

A Global Audience for New Race to the Moon: Outreach for the Google Lunar XPRIZE

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Summary

The Google Lunar XPRIZE aims to open up a new era of space exploration and entrepreneurship through a competition to land a commercially funded robot on the Moon. To raise awareness of the competition, and to help inspire a new generation of scientists and engineers, XPRIZE has developed a suite of public engagement and informal learning activities. These include the MoonBots Challenge robotics competition, the digital planetarium show, *Back To The Moon For Good*, and the MoonBots-in-a-Box interactive kit for science centres. This article presents a review and preliminary evaluation of the Google Lunar XPRIZE's outreach activities to date.

Introduction

The Google Lunar XPRIZE is a competition to land the first commercially funded robot on the Moon and to transmit high-definition imagery and video back to Earth from two points on the lunar surface. Currently, sixteen teams from fourteen countries are building spacecraft to attempt a lunar landing before the prize expiry date of December 2016.

The competition is administered by XPRIZE, a not-for-profit organisation based in Los Angeles, USA, that designs and operates incentivised competitions to encourage innovation and technology breakthroughs. Google Incorporated sponsors the competition and has put up the prize purse totalling 30 million American dollars.

As well as opening up low-cost access to the Moon, a core objective of the prize is to inspire and engage people around the world with science, technology and innovation¹. More than a third of the competing teams are headed by young entrepreneurs

under 40 years old, who are potential role models in science, technology, engineering and maths (STEM).

XPRIZE has developed a suite of outreach programmes to build global awareness of the Google Lunar XPRIZE, the challenges of lunar exploration and the human stories of the competitors. Since 2010, these activities have been implemented through the informal learning environments of robotics competitions, planetariums and science centres.

The MoonBots Challenge — Introduction

Programmes that engage students in project-based learning founded on real scientific problems can have a significant effect in promoting an interest in STEM and a positive attitude to science (Welsh, 2010). As its first outreach programme, Google Lunar XPRIZE conceived a junior version of the competition, called MoonBots², in which teams of young peo-

ple would construct a robot using LEGO MINDSTORMS³ and complete a series of challenges on a simulated lunar surface.

Like the Google Lunar XPRIZE teams, MoonBots competitors were also given a remit to communicate their activities in their local and online communities. The MoonBots Challenge was launched in 2010 and has subsequently run in 2011, 2012 and 2014. Over the four rounds, MoonBots has attracted more than 2500 participants aged 9–17 and around 700 adult team members from 36 countries. There have been at least 120 000 views on YouTube of videos associated with the competition and around 25 000 people have attended community outreach demonstrations by the finalists.

The MoonBots Challenge — Promotion

MoonBots was set up through a partnership of organisations that included the XPRIZE Foundation, Google, LEGO Group,

	2014			2012			2011			2010			Overall		
	Phase		Winner*	Phase		Winner*	Phase		Winner*	Phase		Winner*	Phase		Winner*
	1	2		1	2		1	2		1	2		1	2	
# Participants	1131	107	21	527	110	18	302	86	14	887	84	13	2847	387	66
% Female	36	57	33	30	33	33	26	16	29	27	29	33	31	35	32
% Male	64	43	67	70	67	67	74	84	71	73	71	67	69	65	68
Number of all-female teams	53	7	0	11	2	0	4	1	0	12	1	0	80	11	0
Number of all-male teams	121	3	1	61	10	1	32	11	1	89	8	1	303	32	4
Number of mixed teams	124	15	4	65	18	3	40	8	2	110	11	2	339	52	11
Average age	12.56	13.15	13.95	12.93	12.85	13.89	12.94	13.17	13.36	13.12	13.73	13.83	12.87	13.19	13.78
Team size	3.8	4.28	4.2	3.84	3.7	4.5	3.97	4.3	4.67	4.2	4.25	4.33	3.94	4.09	4.4

Table 1. Basic quantitative data for each phase of the competition over the four-year period. The 2010 dataset has been filtered to exclude adult members. *Includes winning and runner-up teams.

WIRED and National Instruments. Because of the ambitious scope of trying to launch a competition to a global audience, the partners decided to focus on working with existing networks, such as the FIRST LEGO League (FLL), that had already developed communities and dissemination channels.

MoonBots was promoted through LEGO Education⁴, editorials in WIRED⁵ and GeekDad⁶, XPRIZE social media channels and through dedicated online and social media platforms for MoonBots. In later years, to attract a wider participation from outside the US, the competition was promoted via international educational, science communication, and science centre networks and mailing lists, such as Ecsite⁷, Psci-Com⁸ and the Galileo Teacher Training Programme⁹. The Google Lunar XPRIZE teams have also promoted the competition through their own outreach networks and, in some cases, have acted as mentors for MoonBots teams.

The MoonBots Challenge — Teams

Initially, the 2010 MoonBots competition was open to teams of 4–6 adults and children aged 13 and over, with at least three members aged 13–18. However, due to requests from potential participants, the minimum age was lowered to nine years old. In subsequent years, the

rules have been amended so that teams include one adult (the team captain) and the other 2–5 team members are aged 9–17 years old.

