first Saturday of each month. Further information on the new planetarium and its presentations are available at www.planetarium-goettingen.de/index.htm. Contact: Förderkreis Planetarium Göttingen e.V., c/o Dr. Thomas Langbein, Nordhäuser Weg 18, D-37085, Göttingen

Berlin. Some 50 years ago, on 18 June 1965, the Zeiss-Planetarium am Insulaner, situated in the borough of Schoeneberg in the western part of the divided city of Berlin, opened its doors to the public. It wasn’t the first planetarium in Berlin, as an earlier planetarium, opened in 1926, was damaged during the war and was subsequently torn down in 1955.

In the East of the divided city, a small dome opened in 1954 at the Archenhold Observatory in the borough of Treptow, but due to political circumstances, the inhabitants of West Berlin could not access this facility after 1961.

A few years after the war, though, some West Berlin amateur astronomers founded a non-profit association and constructed a provisional observatory, the Wilhelm-Foerster-Sternwarte. In 1963, this observatory moved to the top of the Insulaner Hill, an artificial hill made of World War II debris and covered by a park. At the bottom of this hill, a planetarium with a 20-m dome was constructed: the Planetarium am Insulaner, which can now celebrate its 50th anniversary.

The projector was, and still is, a Zeiss Vb projector from Oberkochen. Over the years, new technology was added, the most recent (but not least) a Zeiss Velvet 4k full-dome projection system in 2010. The institution, consisting of a rare combination of planetarium and

RPA: (Top) Participants of the festival in Yaroslavl. Courtesy of Alexandr Popov. (Right) Cosmonauts, after farewell, head for launch in Baikonur. Courtesy of Marina Kislitina.
In February 2015, a groundbreaking ceremony for the new ESO Supernova planetarium was held on the European Southern Observatory’s Campus in Garching, near Munich. Just months later, and two years ahead of the planetarium opening, ESO’s planetarium team has presented its first fulldome show From Earth to the Universe. The premiere was held on 22 June in parallel at the Eugenides Foundation planetarium in Athens, Greece, and at Hamburg Planetarium in Germany.

Directed by the young Greek filmmaker Theofanis N. Matsopoulos, From Earth to the Universe leaves our home to take the audience to the birthplaces and burial grounds of stars, and beyond, to the galaxies. Along the way, the audience learns about the history of astronomy, the invention of the telescope, and today’s giant telescopes. The show can be downloaded for free from ESO’s website at: www.eso.org/public/usa/videos/eso-fettu. (See more about the program on page 16.)

Italian Association of Planetaria

Veneto. Among the astronomical centers in the north of Italy there is the Centro Astronomico Giuliano Vanini located in Arson, a village placed in the northern hills of Feltre, about 10 km from the town. The main building is an 8-meter dome planetarium able to hold up to 70 people. The digital projection system has a resolution of 1200 pixel along the meridian.

Close to the planetarium a second building with a sliding roof, the principal pavilion of the observatory. It houses two main telescopes: an 8-inch f/5 Newton and a 14-inch f/5 Newton reflector with automatic pointing system.

Finally, a third sliding-structure contains “the little leviathan,” which is the largest instrument. It is a 25-inch Dobson-type reflector served by an automatic pointing system.

The astronomical center is managed by the Associazione Astronomica Feltrina Reticus. It is open to the public every Friday night, and receives hundreds of schoolchildren each year. In its first three years of opening it has been visited by about 7000 people, with a prevalence for the summer months.

Besides the main telescopes, the observatory also has an 8-inch f/10 Schmidt-Cassegrain, a 5.5 inch f/8 Schmidt-Newton camera, a 6-inch f/8 Schmidt-Newton camera, two solar telescopes for H-alpha observations, and 20-30-37 x 100 binoculars served by an automatic pointing system. The astronomical center is managed by the Associazione Astronomica Feltrina Reticus.

To introduce people to the knowledge of our solar system and stimulate scientific tourism, Planit realized the Planitalia project, an idea born at the IPS Conference in Alexandria in 2010. The project plans the construction of a model of the solar system built in proportion to the actual distances between planets. The planets are shown by a panel or totem with information about each one and are distributed throughout Italy at planetariums, observatories, and science museums that fall within the orbit of a planet in the model.

The calculation of the distribution of planets was made to encompass most of the Italian territory and to involve the largest number of sites. The sun is located in Padua, because in that area there are several astronomical sites that facilitate the positioning of the inner planets correctly. Catania is the landmark for the farthest planet.

The “StarLight... a handy planetarium” association made the organization and the implementation of the project. Stars in the map (see below) show the distribution and all the participants, but PlanIt hopes they will become more and more in future.

Among the next Italian initiatives is the National Day against light pollution (10 October), the deadline of the Page of Stars prize (31 December) and the PlanIt Prize (28 February 2016) for an original video production, organized each year by Italian Association of Planetaria (PlanIt). The prize is open to everyone. First prize is 500 euro. For more information see: www.planetari.org.

European/Mediterranean Planetarium Association

Croatia. The Astronomical Centre Rijeka (Rijeka Sport Ltd.) in Croatia reinforced its regular program for the summer months with special shows for all tastes. In particular, every Wednesday evening it screened Google’s Lunar XPrize fulldome planetarium show, Back to the Moon for Good, in English for the tourists visiting Rijeka.

In 16-18 July, each regular show was preceded by a 15-minute projection dedicated to the 46th anniversary of the Apollo 11 mission, as well as with an overview of the New Horizons mission and its long-awaited flyby of Pluto.

Also throughout the summer months, the Astronomical Center screened the planetaria-
On the panoramic terrace of Astronomical Center Rijeka, the youngest can make observations and learn about telescopes. (Right) A school group in Rijeka’s digital planetarium. Courtesy of Rijeka Sport Ltd.

The regular program for September once again included a matinee for the youngest. At the end of the month, visitors could observe the night sky above Rijeka during the live presentation A guide to the Night Sky as summer slowly drifted toward autumn.

**Southeastern Planetarium Association**

SEPA just concluded a fantastic conference hosted by the Tellus Museum in Cartersville, Georgia. About 120 delegates enjoyed nearly four days filled with workshops, paper sessions, fulldome programs and clips, and vendor demos. One of the conference highlights was a trip to Huntsville, Alabama to the US Space and Rocket Center.

The 2016 SEPA conference will be hosted...
by the Gayle Planetarium in Montgomery, Alabama. Conference dates are 31 May to 4 June. The early dates were chosen to allow attendees to have a buffer between the SEPA conference and the IPS conference in Warsaw. Conference details will be furnished in a future issue of Planetarian.

Looking ahead to the 2017 total solar eclipse, SEPA has created an opportunity for eclipse chasers. The eclipse centerline runs thru Land Between the Lakes (Kentuck) National Recreation Area. Lake Barkley State Resort Park is located within Land Between the Lakes and contains a conference center. The center features 120 rooms with 2 beds, suites, executive cottages, and log cabins. There are also meeting facilities. The entire conference center has been reserved by SEPA. The accommodations will be made available to SEPA members first (with membership thru 2017) and then will be opened up to the general public.

For membership or general information about SEPA, please visit the recently restructured website at www.sepadomes.org.

Southwestern Association of Planetariums

The Fort Worth Museum of Science and History Noble Planetarium, Texas, and the North Texas National Space Society celebrated Asteroid Day on 30 June at the Fort Worth museum. Asteroid Day is an annual awareness event connecting people around the world to bring attention to the need for the search for near earth asteroids using current and new technologies with the ultimate goal of protecting Earth from potential collisions.

National Space Society members provided information at tables available to guests throughout the day. Chapter president Ken Ruffin gave an afternoon talk to an audience of 77 in the planetarium. Throughout the day about 1500 people attending the museum participated in Asteroid Day activities.

Noble Planetarium Manager Sarah Twidal reports: “Mostly people were surprised by the message, but not altogether shocked. I think the public has a cursory knowledge of the threat from near earth asteroids from movies about large impacts and YouTube postings of the most recent real events. It was great to know that we were adding to that the knowledge that larger impacts can be prevented, and that it didn’t have to stay as a ‘Hollywood’ concept. My main focus for the day was not to have people be frightened by the information, but feel empowered to help in the cause. We look forward to continuing this annual event.”

At least three SWAP planetariums hosted programs for New Horizons’ closest encounter with Pluto on 14 July. Again in Fort Worth, Noble Planetarium hosted Plutopalooza, inviting the National Space Society of North Texas to again connect with the public on this unique date. This was an exciting event for guests of all ages—those who knew Pluto as one of the “planets” in their youth to those just getting to know the solar system.

Digital displays switched between content the Space Telescope Science Institute’s permanent virtual exhibit Viewspace and mission status reports at NASA.gov. Guests were given handouts and viewed a 3D printed model of the New Horizons spacecraft.

Staff and National Space Society members spoke with guests about what the journey was like for New Horizons, and, of course, what this meant for everyone’s favorite dwarf planet! National Space Society chapter president Ken Ruffin spoke to a crowd of 98, completely filling the planetarium.

Angelo State University in San Angelo, Texas hosted a New Horizons flyby event on 14 July. The ASU planetarium programs of Exploring New Horizons and telescope viewing were attended by 410.

At the Perot Museum of Nature and Science in Dallas, Texas Portable Universe Planetarium presenters Linda Eaton and Linda Irby provided live “Sky Tonight” to an audience of 125 and featured information about Pluto and the New Horizons flyby.

The Portable Universe, Noble Planetarium, and University of Texas at Arlington Planetarium all attended Moon Day on 18 July at the Frontiers of Flight Museum in Dallas. Aside from the represented planetariums, exhibitors included astronomical societies, space clubs, museums, engineering companies, and hobbyists.

SWAP: Moon Day long-distance conversation

One of the highlights of Moon Day at the Frontiers of Flight Museum in Dallas was an amateur (ham) radio call with the International Space Station. The call was bridged by W6SRA in California.

The crowd of 200 in Frontiers of Flight auditorium fell silent moments before the connection was to be established. After several long moments, Cosmonaut Gennady Padalka’s voice rang through the room as the station came into range. “This is RS0-ISS.” The crowd roared and Padalka then answered questions asked by local schools’ students.

Immediately following the call, Anousheh Ansari, the first female private space explorer, spoke to the crowd regarding her accomplishment of a life-long dream. Audience members, including UTA planetarian Amy Barraclough, were able to speak with Ansari after the talk and pose for photographs.

(Continues on page 62)
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byists. Some 1,600 visitors attended.

The Noble Planetarium presented Two Small Pieces of Glass throughout Moon Day, and the Noble’s portable planetarium, Mobile Noble, shared exhibit space near a robotics group named “Technical Difficulties” and the Civil Air Patrol.

Robots from nearby and from other exhibitors roamed along the narrow pathways, amusing audience members waiting for programs. Girl Scouts and Boy Scouts were present to complete requirements for badges.


