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Europlanet prize 2012 – still committed to outreach

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Abstract

You're certainly doing great research - but did you think of sharing it ? There are many strategies for doing so, and certainly one will suit you ! Here are a few examples of outreach activities, along with some advices and thoughts...

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OpenPlanetaryMap: Building the first Open Planetary Mapping and Social platform for researchers, educators, storytellers, and the general public

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1. Introduction

The popularity and ubiquity of web interactive maps constitute a powerful leverage for telling stories, educating and engaging a wide and diverse audience with planetary sciences. A few excellent planetary interactive maps [e.g. 1,2,3] exist but they are either too complex for non-experts, or they are closed-systems that do not allow for collaborative learning, social interactions, and reusability of data.

OpenPlanetaryMap (OPM) is a collaborative effort from within the OpenPlanetary community [4] and based on "Where On Mars?", a previous outreach project to visualise ESA's ExoMars Rover landing sites candidates [5]. OPM is supported and made possible thank to CARTO [6] and Europlanet [7] through their respective grant programmes.

Our long-term vision is to build a community around an Open Planetary Mapping and Social platform for space enthusiasts, planetary scientists, educators and storytellers. Our goal is to enable them to easily and collaboratively create and share location-based knowledge and maps of others planets of our Solar System.

2. Objectives

Web Map Interface: As part of this platform, we will develop a web map interface that will make it easy and enjoyable for novice people to discover, search, share, discuss and add their own places on Mars and the Moon (we will expand to other planets in a second stage). We aim to provide a social experience that will help creating an emotional connection with Mars and the Moon and incentives to learn and share knowledge about it.

Open Datasets Repository: A key element of the platform will be an open datasets repository containing a curated selection of location-based information and places of interest about planetary geography, topography, geology, weather, climate, scientific missions and discoveries, robotic and human exploration. These scientifically accurate data sets, along with public crowdsourced datasets, will be programmatically accessible and reusable by others to develop third-party applications for specific scientific or outreach purposes.

Basemap: We will also design and implement at least one beautifully crafted vector-based basemap of Mars and the Moon that will serve as the base layer of our web map interface and enrich its overall user experience. It will be made publicly available to foster the creation by others of theme-based planetary maps that can be easily shared on the web and social media.

3. Initial concepts

Initially, the places on Mars and the Moon the audience will learn about will include information from curated datasets, as well as from a public crowdsourced dataset of *Places*. These Places will either be related to a physical object or phenomenon (i.e.: crater, dune, gully, dust devil, cloud), or to a more abstract one that contributes to increasing knowledge of Mars and the Moon (i.e.: scientific publication, blog article, Wikipedia page, tweet, panoramic image, video, question, story, event). Our audience will also learn from discussions they have with each other, including with planetary scientists.

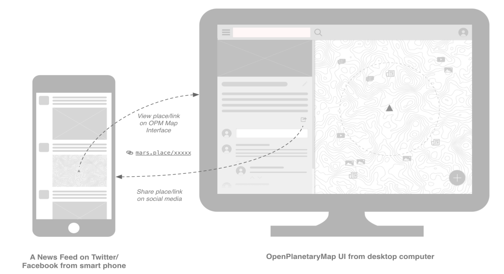

Figure 1: This illustrates the basic concept for the OPM web map interface and sharing places.

One particular requirement that is key to the success of our platform is the capability to handle multiple users and groups for our project team of planetary scientists and cartographers to collaboratively store and manage, publicly and privately share, datasets.

The OPM platform will almost entirely rely on the CARTO Engine and Builder.

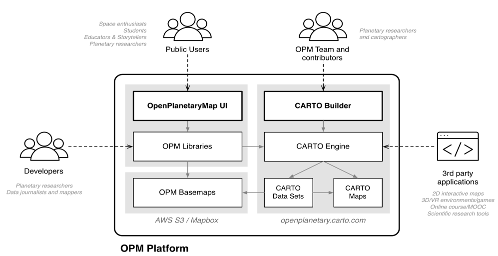

Figure 2: This illustrates how CARTO will fit into the OPM platform, and what users and applications interact with it.

4. Approach

We are a small interdisciplinary and international team of researchers, developers and designers passionate about planetary mapping and cartography. We started to form our team in January 2017 and held a first meeting in Berlin two months later to kick-off the project. Throughout the project, we will adopt an iterative development approach and try to follow a user-centered design process as much as possible; including user research, prototyping and testing methods. We will organize co-located hackathons at planetary data workshops and other events, to learn from potential users and experts, and stay in line with our objectives.

Being collaborative by nature, we will encourage everyone who is interested in this project to contribute [8,9] with their expertise: in planetary cartography, web development, geospatial data processing or any other areas that we haven't yet thought of.

5. Intended outcome and impact

We aim to make novice people feel that Mars is at their reach, both in terms of knowledge and preconceived physical proximity. We want them to use our future web application to quickly and regularly learn something about Mars, just like people head to Google Maps to find their bearings or any location-based information.

With an Open Data and Open Science philosophy in mind, we aim to encourage planetary scientists and mappers to share and collaborate on research data sets in a way that is beneficial to all parties: peers, graduate students, science communicators and the general public.

We aim to encourage science communicators, educators and storytellers to contextualise more their publications or resources by providing better location information, so as to allow their audience for further exploration and better understanding of a related topic or story.

Being an open source project, we also hope to encourage a younger audience of STEM students to apply or acquire new skills in cartography, Geographical Information System (GIS), and programming, by contributing to the OPM software and platform development.

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Acknowledgment

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Firstname1 Lastname1 (1,2), Firstname2 Lastname2 (2) and Firstname3 Lastname3 (1) OR Firstname 1 Lastname1 (1) and/for the Team-Name
presenting author (if already known) shall be in bold (e.g. **Firstname2 Lastname2**); if there is only one affiliation, do not use any numbering (e.g. Firstname1 Lastname1, Firstname2 Lastname2 and Firstname3 Lastname3)
(1) Institute of Physics, Alaska, USA, (2) University of Katlenburg-Lindau, Germany (your@address.com)

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Abstract

Planetary Space weather is a relatively new discipline, still largely unknown to the general public despite its growing importance in our daily lives. One of the most spectacular effects of this discipline is the existence of polar lights.

A century ago, the Norwegian physicist Kristian Birkeland, one of the founders of modern space science, demonstrated the mechanism of aurora formation with experience, the "Terrella". He suspended a magnetized sphere in a vacuum chamber, and to shot electricity on it.

Recently, a modernized version of the Terrella was designed at the Institute of Planetology and Astrophysics of Grenoble, the "Planeterrella". This one allows visualizing the auroras, but still many other phenomena which occur in the space environment of the Earth and the planets. Although the Planeterrella was originally thought of as a local project, it has developed into an international scientific mediation experience. Its success is due to two factors, (i) it is not covered by a patent, and its plans are given free of charge to any public service and (ii) the project is promoted by an enthusiastic scientific community, using its own networks and completely escaping any external pressure.

Today, there are 32 planeterrellas in the world, about 20 are under construction or planned, including two in the Maghreb, one in Brazil, one in South Africa, far away from Europe. In June 2016, several hundreds of thousands of people around the world had seen auroras thanks to Planeterrella, mainly in Europe (France, Great Britain, Switzerland, Belgium, Italy, Spain, Scotland) and in the USA, and were able to learn about planetary space weather. The Planeterrella is also used today for high school and student projects for artistic purposes (music, storytelling, painting).

