I still remember very well the exciting and fruitful days of our conference. 510 participants from 46 countries came and worked together sharing experiences, new ideas and passions and, frankly, enjoying themselves enormously. Planetaria are able to create such unworldly atmosphere and bring it to Warsaw. I hope that reading these proceedings you recall not only the hard facts but also the people who you share them with. We are very grateful to all participants, the whole organising team and our generous sponsors. Together, we did it!

Weronika Śliwa, Ph.D.
Head of Heavens of Copernicus Planetarium
Chair of the IPS 2016 Program Committee
Dear Fellow Planetarians,

IPS is proud to provide these outstanding Proceedings from our IPS2016 Conference in Warsaw, Poland. This compilation of important documents written by planetarium professionals from different cultures and nations are one of the incredibly valuable benefits of your membership. For those of you who were with us in Warsaw, these Proceedings afford you the opportunity to review and reflect on some of the fascinating and useful sessions you attended and a chance to read what you missed during concurrent sessions. Those of you who were unable to attend the conference, enjoy reading through this wealth of research and experience from your international colleagues.

On behalf of the IPS Council, we wholeheartedly thank Robert Firmhofer and the entire staff of the Copernicus Science Centre, our generous sponsors and all of you who attended for making the spectacular and inspirational IPS2016 Conference possible. Our days were filled with the very best of new ideas, new technologies, new teaching methodologies and much more. These Proceedings represent our collaborative efforts and provide a beneficial contribution to the future of Planetariums worldwide.

Wishing you all great success!

Joanne Young
IPS PRESIDENT 2015-2016
Managing Director, Audio Visual Imagineering, Inc.
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01. KNOWING AND BUILDING YOUR AUDIENCE (SURVEYS, DIALOGUE, ANALYZING AND BUILDING PROGRAM)

23 JUNE 11:45–12:45 / URANUS

How to evaluate astronomical fairs? [id: 259]

Speaker: Maja Durlik (pl), The Unit for Social Innovation and Research "Shipyard"

Abstract: How can large events such as concerts, festivals or science and astronomy fairs that often take place in an open space be best evaluated? Participants can be asked to fill in a questionnaire, but more often than not they don’t have anything to write with, nor the time or patience to take part. One way to solve these problems is an evaluation coupon – on the one hand it provides organisers with basic data about the people who come to their events, while on the other it avoids burdening participants with a time consuming, known-all-too-well process of survey filling. We will talk about the coupon’s advantages (and a few limitations) using the example of a study done during “Mercury’s Transit” – an event organised recently by the Copernicus Science Centre. We will also discuss the possibilities for using the tool in evaluating other CSC undertakings.

Public Perception of Planetariums [id: 109]

Speaker: Ian Dyer (uk), Sciss AB

Abstract: The world’s population is just as interested in astronomy now as it has ever been. Data from the US General Social Survey from 2012 indicate that approximately two-thirds of the American public thinks government spending on space exploration is too small or just about right. European numbers are similar. To find out how the public feels about planetariums, we conducted our own survey by analyzing reviews on the travel website TripAdvisor. This survey will give quantitative data that can serve as a basis for discussion. What are the major positive and negative factors that people care about when they go to the planetarium – and what experiences do they take with them when they leave? If we can look closer into these trends, this data can point us in the right direction when we build our planetarium brand and audiences.

One year experiences with digital planetarium in Slovak Central Observatory in Hurbanovo [id: 181]

Speaker: Marián Vidovenec, Slovak Central Observatory, Komářianská 134, 94781 Hurbanovo, Slovak Republic, www.suh.sk, marian.vidovenec@suh.sk

Text: To begin with a little bit of history of the observatory in Hurbanovo till 1947 Stara Dala. Observatory was founded as a private institution by Nicolaus Thege Konkoly in 1871. From its beginning it was formed as a scientific observatory with orientation to regular planet and solar observations, spectroscopy, photometry and meteor shower observing. Observatory has become a state institution in 1899. Its scientific program continued till 1938 with a short break after the First World War.

Between 1938 and 1962 there was a long gap in the activity. The Observatory in Hurbanovo became fully active in 1964. That time it became a local public observatory, but its activity rapidly raised and 1969 it was changed to Slovak Central Observatory with its own scientific program and own popularization and education activities.

Management of the observatory took decision to enlarge education activities by buying planetarium in 1970. At that time fabrication of a new building with a big lecture room and a small 6 meter dome for planetarium started. Unfortunately during its realization it burned down in 1975 and opening of a new building was finalized in 1983. Planetarium ZKP1 was installed that year too. This step extended possibilities in popularization and education field. Program for public was divided into 2 parts: Activities inside the lecture room – projection of films about Solar system and related topics. Activities inside the planetarium – direct speech about orientation in the night sky. Till the end of eighties there were just 5 planetariums in Slovakia, so the number of visitors in Hurbanovo planetarium raised very quickly up to 13000 visitors. 95% of visitors consisted of scholar excursions and whole operation of the observatory was adapted to that. Programs were realized during days without public observations.

Basically the offer of programs did not change till the millennium, but number of visitors slightly decreased to 10 000 a year. Structure of visitors remained the same, 95% of scholar groups and among them over 68% of children to 11 years. It was because of the school curriculum where children obtained the first information about astronomy as 10 year old.

After year 2000 new technologies like computers were spread all over society. New digital technology enabled visualization. People were able to find easily new information on astronomy with great pictures using the internet. Also new planetariums were opened in Slovakia. This started new adverse trend in our audience. A number of visitors fell deep under 10000 a year.

It was necessary to change the offer of the program and also we had to modernize areas for visitors. A new department of the observatory, Museum of Nicolaus Thege Konkoly with main aim to collect heritage in the field of astronomy, was established in 2006. The lecture room was restored to a museum exhibition room, but there was no budget to renovate the planetarium. So old ZKP1 remained. We installed two ordinary data projectors under the dome. That way we were able to show pictures of deep sky or planets to the audience, but we really missed fulldome. Flat format pictures are reachable without problems at comfort of home. Observatory was closed for two years, due to building this museum.

We newly have been opened since 2008. In the area of museum we have explained mainly history of astronomy. We have also presented history of the observatory in Hurbanovo. But main problem was, that museum exhibition was mostly static and the offer of planetarium was without change. Number of visitors in 2008 was 8222, but just 5.7% of them were individual visitors. We were in the same situation again. Visitors consisted mainly of scholar groups.
We perceived the disappointment of our visitors very early. Visitors expected more dynamic program, they missed new technology and comfort too. Next year the number of visitors came down to 5752, mainly from scholar groups. That way percentage of individual visitors raised to 7.3% but in absolute numbers they were nearly the same with small decrease. This situation remained the same till 2013.

In 2012 problems with technical conditions of old ZKP caused a lot of short breaks in program offer. In 2013 the observatory was out of order over 3 months, so number of visitors was just 3298. We have tried to solve this problem by a new offer. Demonstration of astronomical technics and public observation has become an integral part of the program. During the day our visitors can observe the Sun and the Venus, of course in case of good weather. This addition to program stopped permanent decreasing of number of visitors.

Year 2014 was a real breakthrough. We obtained a basic budget for exchanging out old ZKP1 projector to digital. Suppliers were Nowatron and RSA Cosmos. So we obtained a powerful instrument that afforded an opportunity to real restart.

In December 2014 we removed our ZKP1 to the museum exhibition room and we started to prepare our new program offer. But again another but.

Our budget was enough to change the projector but not enough to change the environment of the planetarium. Old uncomfortable seats and also old screen remained. The question was: to wait until another budget to change the seats and make the planetarium more comfortable or to start and show people new technic despite some discomfort. We bet to the second possibility and opened early.

The premiere of a new digital projector was on 9th of March 2015, a few days before the Day of planetaria. We offered free entrance during the Day of planetaria on 15th of March. Over 350 people visited our planetarium in one day. One entrance capacity of planetarium is just 35 people so we made 10 shows. Beginning of the new planetarium was supported by other events so we communicated with media very well. One of them was solar eclipse. We prepared public observation and also fulldome show for visitors. The result was surprising, we had over 450 visitors.

Since March till the end of June we had an examinational period. We adjusted our program offer. So the part of the program besides fulldome show and activities concerning the history of astronomy is demonstration of our astronomical instruments and in case of good weather also public observation. Public observations proved as the best attractor for individual visitors. During a day we offer program for scholar groups and for individual visitors on Friday evening. The number of individual participants raises step by step. We need to be aware that Hurbanovo has 8000 habitants, so the most of individual visitors have to arrive from other parts of Slovakia.

In 2015 we started to communicate with potential visitors using Facebook. Since then the number of visitors has raised especially in case of special events as the Night of Museums or the Children’s day etc.

In 2015 we had 7141 visitors, but the percentage of individuals has rapidly changed. Nearly 15% of our visitors are individual. It seems that this value is also the same in 2016. Finally I have to say in December 2015 we changed our old wooden seats to more comfortable chairs. It seems that our decision to start planetarium without comfort was right. We have a new topic that we can communicate about with our potential visitors, of course, besides new shows we offer. I hope we will be able to achieve our aim to reach 10 000 visitors a year in Planetarium. Improving our offer has a direct influence to number of visitors and of course to better economy results of the observatory.
Great failure ins Planetarium Design – How to avoid them [id: 239]

Speaker: Shawn Laatsch (us), IPS President Elect

Abstract: Infoversum is a facility that was designed by an astronomy professor who had little knowledge of the planetarium world and was unwilling to listen to expert advice. As a result, the facility has a number of severe challenges that limit its operations, productivity, and financial viability. From a lack of adequate workspace for staff, to a faulty air conditioning design causing dome overheating, to the use of minimal projectors for a 20 m dome – these and other problems will be discussed in detail. The presentation will showcase and discuss how the staff have worked around these flaws, along with ways of minimizing them in the future.

People are planetarium guiding stars [id: 262]

Speaker: Dr Weronika Śliwa (pl), Copernicus Science Centre

Text: Five years ago when we started to organize our planetarium we knew next to nothing about the machinery involved. Still, we had a few guiding principles.

First was emphasis on interactivity engaging the audience during the shows. It not only follows Copernicus Science Center principles, but allows for easy adjustment of the shows to visitors needs. We wanted people not only asking questions, but sometimes changing the show course. This opportunity is the more important after the opening, as we can see that approximately only 20% of visitors take into account the recommended age for the show. It could result in half the audience during kindergarten show being secondary school pupils.

The second principle was giving information very up to date which allows for describing Nobel prize the very day of the announcement and organizing spectacular astronomical and space sciences events. To execute the plan presenters have to do their own shows, being able to easily change them and to be really engaged and responsible for the outcome. We decided on full-time employment contracts with small support with Copernicus animators who are also involved in other Copernicus’ activities. We consciously have searched for people of different backgrounds who could show different perspectives of astronomy and starry sky. In our team you will find astronomers and physicists and also archeologists, historians, paleontologists and philosophers. They all want to share their passions with planetarium visitors.

For day to day work under the dome other arrangements are in force. In basic subjects such as latecomers, people getting out, what to say at the beginning of the show, presenters should follow clear and strict rules which reduces unnecessary stress and delays. In important and unexpected situations they have the freedom to decide according to clear priorities. Those are safety of visitors, scientific validity of the shows, visitors satisfaction and the schedule. I see a team building as the most important part of producing good quality planetarium shows. It is much easier to imagine very good shows in a dark dome with no equipment than with empty but fully equipped dome.
Serving the audience during planetarium reconstruction [id: 28]

**Speaker:** Dr Kenneth Coles (us), Indiana University of Pennsylvania

**Abstract:** The 75-seat planetarium at Indiana University of Pennsylvania, USA, has volunteer staff presenting programs to school groups and the public since 1967. The original Spitz optical-mechanical projector is augmented with digital still and video projectors. Demolition of the planetarium is scheduled for 2019, and a new facility will open two years later. Plans to stay connected with the audience during the years without a facility include sky observing sessions with portable telescopes, participation in Globe at Night studies of light pollution, telescope workshops, and public events twice per year for Astronomy Day.

**Paper:** The 75-seat planetarium at Indiana University of Pennsylvania, USA, has volunteer staff presenting programs to school groups and the public since 1967. The original Spitz A3P optical-mechanical projector is augmented with digital audio, still, and video projectors. Since 2004 over 5400 people from outside the University have attended more than 130 programs.

The science building that contains the planetarium is due for replacement. Demolition of the planetarium is scheduled for 2019, and a new facility will open two years later. A major concern is keeping a connection to the public audience built over the previous decade. Past gaps in programs have caused a drop in attendance that takes a long time to recover.

Plans to stay connected with the audience during the years without a facility include several activities:

1) Night sky and daytime Sun observing sessions with portable telescopes;
2) Participation in Globe at Night studies of light pollution;
3) Workshops such as constructing Galileoscopes, using a 20 MHz radio telescope, and making digital images of the Moon and planets.

The University owns a number of portable telescopes, so the primary need is for enough people to operate them for visitors. University undergraduate students will provide the core of this group during the planetarium transition.

Looking Back and Looking Ahead [id: 83]

**Speaker:** Dave Hostetter (us), Lafayette Science Museum

**Text:** In 2012 the Lafayette Planetarium switched to full dome as many of you have done.

This immediately created a big problem: what do we do with all the old equipment? Because we hoped to put our Spitz A4 on display someday, with the help of ASH Enterprises we packed it up for storage, but everything else was basically a storage problem.

Once we were in full dome operation, we started making actual plans to exhibit the star machine, and that morphed into planning for a planetarium exhibit in a small exhibit space of roughly 500 square foot (about 46 square meters).

Then our Collections Curator, Dr. Debbie Clifton, got into it, suggesting that we should hang onto our old equipment for our Museum’s permanent collection. As you might guess, collections curators like to collect stuff, and have a powerful sense of history. They realize that everything can’t be saved but we should at least preserve important examples.

It’s important to understand what I mean by our “permanent collection.” An accessioned, permanent collection is a set of objects a museum conserves and preserves for research, education, and exhibits. It’s a commitment for maintaining those collection items for as long as the Museum exists, and hence is not something done lightly. A permanent collection implies committing staff time, storage space, and funding for doing this.

Museums collect different artifacts depending on the interest and purpose of the museum. Our museum permanent collection includes, among other things, local Native American baskets and effigy figures, Cajun musical instruments and textiles, fossils, meteorites, and now planetarium equipment. Other science museums might well collect other things, depending on the museum’s focus.

An accessioned, permanent collection means that each and every artifact in the collection—and the Lafayette Science Museum collection has literally tens of thousands of artifacts—has a unique number identifying it. Documentation and related items can be tied to that artifact through that number.

I enjoy history and I liked the idea of creating an accessioned planetarium collection. It was a lot better solution than simply throwing everything away!

The old planetarium equipment represented a big part of our Museum’s history that would be lost if we tossed stuff out...and it also represented a big chunk of the history of the planetarium profession. Since I’d been in Lafayette for 35 years, I was in a unique position to curate a collection that could be of actual historical interest.

To give you an idea of the changes we’ve seen, when I started in the planetarium in Lafayette in 1980 the control console was a desk with Sears AC dimmers and Ektographic hand remotes taped on the console to run everything. In 1981 we switched to a MediaTech automation system using inaudible beeps to control most of our slide projectors and special effects. When we moved the museum and planetarium to a new downtown location in 2002 we switched to a JHE computerized system, then in 2012 to Sky-Skan full dome. Many of your facilities probably have similar histories, illustrating much of the technical development of the planetarium field during that time period. Most of our traditional equipment still exists because we kept using it until we went full dome.

Our new accessioned planetarium collection will include the star machine, the different slide projectors that were used, lamps, audio...
equipment, control equipment, and old special effects projectors. We have every commercial planetarium program we’ve used since 1980—audio, script, slides, effects lists, local installation notes, everything. We even have some of the programs from the late ’70s and some of the scripts from the very early days of the Museum, as well as the manuals for most of the equipment we used. All this helps reveal the day-to-day operation of a late 20th Century small planetarium, the type of historical detail that is often lost. The nice thing is that as all that equipment and documentation goes into the permanent collection, storing it all becomes Debbie’s problem, not mine!

Our process started late in 2014. With Debbie’s help I assigned every item for the planetarium exhibit an accession number, provided a physical description of each object, and then a description of how it was used and why it needs to be in the collection. I am now continuing the process for the many, many aspects of traditional planetarium operation that won’t be in the initial version of the exhibit.

A project like this is time-consuming but I can work on it whenever I have a few minutes available. Spending hours working on it non-stop is good when there is time, but it’s not required. It will take a few years, but we will end up with a thorough collection showing the equipment and use of a typical small-to-midsized planetarium in the late 20th Century and early 21st Century.

Switching to full dome dramatically marks the end of one era at your planetarium and the beginning of a new one, and provides a natural opportunity for you to do something similar. It’s good for preserving the history of your facility as well as the history of the field. I think that already having an accessioned collection and a collections curator is key to this. The professional standards for an accessioned collection are high and if you don’t have the professional training for that, you’ll need help to do it right.

At the very least do a thorough photographic documentation of your traditional theater in the final weeks of its operation. Photodocument the changeover as much as possible. Photodocument the new facility when it’s ready to open.

If you and your collections curator want to make a permanent planetarium collection, as you tear equipment out think about how it was used and whether it could help someone understand how traditional planetariums worked. Then preserve the material and work with your collections curator to develop the collection to professional standards. Remember, you will be creating a collection that you hope will be there as long as your Museum is open. Who knows, some historian 75 years from now may use some of your work on a thesis about science education!

As the Lafayette Planetarium looks to its past, though, it also looks to its future with the construction of a robotic, rooftop observatory.

One dome will be dedicated to solar observing and features an 81 millimeter William Optics Gran Turismo f/5.9 refractor with a photographic Baader Herschel wedge. The other telescope is an 80 mm Lunt Hydrogen-alpha telescope. They are mounted together on a Software Bisque Paramount MX+. Both telescopes have Starlight Xpress Trius 825 monochrome cameras.

The other dome, dedicated to robotic night use, will have a pair of Celestron EdgeHD 800 Schmidt-Cassegrains mounted together on a Software Bisque Paramount ME II. One telescope will operate at f/10 while the other will operate at f/2.1 with a Starizona Hyperstar 3 lens. Color cameras will come from Starlight Xpress and Imaging Source, and we also have a Canon EOS 5Ds.

Weather equipment now in place on our roof will monitor sky conditions, and observatory operating software will use that data to ensure the observatory domes open only when conditions are appropriate. One of the challenges we are addressing is ensuring that type of control during the daytime. It appears that most control software is designed only for night use. We may have to develop in-house software for a daytime system, but fortunately we have a technician with the computer expertise to attempt that.

Our intention for the solar dome is to post daily visible light and Hydrogen-alpha solar images to our website, and to stream the solar images if we can find an affordable way to do that. Ultimately the images will be accompanied by classroom-style learning activities about the sun designed for teachers and anyone else who is interested.

The other dome will be reserved for non-solar use. We plan to create astrophotos for use in our planetarium programs as well as for classroom learning activities about the night sky. Ultimately we hope to allow area amateurs and students the opportunity to use the equipment remotely for their own projects. We recognize that since our Museum is downtown in a city of about 128,000 people, we have a serious light pollution problem that will impact how the observatory will be used.

Because the observatory is being built in parallel with a number of other museum projects, we don’t have an opening date. Each dome will go into operation as it is finished, although we do hope to have both in action by the end of this year.

In the meantime we are already doing some occasional observing projects. In September the Lafayette Science Museum Observatory was one of five observatories cooperating with NASA TV to livestream the total lunar eclipse seen across the Americas. As it turned out, there were clouds at all the sites and NASA spent a lot of time showing our rooftop camera images of the overcast! We were fortunate to see a general clearing as totality began, and NASA used our eclipse feed for nearly the last hour and a half of its broadcast. It was also picked up by CNN and the Los Angeles Times web site, giving us a great deal of national exposure. In December we livestreamed the daytime occultation of Venus (with a much smaller audience since NASA TV was not involved), and we attempted the same thing in May for the transit of Mercury [although we had very cloudy conditions with only a few useful minutes]. We’re looking forward to doing more events like this, including livestreaming our partial eclipse in August of 2017.

The Lafayette Science Museum has become a much more dynamic place over the last five years, with improved exhibits and the switch to full dome planetarium programs. At the same time, we think that our new collection and exhibit of traditional planetarium equipment will ensure that our institutional history is not lost, and that our observatory will help ensure that we continue to make progress.

Paper: The Lafayette Science Museum Planetarium (LSM) is looking back to preserve its history while at the same time preparing to expand with new activities for the future.

The Planetarium went full dome in 2012 and planned to discard its old, obsolete equipment except for possibly exhibiting the original Spitz A-4 star projector. It was decided instead to retain as much of the
traditional equipment and documentation as possible to preserve not only the LSM institutional history but also to keep an historical record of how its small to medium-sized planetarium operated and responded to changes in the planetarium industry. To ensure that future curators would not simply regard the traditional equipment as junk and dispose of it, the planetarium curator (the author) worked with the LSM collections curator to create an accessioned permanent planetarium collection as a sub-section of the existing LSM permanent collection.

Ultimately much of the accessioned equipment will go on display near the planetarium dome itself.

The collected equipment includes the Spitz A-4 star projector, slide projectors, special effects projectors, lamps, audio equipment, control equipment, and similar items. Related documentation will include all the commercially available programs used since the author arrived in Lafayette to be the planetarium curator in 1980—original scripts, annotated scripts for daily operations, production notes, set-up check lists, and more—and even some information from earlier programs back to 1969 when the museum opened. LSM believes that the collection will give a unique view of the facility’s day-to-day operation, the type of information often lost as time passes.

This project began in 2014 and will go for several more years, each collection item being numbered, given a physical description, and a description of how it was used and why it should be in the collection. It’s a project that can be addressed for short periods as time is available or for hours at a time when that’s possible. In addition to the physical equipment and documentation, the collection includes thorough photodocumentation of the old facility just before the traditional equipment was removed, the renovation process, and the new facility as it opened.

LSM urges others who are switching to full dome to do something similar (at least the photodocumentation) to preserve the history of your institution and the planetarium profession.

Looking to the future, LSM is building a robotic rooftop observatory, a significant new direction for our education plans. The completed observatory will have a solar dome and a separate robotic dome for non-solar observing. The solar dome features an 81 millimeter William Optics Gran Turismo f/5.9 refractor with a photographic Baader Herschel wedge. The other telescope is an 80 mm Lunt Hydrogen-alpha telescope. They are mounted together on a Software Bisque Paramount MX+. Both telescopes have Starlight Xpress Trius 825 monochrome cameras.

The other dome, dedicated to robotic night use, will have a pair of Celestron EdgeHD 800 Schmidt-Cassegrains mounted together on a Software Bisque Paramount ME II. One telescope will operate at f/10 while the other will operate at f/2.1 with a Starizona Hyperstar 3 lens. Color cameras will come from Starlight Xpress and Imaging Source, and we also have a Canon EOS 5Ds.

Weather equipment now installed on our roof will monitor sky conditions and provide data to operating software to ensure that the domes open only under appropriate conditions.

The solar dome will send daily solar images to the LSM web site in visible and H-alpha light. The robotic dome will create astrophotos for use in educational activities on the web site and will ultimately become available for local amateurs for their own projects.
Beyond the Stars: The Planetarium as a Community Resource [id: 15]

Speaker: Dr. Jorge Perez-Gallego (us), Patricia and Phillip Frost Museum of Science

Abstract: After almost 50 years, the Patricia and Phillip Frost Space Transit Planetarium in Miami, FL closed its doors on August of 2015, retiring its still functioning Spitz Model STP Space Transit Planetarium star projector, a unique masterpiece of its time. Home to the original PBS's naked eye astronomy television show Star Hustler, hosted by Jack Horkheimer, the planetarium was loved and treasured by its community. The new state-of-the-art Frost Planetarium will open in Miami’s downtown in the summer of 2016, and it is committed to honor, and creatively push, our record of live show presentations, while featuring world-class pre-rendered shows, and opening its doors to alternative and innovative scientific, educational, and artistic content from the community. During this session, we will be sharing the process and challenges of building a new trailblazing planetarium, and how the shadow of our beloved old one informs that process.

Paper: Miami didn’t have a science museum until 1950, but once it did, the planetarium became a cornerstone of the community. Our first site was a modest house on the corner of Biscayne Boulevard and 26th Street. We grew quickly, and by 1968 we had a facility on three acres of the historic Vizcaya complex, and by 1968 we built the Space Transit Planetarium which, at the time, was the leading facility of its kind in the world.

Over five decades, the Miami Science Museum and Space Transit Planetarium expanded to have 4,000 member families, over 250,000 annual visitors, one of the largest summer science camps in the nation, and countless additional exhibits, collections and activities. The institution was nurtured by a legion of tireless volunteers and generous contributors. Their abundance of vision and dedication, coupled with that of the museum leadership, made the museum and planetarium a real community resource.

The 65-foot Space Transit Planetarium entertained and educated children of all ages by bringing the stars and planets indoors in animated live star shows, and music-filled laser light shows. It was home to the late Jack Horkheimer’s “Star Gazer,” the world’s first and only weekly television series on naked-eye astronomy. At the heart of the planetarium was a Spitz STP star projector which was retired—still in working condition—in August of 2015 as the last operating star projector of its kind. Astronomy programs were often enhanced next door at the Weintraub Observatory, where two powerful Meade telescopes allowed direct access to the wonders of the night sky. Our planetarium grew to be an essential part of our community—thousands upon thousands of Miami-Dade residents have colorful memories of field trips to the facility, and moments of wonder in the planetarium.

In 2004, Miami voters passed a General Obligation Bond, which included the provision to create a new Miami Science Museum, now called the Patricia and Phillip Frost Museum of Science. Frost Science is currently under construction in downtown Miami, and is scheduled to open early in 2017 to an expected yearly audience of up to one million visitors.

The five-level, 250,000-square-foot, LEED Gold-certified building, designed by Grimshaw Architects, has a campus-like layout featuring the state-of-the-art Frost Planetarium; the unprecedented Living Core, which includes a three-story 500,000-galons Gulf Stream aquarium; the entrepreneurial Innovation Center; and the Exploration Center, which houses inspiring permanent and travelling exhibitions.

Once built, the 67-foot 250-seat 8K Frost Planetarium will carry on our longstanding tradition of being a gathering place for the community, and will be one of the most advanced facilities of its kind in the world. Programming will include the latest pre-rendered shows, engaging live presentations, inspiring school programs, live broadcasts from scientists in the field, spectacular laser light shows, and visuals from both
Earth and space telescopes. Planetarium goers will witness what the night sky looks like, and learn not only about planets, stars and galaxies, but also about other fields of science, such as marine biology and neuroscience, that greatly benefit from an immersive environment.

Immersive environments are on the rise, and it is Frost Planetarium’s goal to open the doors of its dome, as we have always done, to our community. The space will be available to scientists, educators, students, and musicians and visual artists to help them develop their own content, while contributing to their careers, and the furthering of the medium.

Ultimately, Frost Planetarium is committed to become a world-renowned facility and a center of scientific excellence. We are excited to unleash Frost Planetarium, not only to wow Miami audiences, but to strengthen the understanding of the world around us, and inspire the next generation of scientists.

2017. Year of the Madrid Planetarium [id: 265]

Speaker: Asuncion Sanchez (es), Planetario de Madrid

Abstract: The Madrid Planetarium will turn 30 years old on 29 September 2017. Its intensive science outreach activity has been rewarded by the attendance of over 5.5 million visitors. A number of reasons, including the recent financial crisis, have impeded the technological renovation of the Planetarium in the last decade. This situation changed two years ago, when the Madrid City Council and “la Caixa” Welfare Projects [managed by “la Caixa” Banking Foundation] entered into an important cooperation agreement aiming at the technological renovation along with the conduct of various activities of the Planetarium. The Madrid Planetarium is therefore closing its doors on next June for a six-month transformation period. The reopening of the renewed facilities is scheduled for early 2017. As a result of the works, the Planetarium will be equipped with a hybrid system consisting of Sky-Skan digital fulldome technology and a Megastar IIA optical projector.

From Earth to the Universe and Its Innovative Distribution Model [id: 198]

Speaker: Lars Lindberg Christensen (de), ESO

Text: The European Southern Observatory (ESO) is a global driving force behind ground-based astronomy and is also arguably the most productive ground-based observatory in the world. As part of its mission, it provides a wealth of free outreach and educational material.

In 2015 ESO’s Education and Public Outreach Department (ePOD) and the ESO Supernova Planetarium & Visitor Centre (made possible through a donation from the Klaus Tschira Foundation) released their first complete 4k fulldome documentary entitled ‘From Earth to the Universe’. It is the world’s first freely downloadable full-length fulldome show. This 30-minute voyage through time and space conveys, through an arresting combination of impressive audiovisuals, the Universe revealed to us by science.

In our presentation we describe the underlying philosophy for the creation of this fulldome documentary and the innovative distribution model devised by ESO in order to give easy and immediate access to it.

Editor note: see more at https://www.eso.org/public/videos/eso-fettu/

Planetariums and Film Festivals [id: 36]

Speaker: Warik Lawrance (au), Melbourne Planetarium

Abstract: Film Festivals offer a unique opportunity for planetariums to attract new audiences, yet they are often overlooked. For the last six years the Melbourne Planetarium has presented Fulldome Showcases as part of the Melbourne International Film Festival, the oldest and most prestigious film festival in Australia. This relationship has proved very successful. This presentation will investigate the benefits of working with festivals, establishing and maintaining successful working relationships with festival organisers. It will also consider the logistics of contracts, acquiring films and working in with film makers and producers. Finally it will explore festival audiences, who they are, their expectations and how to deliver an engaging experience.

How to brand and market your planetarium using an organisational DNA [id: 199]

Speaker: Dana Sandu (de), ESO
Abstract: The word “Planetarium” is a brand of its own that attracts many people to a venue, but is this enough to have a successful planetarium? In this talk we will be exploring the role of branding and marketing in building a popular planetarium. We will put forward the idea that branding defines the DNA of an organisation that influences all decisions taken later on: from wall colours to the choice of shows, from business cards to partners. We will describe the steps in the process of building the organisational DNA of the ESO Supernova Planetarium & Visitor Centre, a donation from the Klaus Tschira Foundation, while trying to highlight a few general steps that any planetarium could take when building its own brand. We will also look at marketing strategies and discuss how to define one in order to attract more visitors.

05. FUNDRAISING
22 JUNE 17:15-18:15 / URANUS

ECLIPSE! Are you ready? [id: 70]

Speaker: Ken Miller (us), GOTO, Inc.

Abstract: Ken Miller was a “local planetarium host” for total solar eclipses in 1979 and 1991. He will share some best practices: 1. Eclipse time is the perfect time for brand development – everyone is listening! 2. Advance planning is everything when it comes to communicating with the public. 3. Eye safety really can be taught effectively. 4. You can make a LOT of money for your institution before an eclipse! Learn techniques for media and government communication. Learn the effective, FREE viewing technique (no, not the silly paper box pinhole viewers – those don’t work well at all!). And learn how a 9 meter planetarium set about making a $1,700,000 profit from the 1991 eclipse in Hawaii. You can do all of these things, too... well, you’ll have to set your own goals for making money!

Paper: Often, planetariums can play an important role in anticipating or responding to current events in the sky. An eclipse, a comet, a rocket launch, or even a new science fiction movie can mean that the planetarium has an opportunity to both educate, and to advance its own standing within the community – which sometimes means adding funding to their institution.

In this paper, I will focus on the example of a total solar eclipse, since one will sweep across all of America on August 21, 2017. My hope is that everyone in America will be ready for that eclipse, and will not miss opportunities due to lack of preparation. If you are not from America, don’t relax, because some other special event will be coming to you soon!

For any short-term event, one must set goals in advance, and then make sure that no opportunities are overlooked. For a total or partial solar eclipse, such as total solar eclipses when I worked for planetariums in 1979, 1980, and 1991, there were 3 main goals: 1. Public eye safety 2. Astronomy education (moon phases, etc.) 3. “Selling the planetarium” through various marketing efforts.

First, eye safety is THE critical issue at any solar eclipse. Even if you are lucky enough to be in the path of totality, you still have hours of partial eclipse to experience. And for the vast majority of people who are NOT in the path of totality, but who hear the media and internet abuzz with eclipse talk, it is even more important.

Teach everyone that the lens in their eye acts just like a magnifying glass that can set a piece of paper on fire, and that they don’t want that to happen inside their eye. While the eye’s iris muscle’s straining to close off the eye causes pain and forces one to look away on a normal sunny day, during the partial phases of the eclipse, when the sky begins to darken the eye is fooled, and relaxes the iris muscle, letting too much light in and potentially damaging the retina.

The best and easiest way to ensure eye safety is to explain and sell safe solar filter glasses or hand-held viewers. Sold by several reputable
companies, these paper-framed glasses or viewers using aluminized mylar or proper neutral density plastic are cheap and effective.

But the WORST and LEAST EFFECTIVE way to attempt to protect your community’s eyes is to perpetuate the myth that a good way to view the eclipse is using a pinhole projection cardboard box! While the illustrations in many textbooks look simple, anyone who has built the pinhole projection box realizes that the tiny “image” inside the box is totally unsatisfying, and unconvincing, especially to any self-respecting 10-year-old, who will immediately turn around and look at the sun through the pinhole! Wrong, wrong, wrong. Please do NOT suggest or tolerate anyone else suggesting the cardboard box/pinhole projector technique. It doesn’t work, can lead to eye damage when used improperly, and maybe worst of all, deprives the person in the box of the chance to see the partial eclipse!

Instead, if people can’t get their hands on safe solar filter glasses or viewers, try what I call the Miller Mirror Technique. Every household has the raw materials: A small pocket or hand mirror, paper, and dirt, sand, or clay to hold things in place. Cover the pocket mirror with paper, except for about a dime-sized hole. Just for fun, and to convince your audience that they are really seeing an image of the sun, make that dime-sized hole in the shape of a triangle, not a circle. Then place the covered mirror in a container of sand (rice works too) so that it is held steady, but can be re-positioned easily. Reflect the sun’s light off the mirror at least 40 feet/12 meters into a shady area – the darker the better. A good way is to shine the light through an open doorway into a darkened room in your house, and onto a white wall or sheet of paper.

Inside, in the shade, you’ll see an image of the sun which is not a tiny little blip, but an image the size of a soccer ball or larger! And yes, the partial phases are perfectly seen. On a day with large sunspots, you can even see them using this technique! No lenses required, no chance for eye damage while sitting inside the house, yet you’ve got it all... for free! Try this yourself on any sunny day, and you’ll never tolerate a cardboard box over anyone’s head again.

This technique works especially well for schools or preschools, where an adult outside can position the mirror, while another teacher inside can discuss what’s happening using the large image on the wall. An added side lesson to be learned is about the earth’s rotation, as the person outside will need to re-position the mirror every few minutes to keep it pointed in the right direction. Of course if you are in the path of totality, run everyone outside to see second contact!

OK, with eye safety well in mind and being transmitted to all of your community, we move on to astronomy education. Eclipses are the perfect “teachable moment” to teach moon phases. Yes, there is a lot of solar science and coronal detail that can be taught, and I’ll leave that to the reader. But remember that the vast majority of your audience members (of any age) don’t REALLY understand moon phases, or why there isn’t an eclipse once a month. For that, I use two hula hoops, one yellow for the sun, and one gray for the moon. My head is the earth, and these two hoops around my head represent the locus of points that the sun and moon seem to occupy through time. Tilt the two hoops slightly apart, and then explain the whole concept of eclipse seasons. It works, and audiences of all ages will go home to explain all about the eclipse to their neighbors and family.

So that brings us to marketing surrounding the short-term event. For me, this is the fun part. In terms of fundraising, eclipses have been the most effective work I’ve ever done. You can do it too.

Most planetarians are familiar with fundraising via philanthropy. That is, ask people to give out of the kindness of their hearts and see what happens. This may be a grant proposal, or simple begging, but there is never any guarantee of getting any funding.

Instead, for exciting short-term events like eclipses, I urge planetarians to think of MARKETING their planetarium, not just begging. Marketing is “the selling of products or services in such a way as to make them desirable.” You see it all around you. Advertising, promotions, gimmicks, colorful packaging – marketing. You have an exciting short-term event coming up. Now it’s your turn to market.

To market your planetarium, first decide what you want to do for and with your community. Then think how that can be done through goods and services you can sell. And finally, identify who would want to help you in your efforts, and WHAT’S IN IT FOR THEM? This is not begging, this is selling something that somebody really wants.

For the eclipse of July 11, 1991 in Hawaii, the Bishop Museum Planetarium designed a logo, did some planning, and then called a media/press conference 366 days before the big eclipse. One year and one day ahead, we supplied TV, radio, and print reporters with video clips on DVDs, eye safety filters, camera filters, eclipse science background sheets, detailed local timings and circumstances of the eclipse, and a list of events, exhibits, shows, and merchandise that the museum would present in the next year. Their news stories ran the next day... E-Day minus 1 year.

And on everything handed out that day, our logo, contact phone numbers, and museum information was prominently shown – staking Bishop Museum’s claim to the title “Eclipse Central” for the coming year. Follow up media days were also done one month, 2 days, and 1 day before the big day. All of this truly did make the museum the “Go-To Place” for the eclipse, and positioned us well for the marketing blitz that was to come.

Four travel industry companies were approached for sponsorship of the big eclipse show and exhibit the museum had planned. Seeing the media coverage already coming out, they recognized that using the museum’s eclipse activities as one of their advertising outlets was
very cost-effective, and also a feel-good item for their corporate image. So the four companies each committed $50,000 of their ADVERTISING budget – not their philanthropic fund – to the museum. In turn, their logos acknowledging their support went out on every printed item and press release for the next year.

Next, the museum began to use its identifying eclipse logo on merchandise. T-shirt sales netted $156,000 profit. 312,000 safe solar filters with Bishop Museum logos were sold for a total of $460,000 net profit. I wrote a small Eclipse Hawaii booklet in a single weekend that sold 21,000 copies for an $81,000 profit. Posters, postcards, baseball caps, sweatshirts, t-shirts, fanny packs, patches, beach towels, golf shirts, cloisonné pins, and even specially-minted silver and gold coins were produced and sold – many by manufacturers who simply bought the logo license and endorsement of the museum, and then sold products through their regular outlets. The total merchandising profit – not gross proceeds, but net profit – was $1,320,000. This is in an island state with a total population of less than 1 million people, from an island (Oahu) that was NOT in the path of totality.

In addition to merchandising, of course the museum also sold eclipse tours, mounted a 3,000 sq. ft./300 sq. meter exhibit, did outreach activities using 5 Starlab inflatable planetariums on neighbor islands, and produced an original planetarium show which was seen by 57,000 visitors and Starlab attendees in 4 months. You might say, “Wow, but that was you big guys.” However, the Bishop Museum planetarium is only a 30 foot/9 meter dome with 76 seats and a staff of 3 plus 4 part-timers hired as the eclipse fever got hot. We got help from an army of volunteers, and the museum's gift shop and P.R. department, but the power of the eclipse and our early marketing efforts took over and carried us on a wild ride.

The eclipse day went off just fine. It was cloudy where I was, but the entire state and its visitors had a great time, felt that they had received good value for the money they spent, and retained a very positive attitude toward the museum. That positive attitude and larger public image that the museum gained resulted in more than 4,600 family memberships being sold, and new, official designation as the Hawaii State Museum of Cultural and Natural History, which also brought partial, annual state funding for the first time in history. Our proven ability to deliver education to a large public was noticed and resulted in a later NASA grant and a Boeing Company contract. The Explorers Project and Star Station One programs were a direct result of the total solar eclipse marketing impact.

You too can market your planetarium around short-term astronomical events. Think marketing and what you have to sell, not philanthropy and what you can beg for. Excite those who have marketing and advertising money and they will help you get the word out. And look at other events in your community which are heavily marketed. See what is working, and jump in. Happy marketing!

07. THE PLANETARIUM AS A MULTI-MODAL FACILITY (E.G. PUBLIC SHOWS, COOPERATION WITH UNIVERSITIES AND RESEARCHERS)

21 JUNE 18:15-19:15 / SIRIUS

The value proposition of planetariums – an identity crisis? [id: 106]

Speaker: Mike Dowling (se), Sciss AB

Abstract: At the moment, most planetarians think of their planetarium as a building and everything under the dome. However, increased visualization capabilities online are already starting to change this. Pretty soon, virtual and augmented reality glasses will change the perception and value of immersion. Soon, to think of the planetarium as only the dome will probably be a conservative standpoint. Rather, the planetarium is a mission to evangelize and breed interest in astronomy. This can happen online, in exhibitions, in the classroom and under the dome. There is also an argument to be made that the digital planetarium technology is converging with giant screen cinema. While this is arguably true for the technology, there is very little such convergence in terms of purpose and use of the technology.

Public Engagement with Interactive Domes [id: 256]

Speaker: Mischa Horninge (nl), Columbus Earth Theater

Abstract: Domes or large screen theatres have the opportunity to become centres of public participation and dialogue by using their unique digital environment as interactive tools. Our inverted dome theater in Kerkrade (NL) is on its way to developing itself as a centre of city (urban) development tool, using its projection surface as an interactive city map that uses the latest 3D visualisation techniques. Together with an urban engineering agency called IBA Parkstad, we aim to develop an easy to use 3D model of our city region Parkstad, allowing project owners to present their projects in a completely new way and open up interactive discussions with stakeholders. At the same time citizens are invited to see their region as they have not before, and enable them to interact with project owners and the 3D model itself to share their ideas and comments. We are currently experimenting with the interactive system and are bound to have results to share.

Paper: The Columbus Earth Center has a unique immersive projection installation, inspired by astronauts who describe their voyage to space as a mind-changing experience. Seeing Earth from space is a privilege that only 500 people had so far. Our museum in the Netherlands has created a place that lets visitors have the closest thing to such an “out-of-the-earth” experience.

In the theater, visitors stand on circular platforms, looking down as if they are on the International Space Station into a 17 meter wide, 9 meter deep ‘space’, with the planet traveling through it. The theater is based on the fact that actually ‘looking down’ on earth will give you a
more enriched experience compared with regular dome projections where you 'look up' to see the Earth.

The multimedia installations in Columbus offer more opportunities than solely letting visitors look at the Earth. We have developed a second production, which dives 1,000 meters deep into the former coal mines that shaped our region until 50 years ago. Other opportunities are now being developed further, such as using the theater for big data visualisation, serious gaming and urban planning development.

The urban development tool is already taking shape, ultimately using the projection surface as an interactive city map that uses the latest 3D visualisation techniques. Together with an urban engineering agency called IBA Parkstad, we aim to develop an easy-to-use 3D model of our city region Parkstad, allowing project owners to present their projects in a completely new way and open up interactive discussions with stakeholders. At the same time citizens are invited to see their region as they have not before, and enable them to interact with project owners and the 3D model itself to share their ideas and comments. We are currently experimenting the development of such a system, and are seeking project partners who are interested in a similar set-up for their (dome) theater.

Link: www.columbusearththeater.nl
Location: Kerkrade, the Netherlands
Person to contact: Mischa Horninge, Product Manager Columbus, m.horninge@museumpleinlimburg.nl

Do scientists care about domes? [id: 93]

Speaker: Dr Tom Kwasnitschka (de), GEOMAR Helmholtz Centre for Ocean Research Kiel

Abstract: Traditionally, the relationship of science and planetariums as a communicating medium has been unilateral. With the maturing of fulldome engines as immersive real time simulators, our profession is, for the first time in its existence, able to give something back to science and create a dynamic relationship with the creators of the data we use: The international network of domes can potentially serve as an infrastructure for scientists to use, since large-scale scientific visualization infrastructure is surprisingly difficult to fund and maintain. How can domes exploit this situation, and may they uphold such a role in light of the emerging VR and head mounted display market?

Best of both worlds [id: 158]

Speaker: Anna Öst (se), Visualization Center C

Abstract: The Visualization Center in Norrköping, Sweden is a facility hosting both a public science center and the visualization research department of Linköping University. The dome is the heart of the center and is used for both public shows and research. Defined as a “visualization dome” rather than a planetarium, the space can be used as a flexible arena for science communication as well as for development and experiments. The presentation aims to share our experiences on engaging the public in science using visualization as a tool and how to use take ongoing research and turning it into engaging presentations and public shows. What are the people and technology needed, how can it be organized and what are the benefits of close collaboration between research and public facilities?
Space Sciences outreach by special events around the world [id: 134]

Speaker: Diego Bagu, Martin Schwartz, Pablo Santamaría (ar), Planetario Ciudad de La Plata

Abstract: We are living in a golden age in respect to space research. The great advance in science and technology is reflected in a direct way in space sciences. The first landing on a comet (Rosetta-67P), the first fly-by of Pluto or the discovery of the first Earth-like exoplanets are clear examples. In addition, astronomical events like a Super Moon eclipse have become extraordinary phenomena due to great media coverage. Scientific/technological advances plus a significant media dissemination around the world are the perfect cocktail for a planetarium to capture the interest not only of thousands of visitors by organizing special events, but also to a great number of people on a local, national and even international level by producing an outreach program in social media. In this presentation we show different activities at La Plata Planetarium in 2014-2015 and the results achieved.

Paper:

1. Introduction

We are living in a golden age in respect to space research. The great advance in science and technology is reflected in a direct way in space sciences. The first landing in a comet (ESA Rosetta spacecraft over 67P comet), the first fly-by of Pluto (NASA New Horizons spacecraft) or the discovery of the first Earth-like exoplanets are clear examples. In addition, astronomical events like a Super Moon 2015 eclipse become extraordinary phenomena due to a great media coverage. Scientific/technological advances plus a significant media dissemination around the world are the perfect cocktail for a planetarium to capture the interest not only of thousands of visitors by organizing special events, but also to a great number of people on a local, national and even international level producing an outreach program in social media. In this work we show different activities at La Plata Planetarium in 2014-2015 and the achieved results.

2. Goals and activities

The Planetarium of La Plata (PCLP) opened its doors in July 2013 and is part of the Faculty of Astronomy and Geophysics Sciences at the National University of La Plata (1883). It is one of the most modern planetariums in Latin America, an immersive environment where visitors can enjoy an unforgettable sensory experience. In this wonderful theater of science, art and technology that receives thousands of people every week, we produced several “special events” for general public in the last two years. These events covered the most important advances in space sciences. For example, one of the most important events in 2015 was about the NASA New Horizons spacecraft arriving for the first time to Pluto. The world was expecting about that mission and in the PCLP we were enjoying that fantastic moment sharing a NASA Museum Alliance official event called “Pluto Encounter”, a meeting where we talked about Pluto, New Horizons mission, and the Solar System, and a live connection to the Mission Control at Johns Hopkins University waiting for the first signal at Pluto. We received around one thousand visitors and we made a second event after two days (Fig. 1 and 2). We had not only people at the PCLP that night but also a great impact at our Facebook account, showing a great peak in the activity.

We also took part of The International Observe the Moon Night, an international fest in 2014 and 2015. Thousands of people came to the PCLP to enjoy music, plastic art, dance, and of course moon observations with a great number of telescopes. With one of those instruments, we projected the moon in the outer dome of the PCLP. Each person had a moon map to recognize the main features of our satellite (Fig. 2).

We are living in a golden age in respect to space research. The great advance in science and technology is reflected in a direct way in space sciences. The first landing in a comet (ESA Rosetta spacecraft over 67P comet), the first fly-by of Pluto (NASA New Horizons spacecraft) or the discovery of the first Earth-like exoplanets are clear examples. In addition, astronomical events like a Super Moon 2015 eclipse become extraordinary phenomena due to a great media coverage. Scientific/technological advances plus a significant media dissemination around the world are the perfect cocktail for a planetarium to capture the interest not only of thousands of visitors by organizing special events, but also to a great number of people on a local, national and even international level producing an outreach program in social media. In this work we show different activities at La Plata Planetarium in 2014-2015 and the achieved results.
Other important and interesting activity was our participation in the Name Exoworlds Contest of the International Astronomical Union for naming 20 exoworlds. The name proposed by the PCLP was selected among the options given by our public and we obtained the second place among 16 finalists from Australia, Chile, China, Japan, Uruguay, USA and Argentina (see https://www.youtube.com/watch?v=FCBo9tNYHYI). Our goal of doing outreach activities about solar systems and exoplanets, was achieved (Fig. 2).

In September 2015 all the world could enjoy the Super Moon Red Eclipse. We offered a great night of observations with telescopes, info-brochures about the Super Moon phenomenon and eclipses. On the other side, we made special observations for makeing a nice video (see https://www.youtube.com/watch?v=GMQ_2BzDrMk).

3. Resume

These and other activities were performed at very low cost, reaching a great impact in the society, if we take into account the public attendance at the events and the press coverage. We think that a planetarium is a really special place not only to do science outreach activities but also great number of cultural activities.

Social Media as a tool for a continued experience [id: 166]

**Speaker:** Dr Alexandre Cherman (br), alexandre.cherman@gmail.com, Rio de Janeiro Planetarium

**Abstract:** Trying to give its audiences a continued experience, the Rio de Janeiro Planetarium has created, for its new fulldome show “An Adventure at the Planetarium” several Facebook venues. The most obvious one being a page for the show itself, where audiences can read the synopsis of the show, watch a low-res preview and more. But we also created Facebook profiles for the two characters of the show, a Mouse (not the animal, but the computer hardware) and a Monitor. Within the social media environment, people can interact both with the Institution and with the characters themselves, who also interact with each other on the show’s Facebook timeline.

**Paper:**

Who we are

The Rio de Janeiro Planetarium is the largest planetarium in Brazil and one of the largest in the Southern Hemisphere. Established in 1970, we currently have three domes (two digital, one classical) totaling 440 seats. In our domes we show live shows, as well as pre-rendered. On the digital domes we show foreign productions and our own original productions. Our annual attendance is 500,000 people, 70% of which are composed by school groups.

Our main facility, with its two domes. The third dome is located in another, remote, facility.

“An Adventure at the Planetarium”

On January 2016, we opened an brand new, original show called “An Adventure at the Planetarium”, which tells the story of a mouse and a monitor (the hardware) that take over the dome after being left unattended by the planetarian. They tak the audience in a journey through the Universe.

This show is aimed at school kids (ages 7 through 10), and the characters were created to reflect that demographics: they are very appealing to children, and they have a direct connection to the digital world.

The mouse and the monitor, original sketches.

Knowing that this generation is often connected, we offer an “out-of-the-dome” experience to our audience through social media.

The show and the characters have Facebook profiles where kids (and their parents) can ask questions and interact with the characters.

The cover page for the show, on Facebook.

On Facebook, we have a low-res version of the trailer for the show, some bits and pieces of the characters’ development, part of the storyboard, interviews with the authors (both the writer and the director) and more!

Final remarks

It is still too soon to evaluate the effectiveness of this initiative, but as time progresses, we will keep tabs on both the Facebook data and
the actual repercussion measured in the dome. Hopefully this decision will be proven good and we can establish, as a norm, that all our original shows will have a presence on social media.

Let’s group: ideas to strengthen the links between planetariums [id: 29]

Speaker: Simonetta Ercoli (it), Italian Planetarium Association (PlaniIt)

Abstract: In order to engage several Italian astronomical institutions (planetariums, but also astronomical observatories and research centers) in a common project, last year the Italian Planetarium Association (PlaniIt, www.planetari.org) proposed the project ‘Planitalia’. The idea was to create a solar system on the Italian peninsula. It was designed to be in scale and as big as possible, hence placing standard panels with information about all planets in different locations, even hundreds of kilometers away from each other, so as to respect the distance scale of the solar system. The project, launched on June 20th 2015 at the ‘Eyes on Saturn’ event, has been very successful, with over 30 participating agencies. We therefore now propose the creation of a ‘European’ Solar System in scale, which may on the one hand involve planetariums from different countries in a common project, and on the other raise awareness on the issue of distances in astronomy with a concrete example.

Paper: Last year, PlanIt (the Italian Planetarium Association) launched the “PlanItalia” project, in order to engage national astronomical realities (planetariums, but also astronomical observatories and research centers) in a mutual project. The idea was raised among the members of the Italian delegation at the IPS Conference 2010 in Alexandria. It consisted of the construction of a Solar system scale on the Italy, placing standard panels with information on the different planets in locations placed at the most suitable distance scales to the actual distances in the Solar system.

Initially the aim of the project was to create a network among Italian planetariums, but during its development the horizon of possibilities grew so great and so complex that other astronomical sites became involved.

The objectives of Planitalia are:
- to make the community aware of our solar system;
- raise awareness on the issue of distances in astronomy with a concrete example;
- stimulate scientific tourism;
- carry out a joint project;
- extend participation to European partners.

The Map of Planitalia was built according to the following criteria:
- respect proportion to actual distances between the planets;
- cover most of the Italian territory.

The panels were made in different sizes and materials, for their location in the different sites, but with a standard structure. Each appears in the overview map with orbits and indications of host sites and related frameworks to planets with easy-to-understand information for most of the people.

The first step was to construct the map, by searching for the most suitable location to place the Sun. It was necessary to position the inner planets in an area with many astronomical interest sites and the more suitable choice was to place the Sun in the city of Padua. The farthest site Catania, in Sicily, determined the scale of the orbits.

The second phase of the design of the panel.