An evaluation available to guests attending Portable Universe programs relayed that the audience enjoyed both programs and some guests attended more than one during the course of the day.

Sarah Twidal accounts for the day: “It is always a pleasure to take part in [Moon Day] every year. My continued hope is that more and more young students are encouraged to get involved in the STEM conversation and add their voices to it!”

On 21 and 22 July educators and planetarians from Perot Museum of Nature and Science presented a teacher professional development workshop on space and earth sciences to Texas Region 11 seventh and eighth grade teachers.

Beau Hartweg, Chris Strganac, Kyle Doane, Lisa Dwinal, and Rachel Thompson coordinated two days of hands-on experiments, activities, and live planetarium programs for about thirty teachers. One teacher commented “The phases of the moon are so clear when you see it in surround.”

And finally, a very special welcome back to Leslie Barnhill, as she steps into Paul Ballou’s (retired) role at Russell Planetarium in Mesquite, Texas.

Great Lakes Planetarium Association

Illinois. At the Strickler Planetarium on the campus of Olivet Nazarene University, a grant provided $2,000 in transportation funding so that nearby low-income schools could visit the planetarium, setting an attendance record in the process.

The Dome Planetarium at the Peoria Riverfront Museum was busy with school groups and special events this spring. They hosted their first electronic music concert in May, during which Robert Rich played as part of his Filaments Tour. They also participated in the Jet Propulsion Lab’s “I C Ceres” event in May, and hosted a Pluto Party on 14 July to celebrate the New Horizons’ flyby. This summer, to accompany their feature exhibition Dinosaurs in Motion, they used Uniview to teach visitors about Earth’s geologic history and asteroid impacts.

The Elgin School District Planetarium and Elgin National Watch Company Observatory in Elgin recently completed its 51st year. The next year will include daily lessons, merit badge workshops, public evening shows, and boy/girl scout sessions.

The Cernan Earth and Space Center on the campus of Triton College in River Grove enjoyed more changes during the past month than it has during the previous decade. In mid-April, their new Super MediaGlobe II was installed. Late this summer, new theater seating will replace their 31-year-old seats. And, on 1 May, Director Bart Benjamin retired after 30 years at the Cernan Center and 34 years in the museum/planetarium profession.

Indiana. Art Klinger, director of the P-H-M DVT/Planetarium in Mishawaka, has retired after 35 years in the planetarium and 45 years in the P-H-M school district. During the past six months, Art has been mentoring Mindy O’Malley on astrophysics and planetarium operations. Mindy is an eighth grade science teacher who became the director upon Art’s retirement.

The Charles W. Brown Planetarium on the campus of Ball State University in Muncie hosted their first-ever kids summer camp, Adventures in Space, for 4-6 graders in June. For the first time ever, the planetarium had public programs scheduled during the summer months, as well as hosting the American Association of Variable Star Observers (AAVSO) conference in June.

GLPA President-Elect Dayle Brown of South Bend has become president of the Art League auxiliary of the South Bend Museum of Art. Dayle’s most recent book, titled Skylorge from Planet Earth: stories from around the world...Comets and Meteors is now available for sale.

Michigan. The Michigan Science Center continues to make available a free fulldome show about the sun called Sunstruck. This show was funded by NASA and is 21 minutes long, allowing for a live show portion to be added.

The staff at the Chaffee Planetarium in Grand Rapids recently completed their first in-house production using Digistar 5. Titled Dark Side: The Light Show, it features Pink Floyd’s iconic album. They will host GLPA’s 50th anniversary conference this fall.

Ohio. The University of Toledo/Ritter Planetarium’s Brooks Observatory is undergoing a significant renovation this summer. The new facility will be a state-of-the-art instructional observatory.

At the Shaker Heights Planetarium, Bryan Child continues to fully support earth and space science by bringing each K-6 class to the planetarium 2-3 times during the school year. With their new SciDome, Bryan also is expanding his lesson offerings.

Bryan has also been assisting the reopening of the Warrenville Heights Schools Planetarium. It had been inactive for years but reopened this year with a SciDome Touch system and a refurbished room. They had their first elementary field trip in early May.

Formerly at Shaker and now retired in Put-in-Bay on Lake Erie’s South Bass Island, Gene Zajac continues volunteering for Perry’s International Peace Monument, where the park service rangers want telescope viewing nights after his programs. He also has programs centered around a “view the sun” day, teaches celestial navigation and constellations for the U. (Continues on page 64)
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S. Naval Sea Cadets program, and is planning an evening constellation cruise aboard one of the Miller ferries.

Jeanne Bishop gave a series of live planetarium presentations at the Westlake Planetarium for a summer school program. The challenge was presenting the same planetarium topic to a wide age disparity. Farther afield, Jeanne went to the Rio de Janeiro Planetarium in May to present ideas on teaching astronomy in and out of the planetarium as part of the larger program Workshop on Museums and Planetarium Education. (See page 20.)

At the Bowling Green State University Planetarium, Dale Smith has been running Spitz's *Oasis in Space* as his spring public program.

In Youngstown, the Ward Beecher Planetarium again reached out to nearly 800 people attending the annual Summer Festival of the Arts event on the Youngstown State University campus. Planetarium lecturer Sharon Shanks joined the list of retirees at the end of June after 30 years at YSU, 25 of those in physics & astronomy and officially under the dome since 1997.

**Wisconsin/Minnesota.** The L.E. Phillips Planetarium at UW-Eau Claire celebrated Astronomy Day in the Chippewa Valley jointly with the Chippewa Valley Astronomical Society in May. About 175 people had the chance to see short planetarium shows, displays, and interactive activities.

The Manfred Olson Planetarium at UW-Milwaukee is celebrated the arrival of New Horizons at Pluto this July with the special program *Pluto Rocks.* In late August, “Stars and S’mores” highlighted the beautiful night sky and provided yummy treats for students and families.

The Allen F. Blocher Planetarium at UW-Stevens Point presented six different programs this summer. The department was to hire a replacement planetarium/observatory director, but the search was halted in January. The hope is that next year it may be possible to resume the search.

A star show ticket is now free at the Soref Planetarium in Milwaukee, but only with museum admission. The new policy has resulted in much higher planetarium attendance.

The staff of the Bell Museum and Planetarium is busy working with the architects and exhibit designers for their new facility on the St. Paul campus of the University of Minnesota. Tentatively set to open in the summer of 2018, the 62,500 square-foot facility will feature a 120-seat planetarium, permanent exhibitions, and learning spaces.

**Canadian Association of Science Centres**

Alberta. The original science centre and planetarium in Calgary, known initially as the Calgary Centennial Planetarium, later as the Calgary Science Centre, and in its last iteration as TELUS World of Science-Calgary, shut its doors in 2011 and moved to a new location near the Calgary Zoo. Known as TELUS Spark, Canada’s newest science centre includes, besides a host of attractive interactive interpretive and exhibition spaces, a state-of-the-art HD digital dome theatre with E+S Digistar planetarium capability.

But what will become of the old facility? Fortuitously, an organization known as Contemporary Calgary will bring renewed life to the iconic building by repurposing it as a new art gallery. The group’s mandate is to provide Calgarians and visitors a significant destination dedicated to contemporary visual art.

The existing dome will remain, and the theatre it envelopes will be modified to create a flattened main floor with a mezzanine from which digital projections of creative artwork will be projected, completely immersing gallery visitors. Collaborations with live presenters, new media installation artists, soundscape artists and others will be explored in the large, domed space.

The Spitz dome installed a quarter of a century ago will come alive once again, this time with a new purpose stretching beyond the cosmos into the world of digital fine art. The anticipated opening of this exciting new development is 2016. The designer is well known planetarium architect Bill Chomik of Kiasm Architecure Canada.

**British Columbia-Ontario.** A Canada/USA/France/Singapore/Vietnam planetarium connection is being formed. A new planetarium currently under design development will be built at the seaside town of Quy Nhơn in Bình Định Province, Vietnam. It will become part of an existing scientific conference centre in the city and is scheduled to open on 7 July 2016.

Recently, an impressive ground-breaking ceremony was held on the construction site, attended by officials from ICISE (the International Centre for Interdisciplinary Science & Education), as well as Canadian planetarium consultant Ian McLennan and his Vietnamese-born Canadian co-consultant Hô Le from Content Interface Corp., Toronto. They were joined by Steve Savage from Sky-Skan, Inc, chosen by the client as the technology provider, as well as architects from Paris and Singapore.
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Handmade portable planetarium

I introduced Lauren Ard in the March 2014 column. She had started doing business with a portable dome in southern Arizona, USA. I wrote this spring to ask how her business was faring and she responded with a review of how and why she started the business and what she is currently doing. I am happy to share that she is enjoying a successful business and planning for and even busier future!

Lauren explained, “The idea first came when I was a teacher at Sierra Middle School (Sunnyside District) in 2007. Sierra Middle School is a Title I school with no money for field trips, so a trip to the planetarium was out of the question. My first inflatable planetarium was sewn and glued together from discount blackout fabric and fit about ten students at a time. The total cost was about $300.

“After adopting several kids from foster care it was no longer financially plausible to continue working as a teacher (the costs of daycare for three preschoolers is more than a teacher’s salary), so I became a stay-at-home mom for a time, but also wanted to find a way to continue to exercise my teaching talents. I found out from a fellow teacher that the Plan-drau Science Center had lost its funding to continue their portable planetarium outreach program a few years ago. There was a niche in Tucson that needed to be filled!

“In May of 2013 I ran a successful Kickstarter Campaign to raise funds to create a bigger, more durable planetarium that could fit up to 40 students. Construction of the planetarium was completed in October 2013.

“Since December 2013 I have been able to visit 25 schools from four different school districts in Pima County, as well as a few church groups and scout troops in the area. This year I was asked to be an educational presenter for the Pima County Library summer programs and look forward to doing unique astronomy presentations for kids and teens, such as Harry Potter Astronomy, Pop Culture Astronomy, Anime Astronomy, and Animals in the Sky. I will be presenting Star Trek Astronomy and Comics in the Cosmos at the 2015 Phoenix Comicon, an event projected to have over 100,000 in attendance.”

“As a former teacher, I know how important the Arizona State Standards are. Each of my presentations is grade specific, designed to cover multiple state standards not just from science, but also the language arts, math, and social studies as well. I strive to be more affordable than other outreach programs in the area, including the Tucson Children’s Museum, Reid Park Zoo, Arizona Sonora Desert Museum, and Mad Science.

“I plan to apply for grants in the future to be able to visit more Title I schools. For pictures and more info, please visit facebook.com/portableplanetariumpresentations.”

Contact Information: Lauren Ard (lauren.raeard@gmail.com or portableplanetarium@gmail.com)

Mobile news from Mexico

José Antonio Villalón was kind enough to share the following exciting information about an ambitious new program in Mexico.