In this conference, I will discuss how the Planeterrella has developed to become an international phenomenon of scientific mediation. I will also examine some lessons learned from his model: patent or gentleman agreement, big or small, automated or used by hand, possible sources of financing ...

http://planeterrella.obs.ujf-grenoble.fr

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Planetary Maps Designed for Children

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Abstract

A set of children's maps on the solid-surfaced planetary bodies of the Solar System were developed in the framework of the program Europlanet 2012 [1]. The surfaces of the six bodies resulted from the cooperation of planetary scientists and graphic artists. A specialty of these maps compared to other, “scientific” maps is that while keeping cartographic accuracy, they links arts and science, and visualize features in a way that is easier to interpret for the non-scientists. This is the first project in which such detailed, hand-drawn lunar and planetary maps were created specifically for children, in the most common spoken languages of Europe. The map pages, prepared according to the latest data from space probes, are accompanied by a website where background information and interesting facts can be found in a form understandable for children. The topics covered were compiled with the help of the children’s questions that were asked about the maps. The map series was prepared with the support of the ICA Commission on Planetary Cartography.

1. Introduction

The map of the Moon, or Mars, can be found on the walls of many children’s rooms. However, these maps, either from NASA or commercial map production companies, have been designed for “general audience”. Children’s books on planet usually contain photographs, and even is they are picture books, planetary surfaces are rarely depicted in a map-like way. Atlases, where maps are hand-drawn and designed for children, also never contain planetary maps. Although raw spatial data is available for free for cartographer companies and graphic designers, it is still considered an “uncharted territory” for both terrestrial cartographers and book illustrators.

2. Arts and Science in Maps

Figure 1: This is the example of an included figure.

As part of the outreach activity of the ICA Commission on Planetary Cartography, we have developed a new series of planetary maps targeting young readers. This is the third map series from the commission: the first was published 2000-2011 and edited in Dresden University and published in major European languages, the second was re-edited in Central European languages [2]. These series were general-theme (topographic), hand-drawn shaded relief maps for a non-professional audience. This time we focused on the 8-12 age group, which already can read and are still interested in a wide range of disciplines. We decided not to use photomosaics or computer generated data in the maps. We selected six planetary bodies: Venus, the Moon, Mars, Io, Europa and Titan and invited six graphic artists – illustrators of children’s books – with different visual styles (Fig. 1): András Baranyai (Venus), Csilla Gévai (Europa), László Herbszt (the Moon), Csilla Kőszeghy (Mars), Panka Pásztohy (Titan) and Dóri Sirály (Io). Although the overall structure of the maps is similar, the visual approach to each map is fundamentally different. We attempted to create cartographically and scientifically correct maps that are attractive and also understandable for children.

We published the maps online in printable high resolution pdf files in 11 separate language versions at https://childrensmaps.wordpress.com/.

We have added a new map sheet in 2016, following the New Horizons mission [3]. The map shows the geology of the surface together with characters taken from the then-informal nomenclature. The map has the theme of the Halloween, reminding to the mythological Pluto and Charon. The Pluto–Charon map was designed by Adrienn Gyöngyösi.

3. Further directions

We linked planetary scientists with graphic artists: their communication often resulted in misunderstandings, and consequently, numerous redraftings. We realized that the designers must interpret the photomosaics when they simplify them to colorful vector (or manual) graphics. To do this correctly, all graphic designers have to have a detailed understanding of the surface geology and some practice in photointerpretation.

The most controversial issue with the maps is the choice of the narrative story. It should be further investigated how the perception of the surface through the map changes depending on the narrative theme used. An experiment should be developed in which children are given the same maps, but with different theme layers added, including for instance a "plain" map, a map with human figures, a map with alien figures or a map series with returning figures as opposed to our current approach of completely different themes with a similar general layout. In a previous survey [4], children developed slightly different mental view of planetary surfaces when they studied maps with a nomenclature in Latin or their home languages. Different labels emphasized different types of features and different characteristics of the body. Similarly, different themes for a narrative could take the map readers in different directions. We hypothesized in this study that maps with a narrative layer are more attractive for the children than maps that display only geological features. It is also a fundamental question how planetary science content will have its share in the children's attention once they focus on the imaginary or narrative content.

We also considered the map's information content. Although we limited the number of labeled features, the maps may still remained too rich in data, and less so in stories communicating feelings of the landscape. One of the future plans is to simplify the maps to better catch their planetary profiles and make the drawings better translatable to mental pictures of landscapes and events in that space.

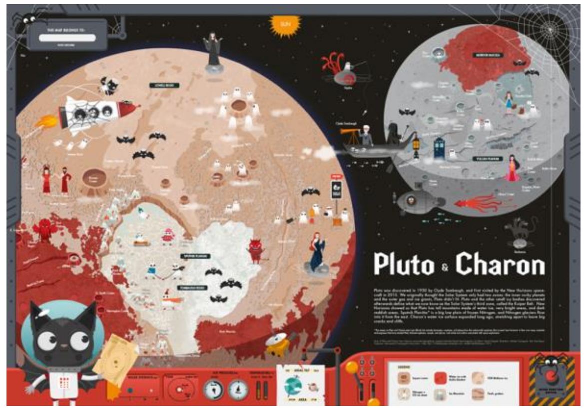

Figure 2: The latest addition to the series depicts the encounter hemispheres of Pluto and Charon. lllustrator:

Acknowledgements

We are grateful for financial support from the Europlanet 2012 Outreach Funding Scheme, Paris Observatory and the International Cartographic Association Commission on Planetary Cartography.

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Planets in a Room: a DIY, low-cost educational kit

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Abstract

"Planets in a room" is a DIY kit to build a small, lowcost spherical projector and planetarium that teachers, museum, planetary scientists and other individuals can easily build and use on their own, to show and teach the planets and the stars. The kit was developpped by the italian non-profit association Speak Science with the collaboration of INAF-IAPS of Rome, the Roma Tre University (Dipartimento di Matematica e Fisica) and the non-profit association AstronomiAmo. The project was funded by the Europlanet Outreach Funding Scheme and presented in a first prototype version at EPSC 2017 [1].

Starting from EPSC2018, "Planets in a room" will be presented and distributed to schools and other education institutions from all over Europe. The distribution phase will take place as a crowdfunding project (http://www.planetsinaroom.com/) that will also involve the outreach and research planetology community, with the aim of bringing planetary science to a larger audience.

Acknowledgements

We acknowledge for this project the vast community of amateur and professionals that is actively working on innovative educational systems for astronomy such as planetarium and virtual reality projects (both hardware and software). Planets in a room is based on the work of this vast community of people and their experiences and results. To cite some of them, we aknowledge the work of Paul Bourke and the Lhoumeau Sky System Open project. We also acknowledge for this work Europlanet for funding Speak Science and finally, all scientists, teachers and students who have used (and will use) Planets in a Room.

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THE EUROPLANET METEORITES VIRTUAL MICROSCOPE COLLECTION.

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Abstract: The Europlanet Meteorite Virtual Microscope (VM) Collection is an Open Educational Resource (OER) which allows users to investigate the optical mineralogy and petrology of 24 varied meteorites [1]. It uses software that duplicates many of the functions of a petrological microscope. The VM's may be viewed at:
https://www.virtualmicroscope.org/content/europlanet-meteorites

Introduction: When The Open University (OU), one of the world's largest Distance Learning Higher Education Establishment, faced the problem of how to supply thousands of undergraduate students with an interactive petrological microscope and a personal set of thin sections, they decided to develop a software tool called the Virtual Microscope (Figure 1). The Virtual Microscope allows users to view an entire thin section in plane polarized light, between crossed polars and also in reflected light.

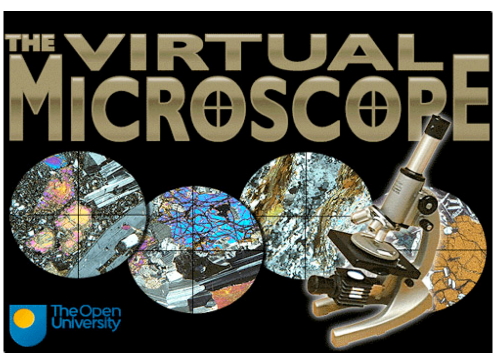

Figure 1: An early version of the Virtual Microscope produced for Open University students.