The third phase was the sharing of the project and welcoming the participants. In order to involve the largest number of sites that chose to join the project, some places which do not coincide with the orbit, but are in its vicinity were involved. Also in this case, the deviation from the exact location was chosen with a range proportional to the amplitude of the orbit.

The fourth phase was the “Eyes on Saturn” launch event on June 20, 2015, the day that at 10 pm all the participants set up their planet panels at their sites during a dedicated event.

The fifth phase, the one still going on, is consolidating the group of participants around new initiatives held at the same time. For example, the organization of events for the observation of the Solar system objects and relevant phenomena associated with them, such as the transit of Mercury across the Sun.
The dome matters [id: 135]

Speaker: Nieves Gordon (es), Planetario de Pamplona

Text: The dome of a planetarium is a very special place and we should not live on the back of it. Instead, you can bring in lots of activities that were once exclusively held elsewhere, but can now occur under the dome thanks to new technologies and digital projection systems. Under the dome everything is special and emotional.

New proposals and new content can make the dome more multidisciplinary, for example live streaming from the ISS, Web Apps, Late News included in the sessions of School of Stars. We can also introduce smart phones apps for sky-gazing.

The planetarium dome can also be a good venue for charity galas, various musical events, special conferences, opening lectures, talks, workshops on new technologies and social networks for parents, teens, grandparents, young people...

Ergo, the dome matters, and you know it.

#AstroEverywhere – Engaging audiences inside and outside our museum walls [id: 18]

Speaker: Dr Michelle Larson (us), Adler Planetarium

Abstract: The Adler Planetarium celebrates #AstroEverywhere by inviting audiences to join us in exploring space both inside and outside our museum walls. We’ll discuss some of our recent efforts like planetarium dome lectures simulcast live across the country, ‘Scopes in the City, and a 300-mile Galaxy Ride, that demonstrate how we are leveraging our assets and expertise to meet people where they are, whether under our dome or in their neighborhoods. We will also discuss some key components to the success of these efforts, including partnerships, institutional culture, funding support, social media presence, and our new Space is Freaking Awesome marketing campaign.

Paper: The Adler Planetarium, the western hemispheres first planetarium, was founded in 1930 by Max Adler on the principle that, The popular conception of the Universe is too meager; the Planets and the stars are too far removed from general knowledge. Eighty-six years later, the Adler celebrates #AstroEverywhere by inviting audiences to #LookUp! and join us in exploring space both inside and outside our museum walls.

Inside the Adler, we are enjoying record attendance levels as we invite others to join us in exploring space. Visitors experience frontier science in our latest sky show, Planet Nine; enjoy festive, themed programming at celebrations like Mars-di-Gras and Adler After Dark; and engage their creative minds in our Community Design Lab. The Community Design Lab engages people of all ages in a daily challenge, turning them loose with common materials such as cardboard, marshmallows, duct tape, and glue guns. Participants meet each design challenge with creativity and original solutions, working collaboratively and often in mixed-age groups. Teachers offer feedback that this space gets kids thinking and suggests new ways of thinking.

Outside our walls, the Adler is delivering urban-neighborhood programs such as Scopes in the City, in partnership with the Chicago Public...
Library and the Chicago Park District. We are reaching rural areas through efforts like our 300-mile Galaxy Ride that in Fall 2015 visited communities between Chicago and St. Louis. And, most broadly, in partnership with planetaria across the United States and the world, our Kavli Full Dome Lecture Series connects people with recent scientific discoveries through live, broadcast lectures with custom, full dome visuals.

With a mission to inspire exploration and understanding of the Universe, the Adler Planetarium is leveraging our assets and expertise to meet people where they are, whether under our dome or in their own neighborhood. As our marketing campaign proclaims, Space is Freaking Awesome, and we couldn’t agree more!

Links:
http://www.adlerplanetarium.org/
http://www.adlerplanetarium.org/space-is-freaking-awesome/

Introducing the REAL outdoor Planetarium [id: 150]

Speaker: Julie Ormonde (ie), Kerry International Dark-Sky Reserve

Abstract: Kerry has no Planetarium. Apart from a small planetarium in a Cork school the Republic of Ireland has no in-situ planetarium at all. But in the KerryIDSR we have four ancient stone forts which are used by the local astronomy group and visiting astronomers to see the sky as it should be seen on clear Moonless nights. No fizzaz, no special effects, just lots and lots of REAL stars. Should the IPS be promoting these kind of natural sky-viewing places more? Not as a rival to the astonishing planetarium technology but to compliment and to underline the fact that no technology can replace REAL stars, and we need to promote dark skies more...

Life Laser Star Party: From Star Pointer to Constellations Plotter. [id: 65]

Speaker: Alexander Adli (ae), Sharjah Center for Astronomy & Space Sciences

Abstract: The general public and amateur stargazers always dream of seeing the constellations and their mythology in the real sky, just like the way they see them on the screen of a computer, a smart phone or even on a planetarium dome. For the general public and beginners, the mythology of the constellations is very much easier to understand than the normal pattern of just scattered stars on the sky. After the difficulties we had experienced in using normal hand torch lights to point to the stars in our past general public star parties, we astronomers now just use 5mW to 50mW green laser pointers in order to make the constellations and the stars more readily at hand. In this presentation I propose the idea of a practical machine, using which a system of laser beams can draw the stick lines and even the mythology of the constellations directly onto the real night sky. This system will have to be synchronized with the real stars at the time we point to a specific constellation. What type of machines can make such amazing figures in the sky? And will they be practically feasible to use in public and what benefits can we obtain from such a laser system?

Astronomical urban revolution [id: 34]

Speaker: Karol Wójcicki (pl), Copernicus Science Centre

Text: A planetarium is absolutely unusual place, but sometimes we need to go beyond it, developing a custom approach to popularizing the wonderful science of astronomy. This, indeed, is my job at the Heavens of Copernicus planetarium.

Our experience has taught us that a little bit of effort can manage to attract 12,000 people to come together in the heart of the city to observe a shower of shooting stars. That the right technology can get the online stream of a lunar eclipse to approx. 100,000 people in the middle of the night. That that the notion of turning off a few house lights has enormous power to influence people.

In this presentation, I would like to talk about how our planetarium’s popularization of astronomy has grown to a mass scale, involving some of the largest and most important social and cultural events in Warsaw.
10. PLANETARIUM EXHIBITIONS

21 JUNE 18:15-19:15 / URANUS

Augmented reality in the planetarium [id: 44]

Speaker: Dr Tomasz Banyś (pl), EC1 Planetarium

Text: Augmented reality is a brand new tool offering continually growing possibilities. It being used in a multitude of new applications, especially in entertainment. It is only a matter of creativity and imagination to come up with ways of using this technology in science education. We will present a few ideas of our own and point you in a new exciting direction, whether you are an educator, science communicator, show producer or vendor. We can present applications that may be useful for you.

AUGMENTED REALITY IN THE PLANETARIUM: THE STORY OF A PILOT IMPLEMENTATION

Introduction

Augmented reality (typically abbreviated ‘AR’) can be defined in many ways, but from a technical point of view we can think of it as a supplementation of standard human sensory input with digital content through the same (sensory) channel. Examples include augmentation of visual input (using specialised technology such as Google Glass and other AR standalone visors, or alternatively, typical smartphone/tablet devices, like Layar). Augmented audio (such as live language translation/interpretation services) is being also developed. Other channels are harder to work with, but that does not mean it is impossible; in fact, one could argue that in order to be as useful as possible, a blended approach, making use of as many simultaneous delivery channels as makes sense in a given context, is recommended (or perhaps even necessary). While theoretically feasible in the future, the majority of people (users, content developers, technology developers) are currently focused on certain sensory channels (augmented vision). Of course, developer attention can be shown to be correlated with popular interest.

While popular interest remains moderate, AR seems to have potential in education (as suggested by Cooperstock[1], Shelton & Hedley[2] and subsequently, many others). Therefore, science and technology centres and planetaria have both a chance and a duty to use AR to disseminate knowledge. But, being focused on their mission, typically such institutions do not have the resources (especially time) to be developing AR tools -- specifically, software. Such was also the situation in our planetarium, which in early 2015 had only two full-time employees, and a single part-time one.

Additionally, use of existing tools where possible would allow us to use AR within a realistic timeframe.

Methods

Bearing our situation in mind, we have carried out a quick study of popular AR tools that we believed could be used to quickly develop AR content. This was because a colleague from a different department has pointed OUT to us that even before an exhibition would be completed around our dome, we could try to use AR with promotional materials, such as conference posters or even a flyer, which would be a good test of the capability. Since the ECSITE conference was coming up quickly, we quickly decided to prepare a simple pilot implementation of AR.

We considered the following tools:

- Augment (www.augment.com)
- Aurasma (www.aurasma.com)
- Blippar/Layar (www.layar.com)
- Vuforia (www.vuforia.com)
- Wikitude (www.wikitude.com)

Note that the situation is dynamic and most likely new software will appear. Having limited time at the moment for making the decision as to which one should we use, we have settled for using Aurasma, with which our colleague has had previous experience, and could therefore be consulted. This has allowed our single graphics designer, who was working part-time at the moment, to focus on the visual aspect.

Results

The result is shown below:

Fig. 1. The front of our first AR flyer.

The new EC-1 Science and Technology Center is located in the center of Poland, in the city of Łódź. Scenery of this place is the historical power plant, more than 120 years old. In this industrial heritage site, modern, interactive, and exceptional exposition will fit in perfectly with authentic, original machinery and round out whole story.

We invite visitors in the second half of 2016 !!!
Without the AR, the flyer looks aesthetically pleasing, but is just a flyer, and unless someone has an inclination to study it in depth, it will capture his attention for only several seconds. However, should one turn it over, simple (3-step) instructions can be found, demonstrating how the additional (AR) content can be activated and viewed.

Visitor response was positive, although limited to users carrying their smartphones during tours and to ECSITE attendees. While we did not have the resources to carry out a proper survey, we have tried to gather opinions. We have met with remarks that our AR added some depth, or dimension, to standard features of the objects it was supplementing. Some people have also stated that they were curious about the content and the technology itself once they learned about it from our instructions, and that alone led them to check out our AR content. Generally positive feedback received during the pilot deployment confirmed our belief that experimenting with AR enhancement, if thought through, is not lost time.

Discussion

These two situations have also demonstrated that developing AR content was possible even with quite modest resources; in our case, effectively 1 digital camera, 1 laptop with a graphics suite, 1 graphics designer (working part-time at that time) and roughly 2 weeks. In the process, we also saved paper and ink (which would have been spent on physical exhibits), time and significant team effort.

As we are currently in the process of planning our exhibition around the planetarium dome, we intend to continue with our use of AR, placing triggers in some select exhibits (including but not limited to posters), or possibly introducing some purely-virtual content.

In conclusion, producing visual AR can be fairly easy and there are numerous solutions available, both commercially and cost-free. AR has potential mostly as a very cost-effective supplementation of traditional content delivery channels, allowing for extension of outreach beyond the physical world (although it could be used for prototyping exhibitions as well). This in effect allows the staff to focus on developing more content. As such, it seems a useful addition to exhibitions at science centres and planetaria.

Footnotes:


EVA simulator DIY: gamification and virtual reality for STEM [id: 240]

Speaker: Marco Brusa (it), Infini.to – Planetario di Torino
Abstract: In the last years, the quality of virtual reality environments has reached surprisingly high levels and the development of new head mounted display devices allows users to be fully integrated inside the digital world. On the other hand, even if the tools are getting more and more powerful, the content creation is now possible for a larger and not highly specialized audience. In this panorama we have decided to develop an EVA simulator, allowing people to experience the marvel of being in space outside the International Space Station.

The implementation of real physical laws gives us the opportunity to use the sim not only as a display for the ISS itself but also to communicate celestial mechanics and space science in general in an engaging and informal way.

Paper: Space exploration is an appealing and fascinating topic and also a good tool to communicate space and astronomy in general. Many planetaria and science center use it to engage the public, that’s why it is maybe a usefull but probably not so original tool. However, it is possible to use it in many different ways, some of them newer and more challenging such as, for instance, the creation of a space exploration related videogame.

Videogames are vastly diffuse and they can efficiently and strongly engage players. On the other hand, they require a big amount of dedicated time, usually not available under the dome or inside a museum. The solution could be the creation of a simulator. Simulators don’t need a gameplay, allowing short play sessions, and they add a lot of interesting features. A simulator must replicate reality, with real physics and real challenges. In order to play it, players must understand the physics involved, learning by playing and having fun.

The subject of the simulator must be chosen carefully: a first person extravehicular activity (EVA) simulator can be a good start. The first person formula is vastly diffused in the player community and extravehicular activities are some of the most exciting moment of a manned space mission.

Back in the ’80s, NASA developed an incredible and futuristic vehicle: the Manned Maneuvering Unit (MMU). The MMU is a completely wireless and autonomous vehicle, featuring more than 6 hours of operational time and 6 degrees of freedom (3 rotational and 3 translational). With no friction and in constant free-fall condition, with no reference frame and fighting against the inertia of the equipment, a ride with the MMU is a challenging task.

In order to provide a real and immersive experience, custom input devices are needed and the implementation of virtual reality head set is the next step in this direction. The capability to develop the simulator and the devices autonomously in a DIY style is a big plus, it gives the possibility to constantly upgrade and modify the scenario taking into account players feedback and new incoming ideas.

Navigating Across the Solar System [id: 227]

Speaker: Dr Andrew Johnston (us), Adler Planetarium

Abstract: New planetarium and exhibition programs have explored the complex story of navigation on Earth and in space. Success for Earth-orbiting satellites and planetary missions has required accurate navigation to guide spacecraft to their destinations. Early Apollo missions to the Moon experimented with celestial techniques similar to those used centuries ago for crossing the oceans. More recent space navigation has combined star sightings with radio transmissions and precise time keeping to land on other worlds with pinpoint accuracy. Today orbiting satellites provide essential global services, allowing people everywhere on Earth to navigate. This presentation will describe how these stories have been told in the Time and Navigation exhibition at the National Air and Space Museum, and how new visualizations have been presented to illustrate trajectories and space navigation in the Einstein Planetarium.

Exhibition in planetarium [id: 253]

Speaker: Michał Piądłowski (pl), Copernicus Science Centre

Abstract: The time spent waiting for a planetarium show to start does not have to be time wasted. An exhibition near the entrance to the projection room can help visitors to get into the atmosphere of curiosity about the world and science. Engaging with a planetarium’s exhibits may also be a great way for visitors to further supplement the astronomical knowledge communicated during shows under the dome. I would like to talk about how to develop an exhibition for display in a planetarium, based on the example of the “Look, There’s the Earth!” exhibition that was created last year by the Heavens of Copernicus planetarium.
11. PROJECTION TECHNOLOGY REVIEW
21 JUNE 09:00-10:00 / PROXIMA

Fusion – Starfield projection technology [id: 41]

Speaker: Dr Alexander Adli (jp), Ohira Tech Ltd.

Abstract: With the Multimillion stars projection concept using the opto-mechanical planetarium projectors that became popular after Megastar’s debut in 1998, hybrid solutions have become a standard trend in the planetarium industry. However, the problem of opto-mechanically projected stars overlapping digital content has become an essential one. The Fusion concept came to answer this problem by individually controlling each bright star (optically projected), and each faint star (digitally projected) over digital content. The combination of optically and digitally projected stars in one starfield is what is called Fusion. Ohira Tech invented and implemented this technology in 2012. In this presentation, we will focus on the technical problems that we faced, what solutions were proposed, as well as reactions from the planetarium community and public.

Paper: With the introduction of hybrid solutions in planetariums, digital systems become responsible for projection all imageries, while opto-mechanical star projectors focused on star projection.

High resolution digital systems would project star fields in digital only systems. However, the brighter the star is, the less realistically it is digitally projected. This is due to technological reasons of the very core of digital projection: while digital projection diffuses light across the entire surface, opto-mechanical projectors are designed to specifically project pin spot lights (stars). Star projection produces sharp shiny points against a deep black background.

The Fusion concept meant to use both advantages of digital and opto-mechanical projection to recreate a realistic and flexible projection of night sky.

The Fusion was invented and first implemented by Ohira Tech in Japan in 2012.

The presentation describes the fusion concept, and the obstacles faced to integrate system parts, and to realistically project stars with both opto-mechanical and digital projectors. It describes special star projecting technologies and algorithms to avoid deformation, implement multiple blending masks, achieve continuous perceptual brightness of the stars regardless to their projection origin.

The Fusion enables full control of the star filed, mask stars, making it, for the first time, possible to use high quality realistic starfield into a full dome show.

Projection technology for planetariums, What’s up? [id: 157]

Speaker: Benjamin Cabut (fr), RSA COSMOS

Abstract: In the past 10 years, projection technology has gone through a significant evolution: mono-DLP, tri-DLP, LCOS, SXRD, Active 3D, INFITEC 3D, UHP Lamps, Xenon Lamps, Laser Phosphore, Laser 6P etc. Let’s take a closer look at the different technologies available today for planetariums and examine in detail how it works and what the benefits and constraints are for the dome and planetarium environment.

Connecting with Your Audience through Hybrid Solutions [id: 8]

Speaker: Dayna Thompson (us), Charles W. Brown Planetarium, Ball State University, 2000 W. Riverside Ave., CP101, Muncie, Indiana USA, dlthompson3@bsu.edu

Abstract: The Charles W. Brown Planetarium’s HYBRID system offers full synchronization and real-time manual control. We depend on both our digital and our analog projectors as educational tools. For example, we have used our new opto-mechanical projector to display a realistic night sky for the year 1953 BCE to see the gathering of the 5 naked-eye planets. From there, the linked fulldome system seamlessly launches the audience into space where they can see the conjunction from above the plane of the solar system. We have taken this beyond real-time astronomy to create two hybrid planetarium productions, revolutionizing fulldome show productions. The abilities of our HYBRID system allow us to make a connection with our audiences, creating lasting memories. Using the GOTO, RSA Cosmos HYBRID system set-up...
at IPS 2016, we will demonstrate how we put the best of both worlds to use.

Introduction
For many planetarium presenters, if they have stars, they have a program. A planetarium show that only uses stars can be a meaningful and inspiring experience for guests. The original planetarium at Ball State University had programs that highlighted our Spitz ASP star field. Now, our new Charles W. Brown Planetarium utilizes HYBRID technology that allows us to expand our educational content. Equipped with an optical mechanical GOTO Chronos II star projector and an RSA Cosmos digital system, we are able to present live programs and cover a myriad of concepts and topics.

The term hybrid can describe planetariums that have both an optical mechanical projector and a fulldome digital system. However, this doesn’t necessarily mean the two are synchronized or even operated under a single control, like a hybrid vehicle. The Brown Planetarium is equipped with an integrated HYBRID system. This means that the analog and digital components are fully synchronized and there is real-time manual control. We have a physical console and a computer that control both the optical mechanical and fulldome projectors. This set-up makes it possible to create the content discussed this paper.

Connecting
Technology aside, our common goal as presenters is to connect with our audience. Creating memorable programs and building an ongoing relationship with your community takes attention to detail and knowing what technology is used. To do this we stay current with astronomy research and discoveries. We include up-to-date images released from Hubble, NASA and other space agencies. We attend conferences to keep inspired, rejuvenated, and to stay passionate. Through this, we don’t just change the words and images in our presentations; we also learn and develop new ways of communicating that content through up-to-date visuals.

Much of the astronomy concepts we discuss are exceptionally visual in nature and require high-quality computer graphics and animations. When the visuals look dated, the science concepts can look dated as well. This can lead to an apathetic audience and can hurt your credibility as a presenter. Our fulldome system comes with a universe of such models which help to capture an audience’s attention and create a memorable experience for them.

The work to create realistic visuals also applies to our star field. Although our digital star field is exceptional, it lacks the dynamic range of our analog projector. Audience members, especially those in our public shows, are captivated by the analog stars because of the strong resemblance to the real sky. In fact, guests often say they cannot tell the difference between the simulated night sky and the real night sky.

1953 BCE Conjunction
Our audience is always amazed to learn we can recreate the night sky of any date and any location on Earth. In fact, both systems can jump 10,000 years into the future and 10,000 years into the past in just seconds. The February 1953 BCE conjunction of the 5 naked-eye planets is a perfect way to use this tool. This is the narrowest conjunction between all 5 naked-eye planets, with a spread of 3 degrees. However, the separation of 4 of the planets (sans Jupiter) is actually less than 1 degree! The next predicted conjunction in September 2040 CE will be a larger spread of 9.3 degrees. This makes the 1953 BCE grouping of planets the closest conjunction over the course of thousands of years (Meis & Meeus 1994).

When demonstrating the 1953 BCE conjunction, we project optical mechanical stars and planets, and use the GOTO console to set the date. Seconds later the audience is looking at the conjunction, just days before the minimum separation of the planets. This view is enhanced by the realistic stars and planets. We can put up labels with the RSA system to identify each planet. Using the console, we can then go forward in time with annual motion until the planets are at their minimum separation. A button on the computer (that could also be added to the GOTO console) contains a script that converts the analog stars and planets to digital ones. With this change, we can then launch from Earth’s surface to see a heliocentric view of this event. While traveling from Earth, the audience looks around them, and takes in the new perspective. With the presenters help, one can see the planets are in the same line of sight from an observer’s perspective on Earth. Although they appear close together in the sky on Earth, they are in fact very far away from each other in space. We have had audience members tell us that they understand the concept of conjunctions better after this demonstration, and viewers often request to see it again when they come to a different presentation.

Content Development
Show creation at Ball State University is nothing new. Before the construction of the new 16 meter Brown Planetarium, our 9 meter dome was a resource for the community for over 45 years. Many programs produced for the first Ball State planetarium were created in-house. Show production has continued and evolved with the addition of the new facility. The 9 meter dome now serves as a production studio to create future fulldome programs. Since opening the Brown Planetarium in October 2014, we have created four full-length planetarium productions, each with their own original soundtracks. Two of these programs, “Saturn & Beyond” and “Tombaugh’s Planet,” are HYBRID shows. This was made possible because the RSA scripts not only control the digital portion of our system, but also the analog. These programs can be played on our system in real-time, or rendered out to share with other HYBRID systems. Playback is simple; programs are started with a single button. The digital and analog projectors are synced during the entire program. Digital planet labels can even keep up with the speedy analog planets when showing annual motion.

University Classes
The Brown Planetarium is located on the campus of Ball State University and is a part of the Department of Physics and Astronomy. In addition to our public, school, and community group programs the planetarium serves as a resource for university classes. Most astronomy students visit the planetarium to learn about the celestial sphere, as the digital coordinate lines help explain these 3D concepts. Beyond this, we use the GOTO stars for our observational astronomy classes. There are multiple Messier objects that when viewed through binoculars, appear as they would in the real sky. Furthermore, small telescopes can be brought into the dome and basics in telescope operation can be taught. This is exceptionally helpful on days that the weather is too poor to open Ball State’s roof-top observatory.

Conclusion
From short demonstrations to full-length programs, we are able to use our HYBRID system to connect with our guests. The fact that each system is integrated makes it easy to give live presentations in real-time. This made it possible to create my first full-length, fulldome production in just 3 months. As a planetarium that serves school groups, the
community, and university students and professors, these capabilities are a vital part of our planetarium.

References

12. FISHEYE PHOTOGRAPHY

22 JUNE 17:15-18:15 / SUN

An innovative way to do 4k fulldome filming: Ultrafast Daytime TimeLapse [id: 57] & [id: 50]

Speaker: Theofanis Matsopoulos (de), ESO

Abstract: With the de facto agreement on the 4k/30 fps fulldome standard and a proliferation of fulldome planetariums, there is an increasing demand for 4k fulldome footage for fulldome shows including footage captured as 4k real-time video. Unfortunately, there is not a single affordable camera on the market that can deliver 4kx4k circular fisheye video. The most common alternative solutions involve using 360 degree rigs with multiple cameras; however, they suffer from various technical drawbacks as well as significant up-front costs for the cameras. In this presentation, we discuss an innovative technique for the creation of smooth and realistic 4k fulldome video, using a single DSLR camera which can shoot 4kx4k stills and 4k video.

FullDome timelapse photography as a powerfull Fish-eye video filming technique [id: 245]

Speaker: Maciej Mucha (pl), Copernicus Science Centre

Abstract: Very often the standard filming techniques are still not applicable for fulldome, or simply hard and expensive to use. In such cases timelapse movie is a natural choice for planetarium filmmakers. This type of photography works well under the dome. In a relatively easy way, we can create a very spectacular content for our show. What is behind a success of a good fulldome fish-eye timelapse clip? Is it the right choice of topic? Or maybe a suitable frame is most important? Or rather, is post production the key component? What is the difference between a flat screen timelapse and a fulldome one? During this presentation I will demonstrate a few ways to create a good timelapse movie.

The fulldome camera in your pocket [id: 215]

Speaker: Mike Smail (us), Adler Planetarium

Abstract: Did you know that there’s a fulldome camera in your pocket? Today everyone can have their own planetarium in their hands. The modern smartphone, coupled with free software, makes for a powerful 360° capture tool that allows for easy transition of images from your phone to your dome, or VR device. We’ll go through the basics of image capture, and show some examples of how you can add this tool to your arsenal.
13. BENEFITS AND THREATS OF VAST
DEVELOPMENT OF VR/AR TECHNOLOGIES

22 JUNE 18:30-19:30 / PROXIMA

THE ULTIMATE DOME. Fulldome Interactive possibilities
[id: 86]

Speaker: Chris Lawes [us], Fulldome.pro

Abstract: The planetarium dome is a brand new platform for augmented and Virtual Reality integration. During my presentation I will present new interactive tools based on the UNREAL and UNITY game engines. What is the next step in immersive media? Public experience in further integration of the fulldome platform with AR/VR content platforms, both as a viewing platform and a production tool will also be discussed. I will present the next generation functionality that will keep the dome platform relevant and engaging for audiences in AR/VR enabled environments.

Challenges of the VR Planetarium Show [id: 151]

Speaker: Patrick McPike [us], Adler Planetarium

Abstract: The planetarium shows of the future may not be under a dome, but could be in virtual reality. There are many ways that this new technology can help and hurt the planetarium. By planning now for the future we can learn how to embrace the positive possibilities and minimize the negative impacts of VR. The challenges lie not only in content creation but in building a VR infrastructure that supports the planetarium community and does not dilute our individual efforts. By collaborating with planetarium software providers and content creators, we as an industry have the potential to expand the planetarium beyond our walls and far into the future.

The future of immersive learning: VR vs Dome [id: 213]

Speaker: Paul Mowbray [uk], NSC Creative

Abstract: The VR revolution is upon us and everyone now can have access to their own personal high-quality planetarium at home. What does this mean to the traditional bricks-and-mortar planetarium? What are the teaching opportunities? What are the business opportunities? What are the strengths and weaknesses of each format? Should we run in fear or embrace and evolve? A lively panel discussion on this hot topic.

Large Group Interactive Full-Dome Simulation Games
[id: 111]

Speaker: Dr Carolyn Sumners [us], Houston Museum of Natural Science

Abstract: We have created three full-dome adventures in Unity 3D for groups of 30 in a single projector dome. Games engage the whole audience with one participant using the game controller. In Ghosts of Tikal, we explore this Classic Maya city, looking for treasure, wildlife, and ghosts. The lead walker changes after each location. In Monster Trucks on the Moon, each student drives a truck around a self-sufficient colony on the rim of Shackleton Crater with solar farms, telescopes, ice miners, and treacherous terrain in 1/6th g. In Mars Plane, students use control surfaces to fly a powered glider into Ophir Chasma, looking for geologic features, weather stations, and landing strips. Games use digital elevation maps to create accurate destinations with authentic renderings of structures. These interactive full-dome experiences engage the entire audience, especially when tumbling off a crater wall, soaring into a canyon, or jumping off a pyramid.
14. FISHEYE VIDEO FILMING TECHNIQUES

21 JUNE 17:00-18:00 / SIRIUS

A new approach to shooting 360 degrees [id: 220]

Speaker: Aaron Bradbury (uk), NSC Creative

Abstract: Using Tomorrow Town 2 as a case study, we'll see how a RED Dragon camera, non-fisheye wide angle lenses, motion control and greenscreen compositing can be used to achieve high fidelity live capture for fulldome and VR formats. This technical presentation will reveal CG and live action integration techniques using 3ds Max and Nuke. Presented by Aaron Bradbury, CG Supervisor at NSC Creative

Fulldome filmmaking in the deep ocean [id: 92]

Speaker: Dr Tom Kwasnitschka (de), GEOMAR Helmholtz Centre for Ocean Research Kiel

Abstract: A recent expedition to explore the hydrothermal vents (black smokers) of the Northeastern Lau Basin (Tonga) has, for the first time, gathered footage explicitly shot for the dome, aimed at a 4k projection standard. A custom developed fulldome camera was submerged over 1200 m on a deep diving robot, but the system can handle up to 6000 m depth. The results will be compiled into a fulldome documentary which is part of a larger immersive media project including 3D photogrammetric scans of the vents and immersive telepresence technology using head mounted displays. This is probably the most demanding fulldome live action application to date in terms of remote control, confinement of space regarding the camera rig, optical challenges as well as demands on the imaging device in terms of sensitivity and dynamic range.

Behind the Scenes: Fulldome Show Production at the Charles Hayden Planetarium [id: 73]

Speaker: Dani LeBlanc (us), Charles Hayden Planetarium, Museum of Science, Boston

Abstract: Take a peek behind the scenes of some of the recent works coming from the Charles Hayden Planetarium in Boston. This talk will explore the team's use of a 360-video rig for our 2014/2015 release “From Dream to Discovery” as well as other techniques and strategies employed in creating our fulldome productions.

15. FROM SURROUND SOUND TO SPATIAL 3D-SOUND: CHALLENGES AND BENEFITS OF IMMERSIVE SOUND IN PLANETARIA

21 JUNE 10:30-11:30 / SIRIUS

3D Audio in Show Production [id: 195]

Speaker: Ralph Heinsohn (de), Ralph Heinsohn Artworks

Abstract: 3D Audio is a great enhancement of immersive storytelling and entertainment. 3D Audio is not only an effect – it is an essential enhancement of creating immersion. This presentation gives insight into specific aspects of story development and production of fulldome films with 3D Audio. Specific challenges from the show producers perspective will be illustrated by excerpts of two fulldome short movies: The children's movie ‘Frida and the Forest’ and the fulldome art clip 'The Doors of Perception'.

Reflections from Montreal [id: 264]

Speaker: Charlie Morrow (us), Charles Morrow Productions LLC

Abstract: At La Sat in Montreal, the IPS board and Charlie Morrow started a discussion of immersive sound in nature and technology. This presentation is part of the IPS-commissioned Immersivity 101 on the IPS website and in workshops, with two goals: to inform decision makers about benefits and options, and to initiate a hands-on course with credits for the makers of immersive experiences. Morrow, a composer and sound artist, developed a patent-pending software for architectural and virtual reality platforms. As a content maker and producer, he pioneers immersive sound projects in planetarium, attraction, museum, hospital, workplace, theme-park and virtual reality. Charles Morrow Productions U.S. and Finnish companies have a global network.

Sound objects in the dome [id: 42]

Speaker: Rene Rodigast (de), Fraunhofer IDMT

Text: A planetarium show or fulldome movie is more than just imagery. Sound is also a key component of any magnificent spectacle under the dome, helping to make it an unforgettable experience. Compared to conventional surround sound, the new 3D audio formats offer the producer and artist many more options in this regard.

Working with sound objects makes it possible to situate sound anywhere in the whole 3D environment. We will discuss how to work with sound objects under the dome, and show examples from a range of German planetariums.
Why Astronomy Visualisation Metadata is a Cool Concept for Planetariums [id: 286]

Speaker: Lars Lindberg Christensen (de), ESO

Abstract: Presenting an image to planetarium audiences involves more than just displaying the image itself. There is additional information associated with the image: position and orientation on the sky, wavelength, description of the image content, the type of the object, credit and licence information. The Astronomical Visualisation Metadata Standard (AVM) is a metadata format to store such information in the header of an image file. In this way, the meta information is shared alongside the image file. This enables advanced applications in the planetarium field, such as automated placement of images at the proper position on the dome, or display of descriptive text to the planetarium lecturer through software such as Digistar, Digital Sky, OpenWWT, and Powerdome. The AVM standard is applied to all images released by ESO, Hubble, Spitzer, and many other observatories, and thus can streamline the use of content in planetariums and other venues.

Using WorldWide Telescope [id: 5]

Speaker: Dr Doug Roberts (us), Dept. of Physics & Astronomy

Abstract: In this workshop, participants will learn how to use WorldWide Telescope (WWT) in their planetarium domes. This includes initial setup and also adding it to existing systems. The workshop will also go over how to use WWT for the production of real-time presentation, as well as rendering frames for video playback (or to create specific layers for compositing). All these experiences can be authored on a standard Windows PC. No special hardware is required but the system can use wireless Xbox controllers as well as commodity MIDI controllers, which will be on-hand for demonstration.

Stellarium360: Shaders (r)evolution [id: 153]

Speaker: Lionel Ruiz (fr), LSS Open Project

Abstract: Stellarium 360 has evolved from its roots and offers many new functionalities. Smoothed rendered visuals, code optimization to draw more objects on the dome, analemma on any planets, drawing of the courses of the Sun, smoothed transition when changing lengthwaves, different atmosphere depending on the planet surface we are on, scripting language permitting loops – jumps – variables – tests – random, integrate 3D models, zooming into more than 400 deepsky objects, the Sun and certain planets with evolutive texture and atmosphere glow, the ability to increase the size of planets smoothly, navigating around the solar system with joypads, ...

Text: Stellarium 360 is an Open Source software package for digital planetariums operating in fish-eye mode up to 4K in resolution. It allows domemasters to be saved at 30fps in any resolution.

It is a fork of Nightshade Legacy (discontinued), which was a fork of Stellarium software from the 0.8.X version. We have corrected most of the inherited bugs and added a lot of new features. It can be controlled with a mouse, a keyboard, a tablet or a joypad.

The new features include the following (listed in no particular order):

- Sun trace during the day or the year from any place in the solar system
- advanced script functions
- antialiasing on any object
- shooting stars only with atmosphere
- date sunrise sunset and midday in scripts
- position action save and load
- the ability to force a dome tilt and save it
- at high altitude, atmosphere fades automatically
- the ability to change altitude/lat/ion smoothly with keyboard
- launching of more than 48 scripts/videos by key action
- only one stellarium360 session at a time
- saving domemasters in JPEG format
- skylines attached to Earth (Greenwich, zodiac, precession, analemman, analemman line, Aries) do not draw on other planets
- planet axis and planet equator visible from space
- draw orbits of planets and/or satellites with toggle
- the ability to change color of planet names/orbits/trail at will
- text command to draw text with different color and position
- Milky Way appear/disappear smoothly
- stars appear/disappear smoothly
- fog available on every panorama
- information indicating the type of object
- the ability to duplicate hour and also lon/lat/alt
- new deepsky objects features (colour pictograms and categories implemented)
- 3D Model integration for satellites and complex objects

In the near future, stellarium360 will become SpaceCrafter. New features will be added and all calculations will be made through shaders that will facilitate better and more complex renderings.

Planned features:

- new script functions like loops, variables, random, jumps, tests, ...
- atmospheres around planets and Sun, planes, terrain engine, galaxy, star flythroughs,...
- star trails
- new skycultures
- video complete integration (fulldome, rectangular, VR360)

More information available at: http://www.lss-planetariums.info
Open Source Planetarium Software [id: 191]

**Speaker:** Dr Mark SubbaRao (us), Adler Planetarium

**Abstract:** This session will examine the advantages, challenges and opportunities of open source planetarium software development. We will give an overview of three significant open source efforts: Nightshade, OpenSpace and WorldWide Telescope, and discuss what is needed to build an active community of both developers and users.

Four-Dimensional Digital Universe Viewer ‘Mitaka’ [id: 114]

**Speaker:** Dr Tsunehiko Kato (jp), National Astronomical Observatory of Japan

**Abstract:** ‘Mitaka’ is software for visualizing the known Universe with up-to-date observational data and theoretical models, developed by the Four-Dimensional Digital Universe (4D2U) project of the National Astronomical Observatory of Japan (NAOJ). Mitaka users can seamlessly navigate through space, from the Earth to the edges of the known Universe. Mitaka has been used for live shows in the 4D2U Dome Theater in NAOJ’s Mitaka headquarters with stereoscopic visualizations. It can also run on a single Windows PC. We release Mitaka as freeware and anyone can download it from the 4D2U website: http://4d2u.nao.ac.jp/html/program/mitaka/index_E.html; In this talk, we will talk about the features of Mitaka and its development.

**Text:** The observational data used in Mitaka include, for example, the topography of planets and moons (Earth, the Moon, and Mars), positional data for the planets, moons, asteroids, stars, globular clusters and galaxies, and surface images of the planets and moons (including the latest images of Pluto and Charon obtained by New Horizons spacecraft last year).

The theoretical models used are:

- a Milky Way Galaxy model constructed based on theoretical models of star distribution and the pattern of the Galactic arms, rendered by a real-time volume rendering method based on the radiative transfer equation, taking account of the gravitational lens effect around the super-massive black hole at the Galactic Center (Sagittarius A*)
- a model of the distribution of stars in globular clusters;
- a model of Earth’s atmosphere,
- the trajectories and 3D models of some spacecraft (including Voyager I/II, Pioneer 10/11, New Horizons, Cassini, and Hayabusa 2).

Mitaka supports many features: e.g. it can play movies, handle multiple languages (including English, Japanese, French and Spanish), and provide domemaster rendering for domes with fisheye projection and Virtual Reality (VR) mode for Oculus Rift.

A beta-version smartphone VR application of Mitaka for Google Cardboard is also under development.

Mitaka has been widely used for a variety of purposes since its first beta release in 2005, such as live shows and exhibitions at planetariums and museums, educational use in schools, TV programs, books, science café events, personal use, and so on. In particular, Mitaka is being used in some stereoscopic dome theaters, including the 4D2U Dome Theater and the Kurobe Yoshida Science Museum, in live shows for the public.

Mitaka is distributed at the Mitaka Website (http://4d2u.nao.ac.jp/html/program/mitaka/index_E.html) as freeware for Windows PC; anyone can download and use it for personal use or educational use.

For uses in planetariums or museums, please contact the 4D2U Project (http://4d2u.nao.ac.jp/english/index.html).
17. AFDI – RELEASE OF FIRST PLANETARIUM INDUSTRY STANDARD & FUTURE
22 JUNE, 9:00–10:00 / SIRIUS

Convenor: Benjamin Cabut (FR) – RSA COSMOS
Speaker: Per Hemmingsson (SE) – Sciss AB, Steve Savage (US) – Sky-Skan, Inc., Michael Daut (US) – Evans & Sutherland

Two years ago, the “Association of Full Dome Innovators” was formed. The core group was enlarged to include all other vendors and a first set of tasks was defined. After several months of efforts, two standards emerged: one defining a “DML” format, as an XML file that can be loaded to all full-dome show hard drives, describing the organization and the different components and parameters of a show, a second defining a “2K” video format that all planetarium software should support, allowing a full-dome preview to be played without the need for slicing and encoding the content.

The session will present these two standards and the different tools created for their support.

The session will then focus on working towards the next steps in standardization, by discussing ideas and the organization of the group. We expect to continue and finalize several standardization efforts that have been started. The involvement of vendors in this process is one of the keys to assuring that these standards will become well established in our industry.

18. PLANETARIUM DESIGN, UPGRADE/ RENOVATION – DESIGN, CONSTRUCTION, FINANCIAL AND OPERATIONS FRAMEWORK (SESSION ORGANIZED BY IPS DESIGN AND OPERATIONS COMMITTEE)
23 JUNE, 14:00–15:30 / JUPITER

Convenor: Bill Chomik (CA) – Kasian, Inc.
Speaker: Bill Chomik (CA) – Kasian, Inc., Manos Kitsonas (GR), Tim Barry (US)

Building on the IPS publication So You Want to Build a Planetarium, this panel session will set out a framework for the design, construction, financial and operational elements that should be considered when developing a new planetarium facility or renovating an existing one. Audience feedback will be used to assist the IPS Design and Operations Committee with preparing an updated version of the original 1994 publication.
**19. PLANETARIUM DESIGN AND BUILDING**

21 JUNE, 18:15–19:15 / VENUS

**Sharjah Center for Astronomy and Space Sciences for Education [id: 145]**

**Speaker:** Dr. Hamid Al-Naimiy (ae), The University of Sharjah

**Abstract:** The Sharjah Center for Astronomy and Space Sciences (SCASS) will be used as follows:

Astronomy, space and physics educational displays for various age groups, which include an advanced space display that allows the universe to be viewed during four different time periods as seen by the naked eye, Galilei, Spectrographic technology and the space technology of today. A space technology display includes space discoveries since the launching of the first satellite in the 1940s to the present day. Our small optical observatory can be used for training and observation while our 28 m planetarium can be used for education and public awareness. The concept of the SCASS involves the dome representing the sun in the middle of the Center, surrounded by planetary bodies in orbit to form the Solar System as seen in the sky.

**A Vendor-Neutral Assessment of Fulldome Projection Systems: The Limitations Imposed by Physics, and Suggestions on How to Mitigate [id: 112]**

**Speaker:** Claude Ganter (us), Sky-Skan, Inc.

**Abstract:** Fulldome planetarium projection systems are unique technical challenge. This includes the way light propagates in the largest optical element of a planetarium: the dome itself. In an ideal world, one would aim for a projection system with high luminosity and high contrast. However, effects such as cross-reflection occur in reality, compromising the projection quality as a matter of fact. In published studies, the interaction of dome reflectivity, projector parameters, projection luminosity and contrast and other factors has been presented from a physical and mathematical point of view. The mathematical treatment is complemented by actual luminosity and contrast measurements in domes and by subjective impressions of the projection. The mathematical model is validated and mitigation strategies for the associated technical challenges are suggested.

**Ancient Chinese Style Planetarium [id: 376]**

**Speaker:** Min Li (cn), Jiangsu Astronomical Society

**Abstract:** An ancient Chinese architecture style planetarium according to traditional Chinese astronomy philosophy and aesthetics would be introduced. To merge Chinese traditional style and current astronomy discovery, the new planetarium is creative building both in architecture and function.

**Text:** Architectural planetarium design seems to be a mature subject, with a nearly 100-year history. The standard and typical appearance is that of a hemisphere or even sphere. In 2010, we were asked to design a planetarium based on certain Chinese philosophy and astronomical concepts. It took us almost 5 years to design and build the planetarium, with two Chinese ancient style buildings located in Zhen Ze Middle School, Wujiang, Suzhou City, China (Fig. 1).

Chinese philosophy governs the life of China, and it is also the core of Chinese culture. Ancient Chinese astronomy was a subject which reflected this complex and profound philosophy. There are two main branches in Chinese philosophy: Confucianism and Taoism. Chinese philosophy is centred around certain typical and unique concepts, such as benevolence, justice, Yin Yang (which means female and male, black and white) and Qi (the gas, from which everything in the universe evolved), as well as such philosophical ideas as order, keeping hearts quiet (stillness), etc.

We chose the human being and the sky (universe) as main subjects for our design. From Taoism, we drew upon a very important idea about the human-sky relation, maintaining that the sky and the human being should merge to one. From Confucianism, we selected Shen Du, which signifies that a man should be cautious and obey rules without surveillance. We wanted to design the planetarium with these two ideas in mind, so that people in our planetarium could strongly sense them.

We began to consider some basic building models, and also whether just one building could achieve our purpose. We ultimately decided to design two buildings, one for teaching, exhibition and observation, the other for displaying fulldome films. The first shape chosen was the circle, a meaningful shape in Chinese culture, signifying the sky. The Chinese believed that the sky was round, the Earth flat. The circle likewise signifies the purpose of life, which is round, smooth and satisfied. It also shows a certain rule by which life and society function: just as there is top and bottom of the circle, so, too, are there periods when you are at the bottom in life, but then began to climb to the top, and when society is at the top disaster would be near. The shape means wisdom – Chinese wisdom not only solves problems, but also does so without tough methods and with less injury. We also drew upon the concept of a Mobius strip to give the building a scientific aspect. As a result, the outer diameter of the first building is 16.7 meters (Fig. 1) and inner diameter of the first building is 18 meters (Fig. 2). We invoked the concept of Ting (like a pavilion, a kind of traditional Chinese architecture), designing the planetarium with a flat roof. Its inner diameter is 8 meters with a 12-face polyhedron (with windows installed, Fig. 3) and it can accommodate 38 students for fulldome films.

The notion of the “five elements” is one of the most important concepts in China, widely used in astronomy, medicine and architecture (such as Feng Shui). According to this theory, metal, water, wood, fire, and earth construct our universe, and each pair of two elements has an either generating or overcoming interaction: for instance, earth generates metal, whereas fire overcomes water. But when three overcoming elements, fire, water and earth are united together, they become bricks, thus showing that men are able to defeat so-called fate. Given the importance of this idea in Chinese philosophy, we decided to use bricks.

Min Li was the PI for the design, while specific architects, the apogee film and MAIA TECHNOLOGY united to create the design.
A Vendor-Neutral Assessment of Fulldome Projection Systems: The Limitations Imposed by Physics, and Suggestions on How to Mitigate [id: 46]

**Speaker:** Max R. Rößner (de), ESO

**Text:** Fulldome planetarium projection systems are a unique technical challenge. This includes the way light propagates in the largest optical element of a planetarium: The dome itself. In an ideal world, one would aim for a projection system with high luminosity and high contrast. However, effects such as cross-reflection occur in reality, compromising the projection quality as a matter of fact. In published studies, the interaction of dome reflectivity, projector parameters, projection luminosity and contrast and other factors has been presented from a physical and mathematical point of view.

The mathematical treatment is complemented by actual luminosity and contrast measurements in domes and by subjective impressions of the projection. The mathematical model is validated and mitigation strategies for the associated technical challenges are suggested.

The Impossible Renovation that Worked! (with centimeters to spare) [id: 164]

**Speaker:** Dr Carolyn Sumners (us), Houston Museum of Natural Science

**Abstract:** Anyone wanting to get 190 seats under a 50 foot dome with a 20 degree tilt and only one floor for entrance and exit – or any subset of these constraints – will benefit from our story. We’ve invented sky boxes, added a lift, discovered lean-back stack chairs and alternating stairs, cut holes in outside walls to vent projectors, repurposed catwalks and demolished concrete rings – with a tolerance of about a centimeter. We’ve repurposed power and ventilation and turned our operator into a maestro on the planetarium keyboard. Long ago we were a flat floored theater, then the first full dome digital video planetarium in the US, and now we’ve wedged an 8K projection system inside an iconic exterior dome, never designed to hold such a theatre. It’s a humorous tale with lots of ideas and a few pitfalls for the patient DIY planetarium renovator.

**Text:** On March 11, 2016 we opened the renovated Burke Baker Planetarium after closing on December 21, 2015. We removed the existing walls, flooring, dome, and doors, except for one exit door. Then we built inward from the theater shell, starting with a NanoSeam dome, followed by walls going up to the dome, leaving holes for projectors. Working with Evans & Sutherland, we installed a projection system that the company had never done before, with projectors that did not exist in December when we closed for renovation.

Perhaps the best critique received has been from Trish Rigdon, Executive Director of the Houston Cinema Arts Society, who is not a regular planetarium visitor: “I recently spent a Saturday attending all of the HMNS films, one right after the other, and I was stunned by the entire experience. From the highest resolution and highest contrast of any projection I’ve ever seen on any screen anywhere, to the fabulous new seating and tilted dome position, I felt like I was flying through the universe in my own private ship.” Since opening we are running 177% above the ambitious attendance we set for the planetarium.
Exploiting shaders – journey to the black hole [id: 236]

**Speaker:** Michał Gochna (pl), Copernicus Science Centre

**Abstract:** By knowing the laws of physics and using computer programmes, today we can create models and animations of various processes that occur in the universe. In this way, for example, we can show on a planetarium’s dome how a black hole can distort the view of stars located nearby. Very helpful in performing such visualisations are graphic shaders – a powerful tool for making splendid visualisations which still shows good performance during a live show. I am a programmer who used to do computer vision on a daily basis in my own startup. I use this knowledge to write shaders that demonstrate specific physics phenomena. I would like to share my experiences and tools that I use to create them.

Science and Data Visualization Showcase [id: 192]

**Speaker:** Dr Mark SubbaRao (us), Adler Planetarium

**Abstract:** The state of the art in scientific visualization will be showcased in this session curated by the IPS’s Science and Data Visualization Task Force. Short clips will illustrate innovative techniques and novel datasets that are making their way into the planetarium.

veRTIGE: Using simulation data to teach about galaxies [id: 156]

**Speaker:** Frederic Arenou (fr), Paris-Meudon Observatory

**Abstract:** After a five year R&D program, the veRTIGE project is leading up to a world premiere: Visualising the result of the simulation of galaxy formation (GALMER) in real-time in a planetarium. Using physics calculations rather than an artist’s CG representation allows much more to be explained, by giving access with a single model to different instruments’ views and the internal structure of the represented galaxies. The veRTIGE project was supported by the France’s ANR, and involved Observatoire de Paris-Meudon (Frederic Arenou, Françoise Combes, Yannick Boissel), Inria Grenobles (Fabrice Neyret, Pascal Guehl, Guillaume Loubet), and RSA Cosmos (Benjamin Cabut, Mikaël Lemercier, Reynal Arnerin)

Text: veRTIGE (visually enhanced Real Time Interactive Galaxy for Education) was a 5-year R&D project dedicated to the improvement of the visualization of our Milky Way in planetariums. This project was carried out in cooperation between Paris-Meudon Observatory, INRIA a French institute specialised in computer graphics, and RSA Cosmos, a French company specialised in planetarium design and installation.

Having a better technology for visualizing our Milky Way in planetariums is important in several respects. First, it is important to give visitors a strong visual experience. Second, it is important to present to visitors the state of scientific knowledge rather than an “artistic-view experience”. Third, having an improved visualization of our Milky Way, with individual stars, dust, etc., all in the right proportions, gives a better impact on the real scale of our Milky Way, and showing correct scales is one of the hardest thing to do in a planetarium. Fourth, having a Milky Way visualisation available in several wavelengths opens up possibilities for education, especially for showing that by using different instruments we can observe invisible things in the visual photometric bandwidth. Fifth, the Gaia project will soon release a “big data” catalogue of more than one billion stars, so technology has to be prepared to receive such an amount of data.

The veRTIGE project fulfilled all those goals, and was recognized as a world premiere during this conference. The veRTIGE visualization uses the output of GALMER (Galaxy Merger) supercomputer simulation. This simulation outputs SPH particles containing stars and gas. Those particles were used to extract dust position and dust data was amplified using fractals to add more detail. Then, open clusters were added to the model using different ages, and the ionised area in the youngest open clusters were calculated by combining dust and open clusters positions. Finally, individual stars are generated procedurally using the right distribution (in term of size, mass, luminosity, metallicity and age) and using the correct density depending the location in the Milky Way (bulge, galactic plane, spiral arms, etc.).
The final model presented at IPS2016 represents:

- 10 million gas & dust particles
- 3 million open clusters
- 117,000 HII region
- more than 150 billion individual stars.

This was done in 6 different photometric bandwidth including visible, Near IR, Far IR and UV.


Acknowledgment: This project has been possible thanks to support from the French National Agency for Research.

Globular clusters: live 3D models and scientific data [id: 90]

Speaker: Emanuele Balboni (it), Infini.to - Planetario di Torino

Abstract: The planetarium dome is a great resource for combining scientific data and fancy 3D models, a useful tool for data visualization as well as science dissemination. We present 3D globular cluster models created from real globular cluster HR diagrams provided by HST (Piotto et al., 2002). Using a mapreduce algorithm, models are created with correct stellar population; in addition every model can morph itself into its color-magnitude-mass diagram. This representation is useful to explain different aging in globular clusters as well as explaining HR diagram and its regions.

Text:

INTRODUCTION

Globular clusters are among the oldest stellar collections in the Universe, with age of at least 18 billion years or more. With their spherical shape and peculiar stellar population, globular clusters are very interesting models to be shown inside a modern planetarium.

CREATING A MODEL

A realistic model of a globular cluster requires the right shape and the right type of star population. The spherical symmetry of a globular cluster makes the first task quite easy: each star in the model can be randomized over spherical coordinates, with a weighted radial distribution that simulates the core concentration (like the Shapley-Sawyer concentration class). On the other hand, the stellar population in globular clusters is not easy to replicate; in this case real observational data can be used. Piotto et al. (2002) provided colour-magnitude (CM) data and diagrams of 74 globular clusters from Hubble Space Telescope observations. Those data were mapped and used as probability distribution to create a stellar population similar to the real object considered. In this way, one can create a model of globular cluster with desired number of stars and concentration: for each star, a position inside the model is calculated, while color index and luminosity are derived from the observed data. In addition, the star mass is estimated from its position inside the CM diagram.

FROM MODEL TO GRAPH

When put into the virtual space of the planetarium, the model is drawn as many hundreds of dots, each dot representing the position of a single star; however, the same dot can be used to show different physical parameters of the star it represents. Thanks to the morphing properties of some models in modern software packages, the globular cluster model can morph into its own color-magnitude-mass diagram: each dot can move in order to show position (xyz coordinates) and physical quantities (B-V, V, mass) of a single star. This property is very useful to talk about shapes and physical parameters of globular clusters at the same time, and to make the CM diagram easier to understand to general audience.