He wrote, “Morelia Planetarium ‘Lic. Feli-pe Rivera’ expanded its reach in the dissemination of science by premiering its mobile planetarium. The aim is to bring the planetarium to 80 thousand people in 150 communities in the state of Michoacan through the ‘Your Planetarium Lives Close’ program. The program is to present basic information about the solar system to the audience with a detailed explanation and projection inside the mobile planetarium.

“The astronomical talk is followed by the installation of telescopes to observe the sky. This program allows the planetarium to reach marginalized or poor communities whose residents find it difficult to visit the planetarium in the capital city Morelia. On September 29, 1975 Morelia Planetarium opened, and now in 2015 celebrates a happy 40th anniversary!”

For more information, go to ceconexpo.com/planetario and es-es.facebook.com/pag...
History of mobile domes in Japan
You read some news from Japan in the June column about a new mobile planetarium initiative started by Mr. Kimura, president of Tokyo Mobile Planetarium Co. Ltd., by using Tennado’s digital mobile planetarium for schools. At that time Meguru Kamiya explained that an operator is sent along with their mobile planetarium with an inflatable dome and they teach basic astronomy according to the curriculum. This system seems to be very popular.

In addition, Meguru also wrote “I would like to mention a rough history of the mobile planetarium in Japan. I was a member of the staff of GOTO Inc. Around 1975 (I am not sure of the exact year), Toyota Motor Company gifted the small planetarium (GOTO pinhole type Planetarium Model E-5) with a 4-m inflatable dome and a Toyota car to 47 prefectures in Japan for promotion of science education.

“But, unfortunately, it was not a program that functioned effectively. The main reasons are as follows
1. Each prefecture had no system for program operation; for example, there were only a few staff members who could be in charge of handling this mobile planetarium system.
2. It took too much time to set up the system.

“GOTO Inc. produced the small pinhole type planetarium (Model E-3, EX-3) with a 3-m umbrella type dome screen and sold around 40,000 sets to schools (some of them were exported). Most of Japanese primary schools have this model, but unfortunately it is not used well because of lack of teachers who have astronomical knowledge.

“The development of the digital projectors with inflatable domes makes possible a delivery type mobile planetarium system. I personally think that our system will be getting popular in Japan.”

Contact information: Meguru Kamiya (kamiya@skylight-studio.jp)

Thank you Meguru for this interesting insight! I knew the schools had many GOTO systems but never knew how many or how it came about. It is a shame they are unused, like many STARLABs around the world that are sitting in closets. So many people in developing nations would love to have them.

I believe the under use of these planetariums is what happens when people have no vested interest in getting the planetarium and someone tries to impose “help” without getting the institution employees “sold” on the idea.

It is lucky for you that you are on the cutting edge of a new planetarium business that I also think will continue to grow as a service to schools. I am distressed to hear from you that most teachers in Japan, like those in the United States, do not have the knowledge of astronomy!

Why we need to find all the portable planetariums
Recently the question was raised, “Why do we ask the affiliates to report how many portables are in their regions/countries?”

The affiliates are asked to report on the number of portables on their yearly IPS Affiliate Report. The idea is for them to seek knowledge of not just portables in their membership, but all they can find in their region. Ideally each affiliate would have a data base of all planetariums in their region and then provide that information to Dale Smith, chair of the IPS Publication Committee, so they can be included in the IPS Directory of the World’s Planetariums.

The reasons for keeping track of the numbers, and ideally the contact information, for all portables in a region are:
• So you can better serve your mobile dome members; to be able to reach out to them to give assistance and to learn from them. Most are grass roots educators and many are brilliant and creative!
• To give assistance to anyone who is thinking of getting a portable; they can be referred to someone who has one in the region and get some advice. If they want to start a business with one and do not know how many are already in their area, they may encounter a lot of competition and their business will fail.
• To seek new members and help the entire planetarium community.

Why did I originally ask affiliates to make a yearly report about portables?
Typically, IPS Affiliates did not pay attention to the portables in their region, especially if they were not one of their members. Having them focus on counting them at least may make them aware that there may be some potential new members for their organization and help them to think about some targeted services the organization needs to provide.

Most portables are isolated and difficult to find and many are reinventing the wheel over and over again—what a shame! Affiliates can ask the mobile planetarium manufacturers to give them some idea of who is operating in their region. Some manufacturers may even send a notice to their customers about the existence of your organization and that may bring in new members.

Most manufacturers, however, will not give up their customer lists, and this is where a problem lies. Big manufacturers of fixed planetariums brag about their installations, but not so with portables. This seems a strange disservice to our planetarium community and keeps mobile domes isolated from the collaboration they need.

Dale and I are working to develop a search option for finding portable planetariums that we already have in the directory. First, we need to examine each entry and try to accurately determine which sites are a portable and also which sites have both a fixed dome and a portable for outreach.

This directory is a valuable tool for assisting all planetarians in collaborating for everyone’s benefit. Please look at the directory for your country/state and let Dale know if you can find an entry that is a portable but not designated as such. He needs updates from each IPS members’ and IPS Affiliate’s own research into all planetariums, whether they are members of an IPS Affiliate organization or not.

Of course, we also want to know how many planetariums in your area are digital, analog and/or hybrid systems. We need to know what industry trends are; we must keep informed about all of these things to be most effective in fulfilling the missions of regional planetarium associations, national planetarium associations, and the IPS!

American in Italy
For the 20th anniversary in 2015 of the “Weeks in Italy Contest,” ShiAnne Katner (Casper Planetarium, Casper, Wyoming USA) had the honor of being selected as the winner. What follows is her glowing account of a planetarian’s adventure!
My exceptional experience as the American Planetarium Operator in Italy

ShiAnne Kattner
Casper Planetarium
Casper, Wyoming, USA
shikatt@gmail.com

As an astronomer and planetarium educator, I love looking up to the sky. But, even with this fascination with the stars and planets, I can never be as connected to the heavenly objects that are strewn across the night sky as ancient civilizations were. People of the Roman Empire thought the planets were gods and stars were objects that were part of their nearby celestial sphere.

Astronomers of the Roman Empire were the forefathers of modern astronomy. The celestial connection we all have to the ancient Roman astronomers was constantly on my mind during my two-week trip to Italy as part of an “American Planetarium Operator in Italy.”

During my stay I presented classroom and planetarium lessons on light to Italian high school students and teachers. I love teaching about light because, not only is it important for everyone (without it we wouldn’t see), but it’s also very important for astronomers. Gathering the light from different objects is the main way astronomers can study the planets, stars, galaxies, and the universe.

The lesson I brought to Italy is always a favorite with the American students I work with. During the lesson, students look at visible light through a diffraction grating, observe ultraviolet sensitive beads change color when exposed to the sun, and see the world through an infrared camera. I was interested to see if the Italian students, who were at least 5 years older than the students I typically teach, would like the lesson as much as American students.

Perugia and Assisi—the beginning

I was able to do a little touring of Northern Italy and Rome before my official trip started. After my stay in Rome I hopped on a bus towards Perugia. As my bus pulled into the depot in Perugia, Simonetta Ercoli and Luca di Bitonto were also just arriving from the PlanIt National Conference in Milan.

After a quick dinner of the local torta, Simonetta and I went back to her house to get ready for the next day, which was to be a busy one. We woke up bright and early the next morning, and after battling traffic, made it to the school where I would be teaching my lesson on light.

After my first lesson was over it was obvious that it was a hit, even with 18 year olds. It was great to see these young adults get just as excited when the beads turned colorful as 8-year-olds do and make silly faces and constantly wave into the infrared camera.

The school did not have a planetarium so I displayed a flat image of the night sky using Stellarium. After three lessons in the morning, Simonetta, Luca, and I walked around the charming town of Assisi. As we walked down to the Basilica of San Francesco I saw monks grouped together walking through the narrow streets, a sight I am not use to seeing.

In the afternoon I gave the same lesson during a teacher workshop. The teachers were just as excited about the activities as the students were. After the workshop we went to dinner and ended the night up at a locally-owned and -operated observatory. I was amazed to hear that all of the telescopes and control systems were hand-made by the amateur astronomers who used them.

The following two days were just as busy as the first. The morning of the 14th I gave three more lessons to students at the school. In the afternoon we met up with a friend of Simonetta’s, who gave me the most wonderful tour of Perugia. Walking around such an ancient and classic city, where you could literally see the layers of history, was amazing. On the 15th I gave my last three lessons in Assisi, said my goodbyes to all the wonderful people I met, and hopped on a train towards Brescia.

Off to Brescia

My three days in Brescia were just as busy as my three days in Perugia. Each morning I taught 3 lessons to 14-19 year old students, but this time half of my lesson was under an inflatable dome. To connect the night sky to my lesson on light I spent a little time showing the students celestial objects in many different wavelengths of light, such as the Crab Nebula, which in visible light looks like an expanding shell of gas. However, in X-Ray the nebula vanishes and a neutron star becomes...
visible within the gas and dust.

This was my first time presenting in an inflatable dome and the majority of student’s first time seeing the night sky projected in a planetarium. Even though the students had to sit on the floor and crowd around the projector, they seemed to enjoy their time in the planetarium. I pointed out the main constellations they could see at that time of year along with some of the planets that were visible.

The first afternoon Loris Ramponi took me around Brescia, which is filled with hidden astronomical gems, such as the beautiful 16th century astronomy clock located in Piazza della Loggia and a sundial that is painted on a ceiling.

During the tour I was able to walk around the Castello di Brescia, which not only provides amazing views of the city of Brescia but is also home to a small observatory that offers public viewings during the summer. I also visited Tempio Capitolino, which is part of a Roman temple where you can still make out a theater and city forum.

Another afternoon I headed up to the gorgeous village of Lumezzane, where I presented a little bit of my lesson at a press conference for the local municipality and got a tour of the Serafino Zani Observatory and the local planetarium. Again, I was astonished to hear that the telescopes were locally built and run by volunteers.

**Leisure and lessons in Gorizia**

After Brescia I headed off to Gorizia, where I had a couple days free. During this time I met some members of the local astronomy club, went into Slovenia, saw world war memorials, and visited the surrounding towns that are rich in history.

We visited Cividale del Friuli, which was populated by Celts, Lombards, Venetians, and Romans. Each civilization left their mark on the city. I walked through a subterranean series of halls that were once used by an ancient Celtic civilization, saw the beautiful frescos in a Lombard Temple, and noticed the Venetian-inspired architecture displayed throughout the city.

I toured Aiello, the town of sundials, where I saw sundials of every type in people’s yard, on private and public buildings, and on the ground. I was taken to Aquileia, which was one of the largest and wealthiest cities in the early Roman Empire, and went on a bike ride to Grado.

I also had the opportunity to do a walking tour of the star-shaped city of Palmanova in the morning and, in the afternoon, do a flying tour of the town and surrounding area with one of Luciano’s friends.