2018 celebrates 25 years of virtual microscope work at the Open University. During this time we have created many OER collections based on terrestrial rock samples - Charles Darwin's Beagle Collection, UK Virtual Microscope Collection, Irish University Rock Collection, St Austell Granite Collection, Greenland Collection. We have also built a Cornish Mineral Heritage Collection based on mineral specimens in the Rashleigh Collection at the Royal Cornwall Museum in Truro, Cornwall.

Our work is not however, Earth-bound and we have five VM collections of samples that are extraterrestrial in origin. The Europlanet Meteorites Collection was the catalyst and the first one of these collections. We have since created
a British and Irish Meteorites Collection:
https://www.virtualmicroscope.org/content/british-irish-meteorites
a Martian Meteorite Collection:
https://www.virtualmicroscope.org/content/martian-meteorites
a Lunar Meteorite Collection:
https://www.virtualmicroscope.org/content/lunar-meteorites
and most recently we are working with NASA to create an Apollo Moon Rock collection:
https://www.virtualmicroscope.org/collections/apollo

Method: Production of a virtual microscope dedicated to a particular theme divides into four main parts - photography, image processing, building and assembly of virtual microscope components, and publication on a website. The method used to produce the VM images has been described earlier [2-5] and involves two automated Leica research microscopes (Figure 2).

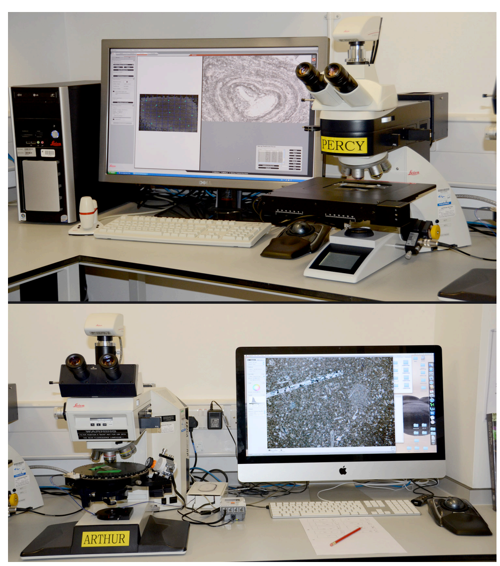

Figure 2: Research microscopes used for Virtual Microscope production at the Open University.

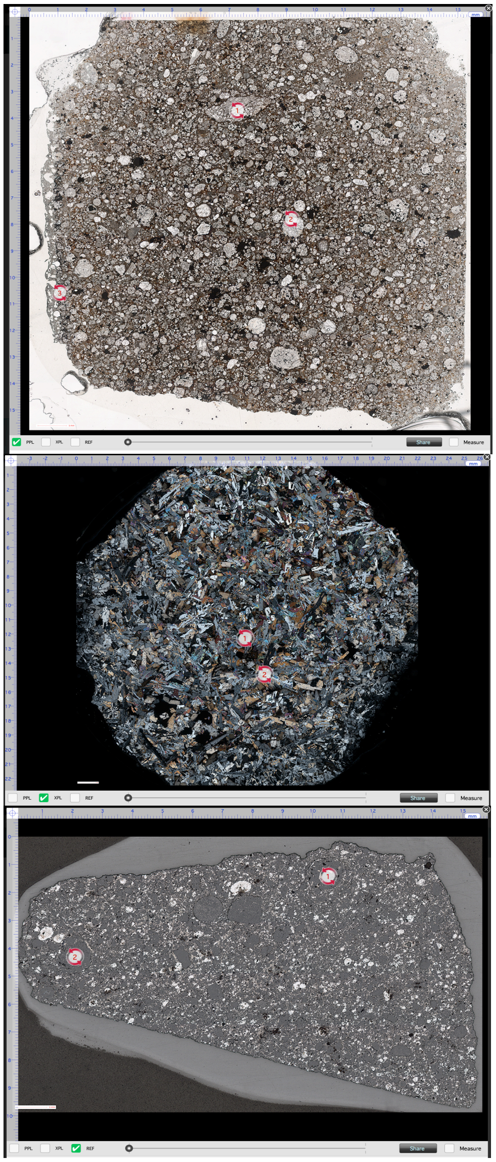

Figure 3: Screen shots from the Lancé carbonaceous chondrite (top), D'Orbigny angrite (middle) and Indarch enstatite chondrite (bottom). In plane polarised light, between crossed polars and in reflected light respectively. Red circles show positions of rotation points.

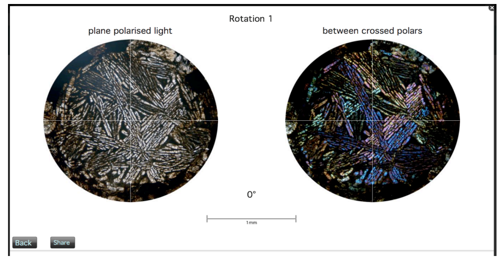

Figure 4: Screen shots of a rotation point from the Chandakapur L5 chondrite meteorite.

The Europlanet VM Collection: This virtual microscope collection of rare and usually inaccessible extraterrestrial meteorite samples was funded by a EUROPLANET public engagement award and is a collaboration between The Open University, The Natural History Museum, London, The Natural History Museum, Vienna and NASA's Meteorite Working Group (MWG). The collection includes carbonaceous chondrites (CO3, CO3.5 and CV3), ordinary chondrites (H3.7, H3.9, H4, H6, L3.6, L4, L4-7, L5, L6, LL3.6 and LL/L3.2), an enstatite chondrite and an olivine-hypersthene chondrite. There are also examples of angrite, aubrite, ureilite, eucrite meteorites and two Martian meteorites. Over the past 5 years the EUROPLANET VM has been showcased at various public engagement events, too numerous to list here, but suffice to mention that it continues to receive a favourable response from a wide spectrum of non-specialists from primary school children to adults and other mature learners.

The Future: We hope to expand the collection to include further examples of the existing classes of meteorites and to extend the collection to include examples of all meteorite types, as and when we secure additional funding.

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AMADEE-18 Junior Explorers Program

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Abstract

During the AMADEE-18 Mars analog field campaign, a human-robotic Mars mission was simulated in the Dhofar region in Oman, where a field crew was supported by a Mission Support Center (MSC) in near-real time. Instrument workflows, pilot data analysis was emulated in a workflow as it is to be expected for future a human-robotic Mars mission. We report on an innovative education project including student teams to mimick the full life-cycle of a Mars analog mission from experiment design to publication. Lessons learned and pitfalls are identified, as well as the long term effects of this inclusion projected.

1. Introduction

AMADEE-18 was an international Mars analog simulation mission of the Austrian Space Forum (OeWF), in partnership with the Oman Astronomical Society. The mission took place in the Dhofar region in Oman in February 2018, including 19 experiments looking into engineering, geoscience and human factors research for future human-robotic Mars missions (Fig.1).

A highly trained field crew, including 7 analog astronauts with high-fidelity spacesuit simulators were directed in real-time by a control center on "Mars" during Extravehicular Activity (EVA) and through time-delayed communications by the Mission Support Center on "Earth" in Austria.

1.1 Student experiments

Building upon previous experiences from Mars analog field campaigns [1], students from Europe and Oman are invited to submit experiment proposals for this extraordinary expedition.

In a dedicated effort, four student teams, three from Austria, one from Oman, were included in the experiment list, complementing 16 peer-reviewed experiments from established research teams.