REFERENCES


Visualization Design for Solar Superstorms [id: 7]

Speaker: Kalina Borkiewicz (us), National Center for Supercomputing Applications

Abstract: The Advanced Visualization Lab (AVL) worked with astrophysics data scientists to create data-driven cinematic scientific visualizations as part of a narrative journey through the dynamic processes of the sun in a digital fulldome production titled “Solar Superstorms”, narrated by Benedict Cumberbatch, as part of the CADENS NSF grant. The visualizations described in this paper represent different parts of the story of the lifecycle of stars, the dynamic processes of our sun, and how they affect life on Earth. The paper discusses the challenges the AVL team faced and the solutions they devised in registering datasets from different data scientists, exploring massive supercomputer datasets in real-time virtual environments, and rendering extremely high-resolution images of spatially dense time-evolving data efficiently.

Text: The AVL is a Renaissance team of artists and programmers who work with scientists to create cinematic treatments of massive supercomputer simulations for public outreach. AVL’s contribution to “Solar Superstorms” consisted of the following six scenes, created from seven datasets. The talk described a selection of challenges faced while working on these scenes:
1. “The Formation of the First Stars and Galaxies”: Creating a new pipeline to design and render the scene directly on the Blue Waters supercomputer, without a graphical user interface, using yt.


3. “Magneto-Convection Emerging Flux”: Artistic challenges, including color choices, and a camera trick to obscure an inconsistency in the data resolution.

4. “Double Coronal Mass Ejection”: Augmenting the commercial software package Houdini to read a non-standard non-uniform grid format, and the resulting challenges with memory management.

5. “Solar Dynamics Observational Data”: Creating a 3D scene out of 2D images by mapping them onto a hemisphere and cone to create a parallax effect as the camera moves.

6. “Solar Plasma Interacting with Earth’s Magnetic Field”: Creating a 2-minute sequence out of only a handful of extremely large 3D data files by step-dissolving, then switching to 2D data slices combined with magnetic field lines traced through the 3D data.

Scenes and versions of “Solar Superstorms” can be viewed and downloaded in several formats at http://cadens.ncsa.illinois.edu/documentary/solar_superstorms
Putting the “Planet” in Planetarium [id: 233]

**Speaker:** Ryan Wyatt (us), California Academy of Sciences

**Abstract:** Morrison Planetarium at the California Academy of Sciences has pioneered the integration of Earth data and natural history research into its catalog of fulldome shows—as well as its live programming! Monthly “Earth Update” programs highlight Academy researchers’ work from around the globe, and every show in Morrison Planetarium includes a presenter-hosted section in which audience members are invited to participate in solving sustainability problems. This presentation will review evaluation results from both the monthly programs and the daily shows, exploring the impact of these experiences. In particular, we evaluate the efficacy of the call-to-action in our “Habitat Earth” show, in which audience members are asked to engage in citizen science, to visit environmentally-protected areas, or to assist in monitoring offshore whale populations.

22. STAY UP-TO-DATE EVERY DAY -TOOLS FOR THE SKY AT NIGHT SHOWS (CALENDAR OF SKY- AND HISTORICAL EVENTS, ASTRONOMY NEWS FROM THE BIG OBSERVATORIES, FRESH SCIENCE TO THE DOME EVERY DAY)

**Session abstract:** Two presentations concerning the subject. It is crucial for planetariums to be up to date with astronomical discoveries, as our audiences often visit us inspired by the news of these discoveries and they actually hope to hear something about them during our live shows. However, it is not always easy for us to provide any information, as this requires a lot of involvement from us. We will discuss good practices and methods of staying up to date and presenting hot subjects under planetarium domes. This session will be also helpful for making our live shows even better generally, as we can learn more about art of storytelling itself and avoiding routine.

From the Earth to Mars [id: 208]

**Speaker:** James Albury (us), Organization: Kika Silva Pla Planetarium

**Abstract:** This presentation is for planetarians interested in developing timely and engaging ways to offer live shows featuring the latest astronomical data. Using R.S.A. Cosmos’ SkyExplorer, it will explore the many factors involved in choosing a good landing site on Mars, including the practicalities and perils of interplanetary space flight and the search for water and life on Mars. It will also describe the “meta-data” necessary for such a journey, like show topics with talking points; suggestions for accompanying visuals; a key to Martian visual data; links to helpful online references; and questions (and responses) for audience engagement. The goal of the presentation is to create the most audience-captivating synergy between the latest planetarium technology and the latest astronomical data. With the help of innovative planetarian-presenters, Mars, like the Moon before it, can inspire the next giant leap for mankind.

Uniform Circular Motion in a Static Universe: Avoiding Millennia-old Mistakes [id: 218]

**Speaker:** Justin Bartel (us), Science Museum of Virginia

**Abstract:** Planetariums have a long tradition of highlighting the annual march of the stars around the sky and the planets’ motion through the stars, but focusing too much on this Earth-centered perspective hides the true reality of the cosmos from the audience. Our modern understanding of the universe is constantly evolving, and the growth of fulldome technology allows us to adjust the stories told under our domes in lockstep with new astronomical discoveries. By continuously updating our live presentations, we avoid the annual procession of unchanging seasonal star talks, and design audience-driven presentations that incorporate the most up-to-date information and
images available. Drawing from recent headline-grabbing topics such as the exploration of Pluto, the possibility of asteroid impacts on Earth, and the discovery of exoplanets ever more similar to our world, new content can easily be incorporated to keep the show relevant to the audience and engaging for the presenter.

Text: The installation of a new fulldome system at the Science Museum of Virginia in the spring of 2014 presented the opportunity to re-design the museum’s astronomy programs and re-introduce planetarium shows to the daily theater schedule. This effort was shaped by the museum’s brand: a combination of our obligation as a state agency to serve all Virginians and our mission to present relevant and current science in a compelling and quirky way. This presentation is a snapshot of how these institutional factors are being combined with the flexibility of fulldome technology to produce unique experiences that bend some of the rules of traditional planetarium programming.

The millennia-old mistakes referenced in the presentation’s title can be re-interpreted as simple rules that guide our programming under the dome. These are: 1) We aren’t the center of the universe, 2) We’re always moving, and 3) The universe is always changing. Applying these rules under the dome goes beyond the basic astronomical implications; they remind us that the nighttime sky over our backyard isn’t always the best way to view the universe, that our audiences are always moving in and out of the theater so our presentations should adapt to each new crowd, and that new discoveries are always on the horizon so it requires diligence to keep up to date in the dome.

Also presented were excerpts from typical live presentations, demonstrating how the latest headlines and scientific research can be integrated into live shows with the help of audience participation and pop culture references, as well as a few key resources for tracking down useful data or information.

Over the last two years, audience reaction to these efforts has been strong. Attendance to daytime shows is steady, while once-a-month evening shows have seen significant audience growth requiring the addition of a second presentation. This is encouraging evidence that constantly-evolving and updated live presentations are a worthwhile and sustainable pursuit.

The sites specifically highlighted were:

- NOAA View Data Exploration Tool: http://www.nvml.noaa.gov/view/globaldata.html
- Outer Planet Atmospheres Legacy Archive: https://archive.stsci.edu/prepds/opal/
- USGS Astrogeology Maps/Products: http://astrogeology.usgs.gov/maps
- JPL HORIZONS: http://ssd.jpl.nasa.gov/horizons.cgi
- Exoplanet Archive: http://exoplanetarchive.ipac.caltech.edu/
- The Extrasolar Planets Encyclopedia: http://exoplanets.eu/
- Minor Planet Center: http://www.minorplanetcenter.net/iau/mpc.html

Data mentioned in this presentation and now available for public download:

Dr. Ian Crossfield’s map of brown dwarf Luhman 16B: http://www.lpl.arizona.edu/~ianc/luhman16.shtml


Follow the space exploration [id: 91]

Speaker: Marco Brusa (it), Infinito – Planetario di Torino

Abstract: 2014 and 2015 have been exciting years for space exploration, with probes sent to every part of our Solar System. Getting citizens involved in this adventure is a privilege and a duty for a planetarium. But this is sometimes not an easy task, due to the restricted time frame of the event, the delay in receiving images and the need of understanding the mission itself. In this presentation, we will analyze four different missions: Gaia, Rosetta, Dawn and New Horizons. These missions share certain similarities but they also exhibit a number of differences, giving us the opportunity to face new problems in each case and seek new solutions. We will discuss the way in which we try to face this challenge, using a mix of scripting, real time shows, live presentations with researchers and technicians involved in the mission itself and 3D printed models.

Text: Space exploration is an appealing and fascinating topic and also a good tool for communicating knowledge of space and astronomy in general. The massive flux of news coming in from satellites and space probes demands a strong effort to be communicated properly. The typical approach taken by planetariums is to create custom scripts, but sometimes important information and content, such as satellite 3D models, probe orbits and so on, are not accessible. That is why it’s important to be able to implement that data independently.

When such information is all collected, it is important to have flexible and interactive storytelling, giving to the planetary the capability to catch questions and suggestions while under the dome. For this, a simple and linear script is not enough; it must be replaced by a set of custom tools such as a dedicated button-box, customizable input devices and action scripts specifically created for each event.

Alongside script creation, other tools can be used, such as a dedicated talk by an expert actually involved in a space mission and, if possible, shared hosting of live shows. For this, it is important to develop a strong and rich network of scientific and technological partners.

New and catchy technologies can also be harnessed. 3D printing and augmented reality are becoming increasingly important. Those tools, in conjunction with the capability to create custom content (3D models), offer different possibilities for interaction and visualization of distant celestial bodies and high-technology probes in a new and uncommon way. Augmented reality gives guests the freedom to explore in the first person. They can choose viewing angles, zoom and the amount of time to be dedicated to exploration. 3D printing adds another dimension to the exploration: people can explore by touching, too. This opens up a completely new scenario for the common guest and also gives greater capacity for blind people to participate.
Session abstract: Depicting the scientific universe to the audience can prove challenging. The large scales involved demand that the laws of physics need to be "bent". The graphical representation is only a part of such shows, we also need to explain some of the problems involved, and do all this to the accompaniment of music. Our audience is experiencing a lot of sensations, which we need to control or at least keep in mind. In addition, we can convey more than just astronomical data, and planetarium technology can be harnessed no only by general audiences. At this session, we will also look at some examples of its use with university students. For questions and comments please use twitter hashtag: #IPSDatasets.

LHC on your dome, and other sciences [id: 228]

Speaker: Dr Keith Davis (us), University of Notre Dame

Abstract: We show how research data in biology and particle physics, in addition to astronomy, is used in the University of Notre Dame's Digital Visualization theater. The visualizations are created for DigitalSky 2 and professors use the visualizations to teach students. One example is the CMS detector at the Large Hadron Collider, and experimental particle collisions are displayed. Rarely seen outside the University of Notre Dame, the non-astronomical sciences open up a wider range of applicability for use of your dome.

Using Astronomical Datasets in Public Shows [id: 238]

Speaker: Shawn Laatsch (us), IPS President Elect

Abstract: From the observatories of Mauna Kea to the European Southern Observatory, explore how astronomical datasets can be used not just for research but to communicate the latest discoveries with your local audiences. In this session I will showcase datasets brought into the digital planetarium and how they can be used to inspire your audiences in new ways. Along the way we will look at how these can be used to leverage speakers for your dome and also enhance teaching opportunities as well.

Teaching Scale with a Digital Planetarium [id: 21]

Speaker: Dr Ka Chun Yu (us), Denver Museum of Nature & Science

Abstract: Most planetarium simulation software packages allow the camera to zoom out into the cosmos, flying at exponentially greater speeds, and propelling the audience from planetary to galactic to extragalactic realms. This feature mimics Ray and Charles Eames' iconic 'Powers of Ten' short film, which first introduced audiences to the idea of nested relative scales in the universe. However, little work has been done to study the effectiveness of such a pedagogical approach. We report here on the use of a logarithmic zoom in real-time fulldome planetarium visualizations to teach college undergraduate students about astronomical scales. Comparisons with control groups show that immersive visualizations can result in greater and significant learning gains. We also describe a novel attempt to incorporate the tedium of space travel to heighten the understanding of scale for the audience.

Text: Astronomical scales and distances are difficult to teach, since the quantities are typically far greater than what people can intuitively comprehend. Previous research has shown both underestimation of distances and overestimation of sizes by students and the general public, with conceptions about scale resistant to change even after instruction (Zeilik, Schau, & Mattern, 1998). The ability of visualization software to represent the wide range of possible astronomical scales suggest a new way to teach scale in a digital planetarium.

The mode of instruction used in this study was inspired by Ray and Charles Eames’ Powers of Ten film, which presents a smooth logarithmic camera zoom into both outer and inner space, as well as the large physical scale models that allow individuals to walk the increasing distances between the planets in our Solar System. The powers of ten zoom is easily replicated in all fulldome planetarium visualization software. However, we added an set of logarithmic grids as a visual ruler to help the audience keep track of distances. The experience of traveling to ever more distant worlds was replicated by flying between planets at a constant instead of exponentially increasing speeds. Even though the virtual camera was still moving many times faster than the speed of light (in order for the presentation to fit within the allotted class time), a several minute long journey from Earth to Jupiter would highlight the vast distance between the planets, and the “tedium of spaceflight” where the scenery does not change once we are too far to see the details of a planet.

A bank of multiple-choice questions – based on questions from prior research studies as well as from analysis of our own pre-instruction interviews with students – was created to assess student learning before, contemporaneous with, and post-instruction. Seventeen classes (with 781 students total) taking part in the study were divided between those that saw no visualizations (Group I), those exposed to instruction using flat screen visualizations in the classroom (Group II) or the same visuals projected in the Denver Museum of Nature & Science’s fulldome Gates Planetarium (Group III).

The results showed that students in all three groups showed learning gains immediately after instruction. However, only the Group III students who visited the planetarium still retained a modest gain from their pre-instruction scores, some 4-6 weeks after instruction. The other two groups showed effectively zero gains. The visuals in both Groups II and III were the same, with the same instructors teaching classes in both groups following the same lecture outlines, and at the same pace. Our results suggest that the immersive nature of the fulldome presentation is the critical difference leading to the greater assessment gains. This agrees with both our (Yu et al., 2016) and other prior research showing better retention for students who received instruction in the planetarium compared to the classroom.
References


24. DATA TO DOME

20 JUNE, 15:15-16:15 / JUPITER

Session Abstract: Astronomy is a dynamic discipline, with news and new data being published every day. Today, the flow of exciting assets from research to planetarium domes is typically not integrated in the way planetariums work: Rather than bringing the latest science into the dome minutes or hours after it was published, new content is typically presented weeks after it was published – or never. The Data2Dome (D2D) project aims at streamlining the content flow from research institutions to planetariums. D2D is composed of two components: A vendor-neutral meta-scripting language for real-time fulldome planetarium systems and vendor-neutral data distribution through cloud solutions. In this way, it is hoped to bridge the technical boundaries both between planetarium systems and between research and outreach, offering up-to-date content to planetarium audiences and easing content exchange. The ideas will be presented and discussed with representatives of vendors, content contributors and presenters in the audience.
25. SEAMLESS VIDEO-SYSTEM

21 JUNE, 09:00-10:00 / SUN

Session abstract: How the pre-rendered content can be used in live shows? Examples and best practices of going seamless between them.

When the live show meets prerendered content [id: 246]

Speaker: Maciej Mucha (pl), Copernicus Science Centre

Abstract: Even in these times of impressive fulldome productions, people do love good live shows. There is something amazing when a presenter leads the show, something like theatre – a theatre of the imagination that gives a feeling impossible to attain from watching even a very good movie. But sometimes it is not possible to show some elements in live mode and they need to be prerendered. How can such prerendered content be used, while retaining the magnificent feeling of a live show and not losing its fluency? Is that possible? During this session I will demonstrate some techniques for using prerendered content in the middle of a show.


Speakers: Martin Ratcliffe (us), Sky-Skan, Inc., Steve Savage (us), Sky-Skan, Inc., John Stoke (us), Sky-Skan, Inc., Ian C. McLennan (ca), Ian McLennan Consulting (with others)

Abstract: This is a combination ‘live’ and full-dome demo illustrating the crucial importance of seamless transitions between highly polished live presentation (for immediacy and topicality) and high production value pre-rendered fulldome content. Presented in cooperation with Sky-Skan, Inc., (Digital Sky Academy), the programme will be 35 minutes in length – with a 25 minute period for active audience participation, discussion, input, critiquing and debate.

Destination Solar System – Live Dome Theater [id: 209]

Speaker: Mark Webb (us), Adler Planetarium

Abstract: Destination Solar System is a live narrative theatrical work designed for planetarium presentation using fulldome, recorded audio, and a live actor. The show is performed 3 to 4 times per day all year long and has been exported to other domes. Many visitors feel that this is an enhanced planetarium presentation and that the use of story, actors, improvisation, and traditional elements of live theater add to the immersive nature of the planetarium experience. This talk will present the challenges of creating this program along with audience reaction to the experience.

26. AUDIENCE PERSPECTIVE IN LIVE SHOWS – BEST PRACTICES

21 JUNE 09:00-10:00 / VENUS

Session abstract: Active learning comes in many forms, and can help students and audiences articulate a problem, deepen their understanding, and creatively apply their knowledge to novel concepts. How does this work in a planetarium? Does the size and configuration of a planetarium determine the programming? Can and should interactive programming happen in every dome for every show? What determines when interactive techniques should be used? What level of interactive activity is appropriate for your audience? How should you balance teaching and other activities? Over the course of this workshop, participants will work in small groups to brainstorm answers, options, and opinions to these and other questions. The ultimate aim will be to create a framework within which the needs and wants of a planetarium and its programming can be assessed to optimize the visitor experience – both in terms of education and enjoyment.

Audience perspective in live shows – best practices [id: 299, 300, 301]

Speaker: Dr Robert Cockcroft (ca) [id: 299], McMaster University, Karrie Berglund (us) [id: 301], Digitalis Education Solutions, Inc., Patty Seaton (us) [id: 300], Howard B. Owens Science Center

Abstract: Active learning comes in many forms, and can help students and audiences articulate a problem, deepen their understanding, and creatively apply their knowledge to novel concepts. How does this work in a planetarium? Can and should interactive programming happen in every dome for every show? What determines when interactive techniques should be used? What level of interactive activity is appropriate for your audience? How do you balance teaching and activities? During the course of the sixty-minute workshop, participants discussed advantages and disadvantages of both live, interactive shows, prerecorded shows and a hybrid approach that combines both types of show. Participants worked in very engaged, small groups to brainstorm answers, options, and opinions to some of the above questions, before sharing them in a full-group discussion – highlights of which are captured below in these proceedings. This workshop helped participants to create a framework within which the needs and wants of a planetarium and its programming can be assessed to optimize the visitor experience – both in terms of education and enjoyment.

Text:

Advantages of live, interactive shows over prerecorded ones

The audience can benefit from a live, interactive show, as it is fun, engaging, memorable and valuable. They can focus their attention by actively participating with a presenter who pays attention to the audience’s presence, to whom they can ask questions, and whose enthusiasm can be contagious and inspirational. A live show is flexible and customizable; it can be adjusted to the appropriate level, steered to the audience’s own interests, translated into different languages, and updated very quickly to include scientifically accurate information. This variety of each show can encourage repeat visits. This
same variety is also good for the presenter, and helps them keep from slipping into a monotonous routine. Presenters can also move past technical errors, or hide them completely, while giving a live show as they tell stories, include anecdotes, and invite audience participation.

Advantages of prerecorded shows over live, interactive ones

Audiences can benefit from a prerecorded show, in that they can see a show multiple times and know that they will receive the exact same content – which may be important, for example, in school standards or for providing consistency for marketing. Other quality controls are also guaranteed: prerecorded shows can approach or even match the effects that audiences are used to seeing in Hollywood productions, important factual points are never missed, there are smoother transitions between segments (and between multiple shows in a day), and it is easier to synchronize audio – both narration and music – with what is displayed. A high-quality prerecorded show with an innovative idea is easy to share with a broader audience by distributing it to other planetariums, and allows planetariums to include material in their programming that they could perhaps not show otherwise (for example, due to personnel budget, training, qualification or other constraints). For qualified and experienced presenters, prerecorded shows gives them a break: they are less stressful, there are fewer variables to worry about, and it is easier to show certain content. Finally, not all audiences want or enjoy having to interact.

Challenges of live, interactive shows

Live shows are obviously more demanding for the presenters. They need more training and experience to be able to allow the audience to “drive” the show, and it can be difficult to teach presenters new techniques while still allowing them to develop their own unique presentation style. The overall quality of the show relies on their skill, they have to balance routine versus improvisation while maintaining high energy levels (sometimes for several shows in a row), and they need to make sure that they are up to date in all areas of current astronomy. They also need to correctly determine and be comfortable with saying “I don’t know”. Some audiences are harder to engage with than others (for example, very young kids or teenagers), and a planetarium might need several different presenters to deal with different audience demographics. It requires more time and money in the long term to have a live presenter. Any live presentation is also harder to market, as the content is not clear and there is no trailer.

Challenges of prerecorded shows

Finding very high-quality prerecorded shows, that do not include a single cringe-worthy moment and do not become quickly outdated, can be very difficult. A bad title can lead to incorrect expectations, and subtle differences in titles have the potential to make a huge difference. The balance between breadth and depth is usually not good – especially when considering this balance needs to be varied for audiences from different geographic areas, time zones, star lore cultures, etc. It is difficult, if not impossible, to accurately determine how well the audience is receiving the information, as the presenter isn’t constantly interacting. The more impersonal nature of the show makes it easier to switch off (and even sleep). Audiences like to record shows with phones – but with a prerecorded show this may lead to copyright infringement. Any mistakes in a show get propagated every time it is shown. Getting audience members involved after a passive show, for example in a question-and-answer session, can be challenging. Attracting repeat visitors is difficult as the show is exactly the same every time. The high production costs, which are needed due to audiences’ high expectations, can be prohibitively expensive for small theatres. The repetition for presenters makes it boring, although they need to stay focused on the technical aspects. Trained staff will still be needed before and after the show.

Discussion on Hybrid Approach

There are essentially three models within a hybrid approach that blends live and prerecorded material into one show: (1) The show begins with a live segment, followed by the prerecording, before finishing with Q&A; (2) A live show has short prerecorded clips interspersed throughout; and (3) A prerecorded show in which a live presenter (or perhaps an actor) is a part of. There was a general consensus from participants that (2) is the ideal model and the one that is already in regular practice, as it can optimize and blend the best of both practices, minimize the weaknesses, and vary the style of presentation (and therefore be more likely to be engaging). Questions that may arise from a prerecorded segment can be addressed in the live portion as can any further explanation or adaptation that may be needed for different audiences. Prerecorded segments could be built up into a library, accessible as and when the live presenter needs them. These segments would also allow the presenter to take a short break. Transitions between live and prerecorded segments need to be handled carefully, both from the technical aspect but also to prevent them being jarring for the overall mood and pacing of the show. Care should also be taken not to repeat material from one section to another.

Final words

We recognized one common aspect regardless of which format a planetarium may use: It is difficult to come up with compelling visuals for new discoveries (e.g., the gravitational wave detection from LIGO). There were other topics which we wished to cover during this workshop, but could not because of time constraints. These topics included how certain approaches may be more appropriate than others for different audiences, what qualifications presenters may need for live and interactive shows, and a discussion of question-and-answer strategies that could be successfully employed. These topics could form a “part 2” workshop at a future IPS meeting.
Session abstract: Modern planetariums can ingest up-to-the-minute data and imagery with the press of a button, and numerous resources exist to help planetarians keep on top of the extraordinary stream of current astronomical discoveries. Furthermore, audiences relish hearing up-to-the-minute news from knowledgeable planetarians, which both enhances the integrity of the host institution and conveys the vibrancy of astronomical research. But how do busy planetarians stay abreast of astronomical discovery at a deep enough level to interpret new results meaningfully for their audiences? Forging connections with the professional astronomical community is a key component to succeeding at this challenge and to helping the planetarium profession remain current. Panellists will share their favourite resources for keeping on top of current events, share their experiences working with professional astronomers, and discuss how planetarians can build stronger relationships with the research community.

Lessons from the Bloemfontein Workshops [id: 302, 231]

Speaker: Martin Ratcliffe [us], Sky-Skan, Inc., Dr Mark SubbaRao [us], Adler Planetarium

Abstract: As part of the Digital Sky Academy held in Bloemfontein South Africa, there were two day-long sessions for researchers from all across South Africa. These data input and manipulation sessions engaged academic researchers from a variety of disciplines in importing, visualizing and exploring scientific datasets in the planetarium. We will show examples of the visualizations created in that workshop and discuss what is needed to unleash the full research potential of the planetarium.

Tools for Data Exploration

Digital Planetarium software has been designed for presenting scientific data. Other visualization capabilities are needed as part of the scientific workflow, in particular the ability to visually explore and interrogate data. As a case study in what is currently possible, we used data from the Galaxy and Mass Assembly catalog. This galaxy survey measured many physical quantities for large number of galaxies, making it a rich, multidimensional dataset to explore. The coupling of the Jupyter notebooks with DigitalSky allowed us to mix 2D work (looking at histograms, scatter plots and tables) with the rich 3D immersive visualizations in the dome.

The workshops consisted of presentations, demonstration and an afternoon “hack session”. Scientists we encouraged to submit datasets ahead of the workshop, and we received observational astronomical catalogs, large cosmological simulations, GIS datasets illustrating land usage across the Free State of South Africa, and three dimensional cell imaging. These datasets were visualized inside the DigitalSky software, and both the visualizations and the process of creating them were shown during the workshop. This process was instructive both for the attendees and the organizers. In fact several important lessons were learned on what is needed to utilize the planetarium as a research-grade visualization facility. The remainder of this paper will summarize the most significant of these lessons.

Speaking the same language

The visualizations were prepared utilizing iPython and Jupyter notebooks. This programming platform (Shen, H., Nature 515, 151–152, 06 November 2014, doi:10.1038/515151a) is rapidly becoming commonplace among researchers across disciplines. Some of the reasons for this are:

- The rich set of standard scientific libraries available (this is abundantly true in astronomy).
- The ability to mix descriptive text, programming code, visualization and interactive elements all in a single notebook.
- The easy way that notebooks can be viewed, shared and presented, even by those who are not programmers, make them an excellent collaboration tool.

The use of python in his respect resonated well with the researchers, and some good conversations took place on how to extend that work. DigitalSky Dark Matter (a new version of DigitalSky which at the time of the workshop was still under development) contains python bindings and a demonstration was presented on how this could be used to create button scripts that queried an online server and updated a dataset. Participants suggested making these bindings more ‘pythonic’ and tightening the integration of python and DS Dark Matter.
Figure 2a (left) shows the Jupyter notebook which contains code and 2D visualizations, this is synchronized with the colormaps and overlays shown in the 3D dome view (right).

However, there are visualization capabilities that need to be developed further. These include:

- Picking: selecting and identifying objects in the dome
- Brushing: being able to ‘paint’ objects in a given region of physical space or parameter space
- Linking: having the brushed and picked objects show up across multiple views

New sciences, new visualization challenges

One of the datasets explored during the work was 3D imaging of cells from Ben Loos at Stellenbosch University. The dataset consisted of a series of image slices which can be stacked together to make a 3D volume. During the workshop we visualized these volumes using the same method used to visualize 3D planetary nebulae in DigitalSky. While this worked to some degree, the visual appearance was not entirely satisfactory. In astronomy we are almost always dealing with incredibly diffuse media. That is not true in medical imaging, which frequently deals with dense, opaque material. In these circumstances different volume rendering techniques are required. Feedback from this experience led to improvements in DS Dark Matter’s volume rendering.

Really Big Data

At the close of the workshop we had a brainstorming session on how to deal with the incredibly large datasets that will be generated by the Square Kilometer Array, involving key players of both SKA and University of Cape Town eResearch. The datasets are high-resolution datacubes, far exceeding what can be loaded into memory. At the end of this brainstorming session we outlined an interesting framework for interactively visualizing these datasets in the planetarium. It would work something like this:

1. In the planetarium, scientists navigate through a low fidelity version of the dataset.
2. When the camera stops moving a request is sent to the UCT eResearch Center to volume render a full spherical map at that position.
3. The scientist can pan around the high resolution map.
4. Once the camera stops moving we switch back to the low fidelity version

Summary

The digital planetarium is indeed an impressive tool for presenting all types of scientific data. With some investment it could become a critical data exploration and discovery tool as well. Workshops such as the one held in Bloemfontein are critical to developing these capabilities. We encourage other planetaria to hold similar workshops for researchers in their communities.

We want to discuss how a natural dark sky looks like and how good it can be simulated in a planetarium. The author has visited many dark sky places with natural skies and initiated to set up dark sky places in Germany.

From astronomical discovery to Your dome [ ]

Speaker: Ryan Wyatt (US), California Academy of Sciences

Abstract: Modern planetariums can ingest up-to-the-minute data and imagery with the press of a button, and numerous resources exist to help planetarians keep on top of the extraordinary stream of current astronomical discoveries. Furthermore, audiences relish hearing up-to-the-minute news from knowledgeable planetarians, which both enhances the integrity of the host institution and conveys the vibrancy of astronomical research. But how do busy planetarians stay abreast of astronomical discovery at a deep enough level to interpret new results meaningfully for their audiences? Forging connections with the professional astronomical community is a key component to succeeding at this challenge and to helping the planetarium profession remain current. Panellists will share their favourite resources for keeping on top of current events, share their experiences working with professional astronomers, and discuss how planetarians can build stronger relationships with the research community.
28. FROM ARTIFICIAL TO REAL STARS
21 JUNE 10:30-11:30 / SUN

Session abstract: If we can simulate the sky with fulldome technologies, why bother to take fisheye photos of the natural sky? Are such pictures still needed in modern planetariums? It is difficult to find an ideal balance between real and artificial sky imagery under the dome. Presentations at this session will illustrate how artificial star images are not the only tool planetariums have for depicting the sky, given that we also have real sky photos, which are very powerful and original content for inspiring the audience. The session will address the problems involved in capturing landscape pictures. What difficulties do we face in undertaking large-scale projects and can how modern planetariums help? We will find the best places for capturing the real sky in pure and light polluted form.

Abstract: Modern planetarium techniques should try to simulate as natural a night sky as possible, especially as the natural dark sky is vanishing through light pollution. A search for a natural dark starry sky was carried out during visits to dark sky parks in Europe and North America. Their night skies will be presented with fisheye photos from these parks and different features of the dark skies will be discussed.

Text: One quality criterion for a dark sky is the number of visible stars. For this reason the number of stars down to a certain magnitude has been determined from the Bright Star Catalogues, but it is complete only down to 6.5 mag. Therefore the Tycho- and Hipparcos catalogues have also been used. From these it was determined that the number of stars to 6.5 mag is 8 000, to 6.7 mag 10 000, and to 7.0 mag is 14 000.

How many stars are really visible depends on the extinction in the atmosphere and the sky background brightness. There are different models for an interrelation between sky background brightness and the limiting magnitude. These and observations (e.g. from Globe at Night) give typically a limiting magnitude of 6.6 mag at a sky brightness of 21.5 mag/arcsec², that about 4500 stars should be visible under the celestial half dome. Under these circumstances Uranus and Vesta are visible to the naked eye observer, which I could confirm through own observations.

Fig. 1: The night sky with the Milky Way near the horizon in spring and high in the sky in autumn in the biosphere reserve Rhön, Germany.

Therefore the quality of the night sky can be judged by measuring the sky brightness with a Sky Quality Meter (SQM) or by taking fisheye images in RAW format. In Germany the sky brightness varies between 18.2 mag/arcsec² in the centre of Berlin to 21.75 mag/arcsec² at dark places like the Nature Park Westhavelland or the UNESCO Biosphere Reserve Rhön. The darkest skies on Earth are supposed to have 22.0 mag/arcsec², corresponding to a luminance of 0.172 mcd/m², as estimated from a compilation of sky brightness at astronomical observatories and from the US National Park Service Night Sky program. So the sky is not absolutely dark on Earth.

Fig. 2: The bands of the Milky Way and the zodiacal band over the Natural Bridges National Monument, USA.

Landscapes generated by fisheye lens for studies in cultural astronomy for digital planetariums [id: 40]

Speaker: d’Ans Barthelemý (pe), Planetarium Maria Reiche

Abstract: In recent studies in Ethno- and Archaeoastronomy, one of the areas of further research is the relationship of man and/or architecture not only with solar astronomical events but with the night landscape. The orientations of structures or observation points with respect to the rising, transit and setting of celestial bodies has been observed not only by day but also at night. The difficulty that researchers face with staying a whole astronomical cycle in one research location and dealing with climate issues, and/or that technicians face with recording astronomical events, force us to seek solutions to recreate these relationships through calculation. This article presents and discusses the results, the lessons learned and adjustments to be made for using images that reproduce the horizon profile to fit in digital planetary systems for research on cultural astronomy in the Andean region.

Text: If we can simulate the sky with fulldome technologies, why bother to take fisheye photos of the natural sky? Are such pictures still needed in modern planetariums? It is difficult to find an ideal balance between real and artificial sky imagery under the dome. Presentations at this session will illustrate how artificial star images are not the only tool planetariums have for depicting the sky, given that we also have real sky photos, which are very powerful and original content for inspiring the audience. The session will address the problems involved in capturing landscape pictures. What difficulties do we face in undertaking large-scale projects and can how modern planetariums help? We will find the best places for capturing the real sky in pure and light polluted form.

What does a natural starry sky look like? [id: 168]

Speaker: Dr Andreas Hänel (de), Museum am Schölerberg
The components that influence the natural sky brightness are:

- The zodiacal light with the Gegenschein, solar light scattered at the dust within our solar system. This can be modelled with a brightness distribution in ecliptical coordinates.
- Another component is the Milky Way, which makes the sky in autumn, when it is high in the sky, about 0.35 mag/arcsec² brighter than in spring when the Milky Way is near the horizon (in mid northern latitudes).
- Aurorae are visible also at lower latitudes – the author could observe them down to 52° North in 2015 – and brighten the sky unpredictably.
- The airglow is mainly visible near the horizon. DSLR pictures exhibit the characteristic green colour of the [OI] emission line. Occasionally wavy patterns can be observed all over the sky, which therefore is brightened.

All these natural influences on the natural sky brightness have been modelled by Dan Duriscoe from the US National Parks Service [1] to subtract it from observational data to determine the artificial brightening of the night sky. Not all of these components seem to have been incorporated in planetarium projection systems. But this model could be used to simulate the natural sky in a digital planetarium.

References

planetariums, they are absolutely right to require equivalent quality for every postproduction.

The text within film scripts correlates with visuals, music and special effects and has to respect timelines. Finally, the selection of the right narration (and professional recording) is no less important. How to comply with all these requirements?

The producer will supply you the script, type of voice and a film preview. You also need to know the number of voices, potential lip synchronization, to devise a plan for the project.

Looking for text translator assistance, it is often assumed that being bilingual is more than enough, but even being fluent in a foreign language does not make one a translator... one has to be able to express other people’s thoughts well, and a fully competent translator should also be bicultural. Profound understanding of the etymological and idiomatic correlations between source and target language is likewise necessary. Familiarity with the subject matter of the text is required as well. A literal translation could cancel or even reverse the intended expressions and effects.

Fortunately the Brussels Planetarium can rely on a vast team of experts at the Royal Observatory and pedagogical scientific collaborators at the Planetarium. A workgroup is established and begins an iterative process of considering how to interact with the images, music, gestures, non-verbal sounds, etc.

The typical difficulties that often occur include: translations which are x-times larger than the source text; visuals that do not correspond or synchronize with the translated text; and expressions that lose their impact, lacking richness for the original wordplay. Assisted by such translation techniques (Gottlieb’s classification) as expansion, paraphrase, imitation or condensation, and with respect to the timeline, tone and rhythm, the final script can be approved by the team and the producer.

There then remains the work of narration and recording, which needs to get specific attention as producers commonly contact famous narrators that complete the public attraction. Professionalism must be guaranteed during the whole process, all the way to the final audio file.

But how to distribute these multilingual films in our theatres? In this regard the Brussels Planetarium generally welcomes 2 types of visitors. During the school period, mainly Dutch and French speaking school groups can make reservations for monolingual lectures, films, courses and workshops. During school holidays, weekends, Wednesday afternoons and every day at 4 pm, all general public visitors can attend our fulldome films. So there is a dual benefit as (foreign) visitors do not have to wait anymore and ticket sales increase significantly!

Technically, distribution is based on a digital audio workstation (DAW) that synchronizes all voiceover languages and channels to the different transmitters and speakers that are installed behind the dome screen. Some planetariums play the original voice-over via speakers, whereas we decided to play all voice-overs separately by a Radio Frequency transmitter system and distribute music and effects by the speakers with a little mix of some sound channels.

Upon entrance to the theatre, a planetarium operator distributes and collects all individual headphones at the ticket control booth. These are Sennheiser HDE 2020s, which have proved to be very flexible, user friendly and sustainable.

Of course, people love to watch live sessions in a planetarium, which is no problem for our monolingual distribution, but challenging for a multilingual distribution. Thanks to our multicultural pedagogical scientific collaborators we managed to create our in-house thematic audio-visual scripts which are automatically coupled by the DAW arrangement programming.

Of course, this was only a brief overview to trigger other colleagues. Wouldn’t it be very interesting to share all international efforts about multilingual adaptations within the IPS community?

Conclusion:

Together with other organizational adaptations the Brussels Planetarium multilingual film offerings require a constant process of work, but the benefits for the Planetarium and public satisfaction largely compensate for all the effort and we invite you all to visit Brussels ... and its Planetarium!

The useful materials for live presentation [id: 39]

Speaker: Kaoru Kimura [jp], Japan Science Foundation/Science Museum

Abstract: How do we build live presentations at fulldome facilities? Providing an interactive story can perk up an audience and an interactive activity can make science more concrete. But what kind of materials are the most useful? When I tried a live presentation using ‘Journey to the Centre of the Milky Way’ provided by ESO, I experienced a couple of problems. When I translated the English script into Japanese, it took 1.5 times longer to deliver. We need a short, less than 3-minute clip. Based on this example, I will introduce some useful tools for live presentation.

Text: Planetariums are often visited by international audience members, so there is a need to offer translations of the shows in foreign languages. Although making pre-recorded multilingual soundtracks for fulldome movies may seem easy, it can sometimes be difficult, for instance when more time is needed to express the same content in one language than in another. Providing translations for live planetarium shows poses a real challenge. How can this be done right? What are the obstacles? How can they be avoided, to offer our guests a good-quality and understandable message? How can we ensure that they do not feel excluded during the show because they do not understand the presenter? What steps can be taken to make them feel as much comfortable as possible?

Translations of live shows [id: 255]

Speaker: Dr Kamil Deresz (Złoczewski) [pl], Copernicus Science Centre
Abstract: There is no good way to create a translation of a live show which will satisfy the foreign-language audience. Very often the "consumers" of such a translation will go to the ticket office straightaway after a show, to make a complaint. My talk will be devoted to the obstacles in translating live shows. A major challenge lies in how to coordinate such a translation with the content being communicated by the presenter, while at the same time maintaining the fluency of the show. We can achieve that in two ways: by shortening the translation to the necessary minimum, or by cutting the recording in earphones during the show if we have to. Both methods require two persons to run the shows – one leading the show in the native language, the second coordinating the recording in the earphones for the foreign-language audience. Both methods also cause the translation to be incomplete. To solve this problem at the Heaven of Copernicus planetarium, we tried to use a plugin which had translated recordings queued up for use during the show, but the technological obstacles of programming proved to be too heavy. No good solution seems readily workable, and translating is no easy thing. I will present some of the lessons learned from incorporating translations inside live interactive shows, including the translation process.

Text: The problem of making translations of content is continual and universal for all popular venues.

We will start with a set of definitions and terms which will be used in this presentation. The "live show" is a planetarium show which is an improvised performance of presenter based on the script and prepared content (graphics, music, effects). For translations we will use "translation system" – a set of technical devices that will deliver translation for the foreign visitors thus helping them understand the show in their native language. "CSC" is acronym for the Copernicus Science Centre, host of the IPS2016 conference together with its Heavens of Copernicus Planetarium.

Different approaches can be applied for translating show content to other languages. Simultaneous interpretation, for instance, is one of the most accurate methods, as we get a full translation, but it has some obvious disadvantages: it is expensive, we rely on the skills of third parties (often lacking basic knowledge of science), it requires additional effort on the part of the team and demands preparation. On the other hand, when we resort to a recorded translations we will have a low cost, as it is just repeated, but it cannot follow an improvised show, it still requires work in being prepared by a team of educators and in handling all the technicalities related to the playing.

When we go through the process of content translation we would usually follow these steps: 1. preparing the text in the original language, 2. translating the text, 3. text proofreading, 4. recording by native speaker, 5. cutting audio files and 6. system upload and software preparation.

As for the CSC planetarium, having an at least basic English translation of some shows is important. Why? Numbers will provide the answer, looking at the example of CSC’s planetarium schedule from April-June 2016 season. We have 51 shows per week (around 50 min. each). The content showed can be divided into: fulldome movies, long live shows, short live shows and other (which include concerts and laser shows). It turns out that around 48% of the total show time consists in live shows. Thus about half of the content may be not available to the CSC’s planetarium foreign audience.

We have a large percentage of live shows, as we want to have interactive presentations, with interactive content which is entertaining and authentic. Thus it is so important to us to have a live presenter and operator working together, changing roles and giving really unearthly experience.

To make this possible we write action buttons (in our case in Digital Sky 2) into the planetarium software so we can control the speed of the show. We give certain degree of freedom by setting various optional buttons. Thus we create an environment where an improvised performance can emerge. However, to give equal experience to our foreign visitors we need to use these buttons to turn on translated content. For example let’s hear the story from our seasonal show (spring 2015) about how an Icelandic mineral was used by sailors to identify the Sun’s position below the horizon.

Creating content in that way gives us the ability to sell a show to foreigners, and you can still slightly adapt its translated content to the audience. In some shows, the text tends to be improvised too much, thus we cannot give enough content which is close to what is being presented in the Polish language. Controlling playback of the translated content is cumbersome, as the show operator has to focus both on the improvised Polish content and on the English content from the translation system.

Are there any alternatives? We thought that we could either enhance the translating system or change the way we do it. First, it might be good to have large array of possibilities: a library of translated content to choose from. Second, we may retain the authenticity of presentation by making a library for each presenter (a kind of "living library"). We also thought about supporting devices, such as a countdown clock which informs both the operator and presenter about the duration of the translation now being played. The presenter could hear the very beginning of the translation, and thus be able to roughly follow it – but this goes too far from an improvised show. We could also dream of some kind of automatic translation – local or using on-line tools. Screened text is another possibility which we have not yet explored – but how can this be done while not disturbing the live show?

We believe that translating live shows still has many challenges to overcome, but these challenges are worth the effort, made together with our foreign audience. There is need for research and development in this field.
Session Abstract: Presenting scientific, artistic and educational subjects on the dome is still a big challenge for many professionals, and the transfer of knowledge is a difficult task for any fulldome video producer. This often leads to long narrative monologues or inauthentic dialogues. Finding a balance between a show’s pace and the amount of science to be explained is one of the key points to success. How can we manage good communication between the technical and the creative, between left- and right-brain thinking processes? During this session we will showcase and discuss various examples of shows and ask authors to share their experiences. How do they find harmony in presenting different elements on the dome? What is the importance of film characters in fulldome movies and can a good entertaining story be built including them. Finally, we will hear about a 13-year-old show converted into the new technology and try to anticipate how the audience will feel about it.

A Tale of Two Domes [id: 132]

Speaker: Dr Alexandre Cherman [br], Rio de Janeiro Planetarium

Abstract: The Rio de Janeiro Planetarium has three domes, two of which share its main facility. Of these domes, one houses an optomechanical Zeiss projector, and the other is digital. Among other shows, the classical dome hosts an original production which opened in 2002, entitled ‘The Science Project’. It is our oldest show still running, and the feedback from our audiences has been positive throughout these 13 years. We use puppets to represent the main characters of the show. Since we opened our Fulldome Production Facility, in 2014, we wanted to convert this show into the new technology. Breaking the fourth wall and investing in self-references, we turned the puppets into animation and we made the characters aware of that, leaving room for interaction with the audience about the digital format. This is a work in progress, and it will open to the public on Oct. 12, 2016.

Text: Presenting scientific, artistic and educational subjects on the dome is still a big challenge for many professionals, and the transfer of knowledge is a difficult task for any fulldome video producer. This often leads to long narrative monologues or inauthentic dialogues. Finding a balance between a show’s pace and the amount of science to be explained is one of the key points to success. How can we manage good communication between the technical and the creative, between left- and right-brain thinking processes? During this session we will showcase and discuss various examples of shows and ask authors to share their experiences. How do they find harmony in presenting different elements on the dome? What is the importance of film characters in fulldome movies and can a good entertaining story be built including them. Finally, we will hear about a 13-year-old show converted into the new technology and try to anticipate how the audience will feel about it.

What’s Never Been Seen – Successful Visualizing for Fulldome Storytelling [id: 174]

Speaker: Dr Carolyn Sumners [us] (author: Tom Casey [us] – Home Run Pictures), Houston Museum of Natural Science

Abstract: A documentary usually shows informative information related to a certain topic. On order to design such a film in an exciting way, one has to find a certain storyline to tell and explain the substance. Just presenting facts leads to audience overload. An advanced further step in presenting scientific, artistic or educational subjects involves finding and narrating an ideally entertaining plot in which the documentary topics are embedded. Here it can happen that either the entertainment and story part takes up much of the space, leaving only little space for the scientific issues, or vice versa. In a narrative plot with characters, it is necessary to introduce the characters, which demands space but is essential for the narrative part. Moreover, there has be a motivation for why the scientific content is presented within the story.

Text: I am making fulldome films that are story-based, character-based. I want to embed scientific knowledge in an entertaining story. The film shall inspire and spark emotional interest in a topic. This is the best way to communicate knowledge, and the best way to memorize topics.

What if learning were fun and creative?

“The world is filled with enthusiastic, energetic people. Too bad they’re usually under the age of seven.” – Esa Saarinen, Ph.D Philosopher & Professor

Many of us associate learning with anything but fun. What if, in fact, learning could be an exhilarating, transformative experience? I believe it should be.

Dome: The environment is inspiring

“If children have interest, education happens...” – Sir Arthur C. Clarke

Arthur C. Clarke’s brilliant observation applies to every learner, child and adults alike.

Learning is not a serious matter. As science shows, learning happens best when learners have fun. We must, therefore, move from teaching to facilitate learning. When we play, when we level up, when we are interested, when we grow and when we flow – that’s when we learn. So let’s play.

IPS 2016 PROCEEDINGS
take the idea of the “artist concept” to new levels. How do we insure a successful pipeline between the scientists supplying the input and the creative people implementing the content, to achieve the desired result, but most importantly, an accurately told story for the educational goals? How do we manage good communication between the technical and creative, between the left and right brain thinking processes? Case histories of several successful productions will be highlighted giving clues to what works... and sometimes what doesn’t.

Text: From the full abstract for the presentation, I want to highlight a couple sentences that specifically lay out what we will address here.

The first being: “How do we manage good communication between the technical and creative, between the left and right brain thinking processes?” This can be interpreted as the scientist giving input vs. the creative person implementing, as well as the technical vs. the creative disciplines within the production pipeline. And secondly: “…how do we create an entertaining story and still meet our educational goals?” In other words, a “catchy” story educates better only if it does educate.

The Traveler’s Guide to Mars – Buhl Planetarium

We will investigate from several perspectives

- a creative theory behind visualizing science concepts
- a science understanding approach to achieving this
- a sampling of how this works

There are three areas I will briefly cover... What might be the most successful creative approach to science visualizations... The necessity of really understanding the science we are visualizing... And some sample application of these approaches during real productions the past few years...

Night of the Titanic – Houston Museum of Natural Science

INFAMOUS QUOTES FROM REAL PRODUCTIONS

- “I’ll give you 5 minutes...”
- “That render test is beautiful... but more cartoon than science visualization!”
- “Guys, stop the Buck Rodgers stuff, or we will never get another NASA grant!”
- “I just looked at the final and was glued to the screen watching the depth and realism of the concept unfolding before my eyes...”

So here are a few what I like to call infamous quotes from over 15 years of fulldome content creation. The first is my favourite. On a rather complex fulldome visualization of the Big Bang theory, where the expert was a Nobel Prize winning astrophysicist, he calls and curtly says, “I’ll give you five minutes.” Now I then assume, he is assuming that as a creative I had no concept of the mathematics involved... so I started talking as fast as I could. Even threw some math back at him when I could. So then at one point he pauses and asks, “so you understand this?” I said, “Well I know you could get over my head very quickly, but yes, I have some math background.” He paused again and said, “I’ll give you ten minutes.” Then we have a quote we don’t want to hear, “That render test is beautiful... but more like a cartoon than a science visualization!” Or humorously, “Guys, if we don’t stop the Buck Rodgers stuff, we will never get another NASA grant!” And finally what we want to hear... “I just looked at the final and was glued to the screen watching the depth and realism of the concept unfolding before my eyes...”

Solar Quest – Buhl Planetarium

Before you start storyboarding

Understand the three overlapping concerns of successful scientific visualization:

- Aesthetics/Drama/Cinema
- Realism/Believability
- Pedagogy – Does it teach?

Let’s look at three aspects of visualization content creation and fit them into this Venn diagram superimposed over a storyboard. First we have the aesthetics, the creative area of making it beautiful. Then there’s realism, important to the scientist, but not always having to be a necessary factor. You would not do a visualization of the Solar System to scale, since it can be explained better without that perfect realism. And then there is pedagogy... or simply, does it teach well? In real production life, we have found that aesthetics is most important because without it being done well, the other two areas will always fail. But we must obviously aim to hit the overlapping center of the diagram to meet our overall goal.

REALLY GET TO KNOW THE SCIENCE AND THE SCIENTIST

Be prepared to develop a solid relationship with the experts you have contact with... don’t try to sound like you know all about the subject... and get well versed in the subject beforehand.

This may sound incredibly obvious, but acquire as much knowledge about the subject as you can... but don’t try to be too much “in the know,” or sound like an expert. Our egos of wanting to sound knowledgeable can sometimes trap us. The best goal is to make the expert we are working with for the visualizations feel you are truly listening and comprehending. Ask if you might not be properly understanding what is being said: your ego will survive.

KNOW HOW TO RESEARCH THE SCIENCE

Thankfully Google is around today as our science library, since our experts are sometimes too busy to be available every time we need them. Learn to use Google well.

Research, research, and more research. The internet gives us access to a wealth of science material. There are even books available giving insight how to use Google more effectively. I really can’t stress this too much. Considering the amount of time and effort it takes to get to the finished visualization in our modern digital world, a mistake can really be a big deal.

Impact Earth – Houston Museum of Natural Science

“All representation relies to some extent on what we have called ‘guided projection.’ When we say that the blots and brushstrokes of the impressionist landscapes ‘suddenly come to life,’ we mean we have been led to project a landscape into these dabs of pigment.”

From Goebbels’ “Art and Illusion”

Much of what we think we see in anything or we design to be seen is supplied through our memory or our audience’s from somewhere else. In this quote from the book “Art and Illusions” the idea of using the basis
of what the audience may already comprehend, or has experienced before, is key to teaching something new. Setting up the new understanding using something that may already be part of our or our audience’s experience. I’ll explain a little later with an example using the poster visual shown here from a past planetarium show.

Dinosaur Prophecy – Houston Museum of Natural Science

“There is something about serendipity and the ‘happy accident’ that you can’t get on a computer... Every result must be thought of and programmed. It is often that unexpected happenstance that makes the shot real, and organic, and truly satisfying.”

Richard Edlund in “Art of Visual Effects”

Then there is the “happenstance” effect, as visual effects director Richard Edlund from Star Wars calls it, that “makes something real.” Now this is hard to design on purpose, but this you can more often reach by NOT locking yourself into the first idea or telling of the concept you come up with. Don’t get so attached to your approach that you don’t investigate further on in the production process. Let’s admit it, we creative-types get stuck on our “art.” And this can be difficult to overcome because of the amount of effort today’s complex digital pipeline involves if we have to change something during production.

WITNESS FROM IMPACT EARTH

Here is a scene [below] from the show, Impact Earth. The Houston Museum of Natural Science was digging up a 150 pound meteorite in a Kansas wheat field. The science team handling the dig said evidence pointed to a 10,000 year ago impact. So we came up with the idea of a witness seeing the impact. So what might be a good setting for the most drama? This connects back to the quote about working with something in our memories, something similar to what we’ve seen before. So obviously a clear dark moonless night, snow covered forest area for contrast... a lone paleo-Indian guarding his family’s camp as he warms himself by the fire. A nice setting from our imagination or is it something we’ve experienced before, maybe at a picnic or campout?