It wasn’t all free time during my stay in Gorizia. The location of my lessons was at the Circolo Culturale Astronomico di Farra d’Isontano (CCAF) Observatory and Planetarium. My lessons here were longer than my lessons in Perugia and Brescia because I was able to do both the full classroom lesson on light and a more detailed planetarium lesson.

Two of the mornings I gave lessons to senior high school students from a nearby school and to students from a nautical school. I also gave a presentation to the public and students from an international school.

During two of my nights in Gorizia I was able to help observe with some of the astronomy club members, where we tried to find or confirm near earth asteroids. Again, the people who built the telescopes and observe at CCAF are all volunteers.

**Homeward bound**

My time in Italy seemed to go by fast, but what an amazing opportunity it was. This trip reminded me how much I love doing astronomy outreach. Making new friends and seeing another country more as a local than as a tourist was a great experience, made possible by Simonetta, Loris, Luciano, and their group of devoted astronomy friends.

I would encourage everyone to apply for this incredible opportunity. For many planetarians, leaving their job for an extended visit to Italy may seem like an impossible task, but this experience is worth it. I immensely enjoyed every second during my trip and feel fortunate that I was to be chosen for such a remarkable experience.

Contact: ShiAnne Kattner (shikatt@gmail.com).

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**Left:** The inflatable dome used for lessons in Brescia. Tarcisio Zani and the 400mm F8 Ritchey Chretien telescope at the Serafino Zani Observitory.
We need your participation

In my June column, I discussed two planetarium participation projects of the Education Committee in detail: 1) An online survey to gather information about education at planetariums and 2) Collection of teaching videos from planetariums to make an archive. The success of the two projects depends on your help.

Please, if you are either a single worker at a small planetarium or one of many education specialists in a large facility, participate in both of these projects by answering the questions on the survey and by preparing a teaching video; many ideas for the video also are in my June column.

Oded Kindermann in Argentina (okindermann@gmail.com) is collecting the video, and you can do a number of things to get your work to him.

Let him know the details of your video, including identification of video format, length of video and any sections, concept(s) covered, age/grade and level of the students (normal, advanced, slow learners), where lesson was given (planetarium, classroom, observatory, museum exhibit, or other space), and what the students have seen or studied prior to this lesson (an introduction, follow-up, part of a series of lessons).

If your video is a clip of less than 15 Mb, you can send it directly to Oded with media formats of .mov or .mp4 (preferred). But Oded thinks that YouTube or Dropbox might work even better for all video lengths, or a video can be posted on the participant’s website. Oded shares the following:

Dear Planetarium Colleagues,
For those who do not know me, I have been an IPS member since 2012. It has been a pleasure...and an honor to be part of this amazing society.

Oded E. Kindermann,
okindermann@gmail.com
Info@astrojujuy.com

Italian education program

Simonetta Ercoli of Italy (Email: mi-rus7678@gmail.com) reports on the nature of astronomy education in her country. Simonetta, who is an active member of the IPS Education Committee, is the first to prepare a report on a country or region’s astronomy and science education. I hope that we can share details of astronomy education in many countries in future Planetarian issues. The online survey, discussed above, will provide information to help make this possible.

Italian schools are organized in the following way:

- Primary School (five years): Student ages are 6-10 years
- Middle School (three years): Student ages are 11-13 years
- Secondary School (five years): Student ages are 14-19 years

There are national requirements for education in Italy. The group that determines and disseminates information about requirements is MIUR, the Ministry of Education, Universities and Research, located at Viale Trastevere, 76/a 00153 Roma. The Italian national curriculum can be found online at: hubmiur pubblica.istruzione.it/web/istruzione/home. The Italian national curriculum was influenced by the OCSE/OECD (Organization for Economic Cooperation and Development)-PI-SA (Program of International Student Assessment) system.

Assessment of teachers and their teaching of the national curriculum is accomplished by periodically checking knowledge and skills of the students, noting the overall quality of the schools. The group responsible for evaluation is the National Evaluation System (SNV).

The main astronomy content at each level is shown in Table 1.

Another opportunity to share

In addition to the educational videos being sought by the Education Committee, the IPS Portable Planetarium Committee, along with the Astronomical Observatory Serafino Zani, sponsors “Pages of Stars.” This annual competition seeks to build a collection of short audio clips (maximum 3-5 minutes each) that can easily be shared among planetarians using mp3 files.

Planetarian colleagues from around the world are invited to prepare a short text, in English, that can be read under a planetarium dome.

The text can be:
- an astronomical and scientific commentary
- a classical Greek (or another culture’s) sky story
- an original story or a poem (any kind of topic) with some astronomical details or with an event that happens under the night sky (including the name of some stars or constellations or other sky objects visible with the naked eye

The author (or a collaborator of the author) must read the text aloud, in English, and record this story as an mp3 file. A committee, selected by the IPS Portable Planetarium Committee in collaboration with the Astronomical Observatory Serafino Zani, will select the winners, and the text of the best entry will be published in the Mobile News column of Planetarian, while the three best works will be made available on the IPS Pages of Stars webpage.

The winner(s) will also receive an Award Certificate on the occasion of the “Day of Planetaria,” which occurs annually in March.

The yearly deadline for applications is December 31.

For full details, check “Pages of Stars” on the IPS website at www.ips-planetarium.org/?page=portablecom, for contact Susan Reynolds Button, sbuttonq2@gmail.com, or Loris Ramponi, osservatorio@serafinozani.it or megrez58@gmail.com.
**Table 1**

<table>
<thead>
<tr>
<th>Subject</th>
<th>School year</th>
<th>Astronomy contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary school</td>
<td>3rd</td>
<td>Getting bearings in space through the cardinal points</td>
</tr>
<tr>
<td></td>
<td>4th</td>
<td>Basic astronomy contents: constellations, and the life of stars Myths and legends of the stars</td>
</tr>
<tr>
<td></td>
<td>5th</td>
<td>Basic contents about the solar system, Earth, and the moon</td>
</tr>
</tbody>
</table>

The astronomy contents are parts of either the geography or the science syllabus. The approach to astronomy is for students to find bearings and understand their spatial location, starting with living space and then moving to understand geographical space and planetary space.

<table>
<thead>
<tr>
<th>Middle school</th>
<th>3th</th>
<th>Historical development of astronomy; formation of the solar system and its organization; key features of the sun; Earth and its movements; main features of the moon and phenomena related to it; space missions: rockets, satellites, space probes; observation of the sky: day and night, direct and indirect</th>
</tr>
</thead>
</table>

Some astronomy contents are carried out by the literature teacher in the geography syllabus and other ones by the math teacher in the science syllabus. The approach is based on both observation and description.

<table>
<thead>
<tr>
<th>Secondary school</th>
<th>1st</th>
<th>Celestial sphere and astronomical measurements; celestial objects; the sun and its energy; the solar system and main features of its planets; the minor bodies of the solar system; genesis of the Earth and its movements; origin of the moon and lunar phenomena</th>
</tr>
</thead>
</table>

New reform requires astronomy to be taught by the science teacher in the first year of course. The approach is based on observation and description, with an introduction to essential ideas of the experimental method. The use of measurement units and criteria for collecting and recording data are covered. The physics teacher treats more in-depth astronomy in the fifth year course, focusing on the principles, models, formal laws, and on the relationship between the various factors involved in a particular phenomenon and between different phenomena.

Classroom lessons, workshops at the school or at scientific museum, problem solving, lessons in the field, scientific tours, etc. The new reformed curriculum emphasizes the Earth, moon, and the solar system, which is different from the previous curriculum. At the middle school level there is now a very simple approach to stars, star evolution other than the sun, the Milky Way, and other galaxies.

Historical ideas about the solar system, including ideas of Copernicus, Kepler, and Galileo, are taught by literature teachers within the history syllabus in middle school. In secondary school, science teachers discuss these historical ideas in depth during the first year.

The electromagnetic spectrum is introduced in the primary school, first as observation. The topic is expanded within the first physics course in middle school. In secondary school, physics teachers cover the topic in depth during the third or fourth year.

In the fifth and final year of secondary school the physics teacher is expected to cover many topics about stars and the universe.

Many schools have several in-depth projects relating to astronomy, which are operated in cooperation with local public or private associations and observatories. For example, my colleagues and I present astronomy workshops at each school level according to the lesson plans of science and literature teachers. This school year we organized a very interesting project for a primary school in Rome, in which many amateur astronomy associations took part. Although the text describing this project is in Italian, there are many photos of our project at: www.starlightgroup.it/index.php/regione-lazio-progetto-on-demand-presso-ic-ennio-quirino-visconti-di-roma-cup/p797e13000770009.html.

Mathematics and non-astronomy science topics in different primary and middle school years shows understandings that can be integrated with astronomy, when possible. See Table 2.

Because subjects taught at different secondary schools are very different and are quite diverse even within the same school, it is not possible to make a similar summary for secondary school subjects.

The Italian national curriculum does not require or suggest attendance at a planetarium. For each school the person who decides on a planetarium visit is different. In general, individual teachers or curriculum specialists decide to make the trips.

In general, primary school teachers meet once a week to plan the week’s activities. In middle and secondary schools, at the beginning of the year teachers divide into committees and then meet monthly to arrange activities. Within these meeting arenas, planetarium lessons would most likely be arranged.

It should be noted that the majority of Italy’s planetariums are small and portable, and these present educational programs as requested by teachers. The large Italian planetariums present primarily public programs.

A map of all Italian planetariums can be found at [www.planetari.or.it/index.php?option=com_content&view=article&id=60&Itemid=154](http://www.planetari.or.it/index.php?option=com_content&view=article&id=60&Itemid=154)

MUIR, national science teacher associations, and universities sponsor local and regional meetings. The meetings are sometimes for teachers only and sometimes for all science education professionals.

Many planetariums suggest activities for classrooms, and here are many educational publications with lessons and activities. Some Italian websites for schools that have good astronomy activities include:

- [www.media.inaf.it/category/scuole](http://www.media.inaf.it/category/scuole)
- [www.spazioallescuole.it](http://www.spazioallescuole.it)
- [didatticaual.it](http://www.didatticaual.it)
- [www.sait.it](http://www.sait.it)
- [www.vialattea.net](http://www.vialattea.net)

**Teaching in Rio de Janeiro**

At the end of May I travelled to Rio de Janeiro for a week to teach as part of a teacher workshop. Celso Cunha, the director, invited me to give presentations during “The First Workshop on Education in Museums and Planetariums” at the Rio Planetarium. The workshop was held at the Museum of the Universe, a large complex that includes two planetariums and many outstanding exhibits, operated by the city of Rio de Janeiro.