The MoonBots Challenge — Format

The basic format for MoonBots is a two-phase competition.

Phase 1: Teams submit a profile and a video in response to a question like: “Who is your favourite Google Lunar X PRIZE Team and why?” Or, “How can robots influence future space missions?” From these responses, 20–30 teams are selected.

Phase 2: Chosen teams receive a LEGO® MINDSTORMS® robotics toolkit, LEGO bricks and other materials to create their own robot and lunar landscape. The finalists must complete their simulated lunar mission in front of a live audience and through a live-stream for the judges and online followers.

The competition is free to participants. All submissions are online and the MINDSTORMS® NXT kit and any other equipment needed are sent to finalists free of charge.

On registration, teams supply contact details of the team captain plus names and ages of the team participants. We have

used this information to carry out a basic quantitative evaluation of the participation in the competition.

The MoonBots Challenge — Overall participation

A total of 722 teams have competed in MoonBots from 2010–2014. The number of teams registering has varied quite widely year-on-year (Table 1), possibly due in part to variations in the timing of the competition’s start and finish months. In the most successful years (2010 and 2014), the competition was launched in early spring, with Phase 2 running from mid-June until the end of August. This fits in with the “off-season” for participants involved in FLL challenges¹⁰.

In 2011 the launch of the competition was delayed until May and in 2012, the competition ran from June–December. While changes in marketing strategy may also be a factor, the significant dip in numbers does suggest that the timing of the launch of Phase 1 of the competition has a strong effect, especially on the number of participants from the USA and those participating in FLL.

The MoonBots Challenge — Geographical spread

MoonBots has been dominated largely by teams from the USA, which account for

73% of the participants overall (Figure 1). However, this has varied substantially year on year: while in 2010 and 2011, more than 80% of the teams were USA-based, in 2012 USA teams only accounted for 48% of registrations. This drop may partly reflect the timing issues mentioned above; but the numbers also represent a trend towards international teams entering the competition.

In 2012, there were significant spikes in participation from teams from Egypt and Chile. These two countries are second and third respectively in the ranking for the number of teams participating in MoonBots overall, followed by India and Brazil. The peak in interest from Chile in 2012 could be attributable to outreach efforts by the Chilean Google Lunar XPRIZE competitor, Team AngelicvM. There is no Egyptian team competing for the Google Lunar XPRIZE, however, all the Egyptian MoonBots competitors have affiliations to robotics clubs, so it may be that advertising through Egyptian robotics networks proved particularly successful.

The top five countries aside from the USA participating in MoonBots are not English speaking and the rules have gradually been changed to make the competition accessi-

ble to a more international and diverse audience. In 2012, a deaf and hard-of-hearing team reached Phase 2 of the competition, delivering their video essay and commenting on their live events in sign language.

Since 2014, teams have been allowed to create videos in their own language, so long as they add English subtitles. They can also speak in their native language for the live-streamed outreach and judging event, so long as there is an English translator on site.

The increased internationality has been reflected in Phase 2 and the winners of the competition. A Hungarian team won the 2012 competition and one of three runners-up came from South Africa. The 2014 MoonBots Challenge was won by a USA team but two of the four runners-up came from Europe — Spain and the Netherlands.

The MoonBots Challenge — Gender balance

Female participants account for 31% of MoonBots competitors overall, 32% of

winners and runners-up, and 33% of team captains. The gender balance for 2014 shows slight signs of improvement, with a 6% rise in the number of female participants compared to the 2012 competition.

In addition, there was a noticeable increase in the number of all-girl teams, rising from 11 to 53, which translated into an increase in all-girl team finalists. In 2014, for the first time, girls outnumbered boys in Phase 2 of the competition — although only a third of the 2014 winners and runners-up were female. While mixed-gender teams form the majority of both the finalists and runners up in each year, the 2010, 2011 and 2012 rounds of MoonBots were won by all-boy teams.

The increase in all-girl teams is largely USA-based, and may possibly be linked to strategic alliances developed by FIRST¹¹ to promote female participation in FLL.

The overall figures are naturally skewed to reflect the gender breakdown of the USA teams and the small samples make it difficult to draw any conclusions about gender breakdown for teams in most of the non-US countries participating in