In our memory we begin to feel we are standing next to the lone witness by the fire. There is the serendipity of a few early shooting stars overhead and then the big meteorite dramatically and unexpectedly comes from behind the witness, and us as well in the audience. The wide spread of rocks found in this area says that a bigger one probably broke apart when it hit the atmosphere. So we visualize a bright event overhead. The meteorite’s light creates moving shadows enhancing the drama. This is an example of the “happenstance” approach in the tune of a surprise... so here we are creating drama by design and thus the storytelling becomes more effective.

http://homerunpictures.com/2015/KANSAS/KANSAS_400.mov

EROS MISSION FROM THE GREAT PLANET ADVENTURES

Here’s a scene [below] from the Great Planet Adventures, a possible NASA mission to asteroid Eros 443. We use views inside our spacecraft and outside to create nice pacing and also to facilitate cuts between scenes... the audience has learned to accept this from watching motion pictures and it still works in the immersive fulldome views although some may disagree. Our spacecraft is accurately created from International Space Station modules, the audience has seen pictures of the ISS so it is a recognizable form... well except maybe for the windowed bridge area in the front which was found in a junk yard on a desert planet [Star Wars pun], but again a recognizable spacecraft concept. To take advantage of our immersive view we employ a long zoom for dramatic fulldome impact. Now this particular task was a good example of the creative types working together with the technical people since we had to create special scripting for ever-more-detailed textures to achieve this zoom. Our Space Exploration Vehicle [SEV] down close to Eros is a real NASA design, so again a known. So our scene is partly made up of things the audience probably has seen before and accepts quickly. And for some of that needed unexpected serendipity, our astronaut at the end just has some fun at the end of his “bungee” cord by leaping off the asteroid at the end of his spacewalk.

http://homerunpictures.com/2015/EROS/Eros_sequence_400.mov

VENUS FLOATING SPACE STATION FROM THE GREAT PLANET ADVENTURES

So also from the Great Planet Adventures planetarium show, we have a visualization of a Venus floating space station, a real NASA concept [below]. Our station is a large circular ring, since space stations usually are rings, and in this case hanging from a recognizable weather balloon style rig. There is a long vertical strut like a kite’s tail for stability. And what about our shuttle craft for exploration? That has to be able to withstand the great pressures and corrosive gases of Venus’ atmosphere, so instead of looking like a space shuttle, it is more similar to a deep ocean submersible with portholes, like those submersibles that explore the Titanic wreck. So for this scene we have a lot of creative types working with engineers for future-like visualization, but still a lot of things similar to what the audience may have seen before.

http://homerunpictures.com/2015/VENUS/Venus_sequence_400.mov

THE SUN FOR SOLAR QUEST

For the Buhl Planetarium’s Solar Quest show, we needed to create a fulldome view of the surface of the Sun that worked effectively and believably along side the incredible images of solar activity being captured by the NASA Solar Dynamics Observatory [SDO]. This required five months of special technical scripting in Maya software using fluid dynamics for the effects and also creation of a special camera for rendering [so internally to the production, the technical married to the creative effort was very present]. Drama was added by having the audience pass under the various solar activity using the fulldome immersive view to its fullest effect. Pacing is obviously in-time-lapse to make the activity most dramatic. And maybe this particular visualization is even something that’s never been seen before as our title suggests.

http://homerunpictures.com/2015/THESUN/SOLARQUEST_Sun.mov

And that’s how we approach creating dramatic science visualizations at animation and visual effects studio, Home Run Pictures. You can see more of these concepts, the technical and creative working together, at the Fulldome @ Home Run Pictures website if you are interested...

http://www.homerunpictures.com/fulldome

Microcosm – E6S
Session abstract: In the visual arts, Composition is the placement or arrangement of visual elements within a work of art. While this is used predominantly for aesthetic effect it also a very powerful means of conveying a narrative, enhancing information, as well as guiding the audience's eye. In cinema, Composition has evolved into a part of the film language, and principles of 'crossing the line', the rule of thirds, and the 30 degree rule are all well understood by cinematographers. But how do these rules apply in a dome? This session will focus on the very challenging, yet relatively unexplored area of Composition in the Dome. How should images be arranged in the dome? How do audiences perceive images on the dome? How can composition in the dome be used to its best effect?

Mass Measurement of Eye movements under the Dome – Proof of Concept Study [id: 352]

Speakers: Dr Max Bielecki (pl), University for Social Science and Humanities, Katarzyna Potęga vel Żabik (pl), Copernicus Science Centre

Abstract: Mass measurement of fixation behaviours is a challenging task. Richard Shillcock and Cara Wase have proposed in their studies a novel way of capturing eye movements in a large group of students watching a video recording in a lecture. In their studies the lecture recording was interrupted systematically by a 15x15 grid of dark-on-light letters-and-digits presented across the whole screen. Participants wrote down the letters-and-digits they saw at that particular moment, and revealed the location of their fixation and attention. Their results show that the proposed methodology makes it possible to generate heat maps qualitatively resembling those created from conventional eye-tracking data and that visual attention of students was related in an expected way to the lecturer’s gestures. In our study we tested the feasibility of using a similar methodology to study eye-movements on a spherical screen during the live shows at the Heavens of Copernicus Planetarium.

Domography: Leading the eye around the dome [id: 226]

Speaker: Aaron Bradbury (uk), NSC Creative

Abstract: The storytelling effectiveness of any shot depends how well the audience’s gaze can be led towards the key story elements. But when the canvas is 360 degrees, how do you control where the audience is looking? How do you allow the audience to explore the dome independently and still maintain a narrative? By looking at some key examples, we’ll explore the different techniques we adopt at NSC Creative when designing our shots. Presented by Aaron Bradbury, Max Crow and Paul Mowbray
32. FULLDOME PRODUCTION: LEGACY OF FILM INDUSTRY

21 JUNE 18:15-19:15 / PROXIMA

Session abstract: The development of fulldome video projection systems has opened up new possibilities for playing movies on an entire dome, giving spectators an amazing experience of a brand new kind. Unfortunately, planetarium productions often fail to fulfil certain expectations on the part of audiences, accustomed to high-quality movies from traditional cinemas. Cooperation among specialists from different fields, such as science, art, astronomy, film, music and others, poses a great challenge but also offers a chance to stimulate one other, to share their passions rooted in different backgrounds and to create magnificent work. This new medium, while representing a great innovation, is at the same time a motion picture in the traditional meaning of the term. During this session we will talk about collaboration between director, producer and scriptwriter in creating a script, and about the universal movie language that can be used in planetarium productions and that could form a framework for the work of experts from various areas of movie-making. We will reflect on the benefits from the film industry’s great legacy and also discuss the possible convergence of large format films and fulldome. We will search for ways of turning a visit to a planetarium into a new experience.

Writing for Immersive Media [id: 217]

Speaker: Michael Daut (us), Evans & Sutherland

Abstract: If a picture is worth a thousand words, then an immersive image must be worth at least ten thousand. When creating a production for the digital fulldome medium or any immersive media, how should you approach writing the script? What considerations should be given to the medium? How can the producer, director, and scriptwriter work together to refine the script through production? In this workshop we will discuss answers to these questions and share specific fulldome examples.

Considerations about fulldome language and production techniques [id: 138]

Speaker: Fernando Jauregui (es), Planetario de Pamplona

Abstract: Based on our own experience and on the work of colleagues immersed in this fulldome environment, we present some tips about how to deal with our very special dome format. We’ll share with you our experience on designing fixed and mobile scenes, real filming and 3D animation, 3D and 2D embedded in 3D sequences... But also the importance of the sound design in every fulldome experience. Examples of good and bad decisions will be presented. The Pamplona Planetarium produces the shows we project and we are able to test them in our own dome with our public. We are creating a new R/V language and we think that sharing our experiences is very important in order to get some feedback on our productions, at least in the designing process.

Fulldome. Multidisciplinary platform for people from different backgrounds. [id: 189]

Speaker: Paulina Majda (pl), Copernicus Science Centre

Abstract: In my presentation I would like to focus on two different languages of film, namely fulldome and traditional cinema. The main issue is to show how these two film perspectives, with their similarities and differences, can stimulate each other, influence each other, interface and be complementary. Is it possible to create a multidisciplinary fulldome platform for people from different backgrounds, like science, art, astronomy, film, music and others, or does one maybe already exist? If so, the issue is how can we improve it and make it stronger for the future. Can an understanding and knowledge of the traditional cinema language be helpful or hampering for fulldome movie productions? How can the fulldome passion be stimulated in various people in many ways? How can we derive greater strength from each other and help in developing this beautiful yet difficult technology? This whole presentation is based on years of experience (2010–2015) in fulldome film production and working at the Heavens of Copernicus Planetarium in the Copernicus Science Centre in Warsaw.

Text: The main idea of my presentation “Fulldome: Multidisciplinary platform for people from different backgrounds” is to show how traditional film language may correspond with fulldome language and how the people from different professional backgrounds may create a strong team followed by a successful fulldome movie.

Year after year I observe how many talented people are joining the fulldome medium and I wonder how does it happen that professionals from various disciplines: filmmakers, astronomers, artists, scientists, film animators, musicians, actors, sound designers, natural scientists and many others meet under the dome. Is it just curiosity for the still-new fulldome medium, or is it maybe something more? We all look at the dome sky and try to fill it with our own sounds and visions of the universe and humanity beauty. This unique diversity of human personalities and backgrounds shows the mystical power of the dome space and the huge potential of fulldome technology and of immersive cinema as a whole.

At present I work at the Production Studio at the Heavens of Copernicus Planetarium in the Copernicus Science Centre in Warsaw, and cooperate with a team consisting of six people. Members of our team come from different professional backgrounds, and their previous experience has an influence on our working process, giving us fulldome producers various kinds of perspectives to draw upon. The mission of our studio is to involve knowledge about science and about the beauty of our world. We would like to show people how amazing it is to feel immersed in the dome space and provide a wide range of visual or sound experiences under the dome. We also try to break through the stereotypical thinking about planetariums in Poland, as they are still very often associated with archaic motionless presentations of astronomical subjects.

The audience, no matter if it’s a planetarium or a traditional cinema audience, is in a sense always the same. First of all, people want to be a part of the movie and they need to feel engaged. Our task, as producers, is to find the best way to reach out to our audience. The cinema language which they know from the life experience can be very helpful and can make fulldome shows easier to watch and understand, the story easier to follow and simply to enjoy.
When you look at the picture above you see the most obvious but at the same time the most particular difference between fulldome and traditional film: the different shape of frame makes you feel a little bit torn between fulldome and cinema language, especially in the beginning when you come into the fulldome industry.

Working on “Dream to Fly” and “Hello Earth” we’ve learned that keeping the right balance between film and fulldome language might be a keynote for fulldome producers. We’ve also learned that strong team cooperation and good communication between filmmakers, scientists, astronomers and people from different professional backgrounds is crucial and may bring rewarding results for everyone – the creators, and more importantly, the audience.

Leave Fulldome to the Pros [id: 52]

Speaker: Adam Majorosi (de), stargarten

Abstract: While Fulldome technology has – hardware-wise – boosted planetariums into the 21st century, Fulldome content has by far not kept pace. Most FD productions world-wide are neither entertaining nor educative, often simply poor. In the medium-term, they will not compete with the rest of the fast developing media /interactive world. Major reasons for this include a lack of professionalism at most of the planetariums in terms of production, and a false self-conception. This may sooner or later spoil the potential of public Fulldome, if there is no change in attitude. This presentation will give hints for understanding the problem in detail and suggest alternatives for how to develop a wide range of professional content for the sake of the planetariums’ benefit.
In our new show, we do not simply give a popular explanation of these phenomena and tell the history of their study, but also present quite impressive fulldome imagery of them, created using numerous photos, videos, pictures and eyewitness descriptions. This is a very emotional part of the show, which, we expect, will grab viewers' attention quite intensely. Through the emotions, through great interest, we prepare the viewers for understanding the physical processes underlying the phenomena described in our program.

**Earthquakes and tsunamis [id: 48]**

**Speaker:** Iryna Filipova (ua), Donetsk Planetarium

**Text:** Our human civilization is developing, our cities are growing, the population is increasing. People are becoming more tightly arranged in space. In some places in the world, millions of people are now living where there once were tens of thousands. Moreover, some such urban concentrations have arisen in the areas of tectonic activity, located for instance in Indonesia, Japan, Turkey and other places. Modern science tries to predict where earthquakes may soon strike, but to date it unfortunately remains not very successful at doing so. Earthquakes which occur on the ocean floor are usually followed by a devastating tsunami, and this is very crucial for the island states. Therefore, it is important to provide timely warnings of impending disaster. We assume that many people are acutely interested in better understanding these phenomena.

In our new show, we do not simply give a popular explanation of these phenomena and tell the history of their study, but also present quite impressive fulldome imagery of them, created using numerous photos, videos, pictures and eyewitness descriptions. This is a very emotional part of the show, which, we expect, will grab viewers' attention quite intensely. Through the emotions, through great interest, we prepare the viewers for understanding the physical processes underlying the phenomena described in our program.
The Man from the 9 Dimensions [id: 263]

**Speaker:** Dimitris Kontopoulos (jp), National Museum of Emerging Science and Innovation

**Abstract:** The Miraikan Dome Theater’s latest movie is about the “Theory of Everything”: the ultimate quest of physics to describe all natural phenomena by a single, consistent theory. We knew from the beginning that we had to take an innovative approach to this challenging topic. This is why we asked Takashi Shimizu, a Japanese movie director known for his horror movies (Ju-on: The Grudge) to direct our project. With his expertise in making memorable film experiences and by collaborating with one of the most talented CG teams in Japan, as well as experts in scientific data visualization, this project became a unique gathering of professionals from many different fields. This film seamlessly fuses live action scenes with mesmerizing CG in order to guide you through the esoteric world of theoretical physics in a way that tries to redefine what can be expressed in the planetarium.

**Text:** This project started from a desire to remind everyone of the awe-inspiring, intellectual adventure to interpret how everything in the Universe works that has continued on for more than 3.000 years. The quest to answer all our questions, including the birth of our Universe, still goes on. Will we be able to understand everything one day? No one knows, but that does not deter the search for more and more answers.

This film deals with difficult concepts like elementary particles, the birth of the Universe, extra dimensions and strings. From the beginning we knew this would not be an easy film to understand completely. Rather than trying to explain every single detail, we decided to create a film that would speak to the senses of the audience, and hopefully awe and inspire them to continue the search for knowledge.

To achieve these goals, we made some very important decisions. The first was to explore and create new expressions and staging methods for the dome theater. So, we collaborated with Mr. Takashi Shimizu, a well-known horror movie director whose movie “The Grudge” (2004) was number 1 for two weeks in the U.S. box office. This film of course is not a horror film, but we believed that although Mr. Shimizu had no experience in directing fulldome films, his techniques used in his previous films could be adapted to the dome in order to provide a new experience to the audience.

The second decision had to do with the visualization of all the abstract concepts that we introduce in this film. In collaboration with the Motion Graphic Artist Mr. Synichi Yamamoto, who has received several awards (e.g. Promax BDA America Broadcast Design Award) and among other projects was in charge of the motion logo for Sony Music, we created a new visual vocabulary for science films. Since the main concepts of our film have no precise appearance we were free to take an artistic approach that reaped unprecedented outcomes. The computer graphics of our film are not just beautiful to watch, each visualization was based on scientific facts that explain each concept we introduce, and we have Prof. Hirosi Ooguri, a superstring theory expert from the California Institute of Technology, to thank for all his valuable advice on this topic and for his guidance throughout production.

The last decision we made was to focus on science data visualization as well. Superstring theory is a big part of this film, but because it has not been confirmed yet, we wanted to introduce real scientific data in order to strike a balance between what has been confirmed and what has not. That is why we collaborated with CERN in order to acquire data from the collisions that produced the Higgs particle and with Harvard University in order to acquire the “Illustris Cosmological Simulation Project” data, the most accurate simulation of our Universe so far which we turned into a 1.2 billion particle scene specially designed for our film.
Visualization of the collision that produced the Higgs particle. Data from CERN.

During production we faced several challenges that lead to some creative solutions/outcomes. i) Shooting with a fisheye lens. Shooting with a fisheye lens was especially difficult for some outdoor scenes, yet the director came up with ideas on how to incorporate the whole dome to make the acting more interesting. ii) Test screenings. The system of our dome theater is quite old and slicing was taking too long each time we wanted test screen a clip. To save time, the R&D team developed a virtual dome using the Oculus Rift and that made for smoother test screenings. iii) Fitting all the content into 30 mins. In order to present this very challenging topic, we could have made the mistake of continually adding content and explanations. Instead we strove to discover the best mix of science, art and entertainment that could fit within 30 minutes.

Space-time quantum fluctuations and virtual particles.

Even though this film’s topic is challenging, the attention from the media (magazines, newspapers, websites) and the reaction of the viewers as received in questionnaires, show that experts and audiences alike have embraced this unique collaboration between professionals from such different fields.

Production webpage: http://www.miraikan.jst.go.jp/sp/9dimensions/en

34. FULLDOME ON A SHOESTRING

23 JUNE 14:30-15:30 / SUN

Session abstract: In theory, there are a great many tools available to create impressive rendered fulldome content, but individual planetariums often have to balance their ambitions with the realities of not having a studio at their disposal. The relative rarity of fulldome venues, the geometry of the projections, the demands of digital systems, software and hardware concerns, and many other factors sometimes make the prospect of trying to create content rather daunting. IPS is the best place to talk about our difficulties! Session panellists will share some of their experiences entering into this strange arena as individuals rather than as part of a studio, but primarily as a way to begin a proper discussion with the audience. We invite everyone – from the absolute beginner just thinking about creating... something, to the self-taught expert who might have the solution to a hundred problems plaguing everyone else – to join us and participate in a community of people trying to create fulldome on a shoestring.

Fulldome on a shoestring [id: 372]

Speaker: Dr Edward Bloomer (uk), Royal Observatory Greenwich

Text: The objective of this session was to provide a discussion space for members of the IPS community engaged in creating, or with ambitions to create, fulldome assets without the levels of available resources typical of a traditional production studio. No particular hardware or software solution was prohibited, though the inherent bias was towards low-cost, or “shoestring” solutions.

A panel of speakers was assembled (Oana Jones, Thor Metzinger, Bartosz Dabrowski, Tom Kerss) to initiate conversation and anchor discussions with specific examples, but audience participation was strongly encouraged and two-way conversation between the audience and panel developed quickly. The session was held in the Heavens of Copernicus planetarium, allowing the use short clips by panellists to illustrate particular methods, processes or outcomes from their own work.

Audience reaction was largely positive, though the most valuable discussions were possibly held after the session itself had concluded. As stated, the objective was to truly discuss the opportunities for and difficulties of low-cost production, and the concentration on practical solutions to common problems. The intention was to avoid a standard “lecture” or “reportage” format. Though no tangible method of assessing the session had been devised, one outcome was the creation of a Facebook group “Budget Planetarians” to allow interested parties to discuss related matters further, and develop a community of like-minded individuals and institutions.

The main conclusion was that there is an appetite within the planetarium community for workshops concentrating on practical skill-swapping and specific solutions. We believe similar sessions (or even more targeted workshops from particular applications like Blender, for example) at the IPS2018 conference would be a welcome strand of programming to sit alongside demonstrations and lectures, and could
Thinking outside the Dome: Full Dome on a Shoestring

Olsztyn the City of Nicholas Copernicus [id: 24]

**Speaker:** Dr Bartosz Dabrowski (pl), Olsztyn Planetarium and Astronomical Observatory

**Abstract:** Olsztyn, the City of Nicolaus Copernicus’ is the first full-dome production by the Olsztyn Planetarium and Astronomical Observatory. The film shows the charms of historic and contemporary Olsztyn. In the first part we are taken on a journey through time. From the charming scenery of the old, “Copernicus” cinema we move to Olsztyn of the late nineteenth and early twentieth century. We may admire how the town looked at that time and how its inhabitants lived. Some parts of the city no exist anymore, but some places, buildings and monuments are recognizable. Returning to the present day, we have the opportunity to walk through the streets, squares and parks and to observe the monuments rebuilt after World War II. We have the chance to enjoy a fascinating peek into some interesting buildings.

**Text:** The film shows the charms of historic and contemporary Olsztyn. In the first part we are taken on a journey through time. From the charming scenery of the old “Copernicus” cinema we move to Olsztyn of the late nineteenth and early twentieth century. We admire how the town looked like at that time and how its inhabitants lived. Some parts of the city don’t exist anymore but some places, buildings and monuments are recognizable. Returning to the present day, we have the opportunity to walk through the streets, squares and parks and to observe some monuments rebuilt after World War II. We are able to enjoy a fascinating peek into some interesting buildings.

The distinction between historical and modern point of view on Olsztyn in our fulldome show was emphasized with the music composed by Robert Letkiewicz. It invokes the music of the late 19th and early 20th century.

The fulldome show was made by Olsztyn Planetarium team in the performance of its duties. Because we were not equipped with a render farm, the whole editing process took quite a long time (we had only 5 computers). The following software was used in the production process: Blender (3D models), Adobe After Effects, and Photoshop.

Allskies were made with Canon 400D camera with lens Sigma 18mm f/2.8 FISHEYE set on Panoramic Head (Nodal Ninja) on a tripod. In this case allskies were combined from 7 pictures. On the other hand, time-lapses were made with Canon 6D camera with Lens Sigma 8mm f/3.5 FISHEYE set on a tripod. Images were taken with 2–5 seconds breaks. They were later combined into a time-lapse movie. Time-lapses were taken during a trial and error process, because we did not have enough experience with carrying them out. Before the editing, they were tested many times, both under small dome (2,0 m) in our studio and under bigger one (15 m) – projection hall in planetarium.

The international premiere of the show took place at the Central European Fulldome Festival Brno on April 14, 2015.

Olsztyn, the City of Nicolaus Copernicus
Produced by: Olsztyn Planetarium and Astronomical Observatory

**Screenplay and realisation:** Dariusz Madaj
**Music:** Robert Letkiewicz
**Animations:** Dariusz Madaj, Krzysztof Zaskórski, Dariusz Prokopczuk, Maciej Wolff, Natalia Oliwiak
**Photos:** Dariusz Prokopczuk
**3D models:** Krzysztof Zaskórski, Maciej Wolff
**Text:** Mariusz Jurak, Jacek Szubiakowski, Agnieszka Zbanyszek, Dariusz Madaj
**Genre:** History
**Release date:** December 2014
**Type:** Feature show
**Long version runtime:** 42 min
**Suitable for:** general audience
**Target audience:** from 10
**Video format:** fulldome
**Resolution:** 2K
**Frame rate:** 30 fps
**Audio format:** 5.1, stereo
**Available languages:** Polish, English
**Show orientation:** yes

Thinking outside the Dome: Full Dome on a Shoestring [id: 173]

**Speaker:** Oana Jones (nz), Otago Museum

**Abstract:** Fulldome format is a specialised, difficult and often expensive medium for which to produce content. Projector speed and resolution have been consistently ahead of the capabilities of film and equipment, forcing a lean towards CGI content and making it difficult and expensive to produce shows. As technology evolves, projects in gaming, film and animation are becoming easier to realise on a shoestring, and those same techniques can now be utilised for making fulldome content cheaper, faster and better. At Otago Museum, we planned delivery of two in-house shows for our planetarium launch. With no other planetariums in the area, an in-house staff of two and access to only three computers, the task was seemingly impossible. In this presentation we will outline the hows and whys of developing content, from creative use of staffing, equipment and software, to our initial ideas, development documentation, decision-making, design and implementation.

**Text:** In theory, there are a great many tools available to create impressive rendered fulldome content, but individual planetariums often have to balance their ambitions with the realities of not having a studio at their disposal. The relative rarity of fulldome venues, the geometry of the projections, the demands of digital systems, software and hardware concerns, and many other factors sometimes make the prospect of trying to create content rather daunting. IPS is the best place to talk about our difficulties! Session panellists will share some of their experiences entering into this strange arena as individuals rather than as part of a studio, but primarily as a way to begin a proper discussion with the audience. We invite everyone – from the absolute beginner just thinking about creating... something, to the self-taught expert who might have the solution to a hundred problems plaguing everyone else – to join us and participate in a community of people trying to create fulldome on a shoestring.
35. GETTING THE CONTENT
20 JUNE 15:15-16:15 / PROXIMA

Session abstract: Making quality content for fulldome productions generates high costs. During this session we will present different examples of ways of acquiring content on a highly affordable budget. We will explore, for example, how to produce a low-cost full dome movie in which we can combine the mainstream live-action documentary techniques used by professional documentary filmmakers with specialised fulldome filming. We will also examine a lot of techniques for connecting real world pictures with planetary software programs, considering their capabilities and restrictions. Finally, we can reduce the costs of our shows by employing an astronaut from the International Space Station as a fulldome movie maker – another good idea for saving our budget.

Mainstream live action documentary production techniques for fulldome [id: 222]

Speaker: Ravi Kapur (uk), Imperative Space

Abstract: As story telling in fulldome has continued to evolve and high resolution filming costs have fallen, the opportunity has arisen to converge mainstream live action documentary techniques with specialist fulldome filming. In this session, UK-based production company Imperative Space, whose work includes television and feature documentary films, presents segments from a recent full-length live action fulldome documentary, following the work of scientists and engineers working on the development of the ExoMars mission. The session will discuss how this production converged television, cinematic and full dome techniques to produce a compelling live action fulldome film for a highly affordable budget. The session will be presented by Ravi Kapur, managing director of Imperative Space and producer/director of ‘Aurora: Europe’s Journey to Mars’

Making of: Closer to the Stars [id: 110]

Speaker: Pavel Karas (cz), Brno Observatory and Planetarium

Abstract: Producing a fulldome show in low-cost conditions is a challenging task. Due to small budget, it is not possible to build fully rendered 3D scenes from scratch. On the other hand, popular low-cost solutions such as timelapses captured by a fisheye camera are not sufficient for a full-length show. Therefore, we are looking for new ways of creating fulldome content. The show ‘Closer to the Stars’ is the first result of our efforts, based on a combination of scenes rendered with the SkyExplorer software framework and real-world images captured by various imaging systems. In our presentation, we will show some of techniques used in production and discuss their advantages, drawbacks and limitations.

INTRODUCTION
The basic concept of Closer to the Stars is to show how a dark sky looks like from remote places on Earth and how this view compares to what we experience in cities. We therefore decided to use as much real footage as possible, in order to provide a realistic impression. The material for the film was acquired in various locations on our planet, from big cities such as Prague and Paris, to villages and countrysides of the Czech Republic, to remote places, namely the Canary Islands, Namibia and Cook Islands. The film was released in October 2015 and was well received by the audience, having 7000 spectators within two months of projection.

VIDEO PRODUCTION
Computer Graphics versus Reality.

The digital planetariums are nowadays equipped with complex projection systems suitable not only for playback of pre-rendered shows but also for creation of own 3D scenes, using built-in production tools. For example, the digital system by RSA which is used in our planetarium contains the SkyExplorer V3 framework [2] with a precise physical model of the Universe, detailed textures of planets and a scripting system. This allows users to program their own scenarios directly, without needing to design objects and textures. However, each computer model is only an approximation of reality. For example, due to the limitations of ray tracing, the objects lit by indirect light sources such as the Moon do not cast any shadows. For the same reason, the light of the Moon does not disperse in the Earth’s atmosphere. This leads to rather unrealistic appearance of certain scenes (typically a night landscape lit by the Moon). Although this particular issue is a subject to change in the new version of the software, we think it is essential for users to know limitations of their framework in order to tune 3D scenes for a more realistic look.

Figure 1. Left: A moonlit landscape of the Grand Canyon, rendered in SkyExplorer V3. Right: The same scene after adding a sky gradient and blending with a day scene.


For obvious reasons, the set of built-in objects and textures provided by a digital planetarium framework is limited to space bodies and does not contain real-world objects such as trees, buildings, etc. However, when no camera movement is needed, this can be overcame by combining a computer model with photography. For example, a 360° panoramic photograph can be used as a foreground and combined with a prerendered sky. This allows us not only to set the parameters of the starry sky according to user’s needs (and not according to actual outdoor conditions) but also to simply include animations typical for the planetarium framework, such as constellation lines and figures.
**Timelapse**

Timelapse is a very popular technique for fulldome video production. It does not require any special hardware or software: the only tools needed are a digital camera with a circular fisheye lens, a tripod or a slider, an automatic or programmable shutter (often built-in in a camera) and eventually a photo-developing software. On the other hand, it is relatively time-consuming, especially when speaking about nighttime timelapse, because it takes at least several minutes of shooting to create one second of video. A slider can introduce a significant dynamism into a timelapse, so 30% of timelapses we acquired for the film were taken from a slider rather than from a tripod.

![Figure 2. A DSLR camera with a fisheye lens on a slider (photo courtesy: Pavel Gabzdyl).](image)

**GoPro Rig**

GoPro and small sport cameras in general offer a very popular lowcost solution for outdoor video production. They have come to be used in fulldome production for their durability, water resistivity and decent picture quality [3]. The cameras themselves have a large field of view, comparable to that of a diagonal fisheye lens. For a fulldome video, however, at least four cameras have to be mounted to a special rig and the videos have to be subsequently stitched together. Commercial solutions are available nowadays, offering different kinds of rigs suitable for different conditions (a stereographic 3D video with a complete 360° view requires up to 12 cameras). We have built our own rig suitable for mounting on a car which was used for shooting outdoor scenes on the Canary Islands. The main drawback of this approach is the complicated stitching process. The gaps between the cameras inevitably cause a parallax error. Hence, this technique requires that all objects should be sufficiently distant from the camera rig (i.e. tens of meters away).

![Figure 3. A single frame from a video taken by 4 GoPro cameras mounted on a custom car rig (see the small picture in the top for a detail).](image)

**Aerial video**

Drones are also getting more and more popular among photo- and videographers. They allow a camera to be positioned at a point high above the scene, which introduces new views to video production. However, advanced drones which are fully stabilized and can carry heavy cameras are still in hands of professional companies, which are usually required to have a special license to operate such devices in an aeroplane space. We are now cooperating with the UpVision company [4] and testing this method for the sake of producing a new film about the region where our planetarium is located. It should be noted that the body of the drone itself limits the camera view significantly. This has to be taken into account during shot design.

**CONCLUSION**

In this paper, we have discussed several methods suitable for a fulldome video production, with special respect to approaches which are accessible to planetariums. We note that high budget production by professional companies plays and will play an important role in the market and this should be the case. However, we think it is useful for planetariums to be able to produce their own shows, in order to bring their own ideas into effect.

**REFERENCES**


**Planetarium Footage from the International Space Station [id: 122]**

**Speaker:** Shaaron Leverment (uk), The British Association of Planetaria

**Text:** Tim Peake is the UK’s first official ESA astronaut to visit the International Space Station, and the UK are celebrating this in style with various educational, interactive and inspirational projects to get everyone involved and interested in his mission.

Tim will be returning from the ISS at the end of June 2016. In the run up to his launch, NSC Creative have produced some short fulldome and standard format clips to support live presentations in the dome. While in orbit, Tim will be attempting to produce some fulldome footage from the ISS to support our education of what it is really like to live and work in space.

It is our hope that, in time for the conference, we will be able to showcase the content – hot from the ISS – that will of course be freely available.
36. IMMERSIVE STORYTELLING

21 JUNE 17:00-18:00 / SUN

Session abstract: Humans have always been trying to create immersive experiences. Starting from cave paintings, through playwrights, art, motion picture and surround sound, we have always sought to find the most engaging way to tell our story. Each of these media types has its own language, its own rules. The development of fulldome projection techniques followed by the invention of VR displays has opened up an opportunity for new virtual reality experiences. Having a much stronger influence on viewers, these technologies can make them believe they are actually immersed in a virtual world. A new visual and storytelling language need to be developed to facilitate the best use of new immersive media. This session will focus on immersive storytelling techniques and lessons learned to share with other producers.

Jules Verne Voyages [id: 64]

Speaker: Ralph Heinsohn (de), Ralph Heinsohn / Rocco Helmchen / Tobias Wiethoff

Abstract: Jules Verne Voyages – Three journeys through the ‘impossible’ is a new pre-rendered fulldome show centered around the works of Jules Verne. It consists of three fulldome episode movies by three independent fulldome film producers (Ralph Heinsohn / Rocco Helmchen / Tobias Wiethoff). The fulldome episodes are three individual interpretations of JV’s work with immersive fulldome CG artwork and they are framed by a story that sums up both novels ‘Journey to the Moon’ and ‘Journey around the Moon’ by Jules Verne, in the style of a visual radio play. Within the ‘moon books’ there are three main characters who take up the adventure of the first flight to the moon in the 19th century – and back. Their adventure bears a certain resemblance to the enterprise of this new type of production model – the collaboration of three individual fulldome artists with three individual episodes into one big fulldome show.

What does it take to make the stars shine? [id: 216]

Speaker: Paul Mowbray (uk), NSC Creative

Abstract: Making of We Are Stars the latest award-winning planetarium and VR film from NSC Creative. A focus on immersive storytelling techniques and lessons learned to share with other producers. Presented by Paul Mowbray, Producer and Max Crow, Director.

Making of Incoming! Asteroids, Comets, and Life [id: 232]

Speaker: Ryan Wyatt (us), California Academy of Sciences

Abstract: Asteroids and comets have collided with our planet throughout its history, changing the course of life on Earth and shaping the world we know today. But their full story includes many twists and turns—from power-law distributions to planetary migration! So how to tell a compelling, data-driven story? This presentation will reveal some of the challenges faced by the production team at the California Academy of Sciences in producing their most recent fulldome show, “Incoming!” The show explores the past, present, and future of our solar system and the landmark discoveries made by spacecraft scouts visiting these tiny worlds. But most importantly, it attempts to weave together a complex narrative that interprets the latest data in the framework of life on Earth. From visualizing planetary accretion to recreating the Chelyabinsk bolide event, the data-driven scenes underscore the idea that these tiny objects tell us more about ourselves.
ART UNDER THE DOME (BUILDING GLOBAL CONSCIOUSNESS, CHALLENGES IN REACHING THE AUDIENCE)

23 JUNE 11:45-12:45 / PROXIMA

Session Abstract: Dome is a unique immersive environment which is also a great space for art. In this session we look for examples of conscious and justified usage of the planetarium space to present art. What can we learn from cohesion of art and the planetarium will be a subject of the session.

From Astronomy to Art [id: 170]

Speaker: Véronique Dubois (fr), Planetarium de Nantes

Abstract: It is not uncommon in astronomy that scientific images reward us with true masterpieces – beautiful images that are sometimes difficult to comment about since they relate to specialized areas. From this sprang the idea of creating aesthetic content from real data. A scientifically valid image can be transformed into a work that will please the eye. The atmosphere thus created is transcended by a sound illustration. The mixture of mathematics, geometry, astronomy, and poetry creates an uncommon visual experience.

Digital Art [id: 85]

Speaker: Chris Lawes (us), Fulldome.pro

Abstract: As a new media format, fulldome theater provides a multitude of possibilities for art and creative people. The dome screen is used as a canvas to surround and immerse the audience in the artwork. No longer constrained by a traditional frame or screen, artwork can fully engage the audience, capture the people’s attention, promote better understanding of the content and even awaken deeper feelings. Digital exhibits are animated and presented in fulldome format, so that the visitors are led from one art work to another, from smaller elements to prominent new imagery.

Based on SAMSAKARA show by Android Jones, THE BEST SHORT SHOW on FISKE FULLDOME FESTIVAL, 2015

Music, Art, and Technology: Innovation under the Dome [id: 74]

Speaker: Danielle LeBlanc (us), Charles Hayden Planetarium, Museum of Science, Boston

Abstract: The team at the Charles Hayden Planetarium at the Museum of Science in Boston have collaborated with a number of partners to offer nontraditional experiences to new Museum audiences. From live music events under the dome, VJing and other video events, experiments with interactive gaming, and bringing art pieces and student works to the dome, come hear how we’re helping to push the fulldome medium forward into new territory.
Session Abstract: Even despite recent advancement in technology, close collaboration between planetariums is still a challenge in many aspects. However, such cooperation may create a brand new possibilities for the popularization of science. Live full-sky images from distant places, simulcasted lectures, financial cooperation, domecasting – such things can greatly enhance what several planetariums each have to offer and further promote the popularization of astronomy. We will present some examples of successful collaboration between planetariums. While discussing what has already been achieved, we would like to focus mutual discussion on working out a roadmap for such collaboration.

Domecasting Live – Sharing Content Across Continents [id: 104]

Speaker: Daniel Arnberg (se), Sciss AB

Abstract: For digital planetariums, the most common collaboration around content has been through the production and distribution of fulldome films. Through the advent of domecasting, we now see how a technology is transforming this existing paradigm. The possibility to share content and presentations has just started to become a reality, and more and more planetariums are signing up to use the technology. For example, Adler Planetarium will continue domecasting their series of Kavli lectures in 2015. In this session, we explore the collaborative approach to domecasting, share successful and unsuccessful use cases, and discuss the potential impact ranging from the future of content production to professional development.

Live Full-sky images in a dome [id: 179]

Speaker: Tadashi Mori (jp), Informatique LLC

Abstract: A system that allows people to watch nearly live full-sky images from distant places. At Galaxcity in Adachi city, Tokyo, visitors to the planetarium can watch celestial images from Atacama in Chile, Subaru observatory at Hawaii and Kiso observatory. We will show how it works, how we use it and how people enjoy it. This presentation will be made jointly with Galaxcity in Adachi city.

The Kavli Fulldome Lectures: Domecasting and Future Planetarium Collaboration [id: 212]

Speaker: Dr Mark SubbaRao (us), Adler Planetarium

Abstract: The combination of a world-class science communicator backed by state-of-the-art immersive, fulldome visuals is an extremely powerful experience. Unfortunately constructing these experiences is both technically challenging and time consuming. Also given the limited seating of the planetarium we are only able to reach a relatively small audience with each lecture. A collaboration between the Kavli Foundation and the Adler Planetarium solves the production side of the ‘business model’ problem. The Kavli Foundation helps identify and recruit world class science communicators from their institutes while also providing funds for the lecture’s production. This funding enables the Adler’s visualization team to spend significant effort creating high quality custom visualizations for the lecture. To extend the reach of these lectures we are using domecasting technology to simulcast the lectures to other planetariums. The domecast allows us to expand the audience for each lecture from a couple hundred to a couple thousand people.
39. USER GENERATED CONTENT

21 JUNE 17:00-18:00 / PROXIMA

Voices from the Dome[id: 377 & 55]

Speakers: Loris Ramponi (it), Centro studi e ricerche Serafino Zani, Susan Button (us), Quarks to Clusters

Abstract: During this workshop you will learn about a new idea. We want to collect your voices! This new project is designed to create a database of planetarians’ voices, speaking in their native languages. This isn’t a competition. Every planetarian can contribute to this copyright-free digital archive that will be made available on the IPS website. These audio files can be used during a live planetarium show under the dome. In our field there is a common practice to share video files, while we don’t often share audio files. It is a pity! Imagine an Audio User Group that shares audio files of astronomical commentaries.

Text: This project is designed to create a database of planetarians’ voices, speaking in their native languages (*). Every planetarian can contribute to this copyright free digital archive that will be made available on the IPS website. These audio files can be used during a live planetarium show under the dome. In our field there is a common practice of sharing video files, however we don’t often share audio files. It is a pity! Imagine an Audio User Group that shares audio files of astronomical commentaries. We would like to collect your contribution; it is very easy to collaborate.

HOW CAN THE AUDIO FILES BE USED?

All planetarians, mainly during a live show, use the same full-dome image; we all present our beautiful night sky projected by the starball or digital equipment. The project “Voices from the Dome” suggests creating live shows not only using different images projected on the dome but also original and creative short sentences from different colleagues. The audience can listen to each mp3 registration after a brief introduction. The speaker, for example, can introduce and comment on each “voice” during a live show; taking about the content of the audio file and the name of the author, institution, city, state or country.

We suggest you listen to only a few seconds of the registration with the audience when it isn’t in the language of the audience; just enough to listen to the “voice,” and then you can describe, in the language of the audience, the content of the sentence (or project on the dome the main part of the text).

It is very easy to prepare a show using these audio files. When a wide audio database becomes available there will be enough to choose a subject or a geographic area of the “voices” to select a list of audio files (as in the past you selected a list of slides for a program) and introduce each “voice” to the audience (or translate the meaning when files of different languages are used) during a special planetarium show. If the audio quality isn’t good enough you can decide to read the text aloud again with your own voice.

Small or mobile planetariums can easily use these files too with just a mobile phone or a computer, on which the files are stored, and a speaker box.

Any kind of topic could be interesting; we are looking for a short comment like an astronomical “tweet.” We suggest an audio file of 3 minutes maximum length.

EXAMPLE OF SUBJECTS:

We are specifically looking for comments that are connected with the classical night vision of the sky, the sky projected by any planetarium, for example:

- Welcome to the Planetarium in various languages.
- Descriptions of celestial bodies and other phenomena visible with the naked eye. Classic planetarium topics (Polar star, apparent movement of the sky, constellations, seasons, equinox and solstice and so on).
- Planetarian personal memories.
- Funny, curious, or interesting facts or events found under planetarium domes and the night sky.
- Original astronomical commentaries and descriptions.
- Curious and original questions from the audience.

Imagine a show devoted to one of these subjects using “voices” and commentaries from different countries. For example: “4 seasons, 4 continents.”

Our goal is to collect audio files from all over the world (Africa, the Americas, Australia/Oceania and Eurasia) and make them available for you in the Free Media section of the IPS website. We look forward to your being a frequent contributor (addressing a variety of topics) to this database!

PLEASE SEND US AT LEAST ONE AUDIO FILE (OR, EVEN BETTER, MORE THAN ONE!).

PLEASE INCLUDE THE FOLLOWING INFORMATION WITH EACH AUDIO FILE:

- Name of the author, Institution, City, State or Country.
- The text of each audio in English.
- The audio file in mp3 format (max 3 minutes for each file). Please make a special note to inform us when the audio is written and read aloud in a local dialect (and indicate the geographic area of the dialect).

(*) If you like the idea, the text of your audio could also be written and recorded in a local dialect (for example not in the language of your country, but for example in a local dialect used in your city). During our workshop, an English translation of the audio file will be projected during the listening.

Also, we suggest that you inform your local newspaper that a text written in your local dialect will be posted on the International Planetarium Society website. Usually local newspapers are looking for original news. Your contribution will also be publicized in the IPS journal, the Planetarian.

CURRENT AUDIO FILES

We already have examples of some audio files for a very young audience. For the general public the sentences can be longer, but we suggest not more than 3 minutes.
Free Planetarium materials from ESO and ESA/Hubble [id: 103] & [id: 197]

Speaker: Luis Calcada (de), ESO

Text: ESO’s Education and Public Outreach Department (ePOD) has always been committed to providing the community with free and high quality audiovisual materials. In fact, ePOD was among the first to produce and distribute HD, Full HD and, most recently, UltraHD 4k content. As ESO embarks on the adventure of operating the new ESO Supernova Planetarium & Visitor Centre, this commitment has expanded to the production and distribution of planetarium resources, including 3D models, fulldome stills, clips and shows.

Apart from distributing our own productions, we also offer free hosting of third-party productions and clips (through our Content Distribution Network powered by our partner cdn77.com). Producers agree to our Creative Commons distribution model and in return enjoy access to the global audience of fulldome planetariums. The free material is especially important for planetariums without large licensing budgets. Selected free content will be shown in the dome as part of this presentation.

Title: Voices from the Dome [id: 377]

Speaker: Loris Ramponi (it), Centro studi e ricerche Serafino Zani

Abstract: During this workshop you will learn about a new idea. We want to collect your voices! This new project is designed to create a database of planetarians’ voices, speaking in their native languages. This isn’t a competition. Every planetarian can contribute to this copyright-free digital archive that will be made available on the IPS website. These audio files can be used during a live planetarium show under the dome. In our field there is a common practice to share video files, while we don’t often share audio files. It is a pity! Imagine an Audio User Group that shares audio files of astronomical commentaries.

Title: Enjoying fulldome movies, in movements of user-generated contents in Japan [id: 126] & [id: 129]

Speaker: Shusaku Tago (jp), niconico Planetarium Club, Shinji Toyomasu (jp), Toyohashi Audio-Visual Education Center

Text: In 2007, Hatsune Miku (VOCALOID) was born in Japan. Japanaese people loved her sweet voice and cute appearance, and started to create various user-generated content (UGC) featuring her. One of those UGCs was MikuMikuDance (MMD), a freeware 3DCG animation tool. The MMD user community created a wide variety of materials, including 3D models and motion data, and shared it for free. And now, MMD is quite popular for amateur movie creators in Japan, because it is easy to use. As seen here, Hatsune Miku has been accelerating UGC movements in Japan. The Niconico Planetarium Club was founded in 2013, to support creators of fulldome movies. One of our members developed a plugin for MMD to render fulldome movies on MMD, and that plugin allowed the easy creation of fulldome movies.

MMD became quite popular for amateur movie creators in Japan because it was free and easy to use. The MMD user community has been active in the creation of a wide variety of materials, including 3D models and motion data. These materials are not limited to Miku, but include a host of original characters. Clearly, Miku has been an important accelerator of UGC movement in Japan.

NOTE: In most cases, the commercial use of MMD materials is prohibited! Most are free only for non-commercial uses.

The niconico Planetarium Club is a non-profit organization founded in 2007. Our objective is to support indie fulldome movie creators in order to expand the fulldome world. One of our members developed a plugin for MMD to render fulldome movies on MMD, and that plugin allowed the easy creation of fulldome movies.

As our primary activity, we hold gatherings several times per year in rented dome theaters, with between 20 and 50 participants attending each event. During our gatherings, any creator may test and show his or her work on the dome by using the AMATERAS Dome Player. In Japan, there are a few planetariums available to rent as a “dome type rental hall”. One example is the Atsugi-city Cosmo Theater in Kanagawa.

The club also runs dome shows by joining certain large events as an exhibitor. These include niconico Chokaigi, niconico Kunikaigi (Singapore), and Maker Faire (Tokyo and China). Audience approval has been very positive.

When you create fulldome movies as a business, it is usually important to include scientific and/or educational material because the movies are usually shown in science centers. However, because niconico Planetarium Club is non-profit, we provide creators with the opportunity to show the content they really want to create, outside the necessities of a business.
We often use MMD because it is popular in Japan, but outside Japan, it is not very popular. However, modern game engines like Unity and UE4 are also great. They are basically engines to develop interactive contents including games, but they are also good as animation tools to create movies, including fulldome and fullsphere movies. Also, they are free for non-commercial uses. They are not quite as user-friendly as MMD, but the quality is superior.

We hope we have inspired you to exercise your own creativity and try something similar! We are not trying to encourage you to use Miku or MMD. We are trying to encourage you to open up some easy ways for creators to access the fulldome world. Let’s revolve the fulldome world with new waves of new creators! http://nicopla.wpblog.jp

**40. EXTENDING THE LANGUAGE OF FULLDOME SPACE**

*23 JUNE 15:45-16:45 / PROXIMA*

*Extending the Language of Fulldome Space [id: 307, 308, 347, 348]*

**Speakers:** Michaela French (uk), Information Experience Design, Royal College of Art, Michal Gochna (pl), Copernicus Science Centre, Kelly Spanou (uk), Information Experience Design, Royal College of Art, Tom Howey (uk), Visual Communication, Royal College of Art.

**Abstract:** The Royal College of Art Fulldome Research Group investigates how the creative, artistic and communicative possibilities of fulldome projection extend the language of moving image and immersive experiences. Existing knowledge of graphic design, architecture, filmmaking and sound design is applied to dome space to identify and develop the sensory scope of the fulldome environment. Drawing on practice-based research as a foundation, Book Designer and PhD candidate Tom Howey discusses the relationship between typography and light and its visceral impact on the reader/viewer within the dome. Architect and Masters student Kelly Spanou investigates the compositional elements of moving image within the architectural space of the fulldome environment. Artist and PhD candidate Michaela French examines the relationship between embodied experience and infinity within immersive fulldome space. Michal Gochna from the Heavens of Copernicus also joins the panel to explore the relationship between astronomical visualisation and live performance as an approach to science communication through art.

**Text:** The primary objective for this presentation was to generate a discussion among the IPS community about the exploration of new forms of content within fulldome space. The Royal College of Art Fulldome Research Group presented their recent investigations into how the creative, artistic and communicative possibilities of fulldome projection can extend the language of moving image and immersive experiences. Michał Gochna from the Heavens of Copernicus spoke of his experience working with live performance in fulldome space.

With an emphasis on practice-based research, the presentation examined how creative process and design can be applied to fulldome space in order to identify and develop the language of the fulldome environment. The discussion was informed by the Fulldome Research Group’s knowledge and experience in graphic design, architecture, filmmaking and sound design as well as their ongoing collaboration with the astronomers at the Peter Harrison Planetarium in Greenwich, London.

Architect and recent RCA Masters graduate Kelly Spanou began the presentation, discussing the history of the dome as an experiential space where architecture and narrative merge to mediate our perception. She discussed the ways in which the topology of the dome, the absence of the frame, and the position of the viewer combined with augmented attention and the activation of peripheral vision all contribute to the immersion of the viewer.

Kelly screened her film “Apeiro” (Infinite) to illustrate how the experience of expanding and contracting space can alter the viewer’s
perception of the dome. At times the dome acted as an enclosure and at other times appeared as an expansive infinite space. Kelly’s creative practice within the dome allowed the audience to experience a range of evolving perceptual spaces that challenged the relationship between the observer and the object of observation.

Book designer and RCA PhD candidate Tom Howey looked at the use of typography in the fulldome environment. He focused on how the conventional square block of text doesn’t sit easily in the curved, frameless, infinite blackness of the dome: it appears distorted, at unusual angles, as though it is floating in space, and failing to convey which parts should be read first. As a result of these issues, Tom proposed new conventions are needed for typography in the dome space. He went on to suggest that the animated, immersive nature of fulldome offers an opportunity for a new, dynamic, physical relationship between text, space and the reader. He pointed out that words in the darkened dome present us with a curious situation: they illuminate our minds with their meaning, while literally illuminating the space we are in.

Artist and RCA PhD candidate Michaela French used Presence Theory to examine the relationship between the individual and infinity within fulldome space. Michaela proposed four primary spaces which define the fulldome experience: the physical space of the theatre, the mediated space of the content, the perceptual space of the viewer, and the apparent infinite space of the dome. In fulldome space, states of presence can be initiated when the mediated content becomes the primary perceptual influence. This occurs as awareness of the physical space falls away and the locus of attention shifts to the content projected in the dome. This shift also initiates a perceived merging of boundaries between the individual and infinite space. Drawing on examples of work from the RCA Fulldome Research Group, Michaela showed how the key factors in creating states of presence, such as locus of attention, opto-kinetic perception, immersion, and personal interest in the content can be used to design meaningful audience experiences whilst also extending the language of fulldome space.

Michał Gochna from Heavens of Copernicus explored the relationship between astronomical visualisation and live performance as an approach to science communication through art. Having produced live concerts with fulldome visualisations for three years, Michał’s approach to creating these hybrid dome experiences included using conventions from cinema, such as characterisation and scenography. Michael’s primary concern in designing these events was to create an experience for the viewer in which the scientific content was self-explanatory, but also had the capacity to engage and move the audience when combined with the emotion of the music and the inherent beauty of the dome.

After producing over 150 concerts and working with musicians from many genres, Michał concluded that maintaining a level of simplicity in the scientific content was valuable, as it enabled the beauty of the fulldome space to merge with the emotional content of the live performance and allowed the audience to experience full immersion in the dome space.

There was a clear agreement amongst the panelists and the audience that the fulldome environment is an extraordinary space with an untapped potential for new creative possibilities. The panel initiated a discussion about the value of the approaches artists, designers and
Researchers can bring to creating enriching and enlightening experiences in fulldome space. These included expanding the boundaries of visual representation, developing new methods of storytelling and exploring the architectural nature of the medium and its complex relationship with the viewer. The discussion also highlighted the ways in which practice-based research can be used to identify and develop the language of the fulldome environment in order to create new forms of experience within the immersive space of the dome.

The interest in this subject resided with a small but enthusiastic group within the IPS community. There is a definite interest in sharing experience and new creative approaches to designing and developing content for fulldome space. Whilst intuitively we understand how to make content for the dome, there are few opportunities for the dissemination of knowledge about the more formal aspects of designing and creating meaningful content for fulldome spaces. This panel presentation provided an opportunity to establish networks of interest which potentially enable an ongoing dialogue in this area.

41. Targeting Different Learning Styles

21 June 2016, 10:30–11:30 / Venus

Targeting different learning styles [id: 309]

Presenter: Karrie Berglund (US), Digitalis Education Solutions, Inc., Dr. Keith Davis (US), Digital Visualization Theater at the University of Notre Dame

Session abstract: This session will review the seven learning styles identified by the Institute for Learning Styles Research. After an overview of the different styles, participants will work in small groups to design activities on a popular planetarium topic (moon phases, seasons, etc.) that target each of the seven learning styles. These activities will be shared orally with the whole group during the session and via email after the conference.

Text:

Overview:
This workshop was designed to cover the seven basic learning styles identified by The Institute for Learning Styles Research, homepage: http://www.learningstyles.org

Goals:
The goals were to introduce the idea of different learning styles to those unfamiliar with it, to enhance understanding of learning styles among those who were already aware of them, and to create a set of planetarium activities targeting each learning style. We wanted to do all of the above using a mix of small and large group activities in a fun, supportive, and creative atmosphere.

Synopsis:
We started with a whole group discussion about learning, using two questions to spark thinking:

1) How to define the word “learning.” Some answers included gathering facts, accomplishing new tasks, and applying knowledge to various situations.