Rio teachers were the primary participants, although I also had the pleasure of meeting a number of planetarium professionals from both the Rio and other Brazilian planetariums. It was an honor and challenge to use the largest planetarium in the Southern Hemisphere, the Carl Sagan Planetarium, to present an interactive planetarium lesson about seasons. That planetarium has a tilted dome, so we needed to infer the true horizon from horizontal dome panels.

After seeing seasonal changes in Rio, we “travelled” to my own home latitude at Cleveland, Ohio, near 40 degrees north. There is a dramatic difference on December 22 between the view from Cleveland and the view at Rio’s latitude of about 23 degrees south. In Rio, the sun makes an almost zenith passage on December 22, the Brazilian summer solstice.

The name in Portuguese for the noon sun at the zenith is “sol a pino.” Normally this event occurs on December 10 and again on January 2nd. People, especially the media, often refer to hot days in Rio as days of “sol a pino,” even if the sun really is not at the zenith. Juan Barrio, current president of the Brazilian Association Planetariums, made a good point: in Rio,
Table 2

<table>
<thead>
<tr>
<th>Subject</th>
<th>School year</th>
<th>Contents for Primary school</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st</td>
<td>Arithmetic: Natural numbers, ordinality, cardinality, recursion, comparison, measurement, positional value, operations</td>
</tr>
<tr>
<td></td>
<td>1st</td>
<td>Geometry: orientation, representation of paths, shapes, symmetries, relationships, measurement, data</td>
</tr>
<tr>
<td></td>
<td>1st</td>
<td>Prediction: comparison of sizes, the unconventional measurement, relations of order and equality, classification on the basis of an attribute</td>
</tr>
<tr>
<td>Math</td>
<td>2nd-3rd</td>
<td>Arithmetic: Regularity, reading and writing natural numbers, positional value, operations and their properties</td>
</tr>
<tr>
<td></td>
<td>2nd-3rd</td>
<td>Geometry: Classification of lines, nomenclature corners, distinguish regions and boundaries, nomenclature of basic plane figures, classification of geometric figures</td>
</tr>
<tr>
<td></td>
<td>2nd-3rd</td>
<td>Relationships, measurement, data, and prediction: Reading and understanding of data; data representation with graphs, tables, charts, and diagrams; argument on the criteria chosen to realize and classify laws</td>
</tr>
<tr>
<td></td>
<td>4th-5th</td>
<td>Arithmetic: Fractions and decimals, property transactions, severability and primes</td>
</tr>
<tr>
<td></td>
<td>4th-5th</td>
<td>Geometry: Triangles, quadrangles, polygons, perimeters and areas, reference systems, plane and solid figures, rotations and symmetries</td>
</tr>
<tr>
<td></td>
<td>4th-5th</td>
<td>Relationships, Measurement, Data, and Prediction: Major international units of measurement; the arithmetic mean, the fashion and the median; reading and understanding data; statistical acquisition; graphical representations</td>
</tr>
<tr>
<td></td>
<td>1st</td>
<td>Direct observation of plants and animals, their oral description and iconic representation</td>
</tr>
<tr>
<td></td>
<td>2nd</td>
<td>The seasons, matter and its member, the three kingdoms of nature</td>
</tr>
<tr>
<td></td>
<td>3rd</td>
<td>Water, air and soil; the sun, light and heat</td>
</tr>
<tr>
<td></td>
<td>3rd</td>
<td>Classification of animals and plants according to their characteristics</td>
</tr>
<tr>
<td></td>
<td>3rd</td>
<td>Foodchains and ecosystems</td>
</tr>
<tr>
<td>Science</td>
<td>4th</td>
<td>Key concepts of biology, interaction between organisms, the environment and related issues</td>
</tr>
<tr>
<td></td>
<td>4th</td>
<td>Knowledge of simple physical and chemical phenomena</td>
</tr>
<tr>
<td></td>
<td>4th</td>
<td>Lexical knowledge of each discipline</td>
</tr>
<tr>
<td></td>
<td>4th</td>
<td>Analysis of the fundamental discoveries in human history</td>
</tr>
<tr>
<td></td>
<td>5th</td>
<td>Systematic study of the human body and its functions (from the cell to the equipment)</td>
</tr>
<tr>
<td></td>
<td>5th</td>
<td>Reflection on behaviors regarding the health of people and the environment</td>
</tr>
<tr>
<td></td>
<td>5th</td>
<td>Study of the systems of the human body: movement and support, nourishment and energy, coordination and control of the body, reproduction and birth</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subject</th>
<th>School year</th>
<th>Contents for Middle School</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st</td>
<td>Arithmetic: sets, numbers and decimal numbering; operations with numbers; mathematical problems; powers; other numbering systems; divisibility; GCD (greatest common divisor) and LCM (least common multiple); fractions, operations and problems with fractions; elements of statistics</td>
</tr>
<tr>
<td></td>
<td>1st</td>
<td>Geometry: measurements, first elements of geometry, straight lines in the plane, polygons, triangles and quadrilaterals</td>
</tr>
<tr>
<td>Math</td>
<td>2nd</td>
<td>Arithmetic: square root, ratios and proportions, proportionality, elements of financial mathematics</td>
</tr>
<tr>
<td></td>
<td>2nd</td>
<td>Geometry: equivalence and equidecomposability, the Pythagorean theorem, isometries and not isometric transformations, circumference and circle, inscribed and circumscribed polygons</td>
</tr>
<tr>
<td></td>
<td>3rd</td>
<td>Algebra: sets, relationships, logic elements, relative numbers, literal calculate, equations, mathematical functions and the Cartesian plane, probability and statistics</td>
</tr>
<tr>
<td></td>
<td>3rd</td>
<td>Geometry: the theorems of Euclid, solids (polyhedrons and solids of revolution)</td>
</tr>
<tr>
<td>Science</td>
<td>1st</td>
<td>Physics/Chemistry: matter and states of aggregation</td>
</tr>
<tr>
<td></td>
<td>1st</td>
<td>Geology: water, air and soil</td>
</tr>
<tr>
<td></td>
<td>1st</td>
<td>Biology: living things, the plant kingdom, the animal kingdom</td>
</tr>
<tr>
<td></td>
<td>2nd</td>
<td>Physics: basic elements of physics (motion, forces, levers)</td>
</tr>
<tr>
<td></td>
<td>2nd</td>
<td>Chemistry: basic elements of chemistry (atoms, molecules)</td>
</tr>
<tr>
<td></td>
<td>2nd</td>
<td>Biology: the human being and his systems (coating, support, muscular, digestive, circulatory and excretory), the principles of food and nutrition</td>
</tr>
<tr>
<td></td>
<td>3rd</td>
<td>Physics: energy and its sources, electricity and magnetism</td>
</tr>
<tr>
<td></td>
<td>3rd</td>
<td>Geology: history and evolution of the Earth</td>
</tr>
<tr>
<td></td>
<td>3rd</td>
<td>Biology: theories of evolution, nervous system, reproductive system, genetics</td>
</tr>
</tbody>
</table>

It was wonderful to meet teachers and hear of their experiences with the planetarium and the needs of their students. In an opening panel session, chaired by Cunha, teachers and special representatives discussed their experiences and perspectives on planetarium education. Astronomer Alexandre Cherman quietly translated main points of the panel discussion for me.

Elementary teacher Roberto Antunes stressed how valuable the planetarium was to his students, specifically how the visits expanded their horizons and provided a connection to the future. Secondary teacher Elizabeth Vieira reported on a program in which students from a prison attended planetarium programs. The prison visits were very successful; the planetarium had a deep impact on the students and seemed to change their attitudes.

An important point made by panel member Mario Chagas, representative from the Brazilian Institute of museums, was that too
often we make a large distinction between formal and informal education. The goals for both classrooms and museums/planetariums are the same and we hope the outcomes of learning and inspiration will take place in both. Maria added that it is important to bring more women into science, including astronomy.

Maria Helena Steffani, planetarium director at the Federal University of Rio Grande do Sul, representing the Brazilian Association of Planetariums, noted that currently there are 80 planetariums in Brazil. Cunha, analyzing attendance at the Rio Museum and Planetarium, finds that 50% of the 7 million attendees are repeating, while 50% are new. Transportation has been a major concern in getting students to the museum and planetarium, but he expects the completion of a new transportation stop close to the museum will help this problem.

I was able to go with Guedes to the Santa Cruz Planetarium and Museum. Lilian Valdoski, the teacher there, and Leandro, showed me the very interesting exhibits describing the cosmological beliefs of native Brazilian groups. At Santa Cruz, as in Rio, there are excellent visual and descriptive astronomy and other science exhibits. I was most impressed with the interactive periodic table of the elements, consisting of element cubes that can be rotated to show many types of information.

Following a multimedia presentation for students who were about age 10 in the Digitstar theater, Leandro invited the students to ask me questions. Leandro interpreted their Portuguese into English for me, I responded in English, and Leandro interpreted my answers into Portuguese for the students. The students were very enthusiastic, and they asked excellent questions, including how the solar system and the Earth’s atmosphere originated, what it would be like to approach a black hole, and how stars form and go through their lives. The students came with their English teacher, and the teacher told me she was delighted that the students had the opportunity to hear me speak English.

Cherman hosted me on a photo expedition to tourist locations, including the famous statue of Christ the Redeemer and Sugarloaf Mountain. The pictures will be incorporated into a fulldome planetarium presentation. The panorama of Rio seen from each of these locations is breathtaking.

Cunha and his family graciously showed me many other beautiful locations in Rio, driving along the ocean on a beautiful day. On one evening Celso and other Rio Planetarium staff tried to have a telescope observing session in a favela location. We drove to the Providencia Favela, but there was a huge rainstorm—the only non-perfect situation in an otherwise wonderful week.
What? No lamps?

For decades, video projection technology has evolved from the CRT to the LCD, LCoS, and DLP. Projector resolutions and brightness have increased over the years as well, with some of the brightest projectors reaching 40,000 lumens and others reaching 4K pixel resolution. In addition to resolution and brightness increase of recent years, there has also been development in the area of illumination.

The lamps that traditionally have been used were either UHP (Ultra High Pressure) or Xenon arc lamps. These types of lamps produced a bright light in a broad spectrum of colors that would allow the accurate reproduction of colors used in video.

One of the attributes of these types of lamps is the fall off of brightness over time, so a projector that might output 2,000 lumens with a new lamp might only put out half that brightness after 1000 hours of use. Another attribute is that the lamps would typically have useable total operating span of 1000 to 2000 hours. After that time a new lamp would have to be installed at a cost of $700 to thousands of dollars.

Years of research have gone into developing better solutions to the issue of lamp longevity and light output reduction. Within the last few years, with the advent of brighter LED technology, the opportunity to produce a projector with a much longer lifespan and more consistent light output over that lifespan became a reality.

Enter solid state LED

These new solid state LED-based projectors were a break through that was welcome, but it came at a price. The light output of a typical LED projector was about a quarter of that of a traditional projector. For some, the low operating cost and low maintenance was worth the trade-off in brightness; however most users desired more light output.