The idea was to have the student teams, consisting of 2-4 students aged between 16-19 years, join the project and work through the full life cycle of a scientific experiment.

The following experiments were choosen:

EOS	HTL Eisenstadt, Austria	Radio Navigation System for EVA's on GPS-less planets
Tumble Weed	Sir Karl Popper School, Vienna	A wind propelled compact rover to be used for efficient Mars exploration.
Water Explorer	Umm Al Khair Primary School, Oman	Water detection via a set of geophones, which measures the reflection of sound waves in the subsurface
A3DPT-2-Mars	TU Graz, Austria	3D printing operational workflow experiments for crewed Mars expeditions

The students were tasked to:

- Define research questions and implement the experiment
- Train the feld crew and interact with the Mission Support Center of the Austrian Space Forum
- Observe *(and tele-operate if necessary)* the experiment during its implementation

- Analyze and interpret the data and publish them in a final experiment report and present the findings at the AMADEE-18 science workshop.

Figure 1: Kepler-Station for the AMADEE-18 Mars simulation in Oman.

Figure 2: The ADAPT2Mars 3d-printing experiment deployed during the AMADEE-18 mission (red plastic and golden silica-coated steel printed soil sampling scoop)

2. Lessons learned

Lessons learned include the realization, that highly motived student teams can contribute to a field campaign like AMADEE-18 like a senior research team when it comes to mission planning compliance and dedication. However, senior team members were required to manage both the expectations and ambitions of the young researchers. These were challenged by the balancing between what they wanted to accomplish and what was realistically possible within budget and within schedule.

The latter seems to be a skillset, that is underdeveloped in this age group.

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3D Tactile Moon

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Abstract

The 3D tactile Moon was a project funded by the Europlanet Outreach Funding Scheme in 2011. The aim was to build a 3D model that would convey in a tactile way what one sees when looking at the Moon. The 3D tactile model is, therefore, accessible to vision impaired audiences.

1. Introduction

The Moon is, together with the Sun, the very first astronomical object that we experience in our life. Since the beginning of history, the Moon has played a central role in human life and culture: agriculture, calendars, poems, pictures, science... But our experience of the Moon is mostly a visual one, and people with sight impairments need to follow a different approach to experience it too.

2. A 3D Spherical Moon

There are already a few resources about the Moon that have been designed for the blind, like NASA's "Getting a Feel for Lunar Craters" [1]. And they all have one characteristic in common: they are flat representations of the Moon.

Therefore we set up to create a 3D spherical model of the Moon, with the goal of conveying the visual impression that we have when looking at the Moon. We did not want a mere topographical representation.

We also wished to build the Moon in an easy to share format to make the model available worldwide. For that we chose the electronic 3D format "stl".

3 Developing the 3D model

We started from NASA's Clementine visual map of the Moon. Too much detail leads to confusion when you are only touching and not seeing, therefore some deleting and blurring of the image was necessary. Only main accidents in terms of visibility were to be represented, even if they were not relevant topologically, like crater rays. We kept only large craters, large maria, large mountain ranges and conspicuous crater rays.

We used GIMP as image processing software to increase contrast, blur and delete structures in the original Clementine image. Each important feature can be labeled with a Braille letter. An accompanying document in Braille lets the user know what does each letter stand for. For example, "a" marks the Copernicus crater, "b" marks the Kepler crater, and so on.

Flat caps mark the poles, and the northern one has a sign similar to a capital T to help with the globe orientation.

The resulting processed image file was then converted into an ascii file and fed into the 3D rendering software MeshLab [2].

4. The 3D tactile Moon

We printed a prototype of the Moon in a 3D printer in polyamide. Then, a silicone mould from the prototype was used to produce 20 cheaper copies in resin.

The 20 copies were shipped around the world (Argentina, India, Brazil, Puerto Rico, Nepal, ...) to educators and outreach professionals who were carrying out astronomical activities including vision impaired people. They were tested with many different persons from a variety of backgrounds and we got extremely positive comments along with some feedback that led to the final model (Figure 1). It is worth to stress that the model was highly appreciated also by the people with no visual impairments.

5. A Touch of the Universe

The success of the 3D tactile Moon made it the seed of the project *A Touch of the Universe* [3], in which we are developing tactile 3D planetary models that have become part of the IAU100 public exhibition *Inspiring Stars* [4]. *A Touch of the Universe* is funded mainly by the IAU Office of Astronomy for Development (OAD).

Figure 1: The 3D tactile Moon for the blind. The northern polar cap has a cross engraved to help with the orientation of the ball. The surface has been largely simplified for the sake of clarity.

In the first release, we built a set of 30 kits to teach astronomy including vision impaired kids where the 3D tactile Moon was a key element (Figure 2).

We have recently developed new tactile models of Venus, Mars and Mercury that can be downloaded for printing from the *A Touch of the Universe* website. This has been possible also thanks to the new software "*Mapelia"* [5] that converts maps into tactile globes.

6. Summary and Conclusions

We have developed a 3D tactile model of the Moon accessible to all persons regardless of their visual abilities. It was the seed of a larger project (*A Touch of the Universe*) that is in the process of developing 3D tactile models of terrestrial planets.

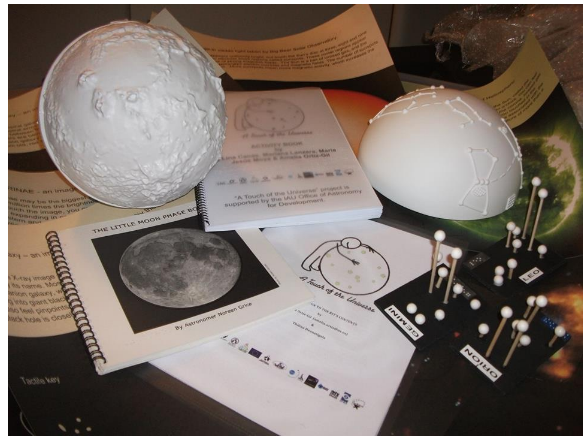

Figure 2: The first kit of "A Touch of the Universe", a set of astronomical learning resources that are accessible also to kids with visual impairments.

Acknowledgements

Many people have helped in the development of these tactile resources. We cannot list them here because of the limited space available but their names can be found at the website of *A Touch of the Universe*. The projects outlined here have been partially funded by the 2011 Europlanet Outreach Funding Scheme and the IAU Office of Astronomy for Development (OAD), with generous support from many other institutions. The author acknowledges financial support from the Spanish Ministry of Economy and Competitiveness under project AYA2016-81065-C2-2.

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Connacht Schools Planetary Radio Telescope Network

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Abstract

This project will fund the installation of eight dual dipole antenna radio telescopes on the grounds and playing fields of several rural secondary schools in Ireland. Each will be used by the teachers and students at these schools to observe the aurora of the planet Jupiter, and in so doing contribute to the larger network of NASA's Radio Jove dipole based facilities used to monitor the giant planet's active magnetosphere. Conducting decameter observations is ideally suited to the 'temperate' Irish climate with the low population density around the western city of Galway limiting radio frequency interference. Each observatory will feed observations in real time to a server operating at the National University of Ireland that will provide both a central repository of this data but also a means to publicise the schools activities to the wider public in this part of the island.