2) How participants know that learning is taking place in their domes. Answers included getting correct answers to questions asked by the planetarium teacher and getting on-topic questions from audience members.

After the large group discussion about learning in general, we moved on to an overview of each learning style, sharing traits of each different type of learner. We also discussed how people do not learn in only one manner. They may feel most comfortable with a few of the different learning styles, but they may be able to learn in any of the seven styles.

Comfort with different learning styles can also change over time. For example, a young child who cannot yet read may become a strong print learner after he/she has mastered reading.
The seven learning styles identified by The Institute for Learning Styles Research are:

- Print
- Aural (hearing)
- Visual
- Haptic (touch)
- Interactive
- Kinesthetic
- Olfactory (smell)

After reviewing the seven learning styles, we broke into five small groups of four to six people each. Each small group discussed a planetarium topic for which they would like to target the various learning styles. In order to create as comprehensive a set of activities as possible, we shared small group topics with the larger group to ensure that no groups were working on the same topic.

Below are the results of each group’s work. These were shared with the whole group orally, as well as written on flip chart pages. Many participants took photos of the flip chart pages, and the pages were left on the walls of the Venus room through the end of the conference.

**Group 1. Topic: Exoplanets**

**Targeting print learners:**
- Infographics (how many exoplanets have been found, distribution, etc.)
- Written activity/in line handouts

**Targeting aural learners:**
- Discussions of various methods of finding exoplanets
- Singing
- Share stories of how we have been surprised by findings. For example, finding gas giants much closer to their parent stars than expected.
- Doppler effect to demonstrate spectroscopic technique

**Targeting visual learners:**
- Discuss transit technique and use a light meter with graphing software
- Imagery to show microlensing technique for finding exoplanets
- Use wine glasses to demonstrate gravitational lensing as the base of wine glasses acts as a lens.
- Use cove lights to show how colours can be combined or separated. Earth’s atmosphere is blue filtered.
- Give students a “mystery planet” in a box. Students would find the size of the planet in the box by using light – a thin box would allow light to pass through while the planet would not. Students could measure the shadow width to estimate planet size. See also bottom bullet point of visual learners activities.

**Targeting haptic learners:**
- Tactile interferometer with laser, splitter, mirrors, and target
- Have students model an exoplanet orbiting its star; use a heat lamp to represent the star (also kinesthetic)

**Targeting interactive learners:**
- Give students a “mystery planet” in a box, and have students figure out if it is a rocky/gaseous/icy planet by calculating its density. They would weigh the box with the “planet” and measure the box width (represents the diameter of the planet). They would use a chart with density of materials or planets in our solar system to say what type of planet it is. See also bottom bullet point of visual learners activities.

**Targeting kinesthetic learners:**
- Have students model an exoplanet orbiting its star; use a heat lamp to represent the star (also haptic)

**Targeting olfactory learners:**
- Smells to represent different types of atmospheres/planets – rotten eggs, dusty, smoky, etc.

**Group 2. Topic: Gravitational Waves**

**Targeting print learners:**
- Image/video showing distortion of space-time
- Image/video of an interferometer
- NASA handouts

**Targeting aural learners:**
- Frequencies we can hear
- Subwoofer sounds

**Targeting visual learners:**
- Show distortion of space-time

**Targeting haptic learners:**
- Touch a wave (string/membrane/subwoofer)

**Targeting interactive learners:**
- Build a model of an interferometer as a group

**Targeting kinesthetic learners:**
- Inflatable castle: Have audience experience the distortion as people move around
- People hold a rope and spin; shorten the rope so they rotate faster and faster

**Targeting olfactory learners:**
- Use an object with a scent; have the audience raise their hands/react when the smell reaches them
Group 3. Topic: Analemma

Targeting print learners:

- List the main components that create an analemma (planet, Sun, orbit, movement, tilt)

Targeting aural learners:

- Traditional spoken explanation
- Discussion of observations of and experience with analemmas

Targeting visual learners:

- Show the components (height difference, left-to-right difference)
- Analemma shape as seen from other locations on Earth
- Analemma shape as seen from other planets

Targeting haptic learners:

- Create a 3D printed model of an analemma

Targeting interactive learners:

- Group project of photographing the Sun (or even just a portion of the Sun)
- Shadow prediction with the actual Sun (also targets kinesthetic)
- Group predictions of rising and setting positions of the Sun

Targeting kinesthetic learners:

- Shadow prediction with the actual Sun (also targets interactive)
- Model the orbit and speed of a body around a star Represent axial tilt with body (with orbit and rotation)

Targeting olfactory learners:

- Local, seasonal smells
- Talk about imagining seasonal smells
- Scratch and sniff seasonal smells
- Candies/diffusers of seasonal smells (but need to be aware of some people’s sensitivity to fragrances)

Group 4. Topic: Seasons (for audiences aged 5–8 years)

Targeting print learners:

- Many students of this age are not accomplished readers...
- Show simple vocabulary words: Orbit and spin, rather than revolve and rotate

Targeting aural learners:

- Singing (also interactive, as well as good for memory with this age group)

Targeting visual learners:

- Pictures representing various seasons – i.e., snow for winter. Have children interpret the pictures. Could also use pictures of activities for different seasons, such as swimming for summertime.

Targeting haptic learners:

- Shadows at lunchtime: Short shadows in summer, long shadows in winter.

Targeting interactive learners:

- Group discussion (also aural)
- Singing (also aural, as well as good for memory with this age group)

Targeting kinesthetic learners:

- Outside: Earth-Sun model with revolution and rotation. Use words “orbit” and “spin;” do not stress upper level vocabulary (revolution and rotation). Can also introduce the tilt of the earth.

Targeting olfactory learners:

- Smells to represent various seasons – dried leaves for autumn, hot chocolate for winter, fresh flowers for spring, and sun tan lotion for summer

Group 5. Topic: Cultural Astronomy

(Note: This table had five participants from five different countries, perfect for IPS!)

Targeting print learners:

Share printed versions of stories, either as they are being told or before/after the presentation.

Targeting aural learners:

Share traditional stories around a campfire (also interactive) and under the real night sky. If possible, use elders to tell the stories.

Use drums to set an atmosphere/ambiance.

Targeting visual learners:

In the planetarium, show constellations from different cultures or images/videos to accompany the stories.

Targeting haptic learners:

If the story incorporates parts of the environment that the audience is in, direct them to touch those things. For example, if the story involves dried grass or dirt, pass around some dried grass or dirt for the audience to feel.

Targeting interactive learners:

Share stories around a campfire (also aural)
Targeting kinesthetic learners:

As the elder tells the story, have the audience members make appropriate movements during the story. For example, if the story mentions drumming, have the audience pretend to drum.

Targeting olfactory learners:

As with haptic above, incorporate smells from the story into the audience experience. If not around a real campfire, use some canned smoke to create the sense of being around a campfire.

We hope that the ideas shared here will be valuable not only to those who participated in this workshop but to all who read them here. Thank you to those who participated for bringing your creativity and enthusiasm to this workshop!

42. IMPROVISATION VS PREPARATION (ENGAGING THE AUDIENCE) – PART A

20 JUNE 15:15-16:15 / SUN

Beyond the Night Sky: Live Programs for any Occasion [id: 72]

Speaker: Danielle LeBlanc (us), Museum of Science, Boston

Abstract: The Charles Hayden Planetarium has a long tradition of high-quality, presenter-led programming for its visitors, and its staff consists of educators and producers well versed in delivering flexible, unscripted shows that respond to the needs and desires of our audiences using the latest digital technology. In the last few years, the team has made concerted efforts to enhance live educational programs at the Museum with innovative, interactive experiences under the dome beyond the traditional “Night Sky” show that audiences still generally expect. We have experimented (and had great success!) with digital, presenter-led “Explore-the-Universe” tours, curriculum-oriented and customized live school shows, and guest speaker presentations exploring specific astronomy fields in greater depth. More recently, we have branched out into topics beyond astronomy such as engineering and underwater exploration. Hear about these efforts and some of the techniques we use to achieve them, and hopefully come away with some ideas for enhancing live programs in your own venue.

Making a live show on the spot [id: 247]

Speaker: Maciej Mucha (pl), Copernicus Science Centre

Abstract: Everyone who works on live planetarium shows knows the situation when the computers storing the content crash and a bitmap appears on the dome. What to do in that case? Show the stars! Sometimes we need to show the stars with nothing but the star projector. Perhaps is it the only equipment that we have? Or maybe we have to start a show quickly, so there is no time to get prepared? How to create a story and a good mood without a lot of preparation, without losing the fluency of the show, maybe with the audience not even realizing that something wrong happened? What should be our foreground?

Training the Planetarium Professional [id: 230]

Speaker: Martin Ratcliffe (us), Sky-Skan, Inc.

Abstract: Making full use of your digital theater requires continual professional development. Sky-Skan’s DigitalSky Academy workshops have been developed to train not only programming skills in DigitalSky, they include voice coach training and professional astronomy content training. This session will describe how connecting astronomers to planetarians for content development, voice coach training is a vital component for planetarians’ professional development.
43. LOCAL VS. INTERNATIONAL ASTRONOMICAL MISCONCEPTIONS

22 JUNE 18:30-19:30 / VENUS

Local vs. International astronomical misconceptions

[Id: 311, 349, 313, 312]

Presenter: Dr Robert Cockcroft (us), McMaster University, Dr Jenny Shipway (uk), Winchester Science Centre and Planetarium, Kaoru Kimura (jp), Japan Science Foundation / Science Museum, Karrie Berglund (jp), Digitalis Education Solutions, Inc.

Abstract: Misconceptions are prevalent throughout astronomy and probably all planetarians have personal experience trying to correct audiences’ perceptions to match scientific reality. During this workshop we plan to explore these misunderstandings, and discover how many are common to all planetariums and which may instead be more localized to a specific region or country. Is there variation seen from place to place about how different factors affect misconceptions – factors such as age of audience, the origin of the misunderstanding, the type of misconception, and how astronomy more broadly sits within the education system? Is the planetarium particularly suited to correcting misconceptions with a certain combination of factors? The goals of this workshop will be to share common astronomical misconceptions from your own country; to learn about those common to other countries; and, to take away ideas of and resources about how to educate audiences about these misconceptions.

Text: This workshop took place in the VENUS room. Our objectives were to have a highly interactive session focused on exploring astronomical misconceptions: What a misconception is, how misconceptions begin or are propagated, some misconceptions that planetarium audiences bring into the dome with them, whether some astronomical misconceptions are localized (as opposed to worldwide), and more.

To reach these goals, we had a mix of small and large group discussions. Each question was first discussed in the small groups, and then ideas were shared with the entire group. Answers were written on flip chart pages and hung on the Venus room walls.

We also showed a short clip from the Veritasium YouTube channel from 2010. The group found that 30% of Australians believe it takes one day for the Earth to go around the sun. The video shared at the workshop can be accessed here:

https://www.youtube.com/watch?v=cU2dZz18P0c&list=PL772556F1EFC4D01C&index=11

A similar but perhaps better known resource on the prevalence of misconceptions is “A Private Universe”:


Questions explored and answers generated by the attendees during this workshop were:

Question 1: What is a misconception?

Answers:

- A personal mental model that is inconsistent with the general model
- A wrong fact about something that is observable
- "Just a concept" – not explored or tested by the holder of the concept, related to:
- Something the audience has never thought about
- Believed to be true but actually incorrect
- Set of incorrect assumptions
- Wrong use of terminology

Important to note that a misconception is different from a faith-based belief

Question 2: What are the origins of misconceptions? That is, how do they get started?

Answers:

- Limitations of technology – i.e., the planetarium is limited in demonstrating scale, and this limitation can lead the audience to incorrect conclusions
- Teachers who hold a misconception and teach it to their students
- Planetarians traveling faster than the speed of light without explanation, related to:
- TV and film, especially science fiction – warp speed, characters get places quickly
- Relying on common sense – can believe something even if the facts prove it wrong, related to:
- Continuing to hold cultural versions even when the science contradicts those versions
- NASA! Over-simplification: Blood moon, etc.
- Human brains accessing the easiest option and struggling to cope with scales of distance and time
- Human brains can’t trust instincts, related to:
- Lack of critical thinking – this needs to be taught
- Media, TV, etc. Repeating and sensationalizing errors and myths like Mars being as big as the moon in the sky
- Internet being considered an authority
- Cultural pollution, such as northern hemisphere bias

Question 3: What are some common misconceptions? And are there regional differences?

Answers:

- The North Star is the brightest.

Regional difference: This misconception doesn’t exist in areas that can’t see the North Star.

- Northern hemisphere – some people think that in the southern hemisphere the sun rises in the west and sets in the east.

There was a comment that people in the Southern hemisphere are exposed to the Northern hemisphere bias much more than the opposite.
• How many times each year the Sun is directly overhead – some people believe that it is always overhead, no matter where you are.
• Seasons are caused by the changing distance of Earth from the Sun.
• Place/size/scale of the solar system – lots of misunderstanding on these topics.
• Phases of the moon are caused by clouds or the shadow of the earth.
• The moon has a “dark side.”
• Phases of the moon are tied to the days of the month – i.e., the first day of the month is always a new moon.
• The Sun is the biggest star.
• There is no gravity on the moon or in outer space.
• The first star to appear in the sky is always the “evening” or “shepherd star.”
• Pluto is gone or has changed into a moon, star, or black hole – something happened to it rather than simply being re-categorized.
• The motions of the planets are commonly misunderstood.
• Earth is moving so slowly that we don’t feel its movement.

Additional regional misconceptions:

• Opposite Europe on the globe is Australia or China (not the Pacific Ocean).
• Tides – if you are inland, people don’t think about them, so misconceptions are not common.
• Australia: The aurora australis is caused by sunlight reflecting off the surface of Antarctica.

We had hoped to spend part of the workshop discussing in small and large groups how to educate audiences about misconceptions, with particular focus on using the planetarium to target misconceptions. However, we ran out of time and had to end before having those conversations.

The audience seemed to enjoy the mix of small and large group discussion, and there was a great deal of laughter, particularly during the common misconceptions discussions. The presenters enjoyed taking advantage of the international flavor of IPS to explore whether or not location had an impact on misconceptions. As noted above, we identified several regional or localized misconceptions, and if we had not run out of time, we likely would have found more.

44. PLANETARIUM AS A TEACHING TOOL
20 JUNE 14:00-15:30 / VENUS

How we use Astronomy to teach Maths and Science with our Planetarium shows in Accra, Ghana. [id: 45]

Speaker: Dr Jacob Ashong (gh), The Planetarium Science Centre Ghana

Abstract: Activities at Ghana Planetarium include visits by schoolchildren and teachers to see planetarium shows. Children are excited to visit the Planetarium and are fascinated by Astronomy and Space. We use this enthusiasm to help them understand some basic Maths and Science relating to the solar system. Knowledge of basic Astronomy and STEM subjects varies widely between children in different schools (and their teachers). In deprived schools teaching tends to be from books, using a chalkboard and written work or rote learning rather than hands-on experience or practical demonstrations. We question children to assess their knowledge and tailor discussion and activities appropriately. Astronomy activities include discovering \( \pi \) (Pi), calculating speeds and distances, light years using powers of ten, using parallax, the scientific method, classification, and the electromagnetic spectrum. We link these activities and demonstrations to planetarium shows and the school syllabus.

Demonstrating Retrograde Motion in College-Level Astronomy [id: 140]

Speaker: Dr Ann Bragg (us), Anderson Hancock Planetarium / Marietta College

Abstract: The retrograde motion of the planets was one of the few observations available to ancient astronomers that indicated a problem with the geocentric model. As such, it is an important topic in introductory astronomy when we teach students how naked-eye observations of the sky connect to our model of the Solar System. Helping students to understand what exactly we mean by retrograde motion can be challenging, however. I have found that brief demonstrations involving “annual motion” with the planetarium projector often confuse students about what sky watchers would have actually observed. In this presentation, I will demonstrate how I simulate observations of retrograde motion for my introductory astronomy students under the planetarium dome to help them better understand what is seen in the sky.
Introduction

As is the case at many institutions of higher education in the United States, all students at Marietta College are required to take at least two “general education” science classes during their college career, regardless of their major. According to the 2015-2016 Marietta College Undergraduate Catalog:

“Specific criteria required for Scientific Inquiry courses must address all of the following:

1. Provide an in-depth analysis of scientific concepts and the scientific method.
2. Include material that demonstrates the discipline’s impact on society.
3. Include some historical perspective with respect to the development of the discipline’s concepts, theories, and models.”

My introductory astronomy course is one of the classes that meets these criteria. As a result, much of the enrolment each year consists of students seeking to fill this requirement. Specific topics covered in the class are therefore chosen to maximize alignment with general education goals.

One of these key topics is the transition from the geocentric solar system model to the heliocentric solar system model. This topic clearly addresses the criterion regarding historical perspectives within the discipline and it is also an excellent example of the scientific method and how observational evidence selects between competing models. While some of the key evidence does involve high precision measurements using telescopes (e.g., aberration of starlight and stellar parallax), some is easily seen by naked-eye observers. Because the observation of retrograde motion does not require any special equipment, it should be accessible to students and easily understandable. Unfortunately, very few students are familiar enough with the night sky and its changes over time to have observed this motion for themselves.

In many semesters, even after spending time on the topic of retrograde motion, many students cannot clearly articulate what it is and will even express the idea that planets rise in the west during retrograde motion or that retrograde motion was discovered telescopically by Galileo. In order to help students better understand what the observation of retrograde motion actually consists of, I typically spend a full class period demonstrating this motion under the dome and then summarizing with students what they saw. My goal is for students to understand and be able to articulate what is observed, rather than simply memorize the phrase “retrograde motion” to be used as an answer to the appropriate questions on class exams.

How I Demonstrate Retrograde Motion

A straightforward way to demonstrate planetary motion in general, including retrograde motion, is using annual motion on a star projector or within a digital system. I find, however, that when I use this method with students, they often misunderstand what they are seeing, which feeds into misconceptions about planets rising in the west. In order to help students better understand what the observation of retrograde motion actually consists of, I typically spend a full class period demonstrating this motion under the dome and then summarizing with students what they saw. My goal is for students to understand and be able to articulate what is observed, rather than simply memorize the phrase “retrograde motion” to be used as an answer to the appropriate questions on class exams.

To ensure that Mars aligns significantly with some notable feature on our constellation artwork (thus making changes in its location over a single night easier to notice), I then choose a starting time when Mars is just rising in the east. For example, for the current retrograde cycle of Mars (April 17, 2016 – June 29, 2016), a good starting date is March 1, 2016.

In the Stellarium screen shot displayed above, Mars is lined up with one of the pans in the artwork for the constellation Libra. After discussing with students the precise location of Mars relative to the background stars, I then proceed through 24 hours of daily motion. My goal is to make sure that students realize that Mars moves across the sky along with the stars. When we reach the next night, I ask them if Mars has moved compared to the background stars.

The Stellarium screen shot above shows the location of Mars on the next night, March 2, 2016. If the students carefully noted the position of Mars at the starting time, they can easily see the change in its position. If they seem unsure, I toggle back and forth between the two dates to make the change more obvious. Then I cycle through a second 24-hour period so that they can again observe the daily motion of Mars and the background stars, finally ending up 48 hours after the starting time.

I choose a starting date about two months before the start of the current/next retrograde cycle of Mars. Mars works well because of its relatively rapid motion. I will fine-tune this starting date somewhat to ensure that Mars aligns significantly with some notable feature on our constellation artwork (thus making changes in its location over a single night easier to notice).
Next, we step through a few more days without including the daily motion, so that students can see that Mars continues to move in the direction they have already observed. Then we step through using larger time periods of 1–3 weeks.

The above screen shot displays the position of Mars after another three weeks have passed. Mars has continued to move in the same direction, but the observed motion is much larger after this longer time period. Another jump of three weeks reveals that motion has continued in the same direction, although it has clearly slowed down.

While Mars was initially moving “down” Libra and Scorpius, it is now moving back “up” through these constellations. I find that referencing the motion to the constellation artwork helps students take note of the changes in Mars’ position. We continue to jump ahead a few weeks at a time until the retrograde motion ends and Mars resumes its motion “down” these constellations.

After the planetarium demonstration, I then ask students to describe the motion of Mars over the various time periods and create a summary on the board. While some students clearly still misunderstand retrograde motion based on their exam answers, many have a better grasp of what this motion actually looks like and how it is observed.

Innovative planetarium programs for education [id: 84]

**Speaker:** Yuki Nishijima (jp), TSUKUBA EXPO’85 MEMORIAL FOUNDATION, Tsukuba Expo Center

**Co-authors:** Daisuke Sato, Rie Hashimoto, Toshio Hagiwara, Minoru Kubo, TSUKUBA EXPO’85 MEMORIAL FOUNDATION, Tsukuba Expo Center; Akemi Murakami; Ihatoke co. Ltd., Brian Landberg, Intel Corporation.

**Abstract:** Tsukuba Expo Center is one of the most advanced science museums in Japan, including a world-class planetarium dome. In 2015, we produced a program titled ‘Canvas of Stars’. This program is based upon astronomy books written by the popular children’s book author, H.A.Rey (who is better known for the Curious George books). We devised the program not only to introduce how to identify various constellations and dynamics in the solar system, but also to encourage visitors to go out and observe the starlit sky for themselves. We added Japanese subtitles and an English version for enabling access to a larger audience, including those with hearing disabilities and visitors who are not fluent in Japanese. Moreover, this project was produced with the enthusiastic cooperation of volunteers from a local company and from an International School. This collaborative project takes advantage of the international quality of the citizens of Tsukuba city.

**Text:** In my presentation, I explain about our original planetarium program called “Canvas of Stars; The Astronomical World of H.A.Rey” (Table 1). I introduce how we created it, and designed it with an educational focus on explaining constellations and other Astronomical concepts that can help beginners to make sense of the night sky.
Our science museum, Tsukuba Expo Center was originally built for the International Science and Technology Exposition in 1985. Our museum is located in the center of Tsukuba, which is also well known as the science city of Japan. Expo Center is one of science museums in Japan, in which the staff plans and produces original programs on our own. Since September 2014, for enabling access to a larger audience, we introduced earphone systems for people who have hearing difficulties. From December 2014, we began to produce an English dubbed audio option for these systems, which was added for non-Japanese speaking visitors to enjoy the planetarium program, as well (Table 2). In addition, from 2016, we show the program occasionally with English as main audio (without earphones), and with Japanese subtitles (Table 3). Here are some comments from parents and children who attended a premier in English screenings:

"It was a great because it was in English"  "It was a great opportunity to know how to find own zodiac. It’s unfortunately raining tonight, but we sure to enjoy looking up the sky. This summer... and winter too!"  "Interesting approach to bring a picture book into such a film. We enjoyed the narration as well."

Our production of “Canvas of Stars” is based upon astronomy books written by the popular children’s book author, H.A. Rey (who is well known for the Curious George books). We devised the program with key educational goals, not only to identify various constellations and dynamics in the solar system, but also to encourage visitors to go out and observe the starlit sky for themselves. This Program includes 3 main messages:

1. TO DRAW: Constellations may be drawn freely, using your imagination, to become more familiar with the night sky.
2. TO UNDERSTAND: Learn about the motions of the solar system and the universe to help deepen your understanding about the Earth, planets, and stars.
3. TO TRY FOR YOURSELF: To search for constellations in the real night sky, using simple rules as a guide.

Also we show some rules introduced in the program for viewers to remember:

• To use the brightest stars as a landmarks in the sky
• To understand about the ecliptic belt, and remember the ecliptic 12 constellations memorize with rhymes like a song
• To find the North Star, Polaris, and understand its significance
• To introduce the features of the stars and constellations in each season

We made this program with care to preserve the spirit of H.A. Rey’s picture book for children. In addition, in the scenes where stars are connected by lines to make constellations, we did NOT immediately reveal the answer from the beginning, so that the audience can have a moment to imagine connecting lines by themselves (Table:4). We hope that this makes the program more interactive and more fun. To summarize, our greatest challenge as a planetarium and science museum is the question of how to involve a larger proportion of the general public. We are continuing to explore more accessible ways to demonstrate the splendor of the night sky to a wider audience.

Online link:

Tsukuba Expo Center http://www.expocenter.or.jp/“Canvas of Stars The Astronomical World of H.A.Rey”
http://www.expocenter.or.jp/?post_type=planetarium&p=18107
Shape Up! – The Night Sky for Young Audiences

Speaker: Patty Seaton (US), Howard B. Owens Science Center

Abstract: How do we introduce the younger audiences to the night sky? In my school district, I offer a program on shapes called ‘Shape Up!’ for both Pre-Kindergarten (age 4) and Kindergarten (age 5) students. Both programs are designed to gradually take the students into darker and darker skies, from finding and matching shapes on the dome to finding the same shapes in the night sky. For age 4, we just focus on finding shapes in the stars. For age 5, we turn each shape into its respective constellation. The programs are highly interactive, interweaving math skills with the lesson. Each planetarium presentation also has a follow-up piece where students connect shapes to architecture.

Text: Teaching the night sky to a young audience presents many challenges. Oftentimes, this is the child’s first visit to a planetarium, and they may be fearful of the strange environment and of the dark. I am pleased to have developed a live interactive program for Pre-Kindergarten (age 4) and Kindergarten (age 5) students that has been met with great enthusiasm by all students, even if they were tentative upon first arriving in the planetarium theater.

Each student is given a piece of paper before entering the theater. For my Pre-K students, they are given one of four shapes: a rectangle, a triangle, an oval, and a square (PowerPoint: ShapeUp-PreK). Once seated, I have each student hold up their shape when it is called, and let them know that they will be asked to lift up their shapes several times during the program. Next, we transform the theater to look like the sky, putting up the sun in a late afternoon position and some All Sky clouds. We then listen to “mystery” sounds of twilight and identify them, showing the pictures as they are identified. Next, we transform the theater again by asking the students to lift up their shapes and place them in the sky. We fill the dome with the shapes at the same time. We choose one shape at a time, asking the students to hold up their shape when we call out its name. We use the shapes on the dome to review the properties of each shape, counting the number of sides (if they exist). Here we are reinforcing the students’ recognition of characteristics and properties of shapes. To make connections with shapes to real life, we look at a picture of a building and find the shapes on the building.

Finally, now that the students are comfortable in this strange new planetarium theater environment, we transform the planetarium again, setting the Sun and rising the stars of the Winter night sky. Now students are asked to connect stars to find their shapes. We find a rectangle (Gemini), and ask the students to lift their shape to cover the stars so everyone can see their rectangle. We then add a rectangle overlay to Gemini. We pretend we have special “sky crayons” which will allow us to color in the rectangle. As the students pretend to color, we crossfade our rectangle outline to a colored rectangle (we use red, because the outline of the rectangle was red). (NOTE: we also point out the rectangle of Orion, although we don’t have an overlay for that.) Next, we find a triangle (the Winter Triangle). Students lift up their triangles, and we add a triangle overlay. Students “color” their triangle green. We find an oval (the Winter Oval). Students lift up their ovals, and we add an oval overlay. Students “color” the oval blue.

I pretend that we’re done, until students remind me that we haven’t yet found a square. I lament the fact that there are no good squares in the Winter sky. Then I “suddenly” remember that the planetarium can take us to any date, any time we want. I tell the students that there is an excellent square in the night sky during the season that comes BEFORE Winter. Students have to remember what they have learned about the seasons to decide we need to visit the autumn sky. I tell them the planetarium can take us there once we count to the magic number: the number of sides of a square! Once again reinforcing properties of shapes, the students count to four, and the planetarium moves into
place. We find the square (Pegasus), and students lift up their squares, and we add the square overlay. Students “color” the square yellow. For this final constellation, we now return to the stars and explain that Pegasus was supposed to be a flying horse. We show the students that if we add a couple of stars to the square, we can see the legs and head of Pegasus. Finally, we add the picture of the constellation of Pegasus. This is the only complete constellation we show the students, telling them that the shapes are the building blocks to bigger pictures (“constellations”), and that finding the shapes is a great first step! Teachers and parents alike have told me on countless occasions how they love this program, because they usually have problems finding constellations themselves, but they can find the shapes we just learned!

Our kindergarten program is a little different. These students are handed papers containing the outline of constellations, labeled with the first letter of the constellation as a very large, pronounced, capital letter (PowerPoint: ShapeUp-K). We include Cassiopeia, Pegasus, Leo, Gemini, Taurus, and Orion. We tell the students that they have been given a constellation, as ask them to look at their papers and at the papers of the people sitting next to them, to give me a definition of “constellation”. Next, as with the Pre-K students, we review the constellations that the students have been given, asking the students to hold theirs up when called. They are asked to identify the constellation by the letter it begins with (ex. “You have Cassiopeia if you have the constellation that begins with the letter ‘C’!”). Here we are reinforcing early reading skills. We then place pictures of shapes (rectangles, triangles, squares, and ovals) all over the dome. We ask the students to identify the shapes they see on the dome one at a time, and then hold up their constellation if they see the shape in their constellation. We decide that we’d like to now find the constellations in the night sky!

So, we start with a late afternoon sky with the Sun. We determine that in order for it to be “night”, the Earth has to rotate. We allow the planetarium to “fast forward” rotation to allow us to make it night. We bring up an autumn sky and find the Great Square of Pegasus. We then bring up an overlay of the constellation. Next, we find the “W” shape (triangles) of Cassiopeia, followed by the overlay of the constellation. To view more constellations, we determine that we must rotate the Earth again (we head to the late winter sky). This time we sing a song about the stars to encourage the planetarium to rotate. The students always choose “Twinkle Twinkle”! Our new sky view brings us Orion, Taurus, Gemini, and Leo. We always start by identifying the main shapes in the constellation, then showing the overlay. As a bonus, we find the Big Dipper, showing that overlay.

In both programs, our goal is to create an inviting environment for students to be introduced to constellations by using shapes. We reinforce concepts they are using in the classroom, such as identification of properties/characteristics of shapes. We reinforce learning skills. Every student is engaged by holding up their paper multiple times during the program. We have found that this is a popular program for students, teachers, and parents. And we are pleased to be able to invite our young students to the planetarium, preparing them for many future journeys to the stars!

**45. SHINING LIGHT ON HOW TO TEACH MOON PHASES IN DARKNESS: MOON MOTIONS TAUGHT DIFFERENT WAYS (SESSION ORGANIZED BY IPS EDUCATION COMMITTEE)**

**23 JUNE 15:45-16:45 / SIRIUS**

**Session abstract:** In this session planetarium educators shared their expertise about ways they teach the concepts of lunar phases and motions within the dome. A variety of creative approaches were used and the audience did participate. Some observations focused on the changing angle between the Sun and the Moon in the sky. Models and multimedia approaches were used. The concept of the difference between a sidereal month and a synodic month was demonstrated and explained for older students, emphasizing both the in-space perspective and the from-Earth perspective.

Closing sentence from Jeanne Bishop, conveyor of the session and Chair of the IPS Education Committee:

When at the conclusion of the workshop I asked those who came if they would like more “how I teach lessons in the dome” sessions at future IPS conferences, the answer was a resounding “yes.” The demonstrations are helpful to both those who have been teaching in the dome for a long time and to those who are newcomers to the planetarium profession. The feedback from our group should help make having such sessions in the future easier to be accepted.

**Why the Phase Month and Moon Revolution by the Stars are Different Length [id: 314]**

**Speaker:** Dr Jeanne Bishop (us), Westlake Schools Planetarium

**Abstract:** I will use a model of the Earth with a small “person” attached, a model Moon, and a model Sun, to demonstrate the reason why the phase month (synodic month) is longer than the star month (sidereal month). Next, in the planetarium sky, we will find the Sun and a waning crescent Moon. We will watch the Moon wane until new and note the right ascension of both Sun and Moon. We will also see the positions of the Sun and the Moon against the Zodiac stars. Then we will view a month of phases, finding that the Moon returns to its previous right ascension and place among the stars without yet being new. The Sun is to the East. We note the right ascension of the Sun at this second time. Finally we see the Moon move to a new phase position and check the right ascension of both Sun and Moon. We judge the angle that the Sun has moved and the period that this takes — about 2 days, the difference between the sidereal month of 27 ½ days and the synodic month of 29 ½ days.

**Moon Hunting [id: 317]**

**Speaker:** Patty Seaton (us), Howard B. Owens Science Center

**Abstract:** Second grade students (age 7-8) in Maryland, USA, are expected to observe two months of Moon Phases in order to determine that the Moon changes in a regular predictable pattern. This is easily
Second grade students (age 7-8) in Maryland, USA, are expected to observe two months of Moon Phases in order to determine that the Moon changes in a regular predictable pattern. This is easily done in a planetarium setting where the weather conditions always cooperate and students can make realistic observations at any time of day and night. We have fun going “moon hunting” to observe and record the phases and then make predictions based upon our observations. For the purposes of this workshop, I will demonstrate one month of moon hunting. Of course, two months must be recorded by the students before they can provide evidence that the moon does change according to a predictable pattern.

During the workshop, I asked participants to pretend to be 7-year-old students, and showed them a third quarter moon. I asked them to describe what it looked like, and asked them if the moon always looked like this in the sky. When participants answered no, I asked them to describe other ways they had seen the moon. Then we decided to go “moon hunting” together. As we changed to a waning crescent moon (“that looks like a letter ‘C’!”), I explained how during my class, students would record this on their worksheet. I would model how to record this by using an overhead projector. I explained how I would usually make a mistake in at least one drawing, and model how to cross out my incorrect drawing since the pencils the students had usually have no erasers (and they are perfectionists!). When the moon disappeared as we moved to the date of a waxing crescent moon, I explain how we “fast forward” the rotation of the Earth, and identify the position of Noon as the sun crosses the sky. We observed a first quarter moon (“That looks like a ‘D’!”) and full moon.

I explained how we go through two months of observations to complete the pattern. When we fast forward the rotation of the Earth to get back to the third quarter moon in the morning sky, I usually point out a few constellations. I let the students identify that one star remains fixed (the North Star). I explained that I will have to make changes to this presentation, since curriculum changes being made in our district appear to be moving this particular objective of observing the pattern of moon phases to a lower grade, ages 5-6. Recording the phases will be a little more difficult for them. One participant suggested I out up images of the zodiac constellations and let the students point out the picture where the moon appears. Another participant suggest that I use a similar method as I presented in Session 44, handing students papers with different phases of the moon as they enter, and allow them to hold up their phase once it has been observed in the sky.

One participant asked me as we transition to the Sun dome why I didn’t do gibbous phases. I don’t use gibbous because the students at this age aren’t expected to recognize the different phases by name, only recognize that the moon changes its appearance in a regular, predictable pattern.

Gibbous phases are a little harder to identify than quarters, crescents, and the full moon.
**46. STAGES OF BRAIN DEVELOPMENT AND THE ABILITY TO UNDERSTAND ASTRONOMY CONCEPTS**

**23 JUNE, 14:30-15:30 / URANUS**

**Host:** Susan Reynolds Button, Quarks to Clusters, Chittenango, NY USA, sbuttonq2c@gmail.com

**Participants:** Mrs. Michele Wistisen, Casper Planetarium Supervisor, Casper, Wyoming USA, Michele_Wistisen@natronaschools.org; Ms. Rachel Thompson, Perot Museum of Nature and Science, Dallas, Texas USA, rachelsusanthompson@gmail.com; Dr. Jeanne Bishop, Westlake Schools Planetarium, Westlake, Ohio USA, jeanneebishop@wowway.com

**Text:** During this workshop we examined how knowledge of human stages of learning must inform creation of age appropriate lessons or programs. Frequently we, as educators, are asked to teach a topic we know would be most appropriate at a later age. After reviewing the stages of human brain development, participants examined some effective strategies for presenting concepts about the Seasons at a variety of levels. The strategies we examined can even be applied to production of educational videos.

**I. Welcome and Introductions**

In order of presentations: Susan Button, Michele Wistisen, Rachel Thompson, Jeanne Bishop

Asked participants to raise their hands in response to questions:

- “Who are you: educational institution, large dome, small dome?”
- “What age group is most difficult for you to work with?” (4-7, 8-10, 11-13, 14 and above?)

Answers indicated a variety of domes and almost an even spread of difficulties with different age groups.

**II. Outline the Workshop**

During this workshop we reviewed some information about human developmental stages of learning and some examples were given for working with each stage while teaching a lesson about the Seasons.

**III. Stages of Learning:**

Piaget believed that children go through four distinct stages of brain development as they move from infants to young adults. These stages consist of the Sensorimotor Stage, Preoperational Stage, Concrete Operational Stage, and Formal Operational Stage. The rate of brain development is determined by each individual's genetics, however the environment and experiences play a very significant role.

These stages do broadly apply to the people we work with under the dome. They are an excellent reference, however, we need to remember that critics of Piaget state that children’s cognitive development is not as consistent as his stages suggest. Some believe that infants and young children are more competent than he indicates and that social components are not emphasized enough.

It is important to note that Piaget does advise that these stages can overlap and when people are experiencing something new they may have to go back to a previous stage before they can construct new learning.

**IV. The big picture**

Power Point/Hand out paperwork and broad overview of the Stages of Brain Development. (See chart attached)

**V. Examples for Teaching Seasons**

**PRE-OPERATIONAL STAGE – Intuitive Phase, Ages 4–7, Susan Button**

Interactive lessons that are rich with strategic use of storytelling, kinesthetic movements, music, singing and opportunities for making observations, predictions and conclusions work well with all age groups but especially this one.

The main objective for any lesson with this group needs to be students observing and stating “what happens” not being able to tell “why it happens.”

**Strategies:**

1. Give students jobs to help you and that will help them remember what they have observed.
2. For each season make the horizon images match the season. This is easy for digital planetariums; for analog planetariums you can have students Velcro seasonal images to the horizon.

3. Since they tend to be egocentric, it is important to make connections to the children’s everyday experiences. Guide students to match the position of the planetarium sun to the time of day and the activities they typically do during the day. When discussing seasons, we also need to relate each season to the activities children enjoy during those seasons. Piaget and Inhelder (1956): It is not until age 7 that thinking is no longer egocentric and the child can see more than their own point of view.

   Example: Have the students make observations and then ask, “What did you notice?” Relate the observation to the children’s personal experience. Example: Child “I see the sun coming up over there.” “Good, that is what we call sunrise and is what happens in the sky in the morning. What is something you do in the morning?”

4. Piaget (1951) argues that language does not facilitate cognitive development, but merely reflects what the child already knows and contributes little to new knowledge. He believed cognitive development promotes language development, not vice versa.

   However helping students build specialized vocabulary (sunset, noon, middleday, sunset, diagonal, season, day, night, east, west, higher, lower, Spring, Summer, Autumn, Winter) enables them to remember and relate what they learned to others.

5. Listening to quiet music while making observations helps students to focus. You can also use music to mark the passage of time and sing (ex. Twinkle, Twinkle Little Star) or clap a rhythm to measure the length of day.

6. Other important characteristics of this age group is that they tend to focus on one aspect of the presentation at a time, have difficulty predicting what will happen next, and have trouble reversing the sequence of events.

   Make predictions using markers on the horizon and pointing as they draw the predicted path. (This is a difficult task for many students in this age group. Even after watching the sunrise, Noon and an hour or two after Noon they believe the sun will set directly down not diagonally. After watching one or more full days they are much better at it. Most 7 year olds can begin to predict the sun’s path and sunset position on their first try.)

7. Build in time to talk about what they learned, with you or each other (their “elbow partner”) and have them show the sun’s path with pointing and drawing it or with both arms making the arc. As they discuss and demonstrate what they learned they are constructing their own knowledge and the meaning of what they observed.

8. You can use stories that will help children think about what they are seeing.

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CONCRETE OPERATIONAL STAGE, Ages 7–12, Michele Wistisen

Students of this age can do:

1. Piaget (1954): Fairly good at going from a specific experience to a general principle.

2. Can do problem solving

3. Can think logically about objects and events

4. Can imagine the consequences of something happening without it actually needing to happen.

5. Shows understanding of cause and effect in short sequence.

6. Can focus on many parts of a problem.

Their limitations:

A. Cannot discriminate priorities in importance of different relevant criteria.

B. Dasen (1994): Cognitive development is not purely dependent on maturation but on cultural factors too.

C. Greenfield (1966): Schooling influences the acquisition of concepts as conservation.

D. Ability to use logical thought only applies to physical objects.

E. Children at this age have difficulty using deductive logic which involves using a general principle to determine the outcome of a specific event. Example: A child might learn that A=B and B=C but might struggle to understand that A=C.

Students were given a worksheet to record their answers pre and post lesson.

SEASON DATA SHEET

1. In which season is the Earth closest to the sun? Circle the correct answer.
   - Summer
   - Winter

2. Watch the demonstration with the heat lamp. When did the heat from the lamp warm the surface of foam the most?
   - When the lamp was pointed at the heat sensitive foam. (indirectly or directly)

3. If the foam represents the surface of the Earth, in which season would the light from the sun hit the Northern hemisphere most directly?
   - Summer
   - Winter

4. Locate each of the probes on the globes. Which globe has the northern hemisphere tilted toward the sun?
   - A
   - B
5. On which globe is the northern hemisphere getting the most direct light?

A  B

6. Look at the graph on the computer screen. The temperature from the red probe increased more than the blue probe because it was getting more _______ light from the lamp. Circle the correct word. (direct or indirect)

7. Record the altitude of the sun for the beginning of the four seasons.

   Summer _______
   Fall _______
   Winter _______
   Spring _______

8. Use the information from number 5 to answer the following question. In which season does the sun appear highest in the sky?

   Summer _______
   Fall _______
   Winter _______
   Spring _______

9. Use the information from number 5 to answer the following question. In which season does the sun appear lowest in the sky?

   Summer _______
   Fall _______
   Winter _______
   Spring _______

10. Record the numbers of hours of daylight for the beginning date of each season.

    [Winter] December 22 _______
    [Spring] March 22 _______
    [Summer] June 22 _______
    [Fall] September 22 _______

11. Use the information from number 8 to answer the following question. What season has the most hours of daylight?

    Summer _______
    Fall _______
    Winter _______
    Spring _______

12. Use the information from number 8 to answer the following question. What season has the least hours of daylight?

    Summer _______
    Fall _______
    Winter _______
    Spring _______

13. Which of the pictures shows the northern hemisphere: tilted toward the sun, with a warmer temperature, and the most direct light from the sun?

A  B  C  D

14. Which of the images shows the northern hemisphere tilted away from the sun, with a cooler temperature, and the least direct light from the sun?

A  B  C  D

Students at this age naturally believe the Earth is closer to the Sun in the summer. This may be related to their lifetime experiences with heat. (Questions 1, 3, 4, 5)

When student see an image that shows the actual distance, many still say the Earth is closer to the Sun in the summer.

They do not realize that the smaller number indicates that the Earth is closest in Winter. (A, C, E) This is counter intuitive to everything they have experienced.

Some student had no background experience with the concept of direct/indirect light. This is why we included a demonstration with a heat lamp and some heat sensitive foam.

Students saw the foam changed much more with the direct light and had no problem choosing the correct answer.

The students struggled with the second part of the question. “If the foam represents the surface of the Earth, in which season would the light from the sun hit the Northern hemisphere most directly?”

Many students struggled to make the connection between direct light and the seasons. (E) Which globe has the northern hemisphere tilted toward the sun? Students often answered this question wrong because they couldn’t identify the northern hemisphere.

This would indicate that it is not developmentally too difficult but that they needed to have prior knowledge to answer the question.

On which globe is the northern hemisphere getting the most direct light? This question requires the students to have prior knowledge about the effects of direct and indirect light. The demonstration about the heat sensitive foam was meant to help students answer this question. However, this requires some deductive reasoning and this comes at a later age. (E)

Students were told that the probes on the globes matched the lines on the computer screen. We found that the students failed to give a correct response even though the prior question was about direct and indirect light. We added: Circle the correct word. (direct or indirect) which helped students know what we were looking for. Students appeared to struggle with this question because it requires some
deductive reasoning moving from the globes to the computer screen. (E)

Question 7: Students had difficulty with this because they didn’t know how to estimate the altitude if it was between two lines. Some students also thought because it was measured in degrees it was related to temperature. (B, C)

We also discovered that students did not make the connection that the altitude of the sun was related to the number of hours of daylight or direct light and heat. (E)

For questions 8-12 students also used the chart pictured below. Students didn’t have any problem with these questions. However they did not make a connection to why this happens. (E)

Questions 13 and 14 were difficult for students even though students at this age should be able to focus on many parts of a problem. (6). It required that the students apply information from the other stations. Therefore success with this question was difficult if they had any problems with the other questions.

Students struggled to identify when the planet was tilted toward the sun. (E) I eventually got out our Trippensee and demonstrated where direct light would appear on the earth during the four seasons.

These are 318 student responses:

<table>
<thead>
<tr>
<th>Pre-Lesson Question</th>
<th>Answer</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>When is the Earth closer to the sun?</td>
<td>Spring and Fall</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Summer</td>
<td>218</td>
</tr>
<tr>
<td></td>
<td>Winter</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>None of these (implies the sun’s path is a circle)</td>
<td>187</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Post-Lesson Question (Lab activities and Planetarium Program)</th>
<th>Answer</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>When is the Earth closer to the sun?</td>
<td>Spring and Fall</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Summer</td>
<td>130</td>
</tr>
<tr>
<td></td>
<td>Winter</td>
<td>192</td>
</tr>
<tr>
<td></td>
<td>None of these (implies the sun’s path is a circle)</td>
<td>65</td>
</tr>
<tr>
<td>If Earth Had no tilt Seasons would be...</td>
<td>Longer than now</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Shorter than now</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Same as now</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>There would be no seasons</td>
<td>313</td>
</tr>
<tr>
<td>The sun would be... three months after Sept. 22</td>
<td>Higher in the sky</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>Same altitude in the sky</td>
<td>158</td>
</tr>
<tr>
<td></td>
<td>Lower in the sky</td>
<td>156</td>
</tr>
<tr>
<td></td>
<td>Not enough information</td>
<td>38</td>
</tr>
<tr>
<td>The reason the N. Hemisphere has hot summers and cold winters is...</td>
<td>Earth is tilted</td>
<td>217</td>
</tr>
<tr>
<td></td>
<td>The altitude of the sun changes</td>
<td>116</td>
</tr>
<tr>
<td></td>
<td>The distance to the sun changes</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>None of these</td>
<td>75</td>
</tr>
</tbody>
</table>

| FORMAL OPERATIONAL STAGE, Ages: 11 to 13, Rachel Thompson |

Children transition through stages of brain development gradually. Between eleven to thirteen years of ages, student behavior is indicative of characteristics in two categories of Jean Piaget’s theory of cognitive development: concrete operational thought and formal operational thought.

Students generally display characteristic of formal operational thought by age thirteen. However, a small study of students entering STEM-based and non-STEM-based fields at Coastal Carolina University provides some evidence non-STEM learners may tend toward concrete operational and “transitional” reasoning rather than formal operational thought. However, authentic research experience may encourage students to transition more fully into formal operational thought.  

Informal Engineering Education allows students to approach scientific problems on their own terms, motivating them as they connect with peers and mentors and as their learning choices allow them freedom to design solutions for problem-based learning. The planetarium setting further enhances learner conceptual model by providing game-based approach to astronomical concepts. Learners piece together the puzzles of nature as they build their conceptual models of seasons by solving mysteries applicable to the everyday world.\(^2\)

By introducing seasons with an inquiry-based activity, students are motivated to find an answer. They draw upon previous experiences, rely upon their skills, and collaborate together to solve a riddle during their planetarium experience.

One such approach presented itself naturally to planetarium and observatory student colleagues at the University of North Texas:

My classmate and I once discussed sunrise and sunset of a beach near his home. “It’s a very famous beach. A person could stay an entire day watching the sun rise and set over water.” What well-shaped land to become such a travel destination! Based upon this description, can you find his home?

This activity is an inquiry test-bed for finding sun angle and its relationship with time, season, and location. Students ages eleven to thirteen are able to solve portions of the problem using the planetarium. However, the activity must be simplified and prior to beginning analysis students must draw upon their previous experiences to understand necessary use of scientific terminology.\(^4\)

Think about the last sunrise or sunset you saw. How would you describe it?

A poet could paint the look of the sky with words:

I’ll tell you how the sun rose,--
A ribbon at a time.
The steeples swam in amethyst,
The news like squirrels ran.
The hills untied their bonnets,
The bobolinks begun.

Then I said softly to myself, “That must have been the sun!”

– Emily Dickinson

Think!

Poets paint with words.

But could you recreate Emily Dickinson’s sunrise scene and find its location from this information?

What terms would you need? (Horizon, Angle, Zenith, Direction, Degrees)

What information are you trying to find out? (Location: Latitude, Longitude)

This description is lovely and vivid. However, it does allow recreation of the location of the sunrise scene. An observer could not find the latitude and longitude of the beach.

To recreate the observer location, students must first understand Earth’s shape and coordinate system of latitude and longitude. Of the two, latitude is the simpler aspect of the problem and within the abilities of the age range.

To find it, students must also understand direction and horizon. In many dome theaters, this exercise includes finding the northern or southern celestial pole and using an image of the neighbouring skyline at the planetarium projector spring line or lighting cove.

Once direction and horizon are determined, a simulated zenith pointer gives students an agreed upon point as, in the dome, the simulated sky has limited size. Either a projected observer’s meridian or a kinaesthetic activity of measuring angular diameter is helpful in allowing students to measure angles of altitude from a horizon.

Refraction of sunlight at sunrise and sunset complicates this problem so it is helpful to begin measuring altitude at solar noon. Additionally, at equinox, the Sun’s declination from the celestial equator is zero so results are the same between northern and southern hemispheres (as well providing additional ease of calculation). However, take note of the date of equinox as it does not always line up with the date printed on calendars.

Determining a location’s longitude is more difficult. Earth speeds and slows throughout its yearly orbit creating a fluctuation in the timing of solar noon. The Equation of Time describes this change for any given date.

This must be simplified for 11-13th year olds. How can we make it an answer they can find?

1. Use Solar noon (refraction at sunrise/sunset makes it more difficult)
2. Use Equinox so sun declination will be zero & will not need to worry about southern/northern hemisphere.
3. Ignore Longitude or make it extra credit. Earth speeds and slows so Equation of Time describes noon time. Also, not date of equinox. It doesn’t always line up with calendar date.

For the student to determine latitude, observe and record measurements for the sample beach in the planetarium or in an online almanac. For the example location, data is below.

Event: Solar Noon
Date: 20/09/2016
Local Time: 12:14 pm
Sun Altitude: 82.7°

Recall the sun is at 0 degrees’ declination placing it at the zero of the celestial equator. Latitude will be 90 minus the sun altitude angle. In this case, about 7.3 degrees’ latitude (north or south of the equator). (Latitude = 90° - Sun Angle; therefore, Latitude = 90° - 82.7°; so Latitude = 7.3°N)

With this introductory mystery solved, your “celestial sleuths” are engaged in extended activities of their upcoming investigation. From here, additional time or visits in the planetarium or follow up activities at the students’ school may be taken. 1. Look up or determine your observing latitude. 2. Measure sun angle, repeat one week later at the same time.

The students must look up or determine their observing latitude by finding its offset from the north/south celestial pole. If the measurements are being done at their school, they will also need a tool to safely measure sun angle. Simple sextants can be built from paper, drinking straws, and paper clips. The NASA provides a template for one, information on the history of sextants, and an observing log at http://solarscience.msfc.nasa.gov/suntime/sxtnt_tchr.pdf.

If students are taking sun angle measurements outside, it is important they learn to make the measurement without looking at the sun and by using the instrument’s projected shadow.

When taking measurements outside, students need to be consistent with the direction and time of their measurement. Repetitive measurements spaced one week apart will reveal the sun’s altitude change allowing students the satisfaction of having solved a real life mystery.

Speaking of celestial sleuthing, did you determine the location my friend’s home is near? The beautiful beach, Kanyakumari, is on the southern tip of India and surrounded by water on three sides.

FORMAL OPERATIONAL STAGE, Ages 14-Adult, Jeanne Bishop

Many of you have seen the film “Private Universe” produced by Philip Sadler at Harvard University. The film shows Harvard graduates in caps and gowns explaining why we have seasons. Some give detailed explanations – that are completely wrong! Even a professor is shown giving a wrong explanation for seasons. I think this film reveals that in spite of intelligence, ability, and probable exposure to the correct explanation, the reasons for seasons is not intuitive and is easily subverted by misconception.

As mentioned earlier, it is at an age of about 14 that most students seem to be able to think abstractly and are able to mentally go back and forth in considering different points of view. To fully understand seasons, which is what Piaget called a “projective concept,” one has to be able to imagine a view from out in space, looking back at the Earth and Sun while at the same time imagining the view from Earth, seeing how one view relates to the other. In my own Ph.D. research I found that in spite of what I considered in-depth instruction with both the space-based view of manipulated models and planetarium views in which observations were recorded, most 13-year olds at my planetarium were unable to show this mental ability. They could not match the correct space view of Earth and sun with the planetarium view.

Sun Altitude: 82.7°
Local Time: 12:14 pm
Date: 20/09/2016
Event: Solar Noon

Recall the sun is at 0 degrees’ declination placing it at the zero of the celestial equator. Latitude will be 90 minus the sun altitude angle. In this case, about 7.3 degrees’ latitude (north or south of the equator). (Latitude = 90° - Sun Angle; therefore, Latitude = 90° - 82.7°; so Latitude = 7.3°N)

With this introductory mystery solved, your “celestial sleuths” are engaged in extended activities of their upcoming investigation. From here, additional time or visits in the planetarium or follow up activities at the students’ school may be taken. 1. Look up or determine your observing latitude. 2. Measure sun angle, repeat one week later at the same time.