Recently a development in the solid state projection technology has combined LEDs and laser into laser/LED hybrid projectors. Combining the benefits of both higher efficiency and higher brightness, laser/LED hybrid projectors use LEDs for red and blue, but generate green using a laser shining through a phosphor. Other designs use a blue laser on a phosphor wheel to produce yellow light, which is then split into green and red.

Cy Furst, midwest representative for Barco, states “many designers, integrators, and end users are increasingly attracted to laser-illumination projectors due to their simplicity in low maintenance, lower total cost of ownership, higher reliability and better image quality when compared with ‘traditional’ lamp-based projectors. This is highly important for large screen/high ambient light applications often found in museums, training centers and auditoriums in which LED-illumination projectors do not deliver the brightness performance that is needed, and where lamp-based projectors of comparable brightness, require frequent maintenance and lamp changes.

“The low maintenance for laser-illuminated projectors allows them to be installed in locations where access may be limited, such as high ceilings in a museum atrium, etc.”

The advantages

These higher brightness laser/LED hybrid projectors have several advantages over traditional technologies, such as:

- Light module lifespan of up to 20,000 hours
- Stable light output level
- High contrast ratios of 20,000:1
- 24/7 operation
- Lower operating costs
- Quick start-quick off
- Lower energy usage
- Low heat and noise
- Excellent color reproduction

These features are highly desirable for most users, especially for museums and special venues where access to the projector might be limited and the projectors are expected to operate 24/7.

“Solid-state illuminated projectors,” says Thomas Wilmers, regional market development manager for Digital Projection International (DPI - with U.S. offices in Kennesaw, Georgia), “remove the lamp maintenance cycles, as well as produce a predictable, linear light output over the course of the 20,000-hour illumination lifespan. That results in an immediate cost-savings in maintenance, as well as compelling long-term savings in consumables, for any venue employing these projectors.

“Most laser projectors can run in an almost unlimited positioning range,” Wilmers adds, “including portrait, straight up at the ceiling, and straight down at the floor—provided the air intake vent on one vertical side is not inhibited. This allows many venues to create vertically oriented portrait imagery for non-projection environments.”
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For licensing please contact Robin Spi: rospi@mirage3d.nl
From Dust to Life: The Origin and Evolution of Our Solar System

John Chambers and Jacqueline Mitton, Princeton University Press, 2014

Reviewed by Francine Jackson, University of Rhode Island Planetarium, Providence, Rhode Island, USA

“Everyone is fascinated by origins. We all want to know where we came from. What was it like in the past, how we fit into the larger scheme of things?” Chambers and Mitton certainly help us try to determine these burning questions.

Through obviously thorough research, they take us to each section of our universe that we now know, and then go into intimate detail about our own part of it, the solar system.

It is amazing that, when taken step by step, our neighborhood is a much more complicated entity than we think it is. The authors wind back the clock to the reason we were able to become a system in the first place and then move on to each individual world.

The authors give us instructions for making planetesimals and the tackle the question of how each planet became its own separate entity. For the moon, they ask did it really come from us? Were we really slammed by a Mars-sized body, and the ejected particles created our beautiful neighbor?

What we traditionally classed as “gas giants” now apparently has been reformatted. The two giants, Jupiter and Saturn, are still called that, but Uranus and Neptune now are considered ice giants. The authors surmise that these latter two, because they are at the edge of the accretion disk, were not able to capture too much of the original nebula. Of course, that doesn’t explain why Uranus is tilted, nor why both Uranus and Neptune possibly were closer to the sun in an earlier time.

The authors really do a very meticulous job of describing our beginnings, all the planets, and the asteroid regions, as well as why we have comet reservoirs. They also have given us a fairly thorough glossary, very needed when attempting to describe a several-billion-year process. Although this book is barely 300 pages, once you finish reading, the ins and outs of the early days of the solar system should be within your grasp. This is not a quick read, but if you do take the time, your efforts will be rewarded.

Dwarf Planets and Asteroids:
Minor Bodies of the Solar System


Reviewed by Stephen Case, Strickler Planetarium, Olivet Nazarene University, Bourbonnais, Illinois, USA

My first research project as an undergraduate was attempting to determine orbital parameters of some asteroids. I remember being fascinated by these obscure bodies and their mysterious, classical names. If I had had Dr. Hamilton’s slender volume at that time, some of my questions would have been answered.

The minor bodies of the solar system are an eclectic group with interesting histories, and Hamilton’s volume cracks the door onto this subject. The book (under 70 pages) gives a brief introduction to asteroids (nine pages), but is primarily a catalogue of information—physical characteristics, orbital data, and explanation of name and discovery—for select bodies.

There is a lot of interesting information here, but, unfortunately, none of it is referenced. One example: according to Hamilton, asteroid 300 Geraldina was named by Auguste Charlois, an apparently prodigious asteroid-discoverer who was murdered by a former brother-in-law. There’s obviously a story here, but without references the reader is left with no avenue by which to learn more.

Worse yet is the omission of information related to the objects themselves. Dwarf planets are mentioned (and distinguished by bolding their names), but there is no discussion of their distinction from asteroids. Comets are mentioned without any explanation of how they differ from asteroids and dwarf planets and what this indicates about the physical nature of the solar system. The Yarkovsky Effect is mentioned three separate times without an explanation of what it is.

Finishing the book, I was left with far more questions than I had upon beginning it. Why do some asteroids discovered later have lower numbers than those discovered earlier (i.e. 6312 Robhielein and 6470 Aldrin, for instance)? Why do some have names consisting of only numbers and letters (2012VP113, for example)? Is Quaoar officially considered a dwarf planet?

A simple response to these might be, “Look it up and find out,” but this leads to my major question regarding this book: in a day when I imagine information about all minor planets is available online somewhere (another reference that would have been helpful in this book), why publish a book with limited information about only a selection of asteroids? It might look good on the observatory shelf, but as a catalogue it is inherently incomplete and immediately out of date.

Planets: Ours and Others: From Earth to Exoplanets
Birth, Evolution, and Death of Stars

Thérèse Encrenaz (Planets) and James Lequeux (Stars), both from World Scientific Publishing Co., 2014

Reviewed by Stephen Case

The art of an insightful, timely, and scientifically rigorous overview is a difficult one. This is compounded when the subjects are as broad as planets and stars, respectively. Fortunately for the educated non-specialists, these two slender volumes succeed where many astronomy texts fail: they provide a comprehensive, up-to-date survey of two fields with enough breadth to be useful and accessible to the astronomy educator while retaining enough technical grit for those desiring more depth.

(Continues on page 78)
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MTE proudly serves as the exclusive North American distributor of Konica Minolta Planetarium systems.
The first volume, by an atmospheric planetologist at the Paris Observatory, frames the current state of exoplanetary research and the search for life in the context of comparative planetology, starting with Earth and moving through our planetary system.

Beginning with a brief introduction to observing and exploring planets (including exoplanetary detection), she moves into a description of theories of planetary formation and then on to the bulk of the book, treating the physical properties of planets. Using Earth as a test case and exploring things like geological activity and the water cycle, she provides in-depth comparison of the atmospheres, compositions, and internal structures of the planets of our solar system, touching briefly on some outer-system moons as well.

All of this sets the stage for the final third of the book, a look at exoplanetary systems—their discovery, their properties, and a quick overview of the status of the search for life in the cosmos. The chapters here remind that this is not a book on exoplanets exclusively; rather, it’s a survey of what we know about planets, which any more must include a detailed exposition of the ways other planetary systems are informing this knowledge.

In some respects, this is more helpful than a book on exoplanets alone, allowing an understanding our own planetary context in light of these new discoveries.

The second volume (though my numbering is arbitrary) is a survey of the physical processes (including a fascinating and detailed analysis of the interstellar medium) governing the life of stars. Lequeux, also of the Paris Observatory, takes a slightly more technical approach. Indeed, it was at times difficult to follow his account of the complex processes taking place within a star at various points in its life cycle.

However, the technical aspects provide a conceptual rigor often glossed over in more popular texts. Topics covered include the birth, physics, evolution, and death of single stars as well as a chapter on the “zoo” of double stars. It concludes with a glimpse of the larger questions of galactic evolution that stellar life and death play into.

Perhaps most importantly, this account discusses the many open questions in stellar evolution, especially star death, and the important of modeling stellar interiors.

Both books are slender, less than 200 pages each, and filled with diagrams, images, and (especially in Lequeux’s) equations. Both are translations of works originally published in French, and the awkward language at times bears witness to this though never actively detracting from the text.

Neither volume is a textbook (there are no problem sets, for instance), nor are they purely popularizations, maintaining a balance between general survey and in-depth technical treatment. Often I read a survey text and learn nothing new; in contrast, these works are introductions written by active experts in their respective fields, lifting the veil on the physics behind the concepts but keeping a wide and fairly accessible scope, filled with a wealth of new information.

**The Ordinary Spaceman**

Clayton C. Anderson, University of Nebraska Press, 2015.

Reviewed by Jack Dunn, South Carolina, USA

Back in 2000 I was attending a NASA workshop at Johnson Space Center in Houston, Texas, for a small group of museum folk (Jim Manning was the other planetaryian in the group). It was not a planetarium conference, so Jim and I were the only odd-balls present.

We were introduced to Susan Anderson, who made a very fine presentation to the group about distance learning services from JSC. At the time she noticed my badge, which gave me Nebraska location. Susan told me, “My husband just started astronaut training and he grew up in Nebraska. You should meet him.”

Flash forward to today. As an astronaut who has retired from spaceflight, this book covers Clayton Anderson’s 30-year career at NASA. But I would suggest his book has far wider appeal than just in his state of origin because it is a story of perseverance, determination, and inspiration. Anderson tells how a person from modest beginnings rises to heights about which most of us only dream. He applied to be an astronaut 15 times before succeeding.

If I were to describe this book in one word, it would be “honest.” Anderson is honest, not only about his background and the love of his family, but also about the difficulties he had understanding or conforming to baffling bureaucracies.

Sometimes his non-conformity got him in trouble.

A good example was his thought early in his career about public service announce-

ments. Anderson noted that we see television PSAs all the time from sports and entertainment figures admonishing students to stay in school and work hard to graduate. But he noticed there were no astronauts making them. He wondered, “Why not?” After all, sports and entertainment figures didn’t necessarily owe success to education and certainly many of them might not have followed practices to pursue a good education.

Astronauts do need that education. Many have at least master’s degrees, as he does. Asking that question of NASA officials got him first brushed off and eventually more or less reprimanded when he tried to pursue it. Today, as a retired astronaut, Anderson has made pro-education public service announcements for Nebraska television stations. By relating this story, we gain insight into the character of someone who thought he could make things better—and sometimes, much to his chagrin, it even became a negative for a career path.