1. Motivation

Finding innovative ways for teachers and students to explore STEM subjects beyond the set national education curriculum forms the motivation for this project. Practical activities in astronomy have great potential in this regard however these are limited due to the need for specialised equipment and facilities, to work at unsocial hours and, of course, clear skies, certainly for optical astronomy. Radio astronomy offers a very cost effective means alternative for teachers and students to participate in actual observations of radio-bright objects such as the Sun and the planet Jupiter, particularly at decameter wavelengths. A simple dipole antenna (Figure 1) with a lengthscale of 7m placed in a low radio frequency interference environment can easily observe at 20 MHz Jovian auroral activity at night and solar flare bursts by day, when both objects transit the local meridian. The acquisition and subsequent analysis of such observational data involves the use of a range of STEM subjects encompassing physics, electronics, computing, applied mathematics and statistics - not to mention astronomy. The automated nature of its operation means observations can be conducted 'after hours' or remotely, regardless of typical Irish weather conditions.

Figure 1: An operating dual dipole antenna [2]

2. NASA's Radio Jove Project

In its second decade of operation, NASA's Radio Jove project [1] is a non-profit organisation that ships radiotelescope kits for assembly and use primarily by secondary schools throughout the US and beyond. Instructions are provided to build the dipole antennae from parts easily obtained at local hardware stores, whilst Radio Jove provide the receiver electronics (pre-assembled or in kit form) and software to visualize the signals detected, with the total cost being $\sim$ \$500 per 'kit'. Once assembled, and connected to a

PC, well detailed lesson plans provided by Radio Jove can be used to fully explore the capabilities of each schools' new radiotelescope, and each group is welcome to participate in the wider Radio Jove community, which counts up to 1100 teams of students and citizen scientists in its community to date.

3. Astronomy with Radio Jove

Using software provided as part of the kit, or alternatively open-source alternatives, observations of the three brightest radio sources in the sky are possible, namely the Sun, the planet Jupiter, and the diffuse radio emission from the Milky Way. Of particular interest are observations of Jupiter, where these telescopes can be used as part of a wider network (Figure 2) in support of studying the interactions between the planet's magnetosphere and its innermost moon, Io. This is currently the case for the Juno mission where the underlying auroral physics are being probed by combining the "near field" measurements of both particles and waves from Juno with the 'far field' wave data generated by ground-based observers. Outside of the annual Jovian apparition, long term monitoring of the solar corona is possible throughout the school year.

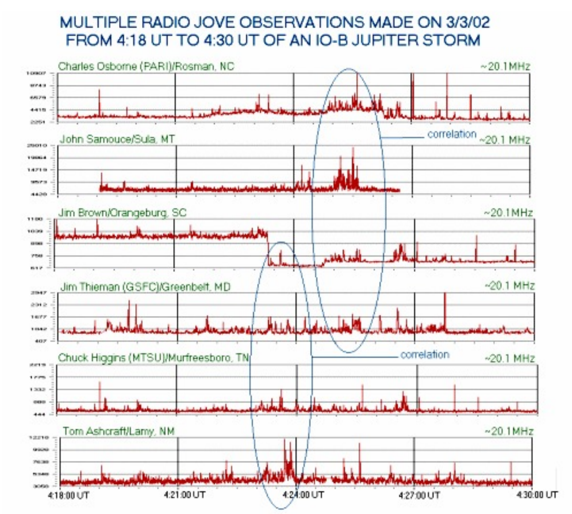

Figure 2: Multiple observations of Jovian Aurora [1]

4. The Schools

With the help of the Irish Science Teachers Association [3], several highly motivated teachers from eight schools in counties Galway, Mayo and Roscommon (Figure 3) will participate in this project. Once installed and operational, the network of radiotelescopes have the potential to be used by over 3500 secondary level students each year as part of their STEM activities, and the low cost and maintenance of each guarantees a long term educational return on a very small initial investment.

5. Project Implementation

Radio Jove 'kits', supplies and instructions for antenna assembly and a dedicated PC form the basis for each 'flatpack' will be delivered to each school and support provided for local assembly and commissioning. A dedicated web/data server at NUI Galway will coordinate operations among the schools and an annual workshop hosted on campus for the teachers/schoolchildren each year to present the results of their work. Having the network operational for the next apparation of Jupiter between April and August 2019 is the project's principal deadline.

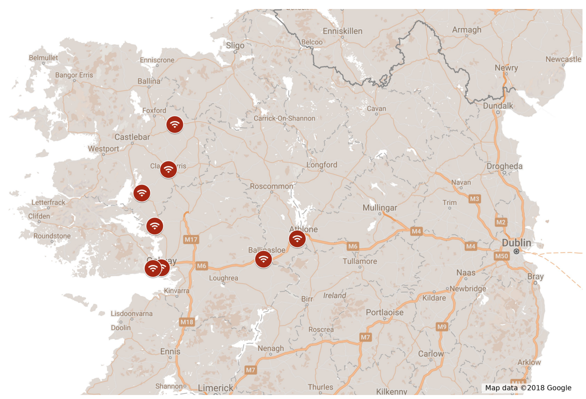

Figure 3: Participating school locations

Acknowledgements

The consortium are very happy to acknowledge support from the Europlanet Public Engagement Funding Scheme to make this exciting project a reality. Míle Buíochas!

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From VMR to ReMY: Game concept awarded by Europlanet becomes Remote Mars Yard

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Abstract

VMR – Virtual Mars Rover, was a concept game proposed by a team later establishing a space startup: ABM Space sp. z o.o. in Poland. VMR was awarded by Europlanet Outreach Funding Scheme in 2011. The initial grant allowed concept development, and together with success of the team in robotic engineering contest University Rover Challenge (Magma team) contributed to attracting seed investor incubator and establishing of a space startup. Today ABM Space runs projects basing on ESA grants, related to Mars navigation, among others. ABM is a laureate of Airbus Merck KGaA Sustainable Exploration Prize 2017 for a solar sail concept. At Polish National RnD Center ABM runs a 500 000 EUR grant within GameINN programme. This is ReMY – Remote Mars Yard, a system combining virtual Mars simulator game, a physical Mars mockup and a physical robot, accessed through Internet. The scenario and gameplay model was largely taken from the original VMR concept.

1. System description

ReMY – Remote Mars Yard is a 40 cm 3D-printed, 6 wheeled rover installed on a Mars mockup terrain. The terrain is designed with aid of planetologists from Polish Academy of Sciences. Currently a 3 x 4 m mockup is available, but 4 new game-rooms 10 x 10 m are developed under GameINN grant. The terrain features numerous geological objects of interest, physically reflected in the relief or visible only in the virtual layer of ReMY software. This software comprises main server system with positioning system, object and scenario database and a web interface. The interface allows logging onto the rover through the Internet browser and performing a simulated Mars mission from any location. The mission bases on printed materials, including system manual, simple Mars geology handbook, “satellite imagery” of the mission site and description of the rover’s science instruments. The physical rover has only a navigation camera on the mast and a science camera on a 2 degrees of freedom front arm. All relevant science instruments are simulated and reflected in the virtual interface. The interface streams video from the two cameras, and from a “lander” camera (external robot view), as well as gives robot telemetry (position, mission time). The telemetry allows pointing on an orientation map and displaying in a 3D pre-scanned mission site visualization.

Faults are simulated. The mission does not include Earth-Mars delay, it assumes operations are performed by the crew orbiting Mars in a manned space station and delay is limited to the native Internet delay. Operation is nearly real-time, performed in steps, with no autonomy.

Scenario requires learning process, creating a mission plan, training, actual mission and reporting. The goal of the game is to gather points for proper interpretation of orbital imagery, ground truth, making choices under time constraints, proper communicating within the team to exchange knowledge about the specificity of surveyed objects and selected science instruments. Time is a limited resource.

2. Pilot sessions

From 2016 pilot sessions on a 3 x 4 m mockup have been organized. 75 Polish schools performed missions during 3 semesters, in a competition form. It was co-organized by the Warsaw Copernicus Science Center and ESERO Polska – ESA’s education office. Further demonstrations are organized for selected partners, such as science foundations, technological corporations (HR departments) and investors community. So far UK, US, Israel, Austria and Russia were the locations outside of Poland to participate.