The students must look up or determine their observing latitude by finding its offset from the north/south celestial pole. If the measurements are being done at their school, they will also need a tool to safely measure sun angle. Simple sextants can be built from paper, drinking straws, and paper clips. The NASA provides a template for one, information on the history of sextants, and an observing log at http://solarscience.msfc.nasa.gov/suntime/sxtnt_tchr.pdf.

If students are taking sun angle measurements outside, it is important they learn to make the measurement without looking at the sun and by using the instrument’s projected shadow.

When taking measurements outside, students need to be consistent with the direction and time of their measurement. Repetitive measurements spaced one week apart will reveal the sun’s altitude change allowing students the satisfaction of having solved a real life mystery.

Speaking of celestial sleuthing, did you determine the location my friend’s home is near? The beautiful beach, Kanyakumari, is on the southern tip of India and surrounded by water on three sides.
degrees, and the night sky differences with the seasons. I show season Sun paths for other key latitudes including 0 degrees (Equator), 90 degrees (North Pole), and 40 degrees south.

Throughout this process, I keep asking questions, ones that will cause students to think critically about what they are seeing, trying to upset preconceived ideas. I am aiming at what Piaget called "accommodation," the difficult mental process of exchanging a misconception or a previous way of thinking for a different idea. Students may or may not know the answers. They may give incorrect answers. If they do answer, I try to keep track of answers and revive them again after the planetarium demonstration. Some questions will be answered as the planetarium work proceeds. I use others later with the space model. I ask students to add their own questions to the list either during or after the planetarium demonstrations. Except for the answers that are provided by further demonstrations, I try to avoid telling students a lot of reasons for things they see.

Some questions I ask during the demonstrations:

1. "Why is the Sun moving eastward through the Zodiac?" (After all, we see the sun moving westward during the day.)

2. After seeing one season Sun path, "What do you predict the rising position, the noon position, and the setting position will be at the beginning of the next season?" Ask students to point out the predicted path. Don't tell anyone he or she is wrong. Just show the next season path.

3. After seeing the four different season Sun paths, "Why does the Sun change 47 degrees altitude at noon during the year?"

4. After seeing the night sky after different season days and the Sun moving through the Zodiac, "Why do the constellations we see in the night sky change for different seasons?"

5. "What are the Sun paths for other latitudes at the beginning of each season?" "What is the Sun path for latitude 40 degrees south when we have this Sun path at 40 degrees north?"

After showing the planetarium's Earth-based view and further student questions are noted, I turn to the space model. In a digital planetarium one could project this on the dome. I use an actual model with a yellow ball for the sun and a small Earth globe with a prominent axis. I point out the North and south Poles and the Equator, showing an Earth axis inclination of 23 1/2 degrees. I explain that size and distance scales are incorrect... I use a hula hoop for the Earth orbit, noting that although elliptical, from space our eyes would not detect a difference in distance of the Earth from the sun when the Earth is anywhere in its orbit. I note the different positions of the Earth in its orbit for each season. Then we turn to the list of questions and answers, finding correct answers. Finally I ask one or two students to explain why we have seasons. I ask more questions – when the model Earth is in a given position, what do we see in the sky from Earth? When we see the Sun path in a given way, where is the Earth in space (in the model)? When the Earth is in a given position, why do people at the Equator, North Pole, or Australia have a different view of the sky than we do at 40 degrees north?

It is valuable to extend learning. It helps students understand the basic concept of seasons better and to be able to apply this understanding to new situations. I ask how our view of seasons would be different if the Earth's axis were perpendicular to its orbit and if the Earth's axis were in the same plane as the Earth's orbit. This understanding can then be applied to seasonal differences on other planets such as Uranus.

Although students probably have studied how Sun altitude affects incoming energy (insolation), it is good to review this. If a misconception about Sun height and incoming energy is present, it will upset understanding of the reasons for seasons. A flashlight held at different angles to a white poster board is a good review demonstration, one which I use even with children 6 years old.

Finally, I have students write a one or two-page page explanation of why we have seasons and the relationship between what is seen in the sky from Earth and the position of the Earth and its axis in space. I have them include a statement of how they will remember what causes the seasons. Personalizing the topic often increases learning impact.

VI. Group work

We had to cancel this part of the workshop due to Awards lunch running late.

Questions/Comments

Divide into four groups - each of us monitors the group that correlates to our presentation. Pose the topic: What strategies do you have for teaching the Solar System for each Stage?

VII. Group reports

VIII. Wrap up

A brief wrap up discussion revealed that participants really like this kind of workshop but wished for a longer period of time to apply what they learned and discuss strategies further.
<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Characteristics</th>
<th>Resources</th>
</tr>
</thead>
</table>
| PreSchool (2-4 years old) | - Frequently fearful or shy.  
                   | They are curious about everything.                                        | **Piaget’s findings about child development. Piaget divided the learning stages into four groups:** |
|                  | - They are restless or antsy; they do not like to sit still for very long. | The Preoperational Phase (2-4 years) egocentric language, beginnings of imaginative play and ability to talk about objects that are not present. |
|                  | - Typically they have a short attention span.                      | Lisa Murphy, the “Ooey Gooey Lady,” is an early childhood specialist and has created some informative and funny videos on such topics as respecting babies, singing songs and setting up inviting spaces for small children that make discipline manageable. She is an educator who is a stand-up comedian; you will enjoy her tips! |
|                  | - They are very literal.                                            | (http://www.ooeygoey.com/)                                               |
|                  | - They are self centered.                                           |                                                                          |
|                  | - They like to pretend.                                             |                                                                          |
| Primary School (4-7 years old) | - Most like to talk and share what they feel, loudly!        | 2. The Intuitive Phase (4-7 years) more social language skills, form crude concepts that are hard to reverse, simple observations focused usually on one aspect of an object or event, intuitive logical concepts in some areas. |
|                  | - They usually do not understand the idea of asking questions.      |                                                                          |
|                  | - They can name and learn the names of things.                      |                                                                          |
|                  | - They can tell stories. The youngest ones have difficulty with long stories and sometimes ramble or repeat. |                                                                          |
| Elementary School (7-12 years old) | - Most are not scared easily by theory discussion.        | **3. The Period of Concrete Operations (7-12 years) less egocentric, can do concrete problem solving, beginnings of organized logical thought.** |
|                  | - They can describe what they see, feel, hear, touch or smell!       |                                                                          |
|                  | - They are enthusiastic.                                            |                                                                          |
|                  | - Many have very little background knowledge.                       |                                                                          |
|                  | - There can be great variation between groups.                      |                                                                          |
|                  | * First Grade                                                      |                                                                          |
|                  | - About half are scared easily. Very vulnerable to believe what they are told, if they understand. Most not yet able to show good understanding of cause and effect, show interest in dinosaurs. Very egocentric (“I” centered) in outlook. |                                                                          |
|                  | * Second Grade                                                     |                                                                          |
|                  | - There can be 10-year-olds who do not understand the idea of asking questions. |                                                                          |
|                  | - They can describe what they see.                                  |                                                                          |
|                  | - They are enthusiastic.                                            |                                                                          |
|                  | - Many have very little background knowledge.                       |                                                                          |
|                  | - There can be great variation between groups.                      |                                                                          |
|                  | * Third Grade                                                       |                                                                          |
|                  | - Most are not scared easily by theory discussion.                  |                                                                          |
|                  | - They can name and learn the names of things.                      |                                                                          |
|                  | - They can tell stories.                                            |                                                                          |
|                  | - They can describe what they see, feel, hear, touch or smell!       |                                                                          |
|                  | - They are enthusiastic.                                            |                                                                          |
|                  | - Many have very little background knowledge.                       |                                                                          |
|                  | - There can be great variation between groups.                      |                                                                          |
|                  | * Fourth Grade                                                      |                                                                          |
|                  | - Most are not scared easily by theory discussion.                  |                                                                          |
|                  | - They can name and learn the names of things.                      |                                                                          |
|                  | - They can tell stories.                                            |                                                                          |
|                  | - They can describe what they see, feel, hear, touch or smell!       |                                                                          |
|                  | - They are enthusiastic.                                            |                                                                          |
|                  | - Many have very little background knowledge.                       |                                                                          |
|                  | - There can be great variation between groups.                      |                                                                          |
|                  | * Fifth Grade                                                       |                                                                          |
|                  | - About half are scared easily. Very vulnerable to believe what they are told, if they understand. Most not yet able to show good understanding of cause and effect, show interest in dinosaurs. Very egocentric (“I” centered) in outlook. |                                                                          |
|                  | * Sixth Grade                                                       |                                                                          |
|                  | - Able to understand and perform risk-benefit analysis for simple situations. Enjoy interacting with peers. Moving away from the egocentric (“I” centered) outlook of younger children. |                                                                          |
|                  | * Seventh Grade                                                     |                                                                          |
|                  | - Able to understand and perform risk-benefit analysis for simple situations. Enjoy interacting with peers. Moving away from the egocentric (“I” centered) outlook of younger children. |                                                                          |
|                  | * Eighth Grade                                                      |                                                                          |
|                  | - Overwhelming effects of physical maturation on thinking. Peer pressure is very strong. Many are very talkative/communicative with peers and adults in a non-threatening situation. Abstract reasoning is developing, but is not much advanced beyond sixth grade. Review is important to hone thinking skills learned in previous grades. Most would like to work together on projects to help the world. Organized projects are met with high enthusiasm and energy. |                                                                          |
|                  | * Ninth Grade                                                       |                                                                          |
|                  | - They are enthusiastic.                                            |                                                                          |
|                  | - Many have very little background knowledge.                       |                                                                          |
|                  | - There can be great variation between groups.                      |                                                                          |
|                  | * Tenth Grade                                                       |                                                                          |
|                  | - Most are not scared easily by theory discussion.                  |                                                                          |
|                  | - They can name and learn the names of things.                      |                                                                          |
|                  | - They can tell stories.                                            |                                                                          |
|                  | - They can describe what they see, feel, hear, touch or smell!       |                                                                          |
|                  | - They are enthusiastic.                                            |                                                                          |
|                  | - Many have very little background knowledge.                       |                                                                          |
|                  | - There can be great variation between groups.                      |                                                                          |
|                  | * Eleventh Grade                                                    |                                                                          |
|                  | - Most are not scared easily by theory discussion.                  |                                                                          |
|                  | - They can name and learn the names of things.                      |                                                                          |
|                  | - They can tell stories.                                            |                                                                          |
|                  | - They can describe what they see, feel, hear, touch or smell!       |                                                                          |
|                  | - They are enthusiastic.                                            |                                                                          |
|                  | - Many have very little background knowledge.                       |                                                                          |
|                  | - There can be great variation between groups.                      |                                                                          |
|                  | * Twelfth Grade                                                     |                                                                          |
|                  | - Most are not scared easily by theory discussion.                  |                                                                          |
|                  | - They can name and learn the names of things.                      |                                                                          |
|                  | - They can tell stories.                                            |                                                                          |
|                  | - They can describe what they see, feel, hear, touch or smell!       |                                                                          |
|                  | - They are enthusiastic.                                            |                                                                          |
|                  | - Many have very little background knowledge.                       |                                                                          |
|                  | - There can be great variation between groups.                      |                                                                          |
|                  | * High School (10-12)                                               |                                                                          |
|                  | - Abstract thinking continues to develop. More diversity exists in attitudes toward ideas. Except with friends, most do not show willingness to have much interaction. Group discussions can be excellent if time is spent with motivation. Diversity in thinking ability is great. Values are less idealistic than those of younger students. These students know more and have a greater variety of thinking skills than many adults, but they lack experience of solving everyday problems. Solutions they suggest can be impractical. |                                                                          |
|                  | * Junior High School                                                |                                                                          |
|                  | - They are enthusiastic.                                            |                                                                          |
|                  | - Many have very little background knowledge.                       |                                                                          |
|                  | - There can be great variation between groups.                      |                                                                          |
|                  | * Middle School (13-15)                                             |                                                                          |
|                  | - They are enthusiastic.                                            |                                                                          |
|                  | - Many have very little background knowledge.                       |                                                                          |
|                  | - There can be great variation between groups.                      |                                                                          |
|                  | * Senior High School                                                |                                                                          |
|                  | - They are enthusiastic.                                            |                                                                          |
|                  | - Many have very little background knowledge.                       |                                                                          |
|                  | - There can be great variation between groups.                      |                                                                          |
|                  | * College/University (16-18)                                        |                                                                          |
|                  | - They are enthusiastic.                                            |                                                                          |
|                  | - Many have very little background knowledge.                       |                                                                          |
|                  | - There can be great variation between groups.                      |                                                                          |
|                  | * General Public                                                    |                                                                          |
|                  | - They are enthusiastic.                                            |                                                                          |
|                  | - Many have very little background knowledge.                       |                                                                          |
|                  | - There can be great variation between groups.                      |                                                                          |
47. MY SKY TONIGHT: INSPIRING AND ENGAGING ACTIVITIES FOR 3-5 YEAR OLD AUDIENCES (SESSION ORGANIZED BY IPS EDUCATION COMMITTEE)

22 JUNE 2016, 9:00-10:00 / VENUS

Convenor: Dr Julia Plummer (US) – Pennsylvania State University
Speaker: Dr Julia Plummer (US) – Pennsylvania State University, Chrysta Ghent (US) – Pennsylvania State University

Young children are very interested in the day and night sky, but how do we support and extend that natural curiosity? For the last 4 years, the My Sky Tonight project has been developing and testing astronomy activities with children ages 3-5 years old to be used in museums and other informal settings. These activities help children extend their interests in astronomy and extend their own early observations, such as investigating the pattern of the lunar phases and shadows on a sunny day. Many of these activities are natural extensions to topics taught in the planetarium. In our workshop, we will engage participants in learning specific activities that can be used before or after a planetarium program with preschoolers. We will also share our methods of adapting these effective preschool activities for use in the planetarium environment.

Text: The multi-institutional My Sky Tonight team has spent the last four years developing a toolkit of astronomy activities for young children in informal settings and supporting educators through online professional development workshops. Our activities were designed as drop-in activities or for workshops at museums. And yet, we often have members of the planetarium community attend our online professional development workshops. Therefore, with the help of those previous My Sky Tonight workshop attendees, and our own field-testing at the Pennsylvania State University planetarium, we introduced activities in ways that could be used to support planetarium programs for 3-5 year old audiences.

My Sky Tonight Activities and the Planetarium

The planetarium can help children observe astronomical phenomena as they explore, investigate, and make sense of their world. The My Sky Tonight activities can be used as introductions, before children come into the planetarium, as follow-up activities after a planetarium visit, or in some cases, integrated into children’s experience in your dome. Below are descriptions of two of our activities and planetarium adaptations. You can also download the full activity write-up and additional materials from our website, along with a selection of additional activities for 3-5 year old audiences: http://www.astro society.org/MySkyTonight

Moon Phase Matching

Moon Phase Matching engages young children with a familiar astronomical phenomenon: the Moon appears to change shape and there is a pattern to this change. The activity is focused on a large banner showing images of the Moon throughout its cycle. Children select pictures of the Moon phases on cards and are then encouraged to come up to the banner to try to find a match. This is the start of many possible conversations around observations of the phases of the Moon and how the phases appear to change.

Using Moon Phase Matching with the Planetarium

The Moon Phase Matching activity can be set-up as a station outside the planetarium so that children can come up individually to engage as a free-choice activity or as part of a small group, before entering the planetarium. It works best if there is a docent or educator present to help facilitate the interaction. Suggested questions for an educator to use with visitors and extension activities for the station are included in the full activity write-up online. Participating in this activity may help children focus more carefully on what they observe and hear about the Moon and its appearance in the day and night sky when they visit the planetarium.

We also recommend Moon Phase Matching as a follow-up activity to a visit to a planetarium, either in the museum setting or for a teacher who may have brought a preschool group to the planetarium to use back in her classroom. This will give teachers the opportunity to build on what they learned in your planetarium and continue the conversation after their visit.

Bear’s Shadow

Bear’s Shadow is based on the book Moonbear’s Shadow by Frank Asch. It tells the story of a bear who is frustrated in his efforts to go fishing because his shadow scares away a fish. Early in the morning when he first goes fishing, his shadow is pointing towards the pond and so it scares away the fish. Throughout the day he unsuccessfully attempts to get rid of his shadow. At the end of the day, he finds that his shadow now points away from the pond (because the Sun is now in the opposite side of the sky) so he can finally catch a fish. Throughout the book, the Sun is shown moving across the sky with Bear’s shadow changing length and location. After listening to the story, children have the opportunity to recreate scenes from the story using a model of a bear and a flashlight to represent the Sun. With guidance from an educator or parent, children can construct their own explanations for how the Sun’s location affects the location of bear’s shadow based on observations of the shadows in their model.

Using Bear’s Shadow with Planetarium

Start this activity by reading the story in the planetarium; you might project the images from Moonbear’s Shadow onto your dome. After reading the story, you can easily use the planetarium to demonstrate one of the central phenomena in the story: the apparent motion of the Sun throughout the day. You can then help them make observations of how the Sun is low in the sky in the morning, moves higher and higher throughout the day, and then gets lower as it heads towards the opposite side of the sky. With a small group of children, you might introduce flashlights in the dome and encourage exploration of shadow puppets and other investigations of the shadow phenomenon. Otherwise, this can be saved for working with the rest of the materials in a workshop setting or as a post-visit activity for teachers to do in their classroom.

Acknowledgments:

We would like to thank planetarium educators who previously participated in our previous workshops for their suggestions on how the My Sky Tonight activities can be used with the planetarium: Katy Accetta, Noreen Grice, Dan Malerbo, Nathelie Martimbeau, Shira Moskowitz, Mickey Jo Sorrell, and Michele Wistisen. This work was funded by NSF #11217441.
The ESERO Project: – a network to inspire and engage youngsters in STEM [id: 248]

**Speaker:** Clara Cruz Niggebrugge (nl), ESA – European Space Agency

**Abstract:** ESERO (European Space Education Resource Office) is a collaboration project between ESA and national partners started 10 years ago; it is ESA’s flagship project in support of primary and secondary school education in ESA’s Member States. ESERO provides an offer which is truly tailored to each specific national school system, language, curricula and national educational priorities in the STEM field. The project aims at large scale reach across the ESA Member States, through solid national networks of partners which are active, accredited and re-known in the field of STEM education. ESEROs are mostly hosted in Science Centres, Planetariums and Institutions with education expertise, in particular in space education. ESERO efficiently complements, and is complemented by, other educational outreach activities run by space actors, taking advantage of the inspirational value of major space events and milestones, such as astronaut missions, Earth Observation projects, exploration missions to other planets. To this end it utilises both the educational and scientific networks built around the science centres, planetariums and others, creating innovative learning strategies in partnership with an array of partners from both the STEM community and the national space sector. The strengths of the ESERO network and some examples were presented.

We – the Explorers [id: 254]

**Speaker:** Maciej Stanecki (pl), Copernicus Science Centre

**Abstract:** The development of modern information and communication technologies makes discovering and learning about the world easier than ever before. But methods and tools are not enough. Without the ‘human element’ based on curiosity, willingness to collaborate and to share research findings and observations with others, all the resources at our disposal remain untapped. The example of the Young Explorers Club programme shows that we can now develop passion for science regardless of age and places in which we find ourselves. With a little bit of support for our natural creativity and inquisitiveness, our dreams become come true and form new beginnings of great and sometimes lifelong adventures.

Pedagogical mediation of astronomy in training teacher in Antioquia state [id: 138]

**Speaker:** Carlos Augusto Molina Velásquez (co), Planetario de Medellín

**Abstract:** Traditionally planetariums have been seen as scenarios that support formal education in elementary and high school, colleges and universities. But it is increasingly common for such institutions to establish formal relationships with local governments to formulate proposals on both informal and formal levels. In recent years the Planetarium of Medellín has joined programs like NASE and GTTP and has promoted teacher training in astronomy. As a result, we created a particular and contextualized proposal based on learning methodologies by questions and projects. This presentation will showcase some of the results and challenges of this educational experience.

Learning from an astronaut [id: 243]

**Speaker:** Lars Petersen (dk), Orion Planetarium, Tina Ibsen (dk), Tycho Brahe Planetarium

**Abstract:** In 2015 the first Danish astronaut was launched into space on a journey to the ISS. This historical event has been used to communicate space science to young and old. Both at Orion Planetarium, Jels and at Tycho Brahe Planetarium, Copenhagen we have been part of a large nation-wide co-operation including 12 planetariums, museums and science centres. In this project all partners have contributed with competitions, lectures, special events, mission launch parties, new educational material, etc. We will describe some of the activities and events that have taken place in our institutions and discuss the many benefits from the national collaboration which has reached out to more than 50,000 students.
49. STEM (PLANETARIUM INVOLVEMENT IN MODERN EDUCATION)

22 JUNE 2016, 09:00-10:00 / JUPITER

Convenor: Joanne Young (US) – Audio Visual Imagineering, Inc.

Speakers: Mark Watson (US) – Winchester Science Centre and Planetarium, Jaap Vreeling (NL) – NOVA information centre, Kim Small (US) – Arcadia University, Joanne Young (US) – Audio Visual Imagineering, Inc.

Session abstract: Our future security and prosperity has never depended more upon motivated, well-trained professionals in the disciplines of science, technology, engineering and math (STEM) than it does today. STEM subjects and teaching methodologies are continually being developed for schools worldwide. How will planetariums evolve into – and effectively represent themselves as – highly effective STEM learning environments crucial to meeting the challenges ahead, and to remaining relevant in the eyes of education leaders and funders? Join us and interact with planetarians who have been working at the DOME-STEM frontier.

Text:

Editorial note: this is a summary of panel discussion

Our future security and prosperity has never depended more upon motivated, well-trained professionals in the disciplines of science, technology, engineering and math (STEM) than it does today. STEM subjects and teaching methodologies are continually being developed for schools worldwide. How will planetariums evolve into highly effective STEM learning environments crucial to meeting the challenges ahead, and to remaining relevant in the eyes of education leaders and funders.

In the Netherlands, STEM activities are stimulated by the Government through subsidies. Schools choose to work on projects based on STEM activities. Approximately 30% of schools have started coordinating STEM, calling it Technasium for High School students beginning their first year. Students will spend 4 hours per week with extra lessons in problem based learning. The problems are brought in to the schools by local and nationwide companies, universities and institutes (like NOVA and the Royal Dutch Airforce). Our Project supports STEM activities at primary education together with TECHNIEKPACT, which means that schools in the form of projects look into our Solar System. There is a local initiative within schools to connect an Art-stream with technasium activities. The Government is giving schools permission to experiment.

Great Britain has created the STEM ambassador program. It is the only one of its kind in the world, with 32,000 UK STEM specialists (volunteers with careers in a STEM topic) who give talks and presentations, develop and run workshops, and engage with students and public. The main age range the project seeks to engage with are those 5-19 years old, but all ages are ultimately engaged. During the engagements the ambassadors promote STEM subjects and lift the veil about what they involve, detailing what their career entails and how they progressed into the role they are now in, encouraging others to join. Many of these events work with science centres and planetariums. A planetarium is a fantastic aid and provides a strong part of the greater system that helps promote STEM and hopefully inspire a new generation and encourage all generations to continue interest in STEM topics.

In the United States, STEM education provides a platform to connect learners to integrated content and problems, and teaches learners problem-solving skills needed for their future. Local districts are being challenged to find ways to support STEM initiatives within the formal education systems. The planetarium field needs to find ways to be relevant within this STEM world and become or maintain the important educational role that planetariums can provide to ignite STEM learning. All educators, including planetarians, need to revisit what we know about how people learn and are motivated and how this is connected to STEM education.
There are many studies evaluating both the efficacy of planetariums for astronomy instruction at a K12 level (e.g., Brazell & Espinoza, 2009) and on the subject of university students’ level of astronomy knowledge (e.g., Rudmann, 2002). This research aims to fill the gap of studies that investigate the efficacy of the teaching environment of a planetarium compared to that of a traditional classroom or lecture hall for undergraduate introductory astronomy courses.

Constraints such as instructor availability, course scheduling and planetarium seating capacity can limit the teaching time available in the planetarium. Some topics may be more suitable and appropriate than others to teach under the dome rather than in a traditional classroom setting, and therefore we aim to understand how to maximize the impact on student learning within the dome.

Undergraduate students from two introductory astronomy courses offered at McMaster University, Canada (enrollment: 420 and 115, respectively) were invited to participate in our study. Pre- and post-tests were used in conjunction with interventions on two areas of astronomy common to many astronomy courses – celestial motion and the Solar System.

We report on our preliminary findings between classroom and planetarium education, in addition to observations concerning student demographics, before discussing our next steps in the project.

We received ethics approval to complete this study from the McMaster Research Ethics Board.

**Data collection**

Students from two separate semester-long introductory astronomy courses were invited to participate in the study. Course 1 had an enrolment of 115 students, and is aimed towards students, primarily in their first year, who are interested in majoring in either physics and/or astronomy – although we note that only about a quarter were registered in the Chemical and Physical Sciences stream. Course 2 is recommended for students from any year and from across campus for whom astronomy is of interest but they are not physics or astronomy majors, and had 420 students enrolled.

The pre- and post-tests (held in September and December 2015 at the start and end of term, respectively) were identical in that they included the same subset of questions from the Astronomy Diagnostic Test v2.0 (Hufnagel et al., 2008; see also Hufnagel, 2002, for the development of the ADT), but differed in that the pre-tests also asked students about demographic information (such as level, program, gender, age and high school marks in physics and mathematics) and for their permission to view their end-of-term grades. Students received 0.5% bonus mark each for participating in the pre- and post-tests. The subset of ADT questions used in the pre- and post-tests were related to the Solar System and celestial mechanics (i.e., motions of objects visible in the night sky from Earth) – which were the topics for the intervention.

Two weeks before the end of the term, students who had indicated their willingness to participate in the intervention were involved in two extra classes: one in the planetarium and one in a regular classroom. Students did not receive bonus marks for participating in the intervention.

Approximately three quarters of the students learned about the Solar System in the classroom and celestial mechanics in the planetarium, while the other quarter learnt about the same subjects but in the opposite settings. (The groups were intended to be equal in size, but because of the way students signed up and/or cancelled, we had a more uneven split.) With the data from these two groups, we looked at the changes in their pre- and post-test results.

**Table 2: Number of students who participated in the intervention.**

<table>
<thead>
<tr>
<th>Planetarium</th>
<th>Classroom</th>
<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar System</td>
<td>Celestial mechanics</td>
<td>8</td>
</tr>
<tr>
<td>Celestial mechanics</td>
<td>Solar System</td>
<td>26</td>
</tr>
</tbody>
</table>

**Results**

We found that the planetarium appears to be a better setting for learning celestial mechanics than for learning about the Solar System. We found that the mean change in score on the pre- and posttests for students who had the celestial mechanics portion of the intervention in the planetarium (0.21 or 21%) was significantly higher than those in the classroom (0.10; with a t-test $p = 0.838$), whereas the mean change in score for the Solar System learned in the planetarium (0.15 or 15%) was not significantly different than in the classroom (0.21; $p = 0.42$).

Stronger correlations were observed when comparing pre- and post-test scores against demographic information because of the greater number of students who participated in the tests compared to the intervention. High school physics marks have a significant positive correlation with pre- and post-test scores, but high school mathematics marks do not. The end-of-term grade is also significantly positively
correlated with pre- and post-test scores. There are no significant differences between students in different faculties.

Discussion and Next Steps

We caution that because of the small number of students who participated in the intervention, these results only hint at a possible trend which we would like to explore further – obviously by increasing the numbers of students participating in the intervention, but also increasing the number of topics used in the comparison between planetarium-based and classroom-based instruction.

Dome learning results in greater Retention [id: 211]

**Speaker:** Dr Patricia Reiff (us), ePlanetarium

**Abstract:** For the external evaluation of our dome show ‘We Choose Space’, our evaluators presented the show to 200 middle school children. Half of the group viewed the show in a portable Discovery Dome. The other half viewed on a flatscreen computer format. Both shows had the same visuals and sound track. When tested immediately after the showing, both groups showed statistically significant gains in knowledge compared to their pre-test. When tested again six weeks later, the dome group retained essentially all of their gain whereas the computer group had lost ⅔ of their gain, and even that was no longer statistically significant. Therefore, the dome is a powerful tool for extended retention.

Toward a Framework for Integrating Museum and Classroom Learning [id: 16]

**Speaker:** Dr Shannon Schmoll (us), Abrams Planetarium

**Abstract:** Field trips can offer exciting, engaging, and authentic experience for students to learn science. There has been extensive research on how to best integrate museum field trips with classroom instruction. This work applies the lessons learned from integrating museum and classroom learning to understand how well it translates to the planetarium context. This was done by testing a curriculum on apparent celestial motion that integrates the planetarium and classroom environments based on the School-Museum Integrated Learning Experiences in Science (SMILES) (Griffin, 1998) framework for integrating classroom and museum learning. Data in the form of interviews, class work, audiovisual recordings, and surveys were analyzed using qualitative and quantitative methods to find examples of the 6 strands of informal learning (National Research Council, 2012) and suggest revisions to the SMILES framework for use with planetariums and similar informal learning environments.

**Text:**

I. Introduction

A large body of work has been done to study how students can get the most out of a single field trip. However, this work has been done primarily with museums and never planetariums. This is problematic as learning is tied to the context in which it is learned and planetariums are rather different from museums. Museums are characterized by choice of exhibit, longer visit times, and more opportunities for social learning compared to planetariums. This work used guidelines from museum learning research and applied it to an astronomy curriculum that incorporated a planetarium field trip for upper elementary students in the United States. It studied the outcomes of the curriculum to modify museum field trip learning guidelines to be more applicable in a planetarium setting.

II. Foundation

A. SMILES

This project applied guidelines from the School-Museum Integrated Learning Experience in Science (SMILES) framework on integrating museum field trips into a science curriculum (Griffin, 1998). SMILES has three main principles, each with a set of guidelines on how to construct a curriculum with an embedded field trip based on socio-constructivist theories of learning (Vygotsky, 1978).

The first principle states that you should “integrate school and museum learning” and suggests that field trips be firmly embedded in the curriculum with a clear purpose and students should be prepared for the concepts they will see. The second SMILES principle is “provide students with conditions of self-directed learning” suggesting you allow students autonomy in their learning experiences and have students work within groups. Since the planetarium is a place where social interaction and choice are limited compared to museums this principle, these guidelines were implemented in the classroom instead. The third principle says you should “facilitate learning strategies appropriate to the setting” and suggests students are familiarized with the informal learning environment beforehand and that one accounts for fatigue during a visit.

B. Strands of Informal Learning

The curriculum was evaluated on the six strands of informal learning as defined by the National Research Council (2010). These strands are goals that students should reach when learning science and are:

- Sparking interest and excitement
- Understanding scientific content and knowledge
- Engaging in scientific reasoning
- Reflecting on science
- Using tools and language of science
- Identifying with the scientific enterprise

III. Methodology

A. Curriculum and Setting

The curriculum was focused around the question of “How do we use the sun and moon to tell time?” and was conducted in a 5th grade classroom at an elementary school in the midwestern United States and a digital planetarium at a local natural history. Pre-visit activities had students make predictions related to the sun and moon’s apparent motion in the sky to prepare them for the concepts they would see. All predictions were recorded using a modified diagram of the sky from H.A. Rey’s The Constellations (figure 1). The 45-minute planetarium visit
had the students test their predictions through observations to introduce purpose for the planetarium visit. During the post-visit students used what they learned to create devices that used the sun or moon to tell time and allow some autonomy.

B. Data Collection and Analysis

A subset of 12 students were interviewed with semi-structured protocols before and after the curriculum. Students were asked about their ideas regarding the apparent motion of the sun and moon (strand 2). Their ideas for key concepts were ranked according to a rubric based on astronomy learning progressions (Plummer, 2007). During interviews, students were asked to justify their answers to test their scientific reasoning (strand 3). Their justifications were also ranked according to rubric developed from the Claim-Evidence-Reasoning model (McNeill and Krajcik, 2011). Finally, interviews were also analyzed for frequency of correct use of key astronomical terms (strand 5).

Small case studies were done with using audio video recordings for 4 pairs of students to look for patterns of behavior consistent with engagement whiles students worked on their projects (strand 1). Patterns of engaged behavior were found via a grounded theory approach (Patton, 2002). Audiovisual data was also used to look at the frequency of correct usage of scientific tools.

Likert-style surveys were also used to asked students for self-reported levels of interest (strand 1), ideas about the nature of science (strand 4), and their feelings on if their own identity as someone who can do science (strand 6). These results were counted and aggregated across all relevant Likert survey questions for each strand.

IV. Summary of Results and Conclusions

The SMILES guidelines offer an appropriate starting point to be used with planetariums as there were examples of each strand of informal learning observed. However, there were some weaknesses as well, suggesting modifications to the SMILES framework to be more specific with planetarium environment.

For principle 1, the study suggested that students prepare not only for concepts but also language before a visit to the planetarium as some students did not pick up on all key terms. Since language is not a unique consideration for planetariums, it is further suggested that teachers are given scripts of planetarium shows or at least some outline of the show that highlights terms students will hear and the context in which they are used. Also, because students confused details regarding the apparent motion of the sun and moon, it is suggested that students collect data from the planetarium show and explicitly review that information in the classroom so they have multiple exposures and so they can catch key details they need in developing models and argumentation in the classroom.

For principle 2, students should be supported in their choice, control, and social learning in the classroom rather than the informal setting since these characteristics are limited in the planetarium. Students had their interest and excitement sparked by the planetarium as seen in positive Likert results and it was sustained by allowing choice and control in the classroom during the projects, as seen by students deep engagement. However, it should also be noted that students used the planetarium as a justification to their answers. As a result, how to reason with the data should be explicitly taught and modeled for the students. Since planetariums are more likely to have an authoritative voice than a museum, students should focus specifically on practices such as argumentation, explanation, and model creation to ensure they can apply their knowledge and not just parrot back facts.

For principle 3, it was noted that students began confusing ideas from the first half of the show with those in the second half. Thus for the practical aspects of show design, a suggested revision to the framework is to explicitly state that shows should minimize the topics addressed. Multiple topics may be possible, but it is then suggested that the show delineates the change in topic to make students aware that they will be changing contexts.

For the full dissertation related to this work visit: http://bit.do/PlanetariumFramework

References:


Plummer, J. D. (2007). Students’ development of astronomy concepts across time. University of Michigan, Ann Arbor, MI

Measuring Planetarium Learning in collaboration with the Houston Independent School District [id: 80]

Speaker: Dr Carolyn Sumners (us), Houston Museum of Natural Science & Houston Independent School District

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Abstract: Through our partnership with the Houston Independent School District, the seventh largest in the US, we test a random sample of the 28,000 inner city HISD students for whom we offer a program every year with specific learning objectives. This presentation demonstrates our documented successes and persistent shortcomings in teaching diurnal motion, moon phases, and the seasons – especially with upper elementary students who are challenged by having to change reference frame. After pre-post testing and interviews with thousands of students, we are documenting how, when, and why we are teaching or confusing students. We are also quantifying the length of presentations, level of interactivity, modes of illustrating concepts, and association of concepts with student experiences. We have also determined which animations, demonstrations, and discussions are most effective with students who speak English as a second language. Research papers will be provided on line to support this presentation.

Text:

Introduction

There are three reasons to measure planetarium learning: (1) Schools need or even require proof of student learning. (2) Donors are more likely to contribute to a program that can guarantee success. (3) We need to know when we succeed and when we fail. This presentation will illustrate successful procedures we have tried to measure learning in the planetarium environment. Although results are shown, the focus is on procedures rather than results.

Meeting the Standards

More than ever, it is important to identify the standards the teachers must meet and try to help reinforce classroom learning. Figure 1 shows a sample of several programs we offer in the Burke Baker Planetarium and in our Discovery Domes. Teachers often choose programs because of the state standards we address. Notice from this sample that shows which cover more than astronomy topics also address more of the required learning proficiencies.

Setting Up a Film Evaluation (using Great Planet Adventures as an Example)

Step 1: define a Learning Goal: To have students experience what it would be like to live on each world assuming we could get there.

Step 2: Develop experiences that illustrate the temperature, atmospheric conditions, surface gravity, and available resources as well as where astronauts would live, wear, and do to have fun (OffWorlding).

Step 3: Identify measurable outcomes:

1. Students will be able to answer a question about living on each world.
2. Students will be able to describe the experience of being on each planet more accurately and in more detail.

Step 4: Select the most sensitive questions.

1. Ask questions testing what the audience heard, saw, AND experienced.

2. Ask questions that the students do not already know.

Off-Worlding Experiences in Great Planet Adventures:

- Ziplining on Mercury
- Diving in a Venus submersible
- Driving a lunar monster truck
- Rappelling into the Valles Marineris,
- Bungee jumping on Eros
- Spelunking on Europa,
- Powered gliding on Titan,
- Skimming in Uranus’ atmosphere,
- Cliff diving on Miranda,
- Jet packing on Triton, and
- Snowboarding on Pluto.

Consider the results shown below. Gains are significant. Notice that gains in general are greater when more time is spent on a planet. Also notice that gains are greater when the pretest score is lower.

1. The planet closest to the sun is
   Pretest correct: 69.1%, Posttest correct: 76.7%, Seconds in Show: 83

2. What resource will astronauts find in deep craters at the poles of Mercury and the Moon?
   a. gold, b. natural gas, c. water ice, d. coal
   Pretest correct: 33.7%, Posttest correct: 44.0%, Seconds in Show: 81

3. Where is the temperature right for humans living on Venus?
   a. On a desert, b. In a volcano, c. At the poles, d. In the clouds
   Pretest correct: 20.2%, Posttest correct: 56.0%, Seconds in Show: 59

4. If you were on an asteroid, you would wear a cable to …?
   a. carry tools, b. talk to your ship, c. tie down supplies, d. jump safely
   Pretest correct: 75.3%, Posttest correct: 86.7%, Seconds in Show: 72

5. We would go to Jupiter’s moon, Europa, to look for
   a. life under the ice, b. fossil fuels, c. frozen food, d. active volcanoes
   Pretest correct: 42.1%, Posttest correct: 71.3%, Seconds in Show: 43

6. How would you get energy on Uranus?
   a. mine for minerals, b. drill for oil, c. open solar panels
   d. scoop up gas in air
Pretest correct: 35.1%, Posttest correct: 80.3%, Seconds in Show: 104

Using images to teach

Data indicate that students do not know where astronauts have visited and where astronauts are now. Students also lack scale for the planets in size and distance. These 4 images represent full dome movies that can teach without many words. From left to right: International Space Station over the Earth, planets to scale in size, planets to scale in distance including the new hypothesized Planet Nine.

Lessons Learned 1999-2015 from testing thousands of elementary students. Responses indicating significant and meaningful learning (0.01 level or better)

1. Correct drawing of planet orbits (65% correct)
2. Planet with fastest trip around Sun (77% correct)
3. Jupiter’s Red Spot larger than Earth (69% correct)
4. What you can see in a planetarium (81% correct)
5. Naming smallest and largest planets (67% correct)
6. Identification of a star pattern (48% correct)
7. Knowing why we see few stars in Houston (54% correct)
Questions achieving learning at the 0.05 level or better

8. Season when sun is highest in sky (79% correct)
9. Tilt of Earth’s axis causing seasons (50% correct)
Questions failing to indicate significant learning

10. Why stars appear to move across the sky each day (25% correct)
11. What does the Earth do once a year? (67% correct)

Lessons Learned in 2016

Measuring Techniques

It is most effective to collect data in the planetarium before and after the experience. Pre-Post responses for specific students can be compared to provide the most significant indication of student learning. In our renovated planetarium with higher light levels, two techniques have been effective, but both have limitations.

1. Plickers before and after the program: Plickers have the advantage of being easy for students to use and free with only printing of cards required. Since each card is numbered, data are collected for each student and can be matched. However plickers are currently limited to 63 cards so for larger groups you cannot collect unique data on all the students.

2. Photographing students before and after the program: This is a very effective way to collect data provided you have enough light to photograph all of the students. Student pre and post data can be collected and all students can participate. For our tests, we asked students to hold up 1, 2, 3, or 4 fingers depending on the answer selected. In these before and after photos, the correct answer is 3. Notice that more students did pick 3 on the post-test. Although many of the students are still confused about the concept.

Consider these questions and the data collected.

Constellations are rarely taught in schools so it is easy to get significant student gains with very little time spent on description of constellations. Unfortunately constellations are not tested on standardized tests very often.

It is more difficult to connect the Earth’s rotation to what students observe: day and night, the sun rising in the East and setting in the West, the sun’s apparent motion across the sky, or the motion of a sundial’s shadow during the day.

In this question, we do not know what confused the first group using plickers. However, we did get significant gains from the second group.

An explanation of the effects of Earth’s rotation requires that students know that the sun rises in the Earth and moves westward across the sky. Surprisingly only half of the students in the study were aware of the direction of sunrise, so this has to be taught first. Also just because students know the direction of sunrise does not mean they understand the daily motion of shadows. In considering these responses, remember that 25% could represent guessing.

The very significant gain scores have to do with the Museum’s sundial which is shown in full dome after students watch the sun moving across the sky. In these photos you can see the shadow motion as the sun moves from noon to the late afternoon.

Next we decided to tackle moon phases – seeing the topic first as the identification of a sequence and being able to predict what phase comes next. To the left is the question. Below is the first planetarium effect.

After students could draw the order of the phases and answer the question to the left, we created animations that explain the relationship between the moon’s location and its phase.

Comparisons of the Earth’s surface and the Moon’s surface provide the opportunity to discuss the effects of surface gravity on surface conditions.

Over half of the 4th graders in this study thought there was no gravity on the moon, but could look at the Apollo panorama and watch the videos and then change their mind.

The next topic is perhaps the most challenging in conceptual astronomy – what causes the seasons.

Notice the test results. Most students answered that the sun was closer to the Earth on the pretest. The full dome scene to the right is the best animation we have made to answer this question. It shows the sun’s path in summer and then in winter. Students already know that the sun is hotter when it’s higher (noon is hotter than dawn for instance). So this is now a logical explanation for why it’s hotter in summer – the sun is higher in the sky.
Even teachers often miss this question, picking the “closer to the Earth” option. The full dome animation shown to the above has proven to be the most successful as shown by the posttest results. Not only are we causing students to pick the “higher in the sky” option, but many fewer students are choosing “closer to the Earth”.

In Summary:

1. We are required to collect data that measures student learning of specific objectives.
2. It is very important to know what’s working and what’s not. You can’t tell from the verbal responses of students (and often teachers) in the dark.
3. Ask the schools who are paying for the program what they want students to learn.
4. Focus learning on local, state, and national standards including the Next Generation Science Standards.

Keep the planetarium WOW whenever possible and educationally justified!

**Using Realistic Fulldome Visuals to Teach About Solar System Moons [id: 22]**

**Speaker:** Dr Ka Chun Yu (us), Denver Museum of Nature & Science

**Co-author:** Kamran Sahami (us), Metropolitan State University of Denver

**Abstract:** Although substantial research has been conducted into how to teach lunar motion, phases, and eclipses, such work has focused exclusively on Earth’s Moon, and there are no published studies we are aware of on student understanding of other moons in the Solar System. We report on pre-instruction interviews of undergraduate students about their ideas about Solar System moons. We also investigate how tours of planets and their moon systems through the realistic visuals provided by a real-time fulldome virtual simulation software can lead to improved user understanding and recall of information about Solar System moons. The benefits in student learning gains is in marked contrast to previous work, where greater realism can actually result in a reduction in user performance.

**Text:** We studied how lectures in an introductory astronomy class about moon systems in the Solar System can impact learning in college undergraduates under immersive (in the dome) and non-immersive (in the classroom) treatment conditions. In our previous work, we show that immersion may result in better learning in the fulldome theater than in the classroom: spatial information about celestial bodies can be experienced egocentrically, freeing up cognitive resources for constructing a mental model about the seasons (Yu et al., 2015). In this study, we follow the standard “narrative journey” style of presentation, a nearly seamless visual experience with few cuts or edits (Wyatt, 2005). The audience feels that they are literally moving through space as the virtual camera travels from one object to the next.

After analyzing pre-instruction interviews of students about their alternate conceptions concerning planetary moons, we created a bank of multiple choice questions to assess student learning before, contemporaneous with, and post-instruction. Seventeen classes (with 781 students total) taking part in the study were divided into those that saw no visualizations (Group I), those exposed to instruction using visualizations projected onto a flat screen in the classroom (Group II) or via immersive versions projected in the Denver Museum of Nature & Science’s fulldome Gates Planetarium (Group III).

The results showed that students in all three groups showed learning gains immediately after instruction. However the control Group I (with no visualizations) and Group II (non-immersive visualizations in the classrooms) showed almost no retention by the time of the post-instruction assessment, while Group III students who visited the planetarium still held onto a modest gain. This shows that increasing immersion results in significantly greater learning gains, with a clear increase in retention for the planetarium cohort compared to those in the classroom, even though both groups had similar gains immediately after instruction.

We speculate that the greater physical display size and wider field-of-view of the planetarium are the chief factors for the student performance difference. Screen size is correlated with greater arousal and attention (Reeves et al., 1999). The wider FOV means that visual content is not concentrated only in the center forward direction, but can spill over to an audience member’s peripheral vision, especially when the virtual camera moves smoothly (in the narrative journey mode) to the next target. The optic flow of visual content in the far periphery of vision combined with the large screen size may lead to greater attention to the presentation.

**References**


Neurotours: immersive live-travel inside the human brain [id: 180]

Speaker: Daniel Armb erg (se), Sciss AB

Abstract: Neurotours is a live fulldome presentation featuring real three-dimensional neuroscientific data, curated by the Neurodome project in collaboration with fulldome company Sciss. In Neurotours, the latest neuroimaging technology becomes our observatory to discover the inner frontier of human consciousness. Using the immersive experience of a digital planetarium, the datasets comes alive around us as we scale the inner universe. The tour takes us from MRI and CT scans all the way to two-photon microscopy of individual neurons. For most people, Neurotours will be the first immersive live travel inside a real human brain... a truly mind-blowing experience!

Teaching Beginning World Languages Using a Planetarium Program [id: 35]

Speaker: Susan Batson (us), North Hills High School

Abstract: Students learning languages other than their native language can be challenged and encouraged by hearing and experiencing stories in the language they are studying. The planetarium experience adds to the mystique of the stories, helping students strive to learn more. In this talk, I will challenge all attendees to listen to a story in a non-native language and experience the learning power of the planetarium program.

Text: The planetarium is such a unique atmosphere for learning; I like to use the facility in new and interesting ways. One idea I have used to bring more students and teachers into the planetarium to experience this amazing environment is the incorporation of children's books into our world language classes.

I have always thought that a good way to practice the vocabulary, syntax, and grammar of a new language is to read books written in that language. High school students may have some difficulty reading high school level books in foreign languages. But I remember borrowing children's books, written in French, from our high school library. We had such a good time with the books, looking at the pictures and trying to decode the words.

I talked to the World Language teachers in our high school, and they seemed to agree that this would be a good way to approach learning in their classrooms. As a special treat, we would create a planetarium lesson using the children's books and have the students participate.

I wanted to be sure to choose lessons that would allow the students to listen to the spoken language and experience the visuals at the same time. We wanted to encourage them to listen to the whole story, and not just translate each word.

Children's books offer some advantages. They use short sentences, with few vocabulary words, and simple ideas. They often use repetitive language, allowing students to hear the words several times in short succession. Students in first, second, or third year foreign language courses have a greater comprehension of the world than small children, but their skills in reading, listening to, and understanding the words and sentences is similar.

I choose children's books because of their content and their illustrations. I generally choose stories that have some astronomy content, but that is a personal preference. Some that I have used are Orphan Boy by Tololwa M. Mollel and Paul Morin, Aurora: A Tale of the Northern Lights by Mindy Dwyer, and What's Out There: A Book About Space by Lynn Wilson.

Once I chose the book I wanted to use, I contacted the author or the publisher to seek permission to turn the book into a planetarium show. Most have given permission with few questions. The publisher may or may not give permission to scan and use the artwork; if I can, I contact the illustrator to seek this permission. I have been able to use music that was created by my students, my friends, or my family. That has by-passed any issues with copyright laws and synchronization rights. It may be possible to obtain these, or your institution may purchase such rights as part of a package. Our school's sports package gave us the rights to several short musical passages.

Now, the real work begins. I used a scanner to reproduce the illustrations. I found one or more readers with interesting voices. If there are characters in the story, I chose to have a different voice for each character. For the most part, I found readers among my students and colleagues. The most difficult part about having people read for these stories was getting my readers to read slowly enough. I found it important to bear in mind that the students who would be visiting the planetarium to hear these programs would be beginning language learners. They need time to process the sounds they are hearing. Also, if I am timing effects in the planetarium to go along with the story, I will have an interesting job making the events occur at the right time. After all, I seldom speak these languages myself.

I worked closely with the teachers that would bring their classes to the planetarium. Some preferred to have a vocabulary list so students would have a good chance of understanding the story. Others liked a post-visit activity, finding word puzzles and picture activities to be the most useful. If the program turns out to be short, I have time to have the students listen a second time to the story, after a discussion with the teacher. This discussion often happens in the language that I do not know myself. I find that each teacher has their own style of interacting with me, and with their students.

I have used children's books to present lessons for students of French, Spanish, Latin, and German. The technology requirements for this type of project are within reach of any planetarium, full-dome or traditional. This non-astronomy use of the planetarium opens the facility up to a wider audience and increases attendance. I have enjoyed producing these short shows, and I hope you will give this idea a try.
Human Anatomy Education Under The Dome [id: 194]

**Speaker:** Scott Huggins (US), Spitz, Inc.

**Abstract:** It is not only the universe that can be explored under the planetarium dome. This venue that is usually used for star-gazing and taking interplanetary journeys can be also used for visiting the magnificent microcosm of the human body. We will explore the benefits of the fulldome environment for visualizing human body tissues, organs, and organ systems. See how the 360-degree perspective can enhance comprehension of the relationships between various body parts and systems.


**Speaker:** Ellen Zisholtz (US), Center for Creative Partnerships; Dr Cassandra Sligh Conway (US), Impressions Career Development; Dr Elizabeth Mayo (US), Oxford University, England; Dr Elizabeth Charlton (UK), Oxford University Department of Continuing Education

**Abstract:** The I.P. Stanback Museum and Planetarium at SC State is the only museum with a planetarium in any Historically Black College or University (HBCU) and one of the few in the United States. It is a Museum of Conscience, Social Justice and Education that promotes the Arts, Sciences and Humanities, including Civil and Human Rights, building diverse community engagement. Integrating museum exhibition and planetarium content and expanding into various academic curricula enhances the impact of the planetarium on the University and the larger community. The planetarium show ‘Decoding the Stars: Negro Spirituals and the Underground Railroad’, will be presented live in the planetarium. This planetarium show was an integral part of the exhibition ‘Journey From Africa to Gullah at the Stanback’, which explored the Gullah culture and its African origins. It is a unique example of combining the humanities basis of an exhibition with science curricula.

52. CONDUCTING RESEARCH IN THE PLANETARIUM (SESSION ORGANIZED BY IPS EDUCATION COMMITTEE)

**23 JUNE 2016, 11:45-12:45 / VENUS**

**Convener:** Dr Jeanne Bishop (US) – Westlake Schools Planetarium

**Speaker:** Chrysta Ghent (US) – Pennsylvania State University, Dr Shannon Schmoll (US) – Abrams Planetarium, Dr Ka Chun Yu (US) – Denver Museum of Nature & Science, Dr Julia Plummer (US) – Pennsylvania State University

The goal of this workshop is to provide guidance to attendees who are interested in starting or extending their own planetarium-based research. This will allow participants to start answering questions about what is happening in their planetarium and to generate findings to be shared with the planetarium community, funders, other educators, etc. We will share our own experiences conducting planetarium-based research, which has taken place across a variety of age groups and in different settings. The workshop will be designed to engage participants in activities and discussions that will help further their own skills toward conducting planetarium research. Topics will be tailored to the interests of participants and may include: key areas of research, designing appropriate research questions, choosing research methodologies, human-subjects research, and disseminating research findings.

**Text:** This workshop was designed as an introduction to engaging in educational research around our practice in the planetarium. We encourage anyone who attended our workshop, or who did not but has an interested in getting started with educational research, to read the article we published in *The Planetarian* (Plummer, Schmoll, Yu, & Ghent, *A Guide to Practicing Educational Research in the Planetarium*, The Planetarian, 44 (2), 8-24, 30).

Within a single hour, we could only give the briefest of introductions to the complexity that is educational research. So we focused on three main areas:

- The four quadrants of planetarium education research
- Work-shopping our research questions
- Discussing possible methods that can be used to answer research questions.

Finally, we encouraged those who are doing educational research to publish their findings.