We’ve all seen books by astronauts that detail the complex and exhausting training for their job. Anderson goes into the training more deeply than anyone since Mike Mullane’s Riding Rockets (Scribner, 2006). Anderson’s book has the most complete discussion of going to the bathroom in outer space I’ve read so far. Let’s face it—everyone wants to know about it. It’s the most common question asked of astronauts.

Anderson spent over 40 hours spacewalking during his missions to the ISS and on a subsequent shuttle flight. But he also trained for long-duration spaceflight in a project called NEEMO (NASA Extreme Environment Mission Operations). An Ordinary Spaceman takes you through the everyday experiences—the highs and lows encountered by crews testing what humans can achieve and endure in these environments.

Giving full disclosure, I’ve now known Clay Anderson for about 15 years. I’ve hosted him a number of times as a speaker in Nebraska and we’ve worked on projects together at the planetarium and with the Nebraska Star Party.

One might ask: “did you learn anything new, anything you didn’t know about him” in this book. Of course I did. I knew his mom and have met his brother and sister and some other family. But this is a more intimate profile that takes the reader along on that training and the hard road proving oneself as a NASA employee.

He is an excellent spokesperson for NASA and for keeping dreams alive. But those qualities alone won’t always keep you in the favor of government agencies. In the end, it’s an inspiring story of what one person can achieve with perseverance.

Why should planetarians be interested in the book? Most of us are fans of space exploration.
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Richard Conti - Science Museum of Virginia

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Mike Smith - North Museum

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Think your job can have unusual requirements? Then maybe you’ve never worked in a planetarium.

People who work in planetariums often do atypical things as part of their jobs. Not only is the work itself unusual (how many do you know who can potentially spend much of their day working in the dark), but it can require us to do unconventional things while working on a production. This was just the case while I was producing a show about debunking UFOs.

_UFO: Sanningen är här_ (UFO: The Truth is Here) was going to be Cosmonova’s (Stockholm, Sweden) first new public show of the 21st century, so the idea was for a theme that tied in with people’s preconceptions that there was a chance of something happening, even something that was potentially disastrous.

Remember the panic over whether or not computers would understand the change in the century, also known as Y2K? UFOs and the possibility of being visited by intelligent life from “out there” seemed to fit the bill, or at least that’s what the head of our facility believed at the time.

Originally we had thought about doing a re-make of Isaac Asimov’s short story “The Last Question,” since it dealt with the end of the universe, but getting the rights to do it proved to be impossible. Some production company had bought them up with the intention of making a theatrical film (which still hasn’t happened over 15 years later).

Asimov himself loved the notion that it had been made into a planetarium show; Strasenburgh (Rochester, New York) and Abrams planetariums (East Lansing, Michigan) had done a joint production back in the early 1970s just as I was starting out in the field. The great author had even travelled from New York City to Rochester (by train, of course, as he never flew) for a special Rochester Museum and Science Center member’s only showing of the final production.

Prior to the event he sat in the staff area chatting with the technician on duty that night and myself, which is how I got him to autograph my copy of his book, _Opus 100_, featuring excerpts and complete short stories from his first 99 books including, of course, “The Last Question.”

Having started my planetarium career with the original adaptation I was really looking forward to having a crack at it again using more modern technology than was available in the early 1970s, but alas, that was not to be.

Near the end of the UFO show we wanted to make people more familiar with the night sky; what better way is there to help people distinguish natural objects in the heavens so that they are able to tell them from things that were out of the ordinary?

And to help keep it current, those 2½-minutes in the story would change each month for what was visible in sky during the run that the show was being offered.

To introduce this “sky lecture” we wanted to lead in with a montage of three dome-covering all-sky images that were of things that would be associated with that particular month here in Sweden, so, for example, in June we would show an all-sky associated with the Midsommar holiday (like folk dancing around a gaily decorated maypole), as well as vacationers at the beach or sailing.

Taking all-sky pictures

Such all-sky pictures were taken with special fisheye cameras built by ProDome Oy, a Finnish company that also designed and built our pair of 5,000 watt all-sky projectors. There were two models of these cameras; one that used 120 roll film and the other that shot 4x5-inch sheet film, and I was one of the few people who had had the opportunity to use both types.

Rather than the more conventional planetarium all-skies that were made by taking six vertically-oriented shots on 35mm slide film and then projecting them from six carousel slide projectors, these two cameras shot one whole scene onto one image so there was no blending or stitching required. In many on-location situations it took me longer to decide where I wanted to place the camera for that “just right” shot than it did to take the actual photographs.

For convenience, the 120 roll camera was better since it was smaller, lighter, and could take 10 images per roll of film, though at the cost of the images being about 30mm smaller than those taken by the 4x5 plate camera. For maximum resolution, the latter model with its larger image size was unsurpassed, though you had to carry around a lot of pre-loaded dual-sided plate holders and a correspondingly more robust tripod.

Halloween: Not for Sweden

While we celebrate Halloween in the United States, it’s not such a popular holiday in Sweden. I think the most “trick or treaters” I’ve ever had come to our house in one night was fewer than 10 kids.

Rather, they celebrate the church holiday, All Saints Day, which can fall around the same
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time as the popular children’s holiday. It is the probable root, in my opinion, why Halloween is not so popular here.

Most don’t seem to realize that in America and elsewhere where it is celebrated they are two entirely separate and distinct holidays. An associated All Saints Day tradition in Sweden is to light candles held in lanterns posted at family member’s graves in local cemeteries, which can be quite beautiful; a simple act of remembrance in the dark of the year.

You do see these lanterns lit throughout the winter months, but never as many as at this time of year. If you’ve seen a display of Christmas luminaries, you get the idea, although imagine, if you will, a large public cemetery where just about all of the graves have lanterns.

And so to have something representative of All Saints Day for the month of November, I needed one good all-sky image taken of such a scene. There are two cemeteries in Vaxholm, the town out in the Stockholm Archipelago where we live; an older, though smaller, one by the main church on a very busy street near the town itself and a larger one on its western outskirts. This latter one was ideal since there were no streets and car headlights to contend with and you could actually walk deep into its grounds so that you could better control the setting.

Picking just the right cemetery

I opted for this second location, caught the ferry over to Vaxholm (we live on a real island with no bridges) and drove over to the western cemetery with all-sky camera and tripod in tow. It wasn’t until I parked my car by the maintenance shed, unlinked my seatbelt, and climbed out that it hit me. With the exception of a porch light on a small funeral chapel near the center of the cemetery, it was pitch black—except for the grave lanterns and some street lights at the far end of the property.

You no doubt have heard the expression “whistling past a cemetery;” I found myself whistling off and on as I made my way through the cemetery and deeper into the grounds to minimize as much of the surrounding stray street lights as possible.

( Remember: this was in 2000 and if you go there today there are now lights along the cemetery’s sidewalks.)

Finding a likely group of headstones on a side path, I set up the tripod and camera and began taking time exposures. Fortunately it was a cloudy night so I didn’t have to worry about any stars trailing on the images. Since the all-sky camera’s fisheye lens covers 360° around its horizon by 180°, or from horizon, over the zenith and then down to the opposite horizon, thereby covering the horizon plus the entire sky, I had to be below the camera’s field of view, which left me sitting on the ground right by the tripod’s legs.

By now it was 23.30 at night and you can’t imagine how quiet it can be in a place like that. Every cracking branch in a tree, falling acorn, or gurgling stream of water in an underground drain could be heard. Loudly and clearly.

After each series of time exposures of different lengths at each location, I would move to another that looked promising. At one point I was attracted to what I call a “bay” (for lack of a better word) where a large narrow patch of grass and gravestones ran between tall bare trees on either side of it. What made it stand out was that there was absolutely no sign of any streetlights there, so it was about as dark as it could be except for the lanterns.

Off into the darkness

Plucking up the tripod and my courage, I started into the darkness. After I had gone in probably 20 meters, I stopped in my tracks. Nope, that was enough for this producer; I had somehow creeped myself out and I ended up turning around and heading back out to where it was relatively lighter, both literally and metaphorically.

This, in hindsight, was too bad as there are now sidewalk lights down there too and that patch of complete darkness is gone. Would that I had been able to manage and take at least one series of all-skies there.

As I shot one of the last series I heard a jangling sound behind me. Now what? Slowly turning just my head around so that I wouldn’t accidentally kick the tripod and spoil the exposure already underway, I spotted someone walking their dog along one of the parallel sidewalks some 30 meters away. Great. How was this going to look if they turned and headed in my direction? Trying to be as inconspicuous as possible while sitting on the ground, they continued straight along, eventually coming out onto the street at the far side of the cemetery.

The last shot finished, I rewound the roll of 120 film, sealed it shut, popped it back into its foil bag and outer cardboard box, placed the camera back in its case, tripod broken down and back into its carrying bag and I made a beeline back to my car. All I could think about as I drove home after leaving the ferryboat landing on our island of Rindö was “what did the images look like?”

The next day at work I had the exposed rolls of film sent over to the developing lab and then went about the rest of my activities that day. The returned images—good or bad—would not show up until later in the week. A couple of days later I got a call from the Museum’s Information Desk that I had had a deliver-
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This program is funded in part by the Gordon and Betty Moore Foundation.
Salute to Colonel Russo

SEPA President Ken Brandt passes along news and congratulations to “one of SEPA’s newest members, and one of Dome-L’s most ‘frequent flyers,’ Steve Russo.” For his commitment to teaching science to the community, Steve Russo, the director of the East Kentucky Science Center and Planetarium in Prestonsburg, Kentucky, was presented the “Key to the City” of Prestonsburg by Mayor Les Stapleton. At the same event (which also fell on Steve’s 60th birthday), Kentucky Governor Steven L. Beshear commissioned Steve as a “Kentucky Colonel,” the highest title of honor bestowed by the commonwealth.

Wausau schools dome gets grant

Be sure to send big “congratulations” to Chris Janssen, whose Wausau (Wisconsin) School District planetarium has received a $230,000 grant from the Walter Alexander Foundation to fund a two-year modernization project. The foundation is a private charity based in Wausau.

The modernization plans this school year include new hardware, software, and an enhanced projection system. Structural plans during the 2016-17 school include a complete update and redesign of the planetarium into a modern, tilted dome theater.

The planetarium is considered as a “hallmark program” by the district’s board of education and administration.

In a press release from the schools, Janssen said “a facility of this quality...is a true testament to people’s dedication and support of the sciences in central Wisconsin.”

On the move

Mike Murray is the new planetarium manager and astronomer at the Delta College Planetarium in Bay City, Michigan. He says “I am also very happy to be in a state with lots of active planetarians who are very creative, innovative, and collaborative. I hope to see many of you at the upcoming GLPA meeting in Grand Rapids (Michigan), regardless of whether you live in this part of the world, because it’s going to be a special one celebrating the 50th anniversary of the organization.”