3. Commercial target groups

Besides outreach profile the project is being commercialized. Education groups of around 8 students each are one area of interest, to be funded by public or private schemes supporting STEM, general space awareness or incentives to pursue specific education and career paths among communities (such as high-tech/industrial communities wishing to maintain local technology employment in a long-term perspective). This last group interfaces directly with a product for corporations, which can train their employee teams in communication, teamwork, flexibility and resource/time management in an attractive and original form. Entertainment gamers are the third group, important especially from community building perspective.

Figure 1: ReMY rover on a mockup – older rover version.

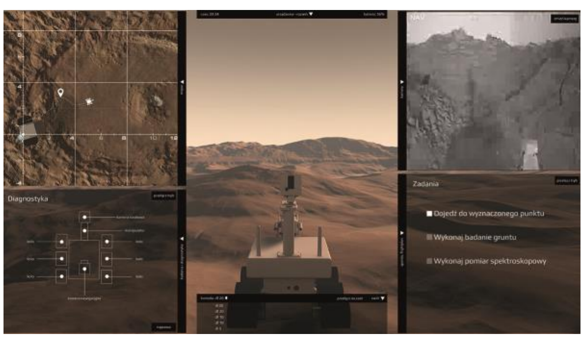

Figure 2: New version web interface

4. Summary and Conclusions

ReMY is an innovative platform for education, training and entertainment. It features solid development potential for human resources and human-machine interfaces, as well as for 3D print and robotics in general. The architecture and approach allow to develop also other philosophies such as multiagent systems, navigation, multi-layered mapping, augmented reality and virtuality.

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Don't Be Afraid of Gaps

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Abstract

Instead of shying away from *Gaps*, it might be wise to consider what *Bridges* can be developed to help our friends across those *Gaps*.

1. Introduction

At the edge of the precipice of a canyon lies the challenge of the **Gap** to reach the other side. Big picture concepts often have a Gap: for example, the Gaps in the legal regime of outer space; the Gap in asteroid mining between the short-term revenue plan and the long-term pay-off, the communication Gap between researchers in Academia and Industry.

Indeed, Gaps might be an indicator of the *breadth* of the proposed concept.

For example, starting at the smallest scale with the individual: Gaps might be one's psychological blocks. I.e. a new concept to jump to with a little bit of support. Or a mental 'I can't' block, to jump over with a brief lesson.

At a larger scale, multi-dimensional Gaps in time and space could be just the challenge with the greatest impacts. Instead of shying away, it might be wise to consider what *Bridges* can be developed to integrate an entire community across those multi-dimensional Gaps.

Gap and Bridge Outcomes

Themes of "Gaps and Bridges" denote a unifying theme for my kind of outreach. The most successful *bridges* I built were those that I found the most fun.

Newsletters. In the 1990s, my Digital Explorations newsletter at NASA Ames helped some of the scientists *bridge* the Gap from a calculator scientist to a savvy Internet user. It tickled my funny bone to use a graphic from my MS Physics simulation for the newsletter's header.

Wavelet whitepaper, talks and colloquia, websites. Near the same time, my favorite mentor, Jeff Scargle, whom seemed to be on eternal quest of digital fun, introduced me to wavelets. There was even a small contract in it for me, if I could *bridge* a mental Gap.

After I taught myself the basics from the top down, so I could program wavelets from the bottom up, I had many Internet resources in hand. I thought others would find my resources useful too. So I built more *Bridges* for their Gaps. I didn't lose the fun element either: wavelets are terrific for audio files to transform your own voice. Or other voices. One of my bits of personal fun was to legally circumvent copyrighted characters from Star Trek audio files by displaying their wavelet transforms instead.

In the last decade, my *Bridges* have become multi-dimensional.

<u>Planet P.I.</u> I'm currently spanning age groups in citizen science to *bridge* the gap of scary engineering. Planet PI *bridges* my own fear of electronics first, in order to show how to build something useful with Rasberry Pis. It turns out that others have the same fears and want to build too. And do science with them. And have fun.

The <u>Asteroid Science Intersections with In-Space Mine Engineering (ASIME)</u> community is my largest Gap in space and time. The fun element is at a maximum when the asteroid mining companies express their claims and everybody else dissects those claims. The ASIME community is a collection of *Bridges* across the multi-dimensional Gaps between researchers (and Research) in Academia and Industry, and between near-term and far-term Industry.

Finally, the <u>Local Organization of the EPSC 2017 Riga</u> followed the *Bridges* idea in its main development.

- *Bridges* across education challenges of the Baltic societies.

- *Bridges* across all age groups.
- *Bridges* across multiple sectors of business.
- *Bridges* across multiple STEM skillsets.
- *Bridges* in geographic and political space between four countries: (FI, EE, LV, LT)
- *Bridges* to the common 100-year birthday celebrations of the four countries (FI, EE, LV, LT).

These multidimensional *Bridges* provided valuable integration and cooperation in the four countries and between them and the international public and scientific communities. The integration success was due partly to the inspirational nature of the subject (Space!), and the rest due to what I hoped was by paying careful attention and understanding the needs of the Baltic region. Naturally, many of those needs were my own, that's why I understood them well.

What was a little surprising to me was how deep and wide the connections/bridges were. What was even more surprising to me is that I had the tools, knowledge, experience and network to make it happen. The EPSC 2017 LOC was almost a confidence-building exercise.

The result of the EPSC 2017 LOC were 190 Baltic people paid directly or in-kind in a plan to represent eight Baltic institutes in the conference (exhibits, booklet), an engagement of the Baltic scientists in the scientific program, employment of five students in the ground-floor, supported 25 early-career Baltic students to display their Summer 2017 internship space projects, invited and supported five Baltic and European government Ministers to give talks, supported a Solar System for Kids Exhibit which is expected to reach 10,000 Latvian (600 visited during the conference week), supported the Latvian social event and art-science exhibits and communicated publicly (600 Latvian and International press mentions) about the event and the value of space for the Baltic region.

What's Next?

A continuation of the foundations I've built:

- Baltic space integration: Next up: a Baltic Climate Change Cubesat called ELLF

- Planet P.I. citizen science: Let's get the device into classrooms and homes.

- ASIME Community: Let's grow our community and check-off the milestones on the Asteroid Mining Roadmap

Acknowledgements

Europlanet, especially Anita Heward, Planetary Science Institute: Mark Sykes and my wonderful PSI colleagues, my great colleagues at the Finnish Meteorological Institute and the University of Latvia, the rest of the Baltic space workers, my dear Riga friends, my Baltics in Space mentor, my far-away family (I miss you!) , the 54 individuals in two crowd-funding campaigns who helped me survive while I developed the EPSC, the asteroid miners and the Luxembourg Ministry of the Economy, the several individuals who are patiently waiting for my financial world to improve so that I can pay them back, and my wonderful daughter, who has carried the largest weight while I build Bridges.

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Sneaking science education into addictive games that can be played by people with diverse needs.

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Abstract

Voluntary game play can be a powerful tool to motivate learners to dig deep into new topics – including planetary and Earth science. If a game is interesting, and students and the public are motivated to play for fun, they will use their free time thinking through strategies to improve their win rates and will do free-choice research into the game's topics. Our team has designed a series of games that teach planetary and earth-science concepts, and that can be played by audiences who have specific needs: our games are designed specifically to be playable by visually-impaired audiences, or by audiences who speak varied languages or who are non-verbal.

1. Introduction

Many animals – including the human animal – employ game play to learn. Things as simple as "Peek-a-Boo" teach object permanence, while games of pantomime and charades teach about non-verbal social interactions. As humans age, their games become more complex, but no less educational. Today, a game player can learn basic interplanetary orbital mechanics from Kerbal Space, while future city planners can gain insights on economics and the importance of entertainment from city and nation simulators, like SimCity and Civilization. Key elements in successful games include; intellectual and social engagement, replayability, and pleasure in developing improved strategies (e.g. learning how to win more often or attain higher scores).