The four quadrants of planetarium education research call attention to two main axes that research on our field could be conducted along. The first axis is the formal to informal continuum, which recognizes that the planetarium has elements of the formal, classroom environment while also has the capacity to engage and inspire like museums, science centers, and other free-choice environments. The second axis we discussed was the in-dome to out-of-dome continuum. While we are interested in what happens in the dome and how that supports engagement, learning, interest, etc., we can also ask questions about what happens to our visitors before and after they leave our domes. Considering the intersection of these axes provides us with a framework for placing our research studies within a broader context of educational research and points to the need to study the planetarium
from multiple perspectives. For more examples, please read our paper in The Planetarian.

One important part of engaging in an educational research is beginning to define your research question. We gave the audience time to discuss in groups potential research questions that they were personally interested in answering. A good research question is based on your own experiences and interests. But it is also based on what is known in the literature, to make sure that this is a question that has not already been answered and thus can extend our understanding of development of interest, student learning, visitors' experiences, etc. The research question is also important in determining what evidence should be gathered and what methods to use to carry out answering the question. Again, examples of productive research questions can be found in our article in The Planetarian.

We briefly introduced two main methodological approaches used by researchers to answer their research questions: qualitative and quantitative. However, many educational researchers answer questions using a combination of these methods. For example, one might conduct a verbal survey with 20 visitors to find out more about their experience in the dome, before and after a program (qualitative). Based on analysis of these results, the visitors' responses can be grouped into similar responses and a statistical, or quantitative comparison can be made from before and after their visit. To help the audience learn more about possible methods for their research questions, we asked volunteers to share their research questions and then took turns suggesting ways we might go about starting to conduct a study to answer that question. Finally, we encouraged everyone to publish the results of their research. There are many possible outlets for your research. A good starting place to try out your ideas is at a conference, such as your regional planetarium society conference or IPS. However, a more lasting and impactful outlet for your research is to publish in a journal, such as The Planetarian. In this way, the community can cite your findings and build towards a better understanding of how learning happens in our domes and what we can do to convince others of the value of the planetarium.

53. TEACHING BASICS OF ASTRONOMY. CURRICULUM INCLUDED

21 JUNE, 10:30-11:30 / URANUS

ESO Supernova – Supporting Education Across Europe [id: 88]

Speaker: Tania Johnston (de) – ESO Supernova Planetarium & Visitor Centre

Co-author: Cecilia Scorza – Haus der Astronomie

Abstract: Today's young people have so much information at their fingertips and access to impressive technology. Planetariums can provide one of the most visually stimulating learning environments. The ESO Supernova Planetarium & Visitor Centre, a donation from the Klaus Tschira Foundation, will provide educational programmes to support school students at all levels, as well as support for teachers. In this talk, we will outline our educational strategy, including the challenges faced when dealing with multiple languages and school curricula.

Text: The ESO Supernova Planetarium & Visitor Centre is a cutting-edge astronomy centre located at the site of ESO Headquarters in Garching bei München, providing visitors with an immersive experience that will leave you in awe of the Universe we live in. The Centre provides school classes and families with an unforgettable learning experience, where even the most abstract and distant topics in astronomy and physics are explained and visualised in an innovative way. The ESO Supernova Planetarium & Visitor Centre is made possible by a cooperation between the European Southern Observatory (ESO) and the Heidelberg Institute for Theoretical Studies (HITS). The building is a donation from the Klaus Tschira Stiftung (KTS), a German foundation, and ESO will run the facility.

ESO, the European Southern Observatory, is the foremost intergovernmental astronomy organisation in Europe and the world’s most productive astronomical observatory. ESO provides state-of-the-art research facilities to astronomers and is supported by Austria, Belgium, Brazil, the Czech Republic, Denmark, Finland, France, Germany, Italy, the Netherlands, Poland, Portugal, Spain, Sweden, Switzerland and the United Kingdom, along with the host state of Chile.

The heart of the ESO Supernova is a planetarium with state-of-the-art projection technology and a scientifically accurate three-dimensional astronomical database, which ensures a unique and authentic immersive experience that allows you to fly to the stars and even to the edge of the Universe. Our programme of shows, suitable for all ages, is displayed on the 360-degree dome that is 14 metres in diameter. Each show also contains a live component, moderated by one of our presenters. All shows are offered in German and English.

The mission of the ESO Supernova is:

“We will make Europeans aware and proud of their astronomical achievements. By sharing the fascinating world of astronomy and ESO,
we will inspire coming generations to appreciate and understand the Universe around us.”

ESO Supernova educational programmes will be aimed at groups from Kindergarten to 13th grade (K-13), with the goal of increasing their scientific literacy in subjects related to astronomical phenomena affecting daily life, the origin of life in the Universe, as well as the uniqueness and preservation of our planet.

Our educational programmes will deepen the experience for visitors by making them participate actively in the knowledge acquisition process via interactive planetarium shows and interactive tours and workshops. For the younger audience we will make sure that, during the exhibition and workshops, for at least one hour, they feel as if they are young astronomers trying to find answers to clearly defined and exciting questions.

Our workshops will also show teachers how exciting teaching school subjects can be when they are taught in an astronomical context. This allows not only to link daily life phenomena (the seasons, day and night, the Moon phases, etc.) to the classroom, but also to connect school subjects like mathematics, physics, biology, chemistry and social studies to big questions like “Life in the Universe” in an interdisciplinary way. With the goal of reinforcing the experience, teachers will receive the complete documentation from the workshop session for implementation purposes in their schools after the visit.

A very important target group for the ESO are teenagers. Between the ages of 14 and 18, pupils make fundamental decisions about their career, often at times life-changing decisions. Due to the brain developmental changes that occur at this age, it is a huge challenge for teachers to motivate them. For this reason, this age group will experience how exciting research can be with the help of interactive planetarium shows featuring impacting images, interactive exhibition panels and models, and short but interesting activities during workshops.

The educational aim is to link the content of the different areas – exhibition, planetarium, and workshops – in such a way that students gather together the presented information within an exciting astronomical context.

The specific objectives for the educational activities at the ESO Supernova – many of them done in collaboration with our Educational Partners (Haus der Astronomie, Technical University of Munich, Ludwig Maximilian University of Munich, Deutsches Museum) – are:

1. To create educational planetarium shows for three different grade levels: 1-4 grade, 5-8 grade, and 9-13 grade.
2. To design educational exhibition elements focused especially on curriculum-based content explaining basic astronomical concepts.
3. To offer guided tours for school classes (see also point 8 below).
4. To create a number of educational Workshops for six different grade levels: K, 1-2, 3-4 5-7, 810, 11-13.
5. To develop educational support material for teachers: a) for the ESO workshops, b) for the planetarium shows, c) for the exhibition. This includes developing illustrations, print, flat video and fulldome materials covering 50 concepts in astronomy, developed in collaboration with the Haus der Astronomie. The aim is to make sure that, before completing high-school, students will learn a number of concepts related to the nature of the most important and fascinating astronomical phenomena and understand their impact on their daily lives. Some of it will be translated to other ESO Member State languages (see point 9 below).

6. Students independent research projects.
7. To offer miscellaneous informal activities for children during the weekends and vacations, such as “Make your own Comet” and “Nights at the ESO Supernova”.
8. To offer teacher trainings ten times per year. The trainings will focus on (a) astronomy and observational instruments and (b) training for teachers to become guides for the exhibition. The latter will motivate teachers to remain active collaborators with the ESO Supernova.
9. To develop a network of teachers in Bavaria, Germany and ESO’s Members States jointly with the Haus der Astronomie that will be supplied regularly with information and updates on the educational materials and will also promote the exchange of ideas between teachers. The national teacher address database will target the teachers of the 7500 Gymnasien, 2700 Realschulen and 3600 Mittelschule existing in Germany.
10. To translate, distribute and promote the educational materials throughout Germany and Europe together with Haus der Astronomie.

The key challenges we face in achieving these goals are:

- Geographic: As a “local” facility based in Germany, of course, it may not be feasible for students from all of our member states to physically visit the ESO Supernova. By making all material we produce available fully Open Source, we aim to reach those unable to come to the ESO Supernova.
- Financial: Many schools face financial challenges these days, making excursions challenging. Again, by sharing our materials, we aim to make it possible for schools to experience the ESO Supernova and the astronomy and technology of ESO from the comfort of their own countries. We will also look for funding opportunities in our member states to support school excursions to the facility.
- Linguistic: Within ESO’s member states, there are a great number of different languages spoken. All activities delivered within the ESO Supernova will be offered in both English and German, which helps to reach at least some of the different countries we wish to engage. In order to reach the wider community we aim to eventually translate supporting materials (such as workshop materials, pre/post visit support materials, etc.) into the languages of our member states.
- Curricular: Even within one country there can be vast differences in the school curricula followed. By working closely with education partners in different countries, and those involved in international projects, we are consulting with a wide variety of curricula in order to make the ESO Supernova offer suitable for all.
Abstract: Steady cuts of astronomical content in the school curriculum continue since astronomy was removed as a separate subject in the seventies. The latest changes almost completely removed astronomy from schools. There are two ways planetariums can counter this trend. First, by supplementing and expanding the learning process; secondly, by presenting astronomy under the guise of physics and geography. We will present a handful of ideas which – while attractive for teachers – can be exciting for students as well.

1. Introduction

The topic of ‘parrying the cuts’ is of most interest to Polish educators, as there have been significant curriculum cuts in our country for the past 25+ years. However, the issues presented herein may be of interest to educators experiencing similar problems elsewhere.

2. The problem

Specifically, throughout the 1970s and 80s astronomy was a separate subject in Polish high schools. On September 1, 1987 abridged astronomical topics were shifted into the physics curriculum (the name of the subject was aptly changed to ‘physics with astronomy’), but they were nonetheless still present and taught. Interestingly, another edition of Professor Rudnicki’s astronomical textbook for high school students was still published a year later, in 1988. However, over the 1990s and into the new millennium, the number of hours slated for those topics systematically continued to be reduced. At the same time, the educational reform of 2000 (introduction of a three-year long junior high schools and shortening senior high school programmes to three years from four, with a similar shortening of primary school programmes from eight to six years) has effectively replaced the older, four-year-long educational cycle with two three-year-long ones. This has mostly led to more examinations and more content repetitions in the educational cycle, decreasing the time originally available for learning new topics.

Since 2009, the new curriculum now includes only physics (without astronomy). Additionally, if there still is some astronomy taught in schools, it is seldom quality teaching. This is due to the fact that most higher education institutions do not teach astronomy at all (and astronomy programmes are offered only by six universities). Even the most basic astronomy elective courses are largely not available to science students (including physics students pursuing careers in education). In effect, if university students were not interested in astronomy beforehand, they do not come into proper knowledge during their undergraduate studies and therefore generally lack knowledge necessary to teach astronomy. This in turn leads these topics to be skimmed over or avoided altogether (as it remains unknown and misunderstood).

Additionally, physicists who are not interested in astronomy tend to largely dismiss the problem.

3. What could be done to remedy this?

One could theoretically try to influence policy makers or submit the problem to governing bodies of higher education institutions so they could include more astronomy in their study programmes. However, both courses of action have proven impractical over the past years. We propose that apart from continuing the abovementioned efforts, astronomical topics (and key concepts) could be sneaked into the curriculum through the use of problem/exercise books.

Examples include mechanics (instead of showing how momentum is transmitted with colliding balls, one could as well analyse colliding galaxies or trace the vectors of speed during close stellar flybys; for angular momentum conservation one could analyse the collapse of interstellar cloud into a star), magnetism and electricity (tracing electrons within a magnetic field of a pulsar), thermodynamics (compression of a gas cloud into a star and calculating the resulting temperature). It doesn’t have to be physics, as well. Some topics (such as analemma, orientation in the sky, directions of the world, planetary surface composition models) could be presented under the guise of geography and chemistry, while others (such as the habitable zone around exoplanets or chemistry of life) could be presented as biology.

4. Discussion

Further study of the topic seems unavoidable and we intend to continue to pursue it. It would be of great help to us if educators posted their own opinions on this subject or suggestions (such as possible other ideas for teaching astronomical concepts through problems from other courses) to astro_book@ec1lodz.pl, allowing us to obtain a wider perspective on the matter.

Teaching tips thanks to digital media [id: 127]

Speaker: Lionel Ruiz (fr), LSS Open Project

Abstract: Giving an adapted immersive answer, using common knowledge, to astronomical topics is a bargain sometimes hard to achieve. Tricks and tips will be presented in fulldome format to answer the following questions: How come the moon is following me? Why does the star Polaris seem not to move? Why does the Milky Way cross the sky like a bow? Why do we see Mars making retrograde motion? What are the sizes in the Solar System? What are those holes on the Moon? Why don’t we fall when we are upside down at the south pole? Why don’t we feel that the Earth is moving? And many others...

The video presents a set of pedagogical illustrations in fulldome format, which could be used to answer many questions that may arise under the dome. Here they are described in order of appearance:

- An image of a carousel, to draw a parallel with the rotation of the stars in the sky and the Polaris axis compared to the axis of riding and one’s the real motion.
- We see Sun and stars moving, but in reality it’s the Earth.
We see the Sun crossing the sky but it is fixed. That way we can visualize that it's the Earth that covers the Sun and not the Sun setting.

When inside a train at constant speed, we can walk and drink as if we are not moving. It's the same with the Earth, it goes fast but we feel nothing as it doesn't stop or change acceleration.

Why does the moon follow me when I walk? It's the same with mountains, you should go faster to pass by them. With the moon it's worse.

Gravity and the fact that we are upside down on the other side. We stay put due to the Earth's attraction. And we have to run at more than 8km/s to avoid falling back when jumping.

The Earth rotates in 23 h 56 min. At the same time, it revolves around the Sun. That makes a 4 min difference.

Imagine you're passing by a red car. You see it in the rear moving backward. But if you turn at the crossroads, it seems that it goes back in the good direction. Same with Mars seen from the Earth.

Retrograde motion of Mars demonstrated with 2 cameras.

The moon rotates around the Earth. That makes phases. Eclipses are harder to obtain due to the 5° inclination of the orbital planes.

Telluric planets' evolution through time.

Rotational speed of planets compared and sizes compared with the Sun at the end.

The trajectory of comets around the Sun and the evolution of tail activity due to the proximity of the Sun, providing meteor showers if crossing the Earth's orbit.

Exaggerating the planetary systems 1000x permits discussion about Exoplanets, accretion disks and the distance to those far objects.

Exaggerating the Earth's course around the sun makes it clearer to deal with parallax of stars depending of the width of their wobble.

A blue car fades to red due to the Doppler Effect and a comparison to sound.

The Ferris wheel at the end makes the best parallel for understanding why the Milky Way seen from the Earth appears as a large line crossing the sky. The center of the Milky Way with more stars is adjusted with the center of the Ferris wheel.

For more information or for some other examples please contact Lionel Ruiz:

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Planetarium of Marseille (Fr) - http://www.andromede13.info
Co-founder of LSS Open Project - http://www.lss-planetariums.info
54. A WORLD OF IMMERSION (SESSION ORGANIZED BY IMERSA)

22 JUNE 2016, 18:30-19:30 / SIRIUS

**Convener:** Dan Neafus (US) – Imersa

**Speaker:** Michael Daut (US) – Evans & Sutherland, Ryan Wyatt (US) – California Academy of Sciences

Join representatives from IMERSA (Immersive Media Entertainment, Research Science and Arts) for an exploration of the expanding world of immersive experiences. IMERSA serves as a bridge between artists, operators, educators, integrators, and creators: planetariums, yes, but also giant-screen cinema, themed entertainment, and virtual reality (VR). The panel speakers will share their unique perspectives of this diverse marketplace and share technical work on best practices, highlights from recent festivals, and some inspirational success stories. From the Allosphere designed for spherical research to the Vortex Dome dedicated to entertainment and art, from the explosion of VR to the evolution of business models, don’t miss this opportunity to hear and see what is happening in our immersive world.

55. OPENSPACE: FROM DATA VISUALIZATION RESEARCH TO PLANETARIUMS AND CLASSROOMS WORLDWIDE

23 JUNE 2016, 9:00-10:00 / SIRIUS

**Convener:** Dr Carter Emmart (US) – Rose Center for Earth and Space, American Museum of Natural History, Alexander Bock (US)

“OpenSpace” is a new open-source project resulting from the academic collaboration between AMNH and Sweden’s Linkoping University (LiU), which originally developed Uniview. It was created to bring data visualization research to the planetarium community and general public. Development of the software began several years ago in collaboration with NASA Goddard’s space weather modeling centre and continued last year with NASA’s New Horizons mission and ESA’s Rosetta mission. This promising preliminary work provided a foundation for recent NASA funding, extending the collaboration to include the University of Utah and New York University, multiple informal science institutions, and key vendors that support planetariums worldwide. The primary focus of OpenSpace is the interactive presentation of dynamic data from observations (image sequences), astrophysical simulation (volumetric rendering), and space missions (observation geometry visualization). OpenSpace was used for a global networking of planetariums across the world for live visualization of the Pluto encounter with scientist commentary from mission control.
**Accessible Space Science: Exceptionalities, Compliance and Universal Design in Planetaria [id: 346]**

**Speaker:** Anna Green (us) – James S. McDonnell Planetarium at the Saint Louis Science Center

**Abstract:** Planetaria serve a variety of people with varying abilities every day. Not all visitors have the same abilities as others, and exceptionalities that prevent them from fully enjoying being in the dome make a visit to the planetarium perhaps not the most positive of experiences. Through Universal Design and best practices, a planetarium can engage all visitors while complying with the Americans with Disabilities Act, §504 and other international laws that require equal access for all. This paper discusses how planetarium staff can most effectively work with visitors with exceptionalities, especially visitors who are visually impaired, have auditory impairments or an autism spectrum disorder. The primary case study is the Feeling the Stars program, successfully implemented in the McDonnell Planetarium at the Saint Louis Science Center for visitors who are blind or have low vision, however, other American and international planetarium museums and organizations (focusing on visitors with autism spectrum disorder, visitors who are Deaf or hard of hearing, and visitors who may need extra physical support) are examined as well.

Keywords: accessible, accommodations, Americans with Disabilities Act, Autism Spectrum Disorder, best practice, blind, compliance, Deaf, exceptionalities, hard of hearing, inclusive, low vision, universal design.

**Text:**

**Importance of Accessibility in Planetaria**

Accessibility in planetaria is important because as planetarians, we should be trying to capture and inspire anyone who may want to enjoy the night sky. Everyone learns in different ways, no matter what their skill level or abilities. By presenting planetarium content and experiences in multiple ways and engaging multiple senses, more visitors are likely to engage and gain something from their time under the dome. To be able to provide best practices for every visitor, a planetarian should learn as much as they can about exceptionalities and the audiences they might encounter. The more that is known about best practice, the better everyone’s experience will be. By providing accessible programming for planetarium visitors, planetarians will be complying with the law and enable everyone to have opportunity to fall in love with Space Science and Astronomy.

**Case Studies and Their Reception from Visitors**

In the case study planetariums and astronomical society (McDonnell Planetarium, Saint Louis, Missouri, USA; Nehru Planetarium, Mumbai, India; Harrison Planetarium, London, England; and the Saint Louis Astronomical Society, Saint Louis, MO, USA), the adaptations, programs and accessible options have been successful. Visitors who have experienced the accessible options in these locations have expressed appreciation and positive feedback. All of these planetaria and the astronomical society have served many visitors multiple times with their programs and adaptations, proving that it was worth the time and effort to include an audience that might not normally be able to enjoy a planetarium or astronomy without an accessible option.

**Online Sources**

Getting a “Feel” for Science Education. The call for discussion. [id: 374]

Speaker: Dr David Hurd (us) – Edinboro University of Pennsylvania

Abstract: A common denominator present in all countries and in all planetariums is that some visitors have challenges beyond the “ordinary.” These challenges are most often categorized as physical disabilities and mental/emotional disabilities. Although most of us feel more comfortable presenting and providing programming for “ordinary” visitors, those with special needs deserve the right to experience the wonders of science in general and space science specifically. This paper will highlight just a few resources available for those with special needs and it is the author’s desire that the 3 papers presented in the session dealing with “how to make the planetarium an inclusive experience for all” will serve as a catalyst for further discussions among planetarians as to how to better accomplish this goal.

Text: It’s an ordinary day at your extraordinary planetarium! The group scheduled at 10:00 am is just now shuffling in. But wait, you didn’t know they would have a student (or multiple students) with... a wheelchair or a seeing-eye dog or an interpreter for the deaf or a behavior modification specialist or... the list goes on and on. In the United States alone, nearly one-fifth of the population aged 5 years or older, or just under 50 million people, has some form of disability. And, although the United States has laws in place to enhance the participation of people with disabilities in public places and in the education system, many facilities are inadequately prepared to provide the least restrictive environment possible for their visitors! Regardless of where your planetarium is located in the world or what laws may or may not be in place, it is in the best interest of humankind to provide reasonable accommodations to those with disabilities. If we want to make our facility user-friendly, then we need to provide reasonable accommodations. These accommodations need not and should not detract from the experience for other participants but rather should give ALL participants who visit our planetariums the same “value” program (to the extent possible). Often times the only way to do that is use auxiliary resources and/or alternative techniques. It may mean allowing your visitors to feel models instead of just looking at them. Or, what about making your scale model of the solar-system an audible one or a tactile one or both?

For the last two decades the author and his colleagues have been working with students, the National Aeronautics and Space Administration (NASA), the National Federation of the Blind (NFB), teachers and parents to make earth and space science accessible for all. They have held workshops for people from across the United States who are, or work with persons who are, blind/visually impaired. With support from NASA, three tactile books (A Tactile Guide to the Solar System, Getting a Feel for Lunar Craters and Mars Science Laboratory) were distributed widely to schools for the blind, state libraries and many public and private schools and museums, all of which passed NASA’s rigorous peer review and testing in the Blind/Visually impaired community. Another NASA-funded publication, Space Science IS for Everyone: Lessons from the Field, summarizes seven years of working closely with the exceptional needs community to identify, implement, test and modify strategies, methodologies, activities, graphics and models related to Earth and Space Science. Currently, funding from NASA Solar System Exploration Research Virtual Institute (SSERVI) is providing a catalyst to develop more tactile books for all learners on eclipses, small bodies, ocean worlds and spectroscopy. Many of these resources are free or can be purchased for a minimal cost.

Most of the work in STEM education that the author has been involved with relates to working with students who are blind. As you are full aware, working with students who are blind in a planetarium presents an unusual set of circumstances in a highly visual medium! Facing this challenge, the author, along with colleagues John Matelock (Tactile Illustrator, Pennsylvania) and Dr. Cass Runyon (College of Charleston, South Carolina) have produced many tactiles to highlight space science. Tactile maps are raised image reproductions that allow those with visual impairments to “feel” the image. Because of the unique nature of tactile production and limited resources, feel free to contact the author about your specific needs regarding working with visitors who are blind. Or, better yet, if you have a government office or education resource that works with blind and visually impaired, ask them for some assistance.

In an “ideal” world, you would know in advance that a group attending your planetarium program has a person, or many people with disabilities. However, we know this is often not the case. So, have a game plan and come up with some resources you can use with visitors with various disabilities. Be sure and put in your brochures and messages that go out to the public that you would like to be made aware of any special needs in advance. Oftentimes, just where a person with a disability is placed in the room will make a big difference. Most of us are not experts in working with those who have disabilities but that’s just fine. Take the time to tap into the available resources and also take time to enjoy the spirit which these “unique” visitors bring to your facility! They, too, have a natural curiosity for the heavens and it will challenge us to come up with unique and creative ways of getting our message across.

Providing an Accessible Planetarium Experience for Deaf Audiences [id: 284]

Speaker: Tania Johnston (de) – Royal Observatory Edinburgh, ES0

Abstract: Presenting in the dark to deaf audiences may seem like an impossible task, but it can be done. “Making Sense of Astronomy” was a project which aimed to increase accessibility to astronomy for deaf audiences in Scotland, and included the delivery of planetarium shows. In this talk, I will highlight some of the misconceptions and assumptions that can be made when aiming to increase accessibility for deaf audiences, and detail some of the modifications to be implemented for successful delivery.

Text: Initially, the clarification was made that there are many different deaf communities, and that this project focused on the British Sign Language (BSL) using Deaf community in Scotland.

It was also clarified that the guidelines created were specifically for delivering live planetarium shows rather than prerecorded.
One of the first stages in the “Making Sense of Astronomy” project was actually to create some new BSL signs specific to astronomy. Many of the common terms used in public outreach simply did not have their own individual BSL signs. For example, the names of the planets in our Solar System would simply be spelled out in letters. After working with a focus group from the Deaf community, we identified a list of over 90 words which would be useful for increasing access to astronomy in public outreach events. A team of Deaf linguists and scientists worked together with astronomy communicators to develop suitable signs for this terminology. These signs were added to an existing glossary of scientific terminology in BSL on the Scottish Sensory Centre website.

Once the signs had been created and tested, we moved on to think about communicating to the Deaf community in dark situations (e.g. stargazing and planetariums). I highlighted that because of my initial lack of understanding of the Deaf community, my first thought had been to find some way to introduce subtitles for a show. There is technology available which is often used in theatre productions, to enable live subtitling. However, through working closely with the Deaf community in Scotland, I was able to learn that people whose first language is BSL often do not read English so well and so subtitles may not be the best method.

Another option which has been used, particularly in planetariums, is the use of glow-in-the-dark gloves and a live interpreter. However, for BSL (and it was noted that there are differences between different sign languages), the facial expression is particularly important in the language. There can be signs with very similar hand movements, but the facial expression can change the meaning. Therefore, consideration has to be given to lighting up the interpreter’s face, which the glow-in-the dark gloves do not provide.

A set of guidelines was produced after thorough testing with mixed audiences (Deaf and hearing together, to ensure that the quality of the show was maintained for all and, as such, a truly inclusive experience, rather than a “Deaf only” show) and interpreters, in fixed and mobile planetariums, for the delivery of live planetarium shows. These guidelines provide information on the lighting levels required and various other physical logistics which need to be taken into account.

57. WE ARE MOBILE
22 JUNE, 17:15-18:15 / SIRIUS

How to build a planetarium from scratch? [id: 244]

**Speaker**: Wojciech Karcz (pl) – Copernicus Science Centre

**Abstract**: When I was in high school I built my very own planetarium from scratch. The dome was made from cardboard and assembled using tape and wallpaper paste. The projector was constructed by myself based on a toy projector. Everything was powered by an old battery from Polish Fiat 126p. It was exactly 10 years ago and I had no idea it was a STEM or STEAM project. More recently, I have been the FabLab coordinator at the Copernicus Science Centre in Warsaw, Poland. After 10 years I decided to remake my original project using recent technologies like Arduino, RaspberryPi, laser cutters and 3D printers. In my presentation I would like to compare my previous project made completely from scratch using only simple tools and materials with a new planetarium created in our FabLab in the realities of the year 2016. Furthermore I would like to show how building such a planetarium in schools can help in teaching STEAM.

Making your own Planetarium [id: 1]

**Speaker**: Oded Edgar Kindermann (ar) – Astrojujuy

**Abstract**: During IPS2014 in Beijing, I had the opportunity to present my personal project and dream, finding different ways for building my own planetarium. Today I am in the final process of opening the first Geodesic Planetarium in the north region of Argentina, where there are only 4 fixed planetarium for over 45 million people. I would like to take this opportunity to show how the project was made, and most important, the benefits for the region and local community, and that we can all have our own planetarium with persistent and personal effort.

STEM Under the Stars [id: 96]

**Speaker**: Dr Carolyn Sumners [us] – Houston Museum of Natural Science

**Abstract**: In 2004, we began traveling with full-dome digital portable planetariums, offering pre-rendered experiences as well as live astronomy programs. We now reach over 70,000 students each year by providing a range of STEM (Science, Technology, Engineering, Mathematics) topics from which teachers choose the most appropriate programs for their students. We currently offer 35 different experiences in the Earth, life, and physical sciences as well as social studies. We align all programs to the local and state STEM standards at each grade level. We have been surprised by teacher requests and how they differ from the general public. This presentation features which programs teachers choose most often based on what they teach and how they extend the
planetarium experience into a wide variety of STEM classrooms. Whenever possible, we make a conceptual connection between non-astronomy content and related astronomy topics or we apply non-astronomy concepts in an astronomy context. Examples provided.

58. VISION 2020 (SESSION ORGANIZED BY V2020 COMMITTEE)

21 JUNE 2016, 18:15-19:15 / JUPITER

Convenor: Jon Elvert (US)

Speaker: Ruth Coalson (UK) – NSC Creative, Karrie Burglund (US) – Digitalis Education Solutions, Inc., Dr Mark SubbaRao (US) – Adler Planetarium, Marc Moutin (FR) – Cite de l’espace, Mark Watson (UK) – Winchester Science Centre and Planetarium, Dan Tell (US) – California Academy of Sciences, Jon Elvert (US)

Since the 2014 Beijing conference, Vision 2020 has gathered comprehensive input from IPS members on how they envision the Society’s future. The panel session, including the V2020 team, presented individual goals relating to the collective feedback from membership, Council, vendor, and other participating organizations, which are outlined below. Sufficient time was given for questions and answers. Interest from audience focused on membership categories and benefits, fundraising scenarios for increased revenues, paid staff, and attracting new members (several new members were in the audience).

In Warsaw, Vision 2020 proposed the following recommendations which were approved by Council for further development: 1. Drafting mission/vision statements, 2. Continue collaboration efforts with relevant organizations, 3. Develop new membership categories with related sliding scale benefits, 4. Recommendations for updating and redesign of web site, and 5. Develop professional development options.

Text:

Goal 1 Professional Development: Improve and increase professional development efforts that are based on research and best practices (e.g., summer schools, KAVLI Institute)

A summary of the Professional Development (PD) team’s activities was provided by Karrie Berglund, team leader. The list of PD team members was shared, and the three team members who attended the panel (Kaoru Kimura, Jaap Vreeling, and Ryan Wyatt) were invited to stand for recognition.

The presentation also included basic information gathered from a PD survey posted in March, 2015 on Survey Monkey and via paper at a Japan Planetarium Association meeting. The full results of the survey were shared at three US regional planetarium conferences by Karrie Berglund in 2015, as well as by Kaoru Kimura at another meeting of the Japan Planetarium Association.

Future plans of the PD team were also shared. These include organizing and posting a survey to gather information from the 2016 IPS conference attendees (this was posted on June 29, 2016). These results will be used to help set conference sessions and workshops, in order to make conferences as valuable as they can be for professional development. The PD team also wants to compile and organize a database of online resources; that effort will need coordination with the IPS webmaster.
The Vision 2020 Professional Development team invites you to discuss your ideas and wishes with us at any time. The team is composed of:

- Karrie Berglund, Digitalis Education Solutions, Inc. (main contact for PD inquiries/suggestions: karrie@DigitalisEducation.com)
- Kaoru Kimura, Japan Science Foundation
- Karen Klacznyski, Evans and Sutherland
- Waylena McCully, Parkland College
- Martin Ratcliffe, Sky-Skan
- Kim Small, Sandy Run Middle School
- Jaap Vreeling, NOVA (Netherlands Research School for Astronomy)
- Christi Whitworth, PARI (Pisgah Astronomical Research Institute)
- Ryan Wyatt, California Academy of Sciences

Goal 2 IPS Science and Data Visualization Task Force: Strengthen ties with professional astronomy and Space Science scientific communities (NASA, ESA, ESO, IAU, NAOJ, AAS...)

The goal’s mission is to streamline the process of going from data to dome, increasing the potential for scientific communication and storytelling in the planetarium.


Goal 3 IPS International Outreach: Expand international collaborations in recognition of the more global nature of our Society and foster enhanced financial support

In recognition of the increasingly global nature of our industry (and society at large), this goal’s mission is to expand international collaborations, increase media coverage for IPS, and foster enhanced financial support.

Strategies for achieving mission: 1. Evaluate current membership locations worldwide and to get new markets, 2. Develop web-based systems that increase the value of being a member of IPS, 3. Create partnerships with other relevant international organizations to help raise awareness of IPS, and 4. Build and nurture relationships with relevant media and press worldwide.

Goal 4 Recognize STEM Related Projects: Gain greater recognition for IPS members’ efforts and results as related to STEM or STEAM education

Goal’s mission is to make STEM projects and pilots more visible, share best practices, ideas and experiences.

Strategies for achieving mission: 1. Communicate more about education practices through the education committee and web site, 2. Create an education committee users group, 3. Use of social media tools, 4. Enhance education sessions at conferences, and 5. Create an education and best practices under the dome awards.

Goal 5: Provide support and leadership in transitioning to next-generation planetaria design, technologies and content development

IPS’ relevancy hinges not only on embracing forthcoming technological developments, but also in embracing the planetarium of today. IPS should position itself as a nexus for all interest dome related; should provide reference materials for planetarium design, renovation and improvement. IPS can enhance planetarium content, and should leave no one behind by being inclusive.

Goal 6: Encourage and attract younger members to become involved in the future of the IPS, particularly in serving or contributing in leadership roles around the world

Career starter defined as someone with 3 years or less experience as a science communicator or planetarium operator. Challenges for career starters are: financial constraints (support), experience (mentoring and financial support), daunting commitment to serve (term length), and incentive to join (membership perks).
Peterson Planetarium: Evolution and function of a small planetarium [id: 108]

Author: Dr Susan Aber (us) – Emporia State University

Abstract: Peterson Planetarium at Emporia State University was added in the sub-basement of the new science building in 1959. A 7.3 m fiberglass dome was illuminated with incandescent cove lighting. Bench seating surrounded the centrally located Spitz A-2 star projector. In 1994, a flood destroyed the planetarium, and rebuilding in the same location took three years. The new dome was made of perforated aluminum, and 38 front-facing seats flanked the new Spitz 512 star projector. Audio/video equipment and two video shows allowed visitors to see beyond the Milky Way. By 2014, the equipment was failing and obsolete. Given a modest budget for renovation, the Spitz 512 was repaired and retained; new LED cove lighting was installed. A spherical mirror projection system and 20 video shows varying from earth to space science provide a full dome, immersive environment for science education and entertainment appealing to a 21st century audience.

Text: Planetariums as known today began in the early 20th century and have evolved from mechanical to digital devices that present the night sky on an indoor, dome-shaped projection screen. Peterson Planetarium opened in a sub-basement of a new science building in 1959 on the Emporia State University campus (emporia.edu/planetarium). This educational theater had a 7.3-m fiberglass dome and was illuminated with incandescent cove lighting. Bench seating surrounded the centrally located Spitz A-2 star projector. The star projector was a two-axis model that controlled daily motion and latitude position. This provided the Earth-bound perspective of the night sky and allowed basic space concepts to be demonstrated. The room could seat 72 and most visitors were primarily university campus students. The cost of Spitz A-2 was $500 US.

Pictured is Ken Ohm, the first student planetarium operator who also helped to assemble the dome.

In 1994, an underground water pipe broke and flooded the planetarium facility with two meters of water. Since it happened during December holidays, the flood was not discovered for a week. This devastating event destroyed the facility furnishings and equipment. After securing funding, of approximately $458,000 US, rebuilding was in the same location and the entire process took three years. The new dome was perforated aluminum, and 38 front-facing seats flanked the new Spitz 512 star projector.

The three-axis star projector controls daily motion and latitude, with the vertical axis to reorient horizon direction or move the cardinal points. Audio/video equipment was added to present a space-based perspective, allowing the visitor to see through the eyes of space telescopes into and beyond the Milky Way.
In the 1990s, the equipment added for playing video programs included Pioneer LaserDisc, DVD, and VHS players. Projecting video programs was a two-fold process using four Kodak Ektapro 7010 carousel-film-slide projectors with timers for photo transitions and dissolves as well as an AmPro RGB CRT video projector.

Audio sound system involved a Hafler trans nova amplifier, Rane micro graphic equalizer, TASCAM 134 Syncset cassette tape player, Yamaha MV-802 mixer, and speakers. A computer with ATM-3 software controlled the star projector and controls on the console synchronized the analog equipment for audio-video programs. Two video shows were presented for the next 17 years and two additional videos were added in 2009 along with an upgrade to ATM-4 software.

By 2014, the video equipment was failing. Because the devices were obsolete, replacement was only possible with other used equipment. Given a modest budget of $162,000 US for renovation, the Spitz 512 was repaired and audio sound system retained. The dome was vacuumed and painted.

New LED cove lighting was installed, and Warped Media, a spherical-mirror, digital-video projection system, was added.

The mirror and projector are mounted at the spring line and created the need for a lift to lower the star projector, keeping its shadow off the dome during video programs. An auxiliary projector can project DVD or internet onto the dome as well.

In 2016, a display cabinet and historic, framed Trouvelot astronomical chromolithograph prints completed the facility renovation. For presentations, night sky lectures using the star projector are given and we offer twenty video shows varying in length and theme. As such, the evolution of the planetarium retains its educational function, and video provides a full dome, immersive environment that enhances scientific visualization using an entertainment format appealing to a 21st century audience. Finally, to promote and re-discover our planetarium we created a “new constellation” visible only on this campus in Peterson Planetarium: Corky the Hornet, the university’s mascot in the stars!
Planetarium domes in the era of VR/AR and other mixed reality experiences [id: 60]

Author: Julieta Aguilera (us), julietina@me.com – University of Plymouth, UK

Abstract: This poster describes perceptual aspects addressed by Virtual and Augmented Reality (VR/AR) applications, and how these mediums reflect on the planetarium dome experience. Human senses are not equal in terms of space, and vision is the only sense capable of escaping Earth’s atmosphere. Telescopes extend vision even further. The data comes back to us to be scaled to what we can experience with our body, creating a virtual model that is real yet can never be realistic. Understanding the capabilities and vocabulary of the human body, accumulated by being in the world, and how the different senses come together in perception is part of the artist’s research. As AR/VR spread into public consciousness allowing us to experiment with spatial and temporal abstractions, astronomy visualization in the planetarium dome is enriched, further enhancing our connection to the Universe.

Text:

Immersive and interactive media

Planetariums are unique spaces. While film theaters show a movie where viewers are passive and paralyzed, in planetarium shows – the “hard core” ones– there is a live person navigating what you see and you can look around, similar to being driven in a car. Early planetarium shows were informed by film media, but today they are also informed by interactive and immersive devices, accessible through widespread mobile device use, so agency, spatial depth and time are better understood. These devices did not appear out of thin air, but evolved from media such as planetariums.

Immersive devices evoke the natural world because we ARE here: the media develops because we can match our tools better to our body. VR/AR is achieved by establishing a field that is large/close enough to feel surrounded, a sense of depth to measure distance, a representation of the self to understand a role, and connecting body motion to camera view or motion in the environment.

- In the past, murals provided a sense of immersion. Today large displays, planetariums, or head mounted displays like the Oculus or Vibe do so.
- In the past, dioramas and stereo viewers provided visual depth. Today visual cues in computer graphics do so.
- In the past, a narrator would walk you through a story. Today we have graphical representations of ourselves (avatars) to be in the story.
- In the past, optical illusions and perspective drawing drew windows into 3D spaces. Today we can track the movement of a person, from the GPS or gyroscope in a mobile phone, to motion tracking.

While not all these capabilities are afforded by a planetarium and a planetarium is not a VR environment, many people who come to planetariums have experienced some level of VR/AR, and therefore understand what they see in the projections differently from a person decades ago.

Perception

Astronomers extend their senses through detectors. Visualization artists manipulate data to reveal it to people, as they have an understanding of the common perceptual apparatus we share: the body. The body allows us to experience space through our senses but senses are not equal in space. We can feel pressure, pain, temperature inside and in contact with the body. We can taste what comes into the body, or smell what is in the body’s immediacy. We can capture sound waves at a distance. All these stimuli require us to be in a suitable atmosphere. Yet we can see stars.

Today we can tailor space and time to suit the thresholds of human perception. Data can be scaled and reconfigured to match human spatial biases, and create scientific visualizations that allow us to experience relationships in the data. We have an understanding of what we see, less like a flat static image, and more like a realm with objects in space that match our perceptual system. Today we are “primed” by representations such as movies and games to think of scientific visualizations as things that exist in three dimensions of space among which we can move and act.

The human body senses the environment as overlapping sensory input. In turn, the purpose of a visualization is to understand a situation.

- A scientist understands the data and the underlying phenomena that may require attention.
• An artist, not only in the visual arts, but also in music, dance and the like, understands how an experience will reach the senses and our attention.

• Visualization is a point of convergence for the disciplines that further engages the community in scientific and aesthetic exploration.

Scientific Visualization

Data complexity is increasing together with the familiarity of immersive and interactive devices, as well as the need to communicate the degree to which spatial and temporal variables are being adjusted to suit human perception. Museum visitors are often curious about how “real” scientific visualizations are. There is “real data” and the “realistic look” of things: the planetarium dome has never been “real”, but an abstraction of time and space.

I propose that it is necessary to frame and spell out visualization techniques to the public. If learning how to read was important to spread knowledge, today we need to educate about the aesthetics of scientific visualization in order to communicate complex relationships that connect vast spatiotemporal scales across the Universe.

Conclusion

Planetariums have been the immersive and real time interaction referent for the past century, and are today informed by VR/AR mobile and gaming devices. Research in the arts and the sciences, coupled with their corresponding technical developments, challenge us to understand how we think as we are perceiving, and must address the multi-sensory experience of the human body in space. Even though a group of people are arguably not experiencing VR in the dome because their bodies are not being individually tracked and the view is not affected by their motion, aspects of perception can be evoked cinematographically. Ways to engage the body into agency and presence can be explored via the concept of avatars or dynamic objects in space. Taking advantage of the users’ familiarity with VR/AR media, the relationships and roles of these objects should be tailored to share the virtual space of the planetarium dome.

References:

https://planetary-collegium.academia.edu/JulietaAguilera

Idea to create consultative body to give guidelines for planning, construction and running planetarium [id: 121, 128, 144]

Authors: Khalid Abbas Ahmed Al-Karkhi (iq), Basim Abdullah Sultan Al-Saadi (iq), Razzaq Hussein Kadhem Shubar (iq) – Directorate care and scientific – astronomical dome Baghdad

Abstract: Proposals and solutions to create a pool or an international actress undertake the construction of the domes of the astronomical developing countries which want to and are looking to identify and increase the knowledge of the audience inhabitants and astronomical presentations or movies Scientific and these companies provide designs and models of buildings domes and provide them with attribution of technical and artistic.

Text:

Introduction

The goal and purpose of the Baghdad planetarium building’s is to provide the best possible space to promote scientific and astronomy topics, with giving simulations of the Earth and space. These will be experienced with and in connection with the viewer audience, venturing through and viewing the dome building and its space. Thus architecture and structure of the building should be planned to reach aims mentioned above. Furthermore we plan to use building’s corridors to promote science using interactive exhibits and historical items.

The issues

In this study we addressed the most important problems and obstacles of the rehabilitation and restoration of the Dome of Baghdad astronomical building, which can be identified as follows:

• weak technical expertise
• financial support and funding
• no communication with the expertise holder

The points mentioned were diagnosed since the start of the work and implementation phase (1st October 2011). The Iraqi contracting company, which in turn, contracted a specialized subcontractor well-known in the field of constructing domes and astronomical facilities, was engaged to carry out the project’s provisions. This include technical and artistic aspects of the fulldome experience (video display devices, visual display screen, sound system and so on). Following a good year of working and a six-month work stoppage, the primary contractor’s failed to meet its obligations in terms of payments to the secondary contractor. This resulted in a cessation of activity, thus preventing the planetarium from performing its role.

Proposed solutions

With guidance from those with prior knowledge of the subject or experience with such projects, we suggested forming a point of substantive and technical consultation through international conferences dealing with planetarium domes. This would take the form and shape of a consultative body (a consulting firm and executive projects) including a group of specialized companies working on planetarium domes and institutions already running planetarium dome. The cooperating participants would facilitate the implementation process and provide advice on identifying the beneficiaries of the contractual obligations, installing the programming and scheduling payment of financial obligations to fulfill the financial and legal provisions.

Conclusion

We have benefitted greatly from remarks, ideas and solutions on facilitating the task of constructing, re-developing and restoration of domes and astronomical facilities. Our aim at the conference was to listen to the contributions of the attendees and listeners suggesting support for the proposal, so as to emerge with an integrated and enjoyable project consistent with the architect’s design and the interests of visitors and the environment.
Abstract: Kyiv Planetarium – scientific-educational center for propagation of astronomical knowledge in Ukraine: history and modern activity [id: 178]

Speaker: Dr Klim Churyumov (ua) – Scientific-educational Center ‘Kyiv Planetarium’

Abstract: Kyiv planetarium is the oldest and the biggest planetarium in Ukraine. It was initiated by the famous astronomer Sergey Vsehsvyatsky, and started its activity in 1952. During the last 35 years Kyiv planetarium has operated a Carl Zeiss Skymaster IV opto-mechanical projector. The dome is 24 meters across, and 320 seats are placed in amphitheatre. Four lecturers are delivering more than hundred different live lectures and audiovisual shows. During weekdays the planetarium offers its programs (supporting school curricula) to school pupils, on a season-ticket basis – five or six programs a year are offered at a considerable discount. On weekends, the broader public attends shows for different age groups. About 200,000 visitors attend planetarium programs yearly. Beyond its main focus activities, the “Our Sky” magazine is issued by Kyiv Planetarium, aimed at amateur astronomers and a wide audience. It covers current space missions, interesting objects to observe, and general astronomy overview papers. The Kyiv Planetarium scientific-educational center plays an important role in the propagation of astronomical knowledge in Ukraine. The main task of Kyiv Planetarium, side by side with lecturing on astronomy and space physics for the population, is also active support of teaching astronomy in secondary and high schools. Educational astronomical programs are made at the Planetarium so as to be closely connected to the school teachers of Kyiv and aim to introduce certain additions to the traditional school programs and therefore their expansion. They allow numerous astronomical phenomena and the physical mechanisms of cosmic processes to be better understood and studied more deeply. The Planetarium’s educational programs include up-to-date scientific information about new discoveries in astronomy obtained with the help of the world largest telescopes, the Hubble Space telescope and space probes such as Rosetta, Kepler, Gaia, Plank, Hershel and others. Our lecturers make wide use of the full-dome astronomical films and presentations during astronomical lectures. The problems of Kyiv Planetarium’s modern development and astronomical education in Ukraine will be discussed.

TEDUTAINMENT, a new learning media in dome format [id: 87]

Speaker: Yana Fedorova (us) – Fulldome.pro

Abstract: Presenting a complete educational and entertainment concept with the most educationally effective children’s programs, so fun-loving kids won’t even realist they are learning… and their parents might learn something too! A fulldome show or presentation is a great way to engage children and facilitate learning and imaginative play. The fulldome format puts the class into the picture and promotes engagement with the topic by providing a more stimulating viewing experience. In addition to the traditional planetarium shows of the solar system and night skies, there is a huge range of educational content to choose from. Mobile domes are an easy and affordable way to bring the latest educational shows to small schools in remote areas, giving access to new learning opportunities previously only available in big cities. Just like your very own magic school bus – taking students through time and space without ever leaving the school.

Text: Education today is about much more than chalkboards, desks and text books. Learning is now less prescriptive and more interactive and experiential. EDU DOME is part of the classroom of the future, bringing immersive edutainment to the audience, making it part of everyday learning, instead of an occasional field trip. Nowadays television doesn’t command the full attention of the younger generation. In order to engage with content, they must tweet about it or discuss it on social media as the drama unfolds! So showing a video to a class is no longer enough. A well-crafted 360 experience can overcome
indifference, making the audience part of the environment, not just a passive observer.

Research has identified several affordances for learning in 3D virtual environments. Some of these are particularly relevant for 360° or dome content. Through virtual reality students have the opportunity to explore places and take on roles not practical or possible in the real world. They can learn about the migration of salmon fish – from the perspective of a salmon, they can visit distant planets or ancient civilizations. A well designed immersive learning experience can be so engaging that it shifts the mental focus of the audience from the surroundings and allows them to focus solely on the content being presented. For just a brief time they may forget about their mobile phones or the cute girl in the next row and concentrate on learning. Likewise, virtual worlds can provide levels of visual or sensory realism and interactivity consistent with the real world, leading to sense of presence in the audience. Ideas and events can be better recalled than if they were just presented as facts on a page because the knowledge can be internally anchored to experience.

EDU DOME is easy to operate, and can be controlled from a simple iPad interface. The teacher is free to move around inside the dome, to pause the program and elaborate on a point or answer a student’s question. The open-sided design means the teacher can also observe their class from outside the dome. Unlike other forms of viewing VR content EDU DOME makes learning a shared, group experience.

EDU DOME comes with our own astronomical simulator, to turn the dome into a planetarium and can be used with other simulators like Stellarium or World Wide Telescope. It also comes with the tools to allow teachers to create their own dome presentations, and with 360° cameras now beginning to reach the consumer market, anyone can become an immersive filmmaker and exhibitor.

EDU DOME provides a platform for immersive and entertaining education – keeping students so enthralled they will forget they are learning but won’t forget what they have learned.

The way we saw IPS2016

REVOLVE your way of thinking – during the conference we sought to look at well-known issues from different points of view, overstep certain limits, leaving behind our “comfort zone” and perhaps even transcending and revolutionizing our pre-conceived notions.

SOLVE your problems in your day-to-day work – we wanted to draw together ideas for problem-solving and rising to new challenges, and to find ways to be the best in today’s demanding world.

REVOLVE based on your needs and interests – we wanted to know what interests you, so that together we could come up with the right program topics, formats, and arrangements to ensure that everyone finds what they are looking for and takes new knowledge and ideas back home with them.

INVOLVE you in every stage of the preparations and during the conference as a whole – thank you for getting involved in the discussion and sharing your knowledge and experience, your interests and dreams.

Aim of Booth S3

Affordance 1: 3-D VLEs can be used to facilitate learning tasks that lead to the development of enhanced spatial knowledge representation of the explored domain.

Through virtual reality students have the opportunity to explore places and take on roles not practical or possible in the real world. For example, when studying coastal environments students may explore as a scientist collecting samples in the shallows, from underwater as a fish or other marine creature, or from above as a shore bird. In other examples the audience may explore an atom from the inside or visit a historic Italian theater as it would have been in its heyday.

Affordance 2: 3-D VLEs can be used to facilitate experiential learning tasks that would be impractical or impossible to undertake in the real world.

The use of a virtual world can be useful when teaching abstract concepts that do not correspond directly to material objects. The examples cited included a virtual world for developing an understanding of geometry and another micro-world to teach computer science from inside a microprocessor.

Millennials are experiential learners, so virtual reality is an ideal medium for educating today’s students.

Affordance 3: 3-D VLEs can be used to facilitate learning tasks that lead to increased intrinsic motivation and engagement.

A well designed immersive learning experience can be so engaging that it shifts the mental focus of the audience from the surroundings and the day-to-day goings-on and allows them to focus solely on the content being presented. Improvements in the quality and clarity of graphics may increase the likelihood of learners becoming psychologically immersed in the virtual environment.

Affordance 4: 3-D VLEs can be used to facilitate learning tasks that lead to improved transfer of knowledge and skills to real situations through contextualization of learning.

Because virtual worlds can provide levels of visual or sensory realism and interactivity consistent with the real world, ideas learnt within an immersive virtual environment should be more readily recalled and applied within the corresponding real environment. This is a logical corollary to the idea that knowledge can be internally anchored to experience.

Rio de Janeiro Planetarium: Sustainability Experience [id: 196]

Speaker: Carlos Augusto Freitas de Oliveira Gôes (br) – Fundação Planetário do Rio de Janeiro

Abstract: Rio de Janeiro Planetarium launched a low carbon strategy in 2013, aiming to identify and reduce its GHG emissions through actions supported by available mechanisms in Brazilian public policies for energy efficiency and environmental sustainability, and opportunities in the carbon market. The initial step was the annual elaboration
Relaxing with music under the dome [id: 139]

**Speaker:** John French (us) – Abrams Planetarium

**Abstract:** The Abrams Planetarium in conjunction with Michigan State University’s Health-4U department started a new program to help faculty and staff relax and improve emotional wellness. The program is called Rest with Music. It incorporates live music and relaxing planetarium imagery.

Dome content designed to support formal education in Mexico [id: 225]

**Speaker:** Carmen Gonzalez Paura (mx) – Planetarium Torreón

**Abstract:** Dome content designed to support formal education in Mexico is a new strategy for teachers to visit the planetarium as a real support in their classes. Moreover, the most important research projects are presented for students to see that scientific careers are a real option for their studies. Evaluations from students visiting the planetarium and after the visit yield important data on working practices. 5000 results of 50,000 samples are presented in this project.

New Concepts for inflatable domes [id: 202]

**Speaker:** Ralph Heinsohn (de) – TAT Team GbR & Ralph Heinsohn Artworks

**Abstract:** TAT Team GbR is a company specialized in developing inflatable structures and Domes with 35 years of experience. The company has a strong expertise in creating inflatable structures for events, fairs and exhibitions and the like. Lately they have teamed up with full-dome producer Ralph Heinsohn to find ways of making use of the company’s experience with inflatable dome structures to create new types full-dome show entertainment venues, resulting in innovative inflatable dome structures that can be especially installed for outdoor usage, even in windy areas with up to force 10 wind. In this presentation we would like to present the advantages and new production methods of modern mobile dome architecture – for indoor and outdoor use.