Don’t worry about losing your contact for show production at the Clark Planetarium in Salt Lake City, Utah; you’ll be able to work with Ron Proctor, the new production manager. You can reach Ron at rproctor@slco.org.

Mike’s email is astromike1971@gmail.com; the planetarium’s website is www.delta.edu. ★

Robert Andress Jr., 1931-2015

Robert Andress, retired long-time director of the planetarium at Warrensville City Schools in Warrensville Heights, Ohio, and an early member of the Cleveland Regional Association of Planetariums, died on May 11, 2015, in Green Valley, Arizona.

Bob also was the former director of the Stephens Memorial Observatory at Hiram (Ohio) College. He was an 1953 Hiram graduate.

Born in Easton, Pennsylvania, he was a veteran of the U.S. Army. He taught for 30 years, including middle and high schools and at Hiram College. In addition to astronomy, he enjoyed travel, toy trains, and singing in the church choir.

In Arizona, he was active in the Sonora Astronomical Society.

With appreciation to the Stephens Memorial Observatory and James Guilford for the photograph. ★
SOLAR SUPERSTORMS
NARRATED BY BENEDICT CUMBERBATCH
2015 International Year of Light
4-6 September. Nordic Planetarium Association Biennial Conference, AIIHAA Science Center, Heureka, The Finnish Science Centre, Helsinki, Finland. www.heureka.fi Contact: Kai Santavouri, kai.santavouri@heureka.fi
15 September. Deadline for the applicants of “A Week in Italy for an American Planetarium Operator,” in collaboration with IPS Portable Planetarium Committee. www.astrofilibresciani.it/Planetarii/Week_in_Italy/Week_Italy.htm
23-25 September. Live Interactive Planetarium Symposium (LIPS), California Academy of Sciences, San Francisco, California, USA. Contact: Karrie Berglund, karrie@digitaliseducation.com; LIPSymposium.org
23-26 September. Dome Festa, Koriyama City fureai Science Center, Koriyama, Fukushima, Japan. imagesci-fest.net/2015/en/dome.html
25-26 September. British Association of Planetaria (BAP), annual meeting, Winchester Science Centre and Planetarium, United Kingdom. Contact: BAP President, Mark Watson, m.watson.bap@gmail.com; www.planetaria.org.uk; bapconference.org.uk
10 October. Astronomical Society of Planetaria, 127th ASP Annual Meeting, Chabot Space and Science Center, 10000 Skyline Blvd., Oakland, California, USA. Featuring: Public lectures on recent developments in astronomy; Astronomy Workshops for Teachers; Telescope Observing and Planetarium Shows; Photography ContestM; ASP Awards Banquet in the Evening. Contact: Andrew Fraknoi, fraknoiandrew@fhd.com; www.astrosoociety.org
14-17 October. Great Lakes Planetarium Association Conference, the 50th anniversary of GLPA, Grand Rapids, Michigan, USA. www.glpaweb.org
17-20 October. Association of Science-Technology Centers (ASTC) Annual Conference, Montreal Science Centre, Montreal, Quebec, Canada. www.astc.org
23-25 October. Workshop LSS-Planetarium, Saint François de Sales, Station des étoiles, Massif des Bauges, Savoie, France. Contact: lionel.ruiiz@live.fr
28 October - 1 November. Meeting of the Association of Brazilian Planetarium (ABP), Brasilia Planetarium, Federal District, Brasil. Contact: contato@planetarios.org.br; www.planetarios.org.br
31 December. Deadline of the prize “Page of Stars” organized by IPS Portable Planetarium Committee in collaboration with Serafino Zani Astronomical Observatory. The prize rules are available at the IPS Mobile Planetarium Committee web page. Contact: Susan Reynolds Button, sbutton2c@gmail.com

2016 International Year of Pulses
28 February. Deadline of PlanIt Prize for an original video production, organized each year by Italian Association of Planetaria (PlanIt), Italy. The prize is open to everyone. First prize 500 euro. www.planetario.org
4-5 April. The Australasian Planetarium Society (APS), Meeting 2016, Carter Observatory, Wellington, New Zealand. Contact: Lawrence Warik, wlawrance@museum.vic.gov.au; apsplanetarium.com/2015/03/announcing-aps-2016-wellington-new-zealand
22-24 April. Italian Association of Planetaria (PlanIt), XXXI National Conference, Bari Planetarium, Fiera del Levante, Bari, Italy, www.planetario.org; contact: osservatorio@serafinozani.it
30 April–2 May. Gesellschafr Deutschsprachiger Planetarien e.V., GDP 2016, Annual meeting of Society of German-Speaking Planetariums, Munster, Germany. www.gdp-planetarium.org
18 May. International Museums Day, icom.museum
26-28 May. 10th Fulldome Festival in the Jena Zeiss-Planetarium, “Frameless Frenzy,” Jena Zeiss-Planetarium, Germany. Grand opening 25 May (in the evening). Contact: info@fulldome-festival.de or Schochrot Volkmar, schonrot@zeiss.de, www.fulldome-festival.de
17-18 June. International Planetarium Society Council Meeting, Warsaw, Poland.
19-25 June. Revolve, 23rd International Planetarium Society Conference, Heavens of Copernicus Planetarium, Copernicus Science Center, Warsaw, Poland. Contact: info@ips2016.org; Monika Malinowsky, monika@ips2016.org; Maciej Ligowski, maciejligowski@kopernik.org.pl
17-30 July. Middle Atlantic Planetarium Society (MAPS), Annual Conference, James E. Richmond Science Center, St. Charles County High School, Waldorf, Maryland, USA. Contact: Fatty Seaton, pxts13@yahoo.com; www.mapsplanetarium.org
15 September. Deadline for the applicants of “A Week in Italy for an American Planetarium Operator,” in collaboration with IPS Portable Planetarium Committee. www.astrofilibresciani.it/Planetarii/Week_in_Italy/Week_Italy.htm

For corrections and new information for the Calendar of Events, please send a message to Loris Ramponi at osservatorio@serafinozani.it. More details about several of these upcoming events is included in the International News column in this issue.
The most up-to-date information also is available online at the IPS Calendar of Events at www.ips-planetarium.org
While hunting for fossils, The Zula Patrol discovers that the villainous Deliria Delight has been illegally dumping her company’s toxic trash in Earth’s prehistoric past. The Zula Patrol must find and catch her, before her actions ruin the planet. In the process, our heroes learn all about the formation and development of Earth, and the life forms who call it home. 24 minutes.

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Bits and pieces:

What’s the most interesting object you’ve found left behind in your planetarium after a group visit? Leslie Bochenski, now at Thomas Jefferson High School in Richmond, Virginia, opens the contest with a special find during her tenure at Roanoke Planetarium in Western Virginia: the upper plate from a set of false teeth.

Pat McQuillan, Museum of Science and History in Jacksonville, Florida, shared a story, from when he worked in a museum that was hosting a large dinosaur exhibit.

He overheard a mother and son enter the exhibit, and the son yelled, “Holy s**t!” followed by the sound of his mother’s hand smacking him for using such language.

This was followed by the sound of the mother turning around, seeing the dinosaurs, and yelling, “Holy s**t!”

During one of David Bradstreet’s (Eastern University, St. Davids, Pennsylvania) presentations at a MAPS conference, he said, “I’d like to show you the speed of light in real time. Ready? Want to see it again?”

A series of misfortunate events

Don Lunetta was returning to the console, feeling his way around the back row of seats during a public planetarium program, when he felt a funny, furry thing.

Throwing his arms up, he dislodged the wig worn by a patron in the back row. The wig went flying across the theater and landed in someone’s lap, causing him to vomit onto the person in front of him. We work in a hair-raising profession.

And some good stuff:

I was fortunate to be part of the celebrations at Johns Hopkins University/Applied Physics Laboratory (JHUAPL) this summer, when the New Horizons spacecraft began sending back those incredible images of tiny, distant Pluto. We heard a wonderful variety of speakers, all excellent.

APL engineer and New Horizons project manager Glen Fountain said that the engineers were excited at the launch and during the flight. The scientists were excited for the fly-by. He described the fly-by as an astronomical hole-in-one, like hitting a golf ball in New York City and landing it in the cup in Los Angeles about 2500 miles (almost 4000 km) away.

The “keyhole” through which the craft had to pass to get the best data was a 60 x 90 km area near the Pluto-Charon system. And the craft was spot-on; it was not bad for something the size of a baby grand piano. As one of the speakers put it, “Nine and a half years, three billion miles, and about 200 minutes to gather the data.”

The Lab staff spent years on this project. Years of hard work, being away from their families, sometimes for long periods.

Glen’s wife Sharon said that she traveled to Florida to see New Horizons placed in its “nosecone” and launched. “And who else can watch ‘the other woman’ blasted off into space, and know that she’s never coming back?”

Dr. Ralph Semmel is the current director of APL, working with the lab staff to “develop solutions to critical national challenges through the innovative application of science and technology.” He shared some stories from the 1940’s.

At the time, robots were just being developed, and engineers had built one called The Beast. The machine randomly roamed the halls of the Lab, searching for electric receptacles to recharge its batteries. It wandered into an unoccupied office one evening and got stuck when someone closed the hall door. The robot searched in vain for a charging spot and was later found hunched in a corner.

One of the speakers noted that Clyde Tombaugh discovered Pluto when it was three billion miles (about five billion km) from Earth, and he was 24 years old. “When I was 24, I couldn’t even find my car keys.”

NASA Mission Directorate’s John Grunsfeld said that we go (to space) to discover things. The New Horizons probe won’t discover anything, he said. It’s the people on Earth who will do the observing and discover things. “Maybe a warm salty ocean around a rocky core – it sounds like some kind of candy. It is! It’s science candy!”

Adrian Hill is a principal software engineer at JHUAPL, who led the development of the fault protection system for New Horizons. He’s worked on flight software on a number of other NASA missions as well, including the Hubble Space Telescope, MESSENGER, and STEREO. He’s also a referee for professional (American style) football games. Of the long wait times between sending a signal out to New Horizons and a response, he said, “If you send a signal at 1 p.m. on Sunday, you can get the early game, the 4 p.m. game, and the late game, then come back to work and get the answers.”

Steve Squyers shared stories of some other explorers, ones here on Earth. “You only get to see something for the first time once.”

He said that some people name Columbus, Magellan, or James Cook as discoverers. But they interacted with the people in the places they “discovered.”

Really seeing something for the first time is different. In 1907-1909, when Ernest Shackleton led a trek into the deep interior of the Antarctic, he and his team were the first to see that area.

In 1930, when William Beebe and Otis Burton traveled a kilometer down into the ocean near the Bahamas in a bathysphere, they were the first to observe life in the deep ocean.

And on July 13, 2015, Squyers said, “Tomorrow New Horizons kicks open the door to the outer solar system, and we are incredibly fortunate to be here.” Amen.
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