Many educators and educational designers have worked to integrate games into the classroom as a way of motivating learning. While this can be successful, there are many minefields that must be remembered: 1) Any game played too often or in too restrictive a way will become unpleasurable, 2) A game designed to teach concepts first, and be 'fun' second may not be fun at all, and 3) Learning often comes from free exploration and organic social interactions, rather than from following regimented lesson sheets and required discussion questions.

Our team sought to design a series of games that could be used in a classroom and could just as easily compete for prominence in a family's board game collection. Each game, as described below, is designed with an aspect of Earth and planetary science at the heart of its game play and has been play tested to verify that play includes laughter, the desire to keep playing, and allows groups that include either the visually impaired of non-speakers to participate without adaptations.

2. Our Games

Each game was designed following the same basic project plan. First, we asked, what elements of our work do people already turn into ad hoc games or storylines? For instance, we found people around our office challenging one another to identify the worlds shown in different images, and this seeded *Earth or Not Earth.* From here, we followed a standard model of playing the game ourselves, play testing with friendly strangers, and revising the pieces, images, and instructions until we had consistently good play.

2.1 Earth or Not Earth

Most people have specific mental images of what different worlds look like. These paradigms don't leave space for identical geological features to be found in different places. With *Earth or Not Earth*, we created cards from space images, all in black and white, that ask, "Is this Earth or not?" We worked to find images of the same kinds of geology on multiple worlds. By making the images black and white, vegetation and water don't give away the answer. In order to increase replayability, we curated over 100 images of features on the Earth, Moon, Mars, and other terrestrial worlds. Different versions of game play exist, including an edition good for kids (or intoxicated adults), that has people grabbing colored balls representing planets when they think they know the answer. In all versions, the person who most often matches the image to the right world wins. This game is entirely pictorial and can be played without talking. This makes it possible to play in groups with shy people who'd rather not speak, with non-verbal but visually engaged players, and in groups who speak a diversity of non-overlapping languages.

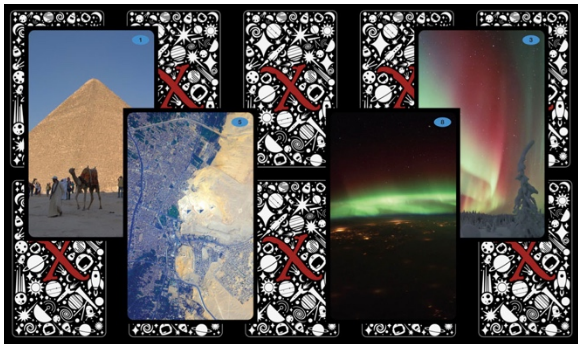

Figure 1: An example of matches from *Earth Match*.

2.2 Earth Match

Many facets of our world go unnoticed to those living on top of it. Without a sky-high perspective, we can miss its changing features and without practice, it is hard to match views from space with views from the planet. With *Earth Match*, we created a matching game that asks players to find images of the same feature seen at different times (for instance river ways when flooded and not flooded.) and the same feature imaged from both the ground and space. While the game is initially played with all the cards face up, it should be played like a game of Memory once the players are familiar with the cards. The instruction manual includes information on all pictured places, and a visual key. This game can be played without verbal communications.

2.3 Terraform

People often dream of terraforming other worlds, but don't understand just how many things can go wrong even when following the best laid plans. In this game of human vs. planet, players are given starting characteristics for a world with a not-quite-right atmosphere, and work to use science to make a Goldilocks planet. Their planets' characteristics are tracked on a peg board, and their resources are tracked with tactile game pieces. During play, a game master (who does need to be sighted until we develop an online app) reads that round's action cards. These may be cards that allow accelerated accomplishments, or that throw monkey wrenches (or at least meteorites) into each player's attempts to terraform their world. All science in the game is based loosely on atmospheric and planetary science. The winner is the person who first gets their world capable of supporting humans walking on the surface.

2.4 Carbon

This is our most addictive game. Each player starts with a small board that is their city-state. The board has a myriad of small holes in which they can, turn by turn, plant trees, develop industry, or build power plants. Based on the decisions made, they will acquire or sequester carbon, and produce food, goods, and power. All pieces and tokens are designed to be pleasing to both sighted and visually-impaired audiences. The goal of the game is for the players to rid their world of carbon buildup while growing their industrial capacity. This cooperative game requires strategic thinking, and like in the real-world, offers multiple ways to win.

3. How to Get Games

We want all of our games to be as assessable to get as they are play! You can download PDF editions and / or instructions to build your own game sets by visiting SpacePlay.org. For many of the games, we also provide lesson plans and teacher guides

Acknowledgements

These games would not exist without the help of a large team of creatives, and wouldn't be worth playing without the feedback we've received from a myriad of play testers. Please visit spaceplay.org/credits for a complete list of our team. Funding for these games was provided by Europlanet, individual donations, and was supported in part by NASA cooperative agreements numbered NNX17AD20A and NNX16AC68A. Any opinions, findings, & conclusions or recommendations expressed are those of this project & do not necessarily reflect the views of the National Aeronautics and Space Administration (NASA). We'd like to thank the Extra Credits series for their content on game design that helped us learn what pitfalls to avoid and what tricks to remember. Finally, we thank Lina Canas and Avivah Yamani for play testing our games in Portugal and Indonesia.

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Spaceguard UK – The First Two Decades

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Abstract

In his presentation Tate will describe the origins of UK interest in the NEO hazard, the political battle to generate official interest and the subsequent establishment of Spaceguard UK and the Spaceguard Centre. The Spaceguard Centre in Wales is the only science centre in Europe dedicated to the Near Earth Object hazard, and Tate will describe what it does and how it does it, including the help provided by the 2013 Europlanet prize.

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Planets In Your Hand

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Abstract

Mankind has an inherent desire to explore the planets, which is closely connected with the nature and curiosity of human beings. Unfortunately, the actual exploration is a privilege of only a few people, at least in the near future. The presented project, entitled “Planets In Your Hand” (PIYH) gives everyone the chance to see, touch and feel the differences of each planetary surface in our Solar System and learn about the world we all live in. The PIYH project consists of a portable exhibition of planetary surface models in square frames. It is carefully designed and addressed to both young and elder people, families, students, educational institutions and especially to visually impaired individuals, giving them a unique opportunity to meet and get familiar with planetary science.

1. Introduction

Planets In Your Hand (PIYH) Team, a public outreach team from the Department of Physics of National and Kapodistrian University of Athens, won one of the two funding awards of the competition "Europlanet Funding Scheme 2017", organized by Europlanet. The proposed project consists of an exhibition of eight planetary surfaces, 4 gaseous and 4 terrestrial, giving a visual and tangible representation of a wide range of environments in our Solar System. The visitors of this exhibition will have the chance to see, touch and have a sense of each surface, where the basic planetary characteristics will be given. For example, large temperature difference on Mercury, high temperature on Venus, the red colour of Mars, the gaseous and windy giant planets will be modelled, by utilizing special materials for surface structure, warm and cool air, gaseous and cold surface, and special LED illumination effects.

2. PIYH project

2.1 Construction

The three-dimensional mockup surfaces of the exhibition will be displayed in wooden frames based on wooden pedestals (Figures 1, 2). The embossed surface of terrestrial planets are represented with solid materials, colours, various textures and geological formations, offering a multi-sensory experience to the visitors. On the other hand, gaseous planets are equipped with special illumination and proper fans, representing the planetary atmosphere, in combination with dry ice and low temperature (Table 1).