Framing Science Stories for the Dome [id: 61]

**Speaker:** Toshi Komatsu (us) – De Anza College

**Abstract:** We are in a new golden age of astronomy, where data collections are vast, publicly accessible, and growing. The ability to interpret the latest discoveries is more important than ever. But, without a hook to engage them, the public is left overwhelmed and confused. I will share lessons recently learned from a book – ‘Connection: Hollywood Storytelling Meets Critical Thinking’ by Randy Olson – on how to craft stories that are both engaging and scientifically accurate. The book details a simple, specific, and flexible set of templates that can be used to focus your story. Whether about the wonder of the sky, planets in the Solar System and beyond, or what you ate for lunch yesterday, every story needs to be a compelling story. These lessons can (and should) be applied to the dome, an inherently striking visual medium and perfect for storytelling.

Visualizing Titan for Dome/VR [id: 152]

**Speaker:** Patrick McPike (us) – Adler Planetarium

**Abstract:** While creating the visualization of Titan’s lake Ligea Mare we focused not just on the science, but also on the art and the story. Only by combining all three elements of art, science, and story can you create a compelling science visualization. This poster looks at how the team came together to create this amazing imagery for fulldome and VR.

Two Dome design in Shanghai Planetarium [id: 118]

**Speaker:** Bo Peng (cn) – Shanghai Science & Technology Museum

**Abstract:** There will be two specially designed domes at the Shanghai Planetarium. The 18m diameter optical planetarium will be set as a very important exhibition item named “starry sky”. Its main purpose is to show visitors an immersive starry sky, which they can hardly see in urban areas nowadays. There is also a giant 23m diameter 8K dome theater system combined with digital projectors, laser shows, omnibearing surround sound system and theater atmosphere rendering. A specially designed stage will stand in the front of the dome, making it possible to hold a starry music show under the starlit sky, and there will be some popular science dramas and lectures, enriching education methods and enhancing communication with audiences.

Importing Legacy Shows into SciDome [id: 81]

**Speaker:** Dr Dale W. Smith (us), dwsmith@bgsu.edu – Bowling Green State University

**Abstract:** We have now imported over 75 of our legacy shows into SciDome. Our experience is that the SciDome version of the show is superior to the slide version. This paper overviews the importing process.
and a lengthy associated user’s guide available on request sets out the process and helpful hints in some detail.

**Text:** We installed a Spitz SciDome XD full-dome system at BGSU in summer, 2014, thanks to generous funding by the University. We kept our Commercial Electronics Omni-Q slide and special effects automation system and our opto-mechanical Minolta II-B star projector, both still working well after thirty years. During three decades of operation, we had built up a large roster of programs and did not want to lose them all as we entered the full-dome era. Our vision was a transition period in which all systems both old and new would be available as we gradually moved to full-dome. Everyone told me the transition period would be briefer than I expected and this has proved to be the case.

Though we have a robust stock of replacement items that could maintain the slide system for perhaps years, we have used the slide system little during transition time and moved quickly to begin importing many of the existing slide shows (legacy shows) into SciDome in order to keep them available beyond the lifetime of the slide system, even as we add full-dome shows to our roster and are developing use of the Starry Night capabilities of SciDome. Indeed, one of the reasons for choosing SciDome was the prospective relative ease of importing slide shows.

There are three primary stages to importing slide shows into a digital system: scanning the slides, preparing the digitized images, and encoding the cues to play them. I will describe the steps briefly here and elaborate in more detail in the User’s Guide that is available on request.

For another paper on importing slide-based shows into SciDome that takes a somewhat different approach from this one, see the excellent paper by Sharon Shanks in the 2011 GLPA Proceedings.

**Slide scanning**

I did most of the scanning of show, teaching, and personal slides during a three-year period from 2008-2011. This work is described in detail in my papers “Scanning 148,000 Slides” in the 2010 IPS Proceedings and “Scanning 176,000 Slides” in the 2011 GLPA Proceedings. At this stage we did not know if we would ever be funded to go full-dome, but did the scanning anyway to be prepared. This proved to be a wise choice as the scanning was behind us when we were funded and did not complete for our time as we worked to import shows.

One critical step in this work was developing an organization for storing the scans that would enable easy retrieval of images for later adjustment and for importing into a full-dome system. The key to this organizing scheme was to create one folder for each slide projector used in a show and store that projector’s images in this folder in order. These folders would then be nested into a larger folder containing all the folders for a given show. All-sky and blended panorama images, with many different shows in the same slide tray, were bundled differently at scanning time and later sorted out to individual shows.

**Image adjustment**

Once scanned, the images needed to be prepared for importing into SciDome. This involved several adjustments that we started in early 2014 and completed by the end of the year for all 23,000 show slides.

I used the Mac’s Preview software to apply brightness corrections to nearly all scans and to crop the smaller number of scans that needed it.

I used iPhoto to apply blemish removal and leveling to the images that needed it and sharpening to nearly all images. Sharpening was critical because the scanner could be fooled into focusing on the glass in the glass-mounted show slides, rather than on the emulsion. Applying both maximum sharpening and maximum definition in iPhoto’s adjustment pane produced a sharp image.

At this point, we tested our results by video projecting a sharpened, brightness-adjusted scan side-by-side with original slide projected by a slide projector. The digital image was superior! We had a green light to move on. We repeated this test with SciDome after it was installed and found the same results.

I used Photoshop Elements to remove black backgrounds from scans. (This is analogous to using LPD4 masks to remove black backgrounds from physical slides. If you understand the last sentence, you are – like me – as dated as if you know the connection between hexagonal wooden pencils and cassette tapes!) When removed by Elements, the background is not just invisible, but is no longer part of the scan. Background removal was applied to most slides, which were then saved in png format.

Most scans of unstitched 6-frame all-sky slides and some scans of un-stitched 12-frame pans were left as jpgs with no background removal.

**Soundtrack preparation**

For more recent shows where the soundtrack was already in digital form, it could be converted to wav format and imported directly into SciDome.

For older shows where the soundtrack was only in analog format, we have pulled it off our reel-to-reel show tapes and digitized it.

**Encoding the show in SciDome**

Show encoding in SciDome involves placing cues on timelines in a template of timelines (Figure 1). The key here is to create a set of virtual slide projectors that correspond to the physical slide projectors used in the legacy show and that point to the same place on the dome. So for each show, I set up a series of timelines, one for each virtual slide projector. Along each timeline, I placed “slide up” and “slide down” cues at appropriate places by listening to the soundtrack and following cues on my original visual design pages (Figure 2) for the legacy slide show. Among other parameters, the slide cue allows specification of the image’s size and position on the dome, which can now change from slide to slide, giving flexibility not possible with physical slide projectors.
The process of encoding the slide commands is relatively slow, about 30-40 images an hour for me. This is about two-and-a-half times slower than recording cues using the physical faders and advance buttons in our Omni-Q system (Figure 3), which used reel-to-reel tapes and was absolutely state-of-the-art and exquisitely designed when we installed it in 1983. But the slower encoding is more than made up for by ease of editing later on and by the increased flexibility of visual design, both made possible now by the advance of technology.

With practice, I learned to encode with the video projectors OFF. While this seems counterintuitive, it led to working substantially faster and with better mental focus.

Since our Minolta was out-of-service during our first transition year while its lift system was being replaced, I put in all the sky sequences using Starry Night rather than leaving them to be done by manual operation of the Minolta. Appropriately placed “target” images have also replaced the need for an operator to point out anything on the dome, a final step in making the imported versions of most shows completely self-contained and independent of operator action or prior equipment. I also did this Starry Night encoding using the screen display and with the video projectors OFF. Again, while this seems counterintuitive, it led to working substantially faster and with better mental focus.

Since we did not have an especially robust set of special effects in our legacy shows, it has been possible to replace most sfx by images or motions, again helping make the imported version not rely on any prior equipment.

Once the show, both images and sky sequences, was completely encoded, then I tuned the video projectors ON and slowly played through the show, correcting errors, tweaking image positions and sizes, adding motions, and refining the visual design. This also moved rather slowly, at the pace of 50 images an hour at best, and much slower at worst.

After another verification pass, the show was done.

I have described the encoding process in detail in a companion “User’s Guide to Importing Slide-Rich Legacy Shows into SciDome” that is available on request from me or in the Proceedings of the 2015 GLPA Conference.

Results

Our experience has been that the version of the show as imported into SciDome is superior to the original version using slides. The images are brighter if not sharper, and the soundtrack is brighter as well. With the flexibility in image placement, sizing, and motion, we have been able to enhance the visual design. So the imported version is proving to be not just nostalgic preservation, but an enhancement of the product for the future.

As we moved to full dome, we kept the Minolta star projector, with a lift system to raise it when needed and otherwise lowered to avoid shadowing in the video projection. The lift system was custom-designed by Mark Perkins of Free Fall Technologies in cooperation with Ash Enterprises. With all the sky sequences in shows now programmed in SciDome, we are using the Minolta less than we had anticipated.

We began the importing of legacy shows in November 2014 and finished importing over 75 shows in June 2016, bringing the transition period to an end. All legacy shows can now be run with SciDome, and the decades of changing slide trays are behind us. We do not plan to remove the slide projectors or their control console; they remain as a backup system if ever needed and the task of their removal will be left to whoever eventually comes after me and oversees the next renovation.

Target earth! Educate public in astronomy [id: 379]

Speaker: Jana Tichá (cz) jticha@klet.cz, Milos Tichy (cz) – Ceske Budejovice Observatory and Planetarium, Klet Observatory

Abstract: Near-Earth Object (NEO) research is among the most popular parts of communicating astronomy to the public. Increasing research results in the field of Near-Earth Objects as well as impact hazard investigations cause growing interest among general public and media. Furthermore, NEO related issues have outstanding educational value. On the other hand, issues related to NEO hazard could attract sensationalists, catastrophists, and so on. It is always necessary to avoid misunderstandings, and so communicating the issues of NEO detection, NEO characterization, possible impact effects, space missions to NEOs, ways of mitigation and impact warnings with the public and media are among the most important tasks of scientists, research institutions as well as planetariums.

Text: Our institution represents the unique liaison of a small professional research institution devoted especially to NEO studies (Klet Observatory, Czech Republic) and an educational and public outreach branch (Ceske Budejovice Observatory and Planetarium, Czech
The Klet Observatory is among the most prolific professional stations in the world providing NEO astrometric follow-up, and it has chalked up more than 1800 asteroid discoveries. The Ceske Budejovice Observatory and Planetarium is the largest astronomical institution in South Bohemia and plays an important role in astronomical communication in the Czech Republic.

This all gives us an excellent opportunity for bringing NEO information to wider audience, and we have been gaining broad experience in communicating NEOs with the public more than twenty years. We have a wide spectrum of public outreach tools aimed to NEO research and hazard, with the most useful ones including: on-line magazines (e-zines), educational multimedia presentations at the planetarium for schools at different levels, summer excursions for the broader public at the Klet Observatory on the top of Klet mountain, public lectures, meetings and exhibitions. The public seems particularly interested in and appreciative of opportunities for formal or informal meetings just with NEO researchers from time to time.

A very important part of NEO public outreach consists in maintaining continual contact with journalists and the media, including press releases, interviews, news, periodical programs. The increasing role of social media cannot be forgotten. There are many interesting and well-designed websites maintained by NASA, JPL, ESA, the Planetary Society, various observatories and institutes, but naturally the vast majority of them are written in English. Given that there is still an unsatisfactory level of knowledge of English in our country, we have decided to design a special website in Czech devoted to NEOs and based on the Klet Observatory’s long-term observing program, its international cooperation and experience in education and public outreach programs.

This Czech public service on NEOs – www.planetky.cz – was launched by the Klet Observatory on February 2001. As of June 2016, it features 348 original articles written for the general public by research team members regarding minor planets, spread into six themes. This number includes 112 articles directly about Near-Earth Objects. To date, as of 8 June 2016, more than 359,000 visitors have viewed more than 3,307,000 pages on the site www.planetky.cz. On the basis of language similarities this website has also been visited by many people from Central and East European countries like Slovakia, Poland, Ukraine, Russia and others.

The website offers the following functions: search inside articles using full-text search procedure, sorting articles into six themes for better orientation, server statistics, external links to important NEO webpages all over the world, orbit diagrams of minor planets, educational multimedia presentations at the Klet Observatory, and the latest news from an complementary Klet server www.komety.cz where information regarding Near-Earth comets can be found. The main recent topics have been the Rosetta mission to comet 67P, the Chelyabinsk meteor explosion, the close approach of asteroid 2012 DA14 and the small asteroid 2014 AA on an Earth-impacting trajectory. Among the main topics presented to the public since 1992, we can mention the comet Swift-Tuttle and its approach in 2126, several close approaches of asteroid Toutatis, the 1997 XF11 affair, future close approaches of Apophis, space missions to asteroids Eros and Itokawa, 2008 TC3, its impact and meteorites found, NEO surveys and discoveries and so on.

The essential goal of all the NEO public communication and educational tools mentioned here is to bring relevant, clear, comprehensive and up to date information to students, educators, the wider public and the media. Lessons that have been learned from communicating Near Earth Objects science with the public and media by Klet Observatory and the Ceske Budejovice Planetarium continue to help us improve our efforts.
Astronomy in the Stratosphere [id: 2]

**Speaker:** April Whitt (us) – Fernbank Science Center

**Abstract:** The Stratospheric Observatory For Infrared Astronomy (SOFIA) Airborne Astronomy Ambassadors program pairs teachers and scientists to bring STEM activities from the real world into the classroom and planetarium. Flying at 11 kilometers above Earth, above most of the atmosphere’s water vapor, our team observed infrared sources in space. We will discuss some of the experiments on the flights, and share some activities and resources.

Research institutions managing Science Centers – The case of the Porto Planetarium [id: 223]

**Speaker:** Dr Ricardo Cardoso Reis (pt), Planetário do Porto – Centro Ciência Viva

**Abstract:** The Centro de Astrofísica da Universidade do Porto (Center for Astrophysics of the University of Porto – CAUP) is a private, non-profit, scientific and technical association, recognized of public utility. Among its statutory objectives is the support and promotion of Astronomy, namely research, education at the graduate and undergraduate levels, activities for Schools, science outreach and the popularization of Astronomy. CAUP currently manages Planetário do Porto – Centro Ciência Viva (Porto Planetarium) and is the host institution of Instituto de Astrofisica e Ciências do Espaço (Institute of Astrophysics and Space Sciences – IA), the largest Astronomy research institute in Portugal. Both IA and the Porto Planetarium are currently ESO Outreach Partner Organizations. In this talk I’ll describe how the Research Institution co-exists with the Science Center, and how CAUP’s Outreach Unit serves both as Press Office for the research institution, and as an Informal Education and Public Outreach Office for the planetarium.

Development of global environment education program by immersive media [id: 101]

**Speaker:** Takeshi Chikakiyo (jp), micromuseum-lab inc.

**Abstract:** How to explain to people the very complicated process of carbon cycling and also the place and role of humans in this cycle? Let’s use the experience of imagery, without using words. Developing a global environment education program by harnessing dome images gives us an opportunity to develop new perspectives on this topic. One of the most noteworthy features of this program is that it provides a special experience of observing the Earth from the atomic-microscopic perspective, to the macroscopic perspective (as seen by the naked eye), up to the global perspective of the Earth overall from outer space. These three perspectives provide an opportunity for cultivating a scientific perspective on understanding the relationship between humans and the Earth. Moreover, the dome theatre environment and the animation imagery that is popular among family audiences provide unique discoveries and surprises for children as well as adults.
Space mission Rosetta-Philae to comet 67P/Churyumov-Gerasimenko nucleus: first scientific results [id: 187]

**Speaker:** Dr Klim Churyumov (ua), Kyiv National Shevchenko University

**Abstract:** Measuring instruments on the Rosetta probe detected water vapor, carbon monoxide, carbon dioxide, ammonia, methane, methanol, formaldehyde, hydrogen sulfide, hydrogen cyanide, sulfur dioxide, carbon disulfide, sulfur, sodium and magnesium. Sixteen compounds were identified, divided into six classes of organic molecules (alcohols, carboxyls, amines, nitriles, amides and isocyanates). Of these, four were detected for the first time on a comet (methyl isocyanate, acetone, propionaldehyde and acetamide). These particles are precursors of molecules important for life (sugars, amino acids, DNA bases, etc.). The nucleus of the comet has a sharply irregular shape with two parts connected by a narrow isthmus: the small lobe measures 2.6 × 2.3 × 1.8 km and the large lobe 4.1 × 3.3 × 1.8 km. The Radio Science Instrument has measured the mass to be 10 billion tonnes, yielding a density of 0.52 g/cm^3. The period of the nucleus revolution is 12.4043 hours (OSIRIS). D/H = 5.3×10^-4, more than three times than in terrestrial oceans. Other scientific results are discussed.

Steering the Stars: Undergraduate-controlled planetarium to drive student learning [id: 76]

**Speaker:** Dr Robert Cockcroft (ca), McMaster University

**Text:** A new six-week experiential astronomy course for undergraduates [maximum enrolment of 20] is being offered at the McCallion Planetarium at McMaster University, Canada. Instead of a one-off planetarium visit common to many undergraduate astronomy courses, interested students are invited to learn and then teach one another about celestial phenomena. Students learn and teach by operating the planetarium and creating simple software scripts, facilitated by our smaller facility and easily-learned planetarium projector and software. The course also requires students to produce material suitable for the purposes of public outreach. In this presentation, we further describe details of the course, present feedback from students in the course’s first offering, and discuss possible future iterations.

**Introduction**

Using the immersive environment of the planetarium and its ability to easily and quickly provide simulations of the celestial motions of a variety of astronomical objects, students explored a number of celestial phenomena across different timescales and different vantage points throughout the Solar System during this 1-unit course (18 hours in class, with approximately equivalent time required outside class for assignments). The planetarium and an adjacent classroom were used every class. The course was assessed on a pass-fail, with a pass achievable by attending all six evening classes and submitting all assessment deliverables. RC was the instructor.

**Assessment Deliverables**

There were five main assessment deliverables that had to be completed in order to pass the course:

1. **Present astronomical phenomena**
   Students worked in pairs to brainstorm their own top five ideas, and the instructor confirmed which single phenomenon to proceed with (this avoided overlap between presentations). Students practiced how to present of their phenomenon, and developed an associated multiple-choice question (MCQ) to ask their peers after the presentation. MCQs were not used for marks, but rather to help engage students in thinking about the phenomena – both those who chose to present it and those who viewed it. This activity was repeated per pair in subsequent weeks.

2. **Review phenomena and provide feedback**
   All students provided feedback to the pair presenting on both the astronomical concept and presentation style.

3. **Contribute to collective glossary**
   Each student was responsible for contributing ten or more words to an astronomical glossary.

4. **Compose a written reflective piece**
   Approximately 1000 words long, discussing the modern-day or historical importance of their phenomenon, how the type of audience might change their presentation style, or how they would develop or explore their ideas further if the course was longer.

5. **Produce outreach material**
   In the format of the student’s choice, they produced material about one of the phenomena that they explored in class. Students presented their work in the final class.

**Course Structure**

Activities were held both in the planetarium and an adjacent classroom over six weeks.

<table>
<thead>
<tr>
<th>Week</th>
<th>In-class activity</th>
<th>Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Instructor introduces the course, provides examples of phenomena; students receive basic planetarium training, start brainstorming phenomena</td>
<td>Choose phenomena #1 with instructor guidance; start astronomical glossary entries</td>
</tr>
<tr>
<td>2</td>
<td>Students practice presenting phenomena #1, one pair at a time; create MCQ #1 associated with first phenomenon; start designing outreach material</td>
<td>Submit MCQ #1; continue working on glossary entries and outreach material</td>
</tr>
<tr>
<td>3</td>
<td>Students present phenomena #1; view other students’ presentations, answer their MCQ #1, and give feedback; brainstorm top five phenomena #2</td>
<td>Use feedback to enhance outreach material; choose phenomena #2 with instructor guidance</td>
</tr>
<tr>
<td>4</td>
<td>Repeat of week 2 but with phenomena #2; begin reflection</td>
<td>Submit MCQ #2; submit glossary entries; continue working on reflection/outreach material</td>
</tr>
<tr>
<td>5</td>
<td>Repeat of week 3 but with phenomena #2</td>
<td>Study glossary compilation; prepare to present outreach material</td>
</tr>
<tr>
<td>6</td>
<td>Instructor tests students on glossary entries, invites students to participate in pedagogical research project (partial results reported in section “7. Student Feedback”); students present outreach material</td>
<td>Submit reflection; submit final outreach material</td>
</tr>
</tbody>
</table>
Phenomena Presented and Outreach Materials Produced

Students chose to present on the following topics (no particular order): transit of Venus, Voyager space probes, Vesta’s apparent retrograde motion, annular solar eclipse, Triton’s retrograde orbit, precession of Earth’s axis, triple eclipse on Jupiter, lunar standstill, stellar proper motion, the motion of Hyperion from Saturn, Uranus’ orbital axis tilt, and scintillation. Students produced their outreach material in a format of their choice. Formats included a children’s book, a YouTube video, two posters, an OKCupid dating profile, and a song.

Student Feedback

As part of the pedagogical research project, students were asked a number of questions:

What components did you most appreciate?
- Being trained to use the planetarium
- Unusual nature of phenomena chosen
- Student-led nature of the course

What components would you change?
- Glossary testing
- Include more lectures from instructor

What were the most surprising components?
- How location on Earth determines motion in sky
- The ability to manipulate time
- One’s own lack of astronomy knowledge

Would you recommend course to others? Why?
- Yes! (All students)
- Increases our ability to understand astronomy
- Interactive, hands-on nature of the course
- Fun / enjoyable / low stress

Possible Improvements for Future Iterations

Based on our experience through this course’s first iteration, and also on the student feedback, we would change a number of components in the next version of the course:

- The reflective piece would need to be structured differently as students gave a summary of their phenomena rather than giving a reflection (as described in section 3).
- The second change would involve the glossary compilation exercise and the associated test. Although this was one of the only low-level learning tasks (as defined in Bloom’s taxonomy as “remembering and recalling”), and even though the glossary entries were directly related to the phenomena explored in the classes, students did not appreciate the relevance. Perhaps move all MCQs to the final class and intersperse with glossary test.
- Given students’ interest, the instructor is considering increasing the course from being a 1-unit (10 hour) course, to one worth 2 or 3 units (20 or 30 hours, respectively), which would then allow time to include formal training to write scripts and require students to write at least one code (only one student chose to write a code for the current iteration). Along with the time increase, the course could also be scaled up to increase enrolment from 12 students to 35 students – a limit imposed by the seating capacity of the planetarium.

Bear and Brothers Revolve: A Six Nations’ Collaboratively-Developed Show [id: 79]

Speaker: Dr Robert Cockcroft (ca), McMaster University

Abstract: We describe a process of creating collaboratively-produced shows that blends local culture, history and modern-day astronomy by a Canadian university’s planetarium, its indigenous studies program, and members of local indigenous communities in the Six Nations. The shows provide context, in-depth knowledge, and artwork of the Cayuga traditional night-sky stories, with narration by a live astronomer and pre-recorded excerpts (in English and Cayuga). They also solve a number of needs from all partners: sharing Six Nations sky lore and language with the general public and students (including students from the Six Nations community); fostering relations with Six Nations communities; providing a variety of planetarium show programming adaptable to different audiences; and offering a different perspective of the celestial sphere. We hope the collaboration, currently focusing on the Cayuga cosmology and bear and brothers’ story around the Big Dipper, will evolve into a series of shows devoted to First Nations’ sky lore.

Introduction

The Haudenosaunee, also known as the Six Nations or Iroquois, are made up of the Mohawk, Oneida, Onondaga, Cayuga, Seneca and Tuscarora nations. Their traditional territories at the time of major contact with Europe around the late 15th and early 16th centuries consisted of what is now known as New York State. The Cayuga originally lived in the Finger Lakes region, along the shores of Cayuga Lake (see Figure 1). Following the American Revolution, in which the Haudenosaunee fought as allies of the British, the majority of the Six Nations migrated to Upper Canada and settled in Southern Ontario beginning in 1785. While the Mohawk, Oneida, Onondaga, Seneca and Tuscarora were able to retain reservations lands in New York, the Cayuga did not. Therefore, the large majority of Cayuga now reside thirty minutes south of McMaster University, Hamilton, Ontario, at Six Nations of the Grand River, the only place in the world where the Cayuga language is now spoken. Although there are fewer than 50 fluent speakers left, a major effort is now underway to preserve the language. Through the pre-recorded excerpts that include the Mohawk and Cayuga languages, this planetarium show contributes to this effort.
The show begins with a brief introduction to the Haudenosaunee and the current night sky, which is very similar to the sky that the Haudenosaunee would have seen for centuries. The first video excerpt summarizes the Haudenosaunee cosmology, introducing the Sky Woman who fell from the Sky World and who was aided by the animals as she fell (pictures to the right). We then draw the audiences’ attention to the motion of the constellations, picking out the Big Dipper and its motion in particular. The second excerpt focusses on the story of the Bear (the cup of the Dipper) and the Brothers (the handle of the Dipper) and how their motion across the sky indicates the start of the Haudenosaunee hunting season. We demonstrate how this motion is particular in time and location to the fall season in Hamilton, before taking questions from the audience.

Process

We expand below on the major components of the project:

Project initiation

McMaster University’s Indigenous Studies Program Director, RM, enquired with the McCallion Planetarium Manager, RC, about a collaborative project in mid-July 2014. They met with the Planetarium Director, SS, Six Nations Polytechnic instructor, TD, and Six Nations Legacy Consortium member, DM, to discuss TD’s previous work on Haudenosaunee sky lore.

Funding

McMaster University’s President financially supported this project through funding established to help, in part, improve the university’s relationship with the surrounding communities.

Intellectual property rights

An important point for all at the beginning of the project was to establish co-authorship of the project. TD and DM retain copyright of their materials, and McMaster owns the electronic files and rights to use them in planetarium shows. RC and SS have been and continue to be sensitive to stories being the cultural property of the Six Nations.

Show drafts and meetings

All five members met once every two months, on average, to review first the progress of the two excerpts and then the show as a whole.

Launch and subsequent shows

The show was successfully launched in December 2015. The show has since been given to several Six Nations school groups, undergraduate classes in the Indigenous Studies Program, elders and language speakers from the Six Nations, members of the public, and to research heads from across Canada.

Learning points

Six Nations community members have commented how the show validates their sky lore; feedback from members of the general public have appreciated learning about both the sky lore and the Six Nations’ languages.

What Next?

The collaboration successfully (and enjoyably) produced this first show, which has been very well received by a variety of audiences. There are several other Six Nations sky lore stories that may be appropriate to explore in the planetarium in the near future. One such story focusses on the New Moon and Pleiades as a way to determine the end of the hunting season and the start of the Six Nations new year.

Image Sources

We gratefully acknowledge the Six Nations Tourism for use of their logo on the poster, and the Jake Thomas Learning Centre for the cosmology images.

Image Captions

Figure 1: A map showing the Finger Lakes, Upper New York State, Lake Ontario and Southern Ontario.

Figure 2: Sky World
Accelerating Universe: An Excerpt of High-Z, a Live, Interactive Performance [id: 214]

Speaker: Dr. Keith Davis (US) – Digital Visualization Theater, University of Notre Dame

Abstract: Led by playwright Naima Kristel Phillips and astrophysicist Lara Arielle Phillips, the High Z Project is an oral history archive and interactive fulldome installation/performance about the 2011 Nobel Prize winning discovery of the acceleration of the expansion of the universe. The High-Z Supernova Search Team, one of two teams responsible for the discovery, operated in a uniquely non-hierarchical way uncommon to large scientific collaboration. The High Z Project is an international collaboration between theatre artists, astrophysicists, and an immersive digital artist to record and share this story with the public. Our creative installation of interaction objects and fulldome visualizations will give audiences behind the scenes access to the scientific inquiry, the collaboration, and the personal journeys behind this revolutionary discovery. We will present a short demonstration of the project and request feedback from the interactive planetarium and fulldome community.

A content development targeted at a specific audience [id: 234]

Speaker: Yadith Flores (MX) – Planetarium Torreón

Abstract: Content development is targeted at a specific audience, with growing interest in the topic and research, assessing the content for spectators and the impact we want to have. The results are the main theme of this workshop, which also evaluates the strategies for harnessing science in support of students and teachers. The study from which we start was carried out in Mexico with the theme of astronomy supporting formal education, reviewing a sample of 5000 student assessments and reviews of teachers. The entire sample is 50,000 students in 24 cities in Mexico.

Gravitation Zero: Drifting By [id: 14]

Speaker: Daniel A. Freedman (HU) – Lux Aeterna Theatre

Abstract: There is no perceiving the ‘Lux Aeterna’ Light Theatre mentally; this is something even psychoanalysis as well as various systems developed from time to time by theatre reformers fail to achieve. Rather, the things taking place here should be... experienced. It is akin to a state of amorousness – light and airy. To a union with the diamonds of the stars. You are simply sitting at the summit of a high mountain. With your eyes closed. Clouds are floating by, below and above you. You let go of your feelings, allowing them to find freedom, making no attempt to restrain them within the boundaries of the material. Set yourself free...

The AStroconcert project: musical storytelling about the sky [id: 113]

Speaker: Stefano Giovanardi (IT) – Planetarium and Astronomical Museum of Rome

Abstract: ‘AStroconcert’ is a multimedia project on communicating astronomy through musical and storytelling events, combining live electronic music with narration. It was started in 2008 by composer and musician Angelina Yershova and astronomer Stefano Giovanardi. The AStroconcert project aims at exploring innovative formats for musical and scientific performances for planetaria, theatres, concert halls. We will discuss how the interplay between music and storytelling creates synesthetic perceptions that give broader meaning to astronomical contents: emotion and science can be mixed at several narrative levels to experience the enchantment of discovering the universe. AStroconcert productions and performances: ‘Stellar Vibrations’ (Rome Science Festival), 2009; ‘Astrotherapy’ (Planetarium of Rome), 2009; ‘Cosmic Echoes’ (Festa Democratica, Rome), 2009; ‘Destination Infinity’ (Planetarium of Rome), 2011; ‘Aurora Borealis’ [‘Voci della
Montagna’ Festival, Pescasseroli; Planetarium of Rome; AWB GAM2014; Festival of Electronic Literature, Naples), 2013; ‘Icy Rose 67P’ (AWB GAM2015; ‘A Testa in Su’ Festival, Cerveteri, in collaboration with the Italian Space Agency), 2015.

‘Content AG’ A content forum within the german planetarium association [id: 200]

Speaker: Ralph Heinsohn (de) – Ralph Heinsohn / Rocco Helmchen / Tobias Wiethoff

Abstract: Since 2014 there has been a new official board within the German planetarium association (GdP), entitled ‘Content AG’ (Content Board), dedicated to the exchange of thoughts and to enforcing communication between all parties and institutions involved into content production. The ‘Content AG’ organizes workshops taking place on the annual meetings of the German Planetarium Association. Founded by Ralph Heinsohn (independent show producer), Rocco Helmchen (independent show producer) and Tobias Wiethoff (Planetarium Bochum), the main goal was to establish an official forum for debates around key topics, such as ‘show concept issues’, ‘handling tight budgets’, ‘production aspects beyond technical issues’, etc., beyond the daily business challenges. Above all, it aims at promoting understanding for the different perspectives of all parties and institutions involved, such as independent fulldome producers and artists on the one hand and planetarium institutions on the other. How can we find connections and maximum synergies in an economically challenging market?

Tochtli – The Lunar rabbit adventure [id: 221]

Speaker: Eduardo Hernandez Carrillo (mx) – Planetarium Torreón

Abstract: The fulldome show ‘Tochtli, the Lunar Rabbit Adventure’, narrates the story of Tochtli, the moon rabbit seeking an answer to the question ‘why do we observe the stars?’. When Tochtli reaches Earth, he begins a tour of the most important centers of astronomical research, such as the Large Millimeter Telescope, the Gamma Ray Observatory HAWC, and some optical telescopes on Mexico. On this tour he talks with the leaders of these projects and learns how we study and understand the Cosmos today. This production was made possible thanks to support from the National Council for Science and Technology of Mexico (CONACYT). It is an effort to support formal education in the areas of astronomy in basic education with 12 aditional contents of 3 minutes, also as additional educational activities for students and guides for teachers in a effort to make visiting the planetarium a supplement to the topics of astronomy seen in the classroom.

Four-Dimensional Digital Universe Viewer ‘Mitaka’ [id: 114, 58]

Speaker: Dr Tsunehiko Kato (jp) – National Astronomical Observatory of Japan, Shoich Itoh Saeki – National Astronomical Observatory of Japan

Abstract: ‘Mitaka’ is software for visualizing the known Universe with up-to-date observational data and theoretical models, developed by the Four-Dimensional Digital Universe (4D2U) project of the National Astronomical Observatory of Japan (NAOJ). Mitaka users can seamlessly navigate through space, from the Earth to the edges of the known Universe. Mitaka has been used for live shows in the 4D2U Dome Theater in NAOJ’s Mitaka headquarters with stereoscopic visualizations. It can also run on a single Windows PC. We release Mitaka as freeware and anyone can download it from the 4D2U web site: http://4d2u.nao.ac.jp/html/program/mitaka/index_E.html; In this talk, we will talk about the features of Mitaka and its development.

The observational data used in Mitaka include, for example, the topography of planets and moons (Earth, the Moon, and Mars), positional data for the planets, moons, asteroids, stars, globular clusters and galaxies, and surface images of the planets and moons (including the latest images of Pluto and Charon obtained by New Horizons spacecraft last year).

The theoretical models used are:

- a Milky Way Galaxy model constructed based on theoretical models of star distribution and the pattern of the Galactic arms, rendered by a real-time volume rendering method based on the radiative transfer equation, taking account of the gravitational lens effect around the super-massive black hole at the Galactic Center (Sagittarius A*)

- a model of the distribution of stars in globular clusters;

- a model of Earth’s atmosphere,

- the trajectories and 3D models of some spacecraft (including Voyager I/II, Pioneer 18/11, New Horizons, Cassini, and Hayabusa 2).

Mitaka supports many features: e.g. it can play movies, handle multiple languages (including English, Japanese, French and Spanish), and...
provide domemaster rendering for domes with Fish-Eye projection and Virtual Reality (VR) mode for Oculus Rift.

A beta-version smartphone VR application of Mitaka for Google Cardboard is also under development.

Mitaka has been widely used for a variety of purposes since its first beta release in 2005, such as live shows and exhibitions at planetariums and museums, educational use in schools, TV programs, books, science café events, personal use, and so on. In particular, Mitaka is being used in some stereoscopic dome theaters, including the 4D2U Dome Theater and the Kurobe Yoshida Science Museum, in live shows for the public.

Mitaka is distributed at the Mitaka Website (http://4d2u.nao.ac.jp/html/program/mitaka/index_E.html) as freeware for Windows PC; anyone can download and use it for personal use or educational use.

For uses in planetariums or museums, please contact the 4D2U Project (http://4d2u.nao.ac.jp/english/index.html).

In February the program deals with the movement of the moon. Games are devoted to New Year's traditions and rituals. In March we celebrate International Planetarium Day. The special program presents planetariums around the world. Workshops: “Planetarium on the table” and “I love the planetarium”. In April we celebrate International Cosmonautics Day. Games are dedicated to the working conditions in space: checking the vestibular apparatus, manipulating small objects while wearing thick gloves, etc. In May we have International Day of the Sun with the special program “On a visit to the Sun”. Physical experiments and demonstrations relate to the energy of the sun. In June comes International Father’s Day, so the games involve dads and children. In July we have Day of the Alien with a competition for fantastic costumes. In August is “Tanabata” - the meeting of two stars. In September we dedicate the program to World Tourism Day with “Guide to the Galaxy”, “Cosmic Journey” and “Sundial”. In October we present World Space Week with the special program “Incredible space adventure” and workshops. In November we have events, games and workshops dedicated to stargazing, meteor showers, and the autumn sky. In December we celebrate St. Nicolas day with the program “Nicholas came to us” and making gifts for disadvantaged children.

A planetarium-centered college-level introductory astronomy course for non-science majors [id: 12]

Speaker: Sheldon Schafer (us), Peoria Riverfront Museum/Bradley University

Abstract: Many colleges and universities in the United States have an introductory course in astronomy as part of their general education curriculum. These courses exhibit a variety of components; comprising lectures, digital visualizations, laboratory exercises, observatory visits and planetarium visits. This paper will describe a planetarium-centered course developed at Bradley University which features 10 planetarium sessions and culminates with an all-sky exam presented in the planetarium that integrates students’ textbook knowledge with sky identification.

Astrofilm [id: 184]

Speaker: Marián Vidovenec (sk), Slovak Central Observatory

Abstract: Since 2007, the Slovak Central Observatory has organised the ‘Astrofilm’ international film festival in the spa town of Piešťany. The main aim of Astrofilm is to bring astronomy to a place without an observatory or planetarium. Astrofilm offers not only films on astronomy, but related movements too. We offer lectures by famous astronomers about current topics, exhibitions of astronomical photographs and astronomical instruments. In good weather, there are public observations of the night sky. Astrofilm is a good opportunity to show portable planetarium programs too. Yearly the festival is attended by approximately 1800 people.
Using Stellarium to teach the Phases [id: 210]

**Speaker:** Michele Wistisen (us), Casper Planetarium

**Abstract:** By using the Astronomy software called Stellarium, students can chart the location of the sun and moon to develop an understanding about why the phases occur.

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60. IMPROVISATION VS PREPARATION (ENGAGING THE AUDIENCE) – PART B

23 JUNE 2016, 14:30-15:30 / MERCURY

**Convenor:** Jacek Mikulski (PL) – Copernicus Science Centre

**Abstract:** Improvisation during live shows in Planetariums has always been a hot issue. It’s easy to say ‘improvise’, but few of us know how to do it well. We lack tools to help us improvise. However, it is possible to prepare for improvisation and there are many exercises that can improve our skills in this regard. There is a long-standing trend in the world of theatre to make improvised performances, called Improv. From Improv we can draw many warm-ups for the audience and ideas inspiring us to make more interactive shows. Improvisational games and exercises can help us improve our nonverbal communication, our narrative and acting skills. In this workshop you can try out some theatre improvisation games and learn how you can use them in your own planetarium shows.
61. ACTIVE LEARNING AND THE USES OF CONFUSION (!) IN THE PLANETARIUM

JUNE 2016, 09:00-10:00 / MERCURY

Convenor: Dr Douglas Duncan (US) – Fiske Planetarium, University of Colorado

Abstract: Twenty years of research has shown that even with the very best presenter in the classroom, with beautiful lectures and visuals, if the students are passive they only master about 25% of what is presented. Are planetariums any different? I will present results of our research trying different ways of turning our 210 seat planetarium into a more active experience for students. Also presented will be fascinating research that shows how carefully planned audience confusion can lead to more learning than a smooth, beautiful planetarium program.

62. BEST PRACTICES IN LIVE TOURING THROUGH THE UNIVERSE – PART B

22 JUNE 17:15-18:15 / PROXIMA


Speaker: Cyril Birnbaum (fr) – Cite des Sciences et de l’Industrie, David Brigitte (fr) – Cite des Sciences et de l’Industrie

Abstract: The mind focuses either on the visual or on listening, which is why different perception times are integrated into shows. There are a few ways of achieving this goal. We can for example break up the rhythm of a show by mixing different types of sequences (sketches, videos, immersion, music…). A good practice is tackle complex notions with perfectly sequenced images, to be understood gradually. To focus the attention of our audience, it’s advisable to relive a historical event to experience the emotion live or associate sequences with different emotional contrasts. Involving the audience to get them to participate in the show is also an unfailing way to keep the concentration of our listeners. Certain tricks can be used to have the viewer reason and adopt a scientific approach.

Text: The 21-meter planetarium of the museum “Cite des Sciences et de l’Industrie” of Paris draws in 2 million visitors per year. We create one show each year, using the astronomical simulator of RSA Cosmos. Visitors come to the planetarium because they are interested in astronomy, but not only. In general they come to have a moment to rest, to dream, and they expect a poetic journey. So we have come up with different tricks to keep their attention. Here we reveal some of our secrets, and we hope that you don’t already know them all!

Tips to catch the attention of the audience and enhance memorization

We need to take into account different modes of perception and memorization. We are all different, so our brains are different, we perceive and memorize in different ways. For example, if your grand-mother tells you a very important secret (the recipe of her delicious chocolate cake) and you want to recall it:

• you may visualize the page where you wrote the recipe.
• you may recall the actions you have associated to the recipe
• you may hear her explanations in your head or verbalize the recipe to yourself in your mind.

(At our conference presentation, we showed a video which is a sequence from our show about satellites. Some participants watched quietly and found it was easy to concentrate, whereas others were impatient and finally lost attention.)

Several modes of cognitive approach exist with different dominant characteristics. Those who will visualize the page where the recipe is written, or who felt impatient with the video, are more visual. Those who recall the gestures are more kinesthetic, whereas those who heard the explanations in their head and who concentrated easily during the video are more auditory. In this group: 20 percent have a prevailing...
auditory cognitive approach, 40 percent have a prevailing visual approach, and 40 percent have a prevailing kinesthetic one.

**Different cognitive characteristics**

People with a mostly auditory cognitive approach need a story told with a linear progress. Pictures and images are less important. These persons are sensitive to music and sound background. For them, repeating facilitates memorization. People who have a mostly kinesthetic cognitive approach are able to envision themselves in a story. They feel, they can handle and they need actions. To understand and memory they need pantomime games, activities and immersive situations. Those who are mostly visual need an overall view before they go into detail. Their perception channels are less available for listening. They need all forms of illustrations and pictures.

(To catch everybody’s attention, we next showed video phases from our show about the Moon.)

We need time to discover the picture without any speech and after, another time to do both: watch the image and listen to the speech. Sequences with less imagery allow concentration on the speech. Auditory subjects stick to the speech easily and visual subjects are more likely to focus on the listening because they are not absorbed by the image. But it is also a matter of proportion, if it lasts too long, visuals may lose attention.

So, how can we try to manage the rhythm in a show? For 35 minutes we have 3 important moments:

- After 10 mins: there is a spectacular sequence
- 10 mins later: there is another spectacular sequence, this one is even more spectacular, it is the great one!
- 10 mins later: there is a journey (for example through the Solar System).

To facilitate concentration between these sequences, it’s better to alternate between time for reflection with explanations, and time to contemplate the Cosmos with enveloping music. To break the monotony we may use different forms of visual displays: educational drawings, digital simulations, illustrations of scientific model, a great journey devised using the sky simulator.

In the last 5 minutes we briefly talk about a complex notion and then, we like to end with a philosophical question or a projection towards the future.

(Next in our conference presentation, we watched the most spectacular sequence in our Moon show: the collision of Theïa and the Earth and the birth of the moon.)

To make a show which works we have to:

- Grab the audience’s attention, arouse their interest, maintain their attention, facilitate understanding and memorization.
- When we are writing the story, we try to answer the prior questions of the audience in order to take their expectations into account.
- We try to connect the notions with everyday life and with their surroundings.
- To maintain attention we need funny or surprising anecdotes.
- We are careful to synchronize speech and pictures without making any digression.
- As you certainly do. To explain a complex concept we progress step by step.
- The explainer is a guide for the audience, he causes reasoned responses. He is a guide for a scientific approach: with observation, comparison, deduction and understanding.

For example, in our show about the moon, we are on the far side and we ask the audience:

- Is it night or day?
- Are you sure we are on the far side? Have you got proof?
- Why is the Moon a world of silence?
- And what about the temperature, is it cold or warm?

In order to catch and to maintain attention we enjoy using a surprise. In our show about the seasons, the explainer is a gardener speaking to his plants. Sometimes we may use a news item which was recently reported in order to build up complicity with the audience. For example, NASA is experimenting with a raft which would perhaps float on a lake on Titan.

(We next showed the video “solar system” from our show about the Moon.)

And we try to create emotion because, as you know, we memorize more effectively things connected to an emotion. Our trick for this is usually a journey with emotional musical background. In such a journey, emotion is important because there is:

- the excitement of exploration
- a desire to discover and understand
- And amazement.

The Rhythm and scale of the music are really important because they induce emotion.

**In conclusion:**

Some questions for which we haven’t any answer right now:

1. Are some subjects so specialized that they are not interesting for our audience? (30 min about the Sun versus 30 min about the Moon?
2. What is the maximum time to explain a concept without losing attention?
3. Does the perception of rhythm vary depending on our age?
4. How can we enhance memorization?
5. Are planetariums going to be more interactive in the future? With Cosmic games for example?
6. How can we improve the techniques to guide the audience in a scientific approach?
Design Considerations for Digistar’s Navigation System

Speaker: Mark Bloomenthal (us) – Evans & Sutherland, Jackob Galloway (us) – Evans & Sutherland

Abstract: What are the design considerations that go into the continuing development of Digistar’s navigation system? How do these considerations affect its graphical user interface components and underlying algorithms? These considerations include using live navigation controls that are intuitive, simple, and clear.

They also include providing the ability to create easily pre-planned tours while allowing spur of the moment changes in response to audience questions and the ability to search quickly large databases for potential navigation destinations and giving search results in a form that can be used easily in a live presentation.

Using smooth camera motions, we can avoid loss of context for viewers, enhance the sense of leaving one object and arriving at another, and that maintains a sense of 3-dimensional space. Also very useful is creating navigation modes using a careful mix of automatic and user-controlled techniques, and creating smooth transitions between these modes.

Text: Our point of view for this discussion is that of developers of planetarium software. Here we emphasize those things we keep in mind when developing both the UI and underlying algorithms for the software’s navigation system. Some of these ideas may seem obvious, but it’s important to state them explicitly and they sometimes have non-obvious consequences.

A live tour of the universe involves more than flying around outer space. A given tour may incorporate many different types of materials in addition to astronomical objects and datasets. These include videos, images, audio files, models, guides, slide sets, snapshots (previous state of the dome saved to a file), and complex scripted actions.

Creation of Presentations

Different tours by different presenters might take very different approaches since there are many different ways to teach and many different ways to learn. We can’t anticipate every approach but we can make it easy for presenters to create their presentations.

A presentation for us is an ordered list of items which can be used during a show or live tour. These can be any item in the system’s library, any item in any database on the system, or any item accessible from the Digistar cloud.

The presenter should be able to create a presentation, edit, and reorder that presentation quickly and easily. To do this it’s important that the presenter be able to search for items quickly and then readily drag and drop those items into the presentation.

Specifying Options for Navigation Actions

Selecting an item in a presentation triggers an action which depends on that item. For example:

- Selecting a video or audio file causes the file to play.
- Selecting a script causes the script to run.
- Selecting a model causes the model to display or move in the dome.
- Selecting an individual astronomical object causes the navigation system to fly to that object.

Each item in the presentation has a set of controls which the presenter can prefigure while designing the presentation in order to tailor that item’s associated action.

In particular an astronomical object in a presentation has fly-to controls which include the ending orbital distance, orbital rate, and orbital orientation around the object.

Giving a Presentation

Using a presentation an operator can give a live tour from the console or from a wireless device such as an iPad, Xbox controller, or presenter’s remote.

For example, using buttons on an Xbox controller the operator can browse through a presentation. While browsing, the system displays text at the back of the dome to indicate the items in the presentation. The operator can then select and run the indicated item. If the item is a navigation target, the system will fly to the target and provide all of the Xbox navigation controls during the flight.

Camera Motion Control

Another major component required for live touring of the universe is of course control of camera motion.

At a high level, the navigation system should allow for a mix of automatic and user-controlled actions and modes. Examples include:

- Free-flight mode which allows airplane like controls of turn, pitch, roll, and forward motion.
- Orbit mode which allows user controlled spiral motion about an object, while viewing that object.
- Automated flight from one astronomical object to any other object.
- Operator-controlled flight from one astronomical object to any other object.

The transitions between modes should be smooth in order to prevent distractions and loss of context for the audience.

Reference:

A test to know our prevailing cognitive approach (A.Giordan): “Ca m’interresse” magazine May 2008, No. 327
Lower level requirements for camera motion can have interesting implications for higher level navigation behaviours. At a low level, camera motion should:

- Have smooth pans and translations.
- Take place over a reasonable time frame, despite the enormous difference in scales that are often involved. This often implies the use of exponential motions.
- Avoid loss of context for the audience. This can require careful algorithms when, e.g., starting to revolve the camera in orbit around an extremely distant object while still near another very compact object. Care must be taken when ramping up orbital rate. (See Fig. 1: Orbiting M51 while near Saturn’s moon Pan.)
- Maintain a sense of 3-dimensional space. This implies the use of motions which can easily be maintained when the operator’s hands are off the controlling device.
- Enhance the sense of leaving one object, travelling to, and then arriving at another object. One approach to doing this is to use carefully timed camera pans: Allow the camera to linger on the object that we’re leaving to impart a sense of motion away from it. Then pan towards the destination object to impart a sense of forward motion.
- Have smooth transitions between reference frames when needed. This includes transitions required to land on a rotating and moving body.
- Provide options to help avoid overly long moments when nothing seems to be happening. Examples include:
  - Having data sets visible which have extents matching the extent of the required exponential motion. (See Fig. 2: Auto-activation of Digital Universe data sets.)
  - Using images, audio, and video during flights.
  - Allowing the operator to control the overall time required for automatic fly-to actions.
  - Having interactive throttle control over forward motion in manual fly-to actions.

**Connection Through Storytelling and interaction**

**Speaker:** Jian-Yi Yong (sg) – Science Centre Singapore

**Abstract:** I would like to present how I develop live shows at our planetarium. Although we are only half a year old, we already have 3 live shows. ‘Cosmic Surfing’ is a show that calls to our wonder of the infinite, the unknowable and the mysterious. ‘Exploring the Planets’ is a self-contained show, very tight, it is more educational oriented. ‘What’s Up There’ is my favourite. The name is self-explanatory, but in the show, we try and relate the constellations in the form of a story, usually humorous. It is our most flexible show and one in which I encourage visitors to come up to the control station and try different things. In all our live shows we try and relate the Universe in human terms, the size, the numbers and even whether we can live there. I will use one of the shows as a case study.
63. RESOURCES FOR THE PLANETARIUM COMMUNITY

23 JUNE 09:00-10:00 / VENUS

WPD: Worldwide Planetariums Database [id: 9]

Speaker: Daniel Audeon (fr) – Planetarium of Nantes

Abstract: The WPD: Worldwide Planetariums Database is a knowledge compendium of domes around the world. Here you can find answers to such questions as: where exactly each planetarium in the world is located, what kind of systems they use and which use a hybrid system, how many and which planetariums are tilted and how many visitors each planetarium has per year. In the WPD you can also find the name of a particular planetarium in its original language, see pictures of its interior and be introduced to key historical dates and recent major changes. We are still developing our database and working to introduce data on how many people work in a particular planetarium, the exhibition space of each building, and the Twitter feeds maintained by planetariums. We’re also trying to identify and classify all providers involved in upgrading planetariums or building new ones. During this presentation I will consider the future for this online database, for increasing the information about each planetarium and increasing the possible questions in the “Query” module.

Voices from the Dome [id: 378], [id: 17]

Speaker: Susan Button (us) – Quarks to Clusters, Loris Ramponi (it) – Centro studi e ricerche Serafino Zani

Abstract: During this workshop you will learn of a new idea. We want to collect your voices! This new project is designed to create a database of planetarians’ voices, speaking in their native languages. This isn’t a competition. Every planetarian can contribute to this copyright-free digital archive that will be made available on the IPS website. These audio files can be used during a live planetarium show under the dome. In our field it is common practice to share video files, but we do not often share audio files. It is a pity! Imagine an Audio User Group that shares audio files of astronomical commentaries.

The video collection project [id: 6]

Speaker: Oded Edgar Kindermann (ar) – Astrojujuy

Abstract: Videotaping one or more of your lessons, either in the planetarium or during a lesson that supports planetarium visits, is a major project of the Education Committee. Committee member Oded Kindermann was inspired by the Great Lakes Planetarium Association’s “Live from the Planetarium” project (glpa.org/resources) to suggest collecting this potentially very valuable resource. The committee has devised a plan to do this, and Oded and assistants will collect the video and prepare clips to place on the IPS website. I would like to take the opportunity to share this project among the planetarium community during the next IPS. For any other questions or inquiry about the project you can check it online at:

https://ips-planetarium.site-ym.com/?page=EdCommVideo
64. MOBILE PLANETARIUM PROJECT

21 JUNE 2016, 17:00-18:00 / VENUS

Speaker: Jaap Vreeling (NL) – NOVA information centre

In February 2010 NOVA, the Dutch research centre for Astronomy, started a project with a Mobile Planetarium. We have been visiting schools on different levels through the whole of the Netherlands. The team consists of astronomers, master's and PhD students. The project is a huge success, with more than 170 visits a year, it is based on interactive shows supervised by astronomical institutes. Schools are trying to organize a visit of the mobile planetarium in connection with their educational program. In May 2014 the project will reach the milestone of 100,000 visitors. In August 2015 all Highschool students in the Netherlands, who are taking Physics for exam, will face Astrophysics as a serious subject to be examined. Already in 2010 NOVA, the Dutch research centre for Astronomy started a project with a Mobile Planetarium visiting Highschool in the Netherlands. As we are coming together in Warsaw we will reach 200,000 visiting students which, is a unique number for a Mobile Planetarium project. Lessons within the dome are based on the principle of Live Interacting and a team of astronomers, master and phd students astronomy is taking care of the content and the lessons on the schools.
Solve, evolve, involve... Revolve!
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