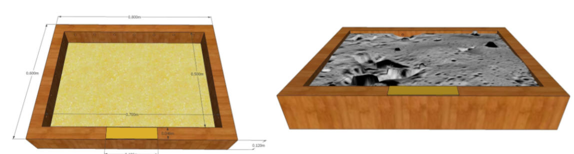

Figure 1: Wooden frame for the planetary surfaces

Figure 2: A 3D virtual wooden pedestal for each surface

The work progress specifically includes the gathering of the necessary materials for every planetary model, the construction of wooden frames in which the planetary surfaces will be inserted and the simulation of the temperature and other circumstances, using suitable materials and effects. Plaster and paint were used to construct the planetary models, in small and regular scale. An electrical circuit with resistances has also been created, in order to complete planetary surfaces that require higher temperatures, such as Venus and Mercury.

Table 1: Main materials for each planetary surface

Planet	Material	Extra
Mercury	Plaster, Grey paint,	Hot only from one side (resistors)
Venus	Plaster, Yellow-Orange-White paint	Hot everywhere (resistors)
Earth	Plaster, Blue-White & Green-Brown paint	Sand (ground) - gelatin (water)
Mars	Plaster, Ceramic-Red paint	Sand (ground)
Jupiter	Plexiglas, Yellow-Orange-White paint	Gas (dry ice), fans & LEDs
Saturn	Plexiglas, Orange-White paint	Gas (dry ice), fans & LEDs
Uranus	Plexiglas, Cerulean paint	Gas (dry ice), fans & LEDs
Neptune	Plexiglas, Ultra-marine paint	Gas (dry ice), fans & LEDs

2.2 Social media and website

The project is accompanied with social media accounts and a specially developed website, including all information about the Solar System and the exhibited planets. The developed website (*en.planetsinyourhand.phys.uoa.gr*)includes a brief description of the project, information about the exhibition and forthcoming events, as well as information and details about the team members. All information is provided in both Greek and English language. Social media pages (*Facebook*, *Twitter*, *Instagram*), as well as an email address have been also created. Visitors can be immediately informed about the progress of the project and follow our activities. The response and attraction with the public, will give a valuable insight and a quantified measure of our achievement.

2.3 Outreach on schools and institutes

Meanwhile, the communication with organizations that would be interested in the exhibition is also very important. Schools and Educational Institutions in Greece, which would like to host the exhibition, have already been reached out. Since the exhibition is portable, it could travel even further, among other cities and countries. Also, schools and groups with visually impaired people have been reached out, in order to give us some advice about details we should pay attention to for a functional exhibition. Furthermore, brochures with information about our exhibition and the exhibited planets have been redacted and will be distributed in our exhibition in Greek, English and Braille language. Talks about the planets and our Solar System, as well as special events have been arranged for the public about PIYH project.

Figure 3: Suggested layout of the exhibition

3. Summary and Conclusions

People who are not familiar with physics and/or planetary science usually tend to have a wrong impression about the size, the surface structure and the morphology or other relevant properties of the planetary system. Such impression is usually confused when interplanetary travelling is discussed or when a mission to a distant planet is scheduled. The goal of this project is to clarify the above concepts, eliminate such or similar misunderstandings, and give knowledge or even trigger people to get themselves occupied with physics and science. It will be ideal to change the way that people think about planetary physics and we will try to make them love planetary science and space exploration and appreciate it the way we do.

Acknowledgements

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Rosetta's Comet Touchdown educational kit

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Abstract

In 2010, Lightcurve Films in collaboration with and with support from ESA, DLR, EuroPlanet and the LEGO® Company, Denmark, produced an educational kit called **Rosetta's Comet Touchdown**. The kit is centered around the Rosetta Philae lander and composed of an explanatory video with a set of Interdisciplinary Activity Sheets (IAS). The IAS contain proposals and suggestions for how to explore the topic of cometary research in a class room setting, using the video as a point of departure. The target audience for the kit is students aged 16 and older. Two high schools, one in Hungary and one in Portugal, tested the kit in 2011.

Introduction

The idea to create a video around the Philae lander started with a conversation with Detlef Koschny (ESA), who had been using LEGO® to help with Rosetta mission operation planning purposes. We produced a short educational video about the Rosetta Philae Lander. In the video Planetary scientist Dan Andrews (Open University, UK) and Engineer Ulrike Ragnit (ESA) explain the science behind and working of Philae, using a LEGO®-comet-landscape and a LEGO MINDSTORMS® version of the lander. The LEGO® lander was built by Dutch LEGO® specialist builders Martijn Boogaarts, Gerrit Bronsveld and Eric Steenstra. The video can be found at www.lightcurvefilms.com/rosettas-comet-touchdown.

At this link, several other videos can be found, such as two videos with Detlef Koschny (ESA), a documentary about the Dutch LEGO® builders and videos produced by the Hungarian high school group that tested the kit.

To provide with ideas of how to use the video and explore the topic of cometary science in a class room setting, *Interdisciplinary Activity Sheets* (IAS) were put together and made available as part of the kit. These sheets contain suggestions of how to use the film, LEGO® and LEGO MINDSTORMS® and other ideas to explore cometary science in an interdisciplinary way, including art, languages, culture, science, technology, etc..

Testing the kit

The kit was first presented in Rome during the EPSC 2010. Twelve student of aerospace engineering (3rd year) and 3 students of design (European School of Design) were found interested to participate. LEGO® MINDSTORMS® expert Martijn Boogaarts was also in Rome and brought the demonstration model. He participated in the event, demonstrating the model and guiding the students. The aerospace students were invited to build their own model and the art student to make a work of art around the theme during 3 hours.

Figure 1: The kit first presented and tested in Rome.

The kit was next extensively tested by two high schools: the Széchenyi István Gimnázium in Sopron, Hungary, and the Escola Secundária do Bocage in Setúbal, Portugal. The Hungarian group was led by physics teacher Ágota Lang, and had the collaboration of teachers from other disciplines. The Portuguese school team was lead by physics teacher Filomena Rodrigues.

The Hungarian group were 31 students of average age 15. They divided in several smaller teams focusing on History, Arts, Science, LEGO® building and media production

Figure 2: The students from the Széchenyi István Gimnázium in Sopron, Hungary, presenting their work.

The general evaluation from both schools was positive, both by the students and the teachers. It was not possible to create a connection between the two groups, due to very different time and work schedules in both countries.

From the Hungarian report: " … the proposed activities in the Interdisciplinary Activity Sheets cover three areas: science, art and building (engineering), so every student can find and work on a favourite theme. The Interdisciplinary Activity Sheets are also very useful, because they provide with starting-points and ideas for the project-leader. …. The interdisciplinary aspect is an excellent idea. All the 3 colleagues - who took part in project - think the same about this and they helped the work of the class 9A pleasantly". The Hungarian team later presented their work as a poster during the EPSC 2011 [1].

The group in Portugal was smaller in number. One sub team worked on a LEGO® model, the other sub team focused on art, creating a surrounding for the model, with the information in the IAS as a starting point. From the Portuguese report: "In our opinion is that the kit should become broader in terms of the theme, not just Rosetta."

Figure 3: The result of the work by the Escola Secundária do Bocage in Setúbal, Portugal.

Acknowledgements

Financial support was provided by ESA, DLR and EuroPlanet. The LEGO® company provided with all the necessary LEGO MINDSTORMS® elements and 40,000 2x4 LEGO® bricks to build the cometary surface for the video.

References

[1] Lang Á., et al.: Touch the comet! Testing of the "Rosetta's Comet Touchdown" educational kit in the Széchenyi István High School, Sopron, Hungary. EPSC-DPS 2011, 2-7 October, Nantes, France, 2011.