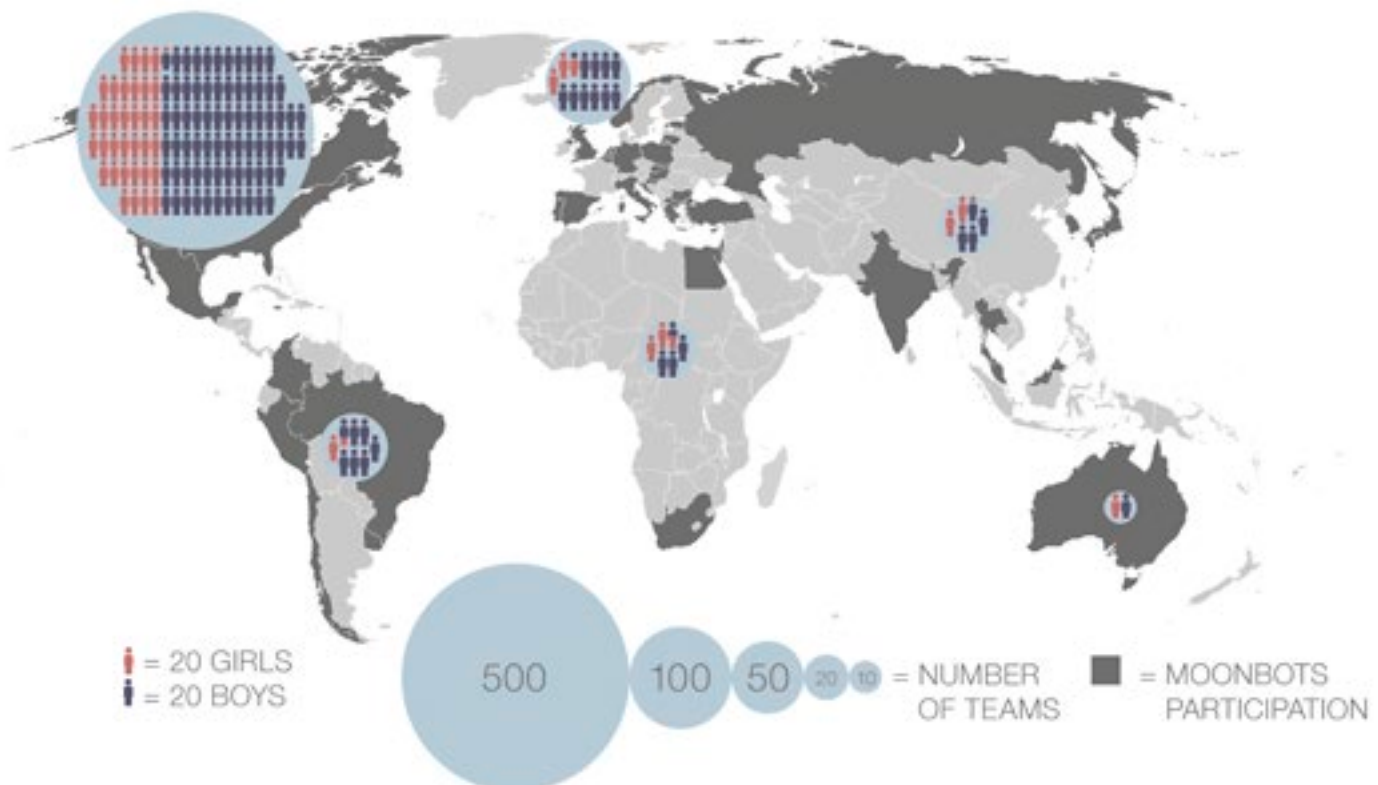


Figure 1. Geographical distribution of teams participating in MoonBots 2010–2014 and gender balance by region. The regions are North America, South America, Europe, Africa, Asia and Australasia. Credit: Google Lunar XPRIZE/MoonBots

MoonBots. However, the other top-five ranked countries do hint at the spectrum of gender balance between different nationalities. Forty-two percent of Egyptian teams are girls and India also has an above average female participation of 36% over the four years. Of the Brazilian contestants 27% are female but only 7% of the Chilean team members are female.

The MoonBots Challenge — Age and team size

In each year there is a general upward trend in the average age of teams as they progress through the down-selection stages. The winner/runner-up average age is 13.78 compared to 12.87 for all participants. Larger teams also tend to do better in the final phases of the competition.

The MoonBots Challenge — Repeat participation

Repeat participation in the competition is high and teams that have members or captains who have participated year-on-year show increased chances of success. Of the 722 teams, 211 share a team captain, either with teams competing in the same year or with a team from a previous year. Eighty-four team captains have coached more than one team, with 41 coaching multiple teams in the same year and 52 coaching teams in different years.

Thirty percent of team captains who coached multiple teams reached the final at least once and 13% reached the final in two or more years. Five of the 12 winner/runners-up teams in 2011, 2012 or 2014 had either participated in previous rounds of the MoonBots challenge or had a team captain who had participated.

The Nebulans, a team from Egypt and finalist in MoonBots 2014, state in their profile: “This is our third year in the competition because that is the AWESOMEST way to spend the summer!” The next round of the MoonBots Challenge launched on 23 April 2015. Registration closes on 23 June 2015.

Back to the Moon for Good fulldome show

There are an estimated 3900 planetariums worldwide, attracting an audience of more than 90 million people each year in over 100 countries¹². These planetariums range from 280-seater fixed-dome facilities that are visited by several hundred thousand people per year, to 3-metre inflatables that seat 20–30 school children. They are operated by a wide range of organisations, including museums, science centres,

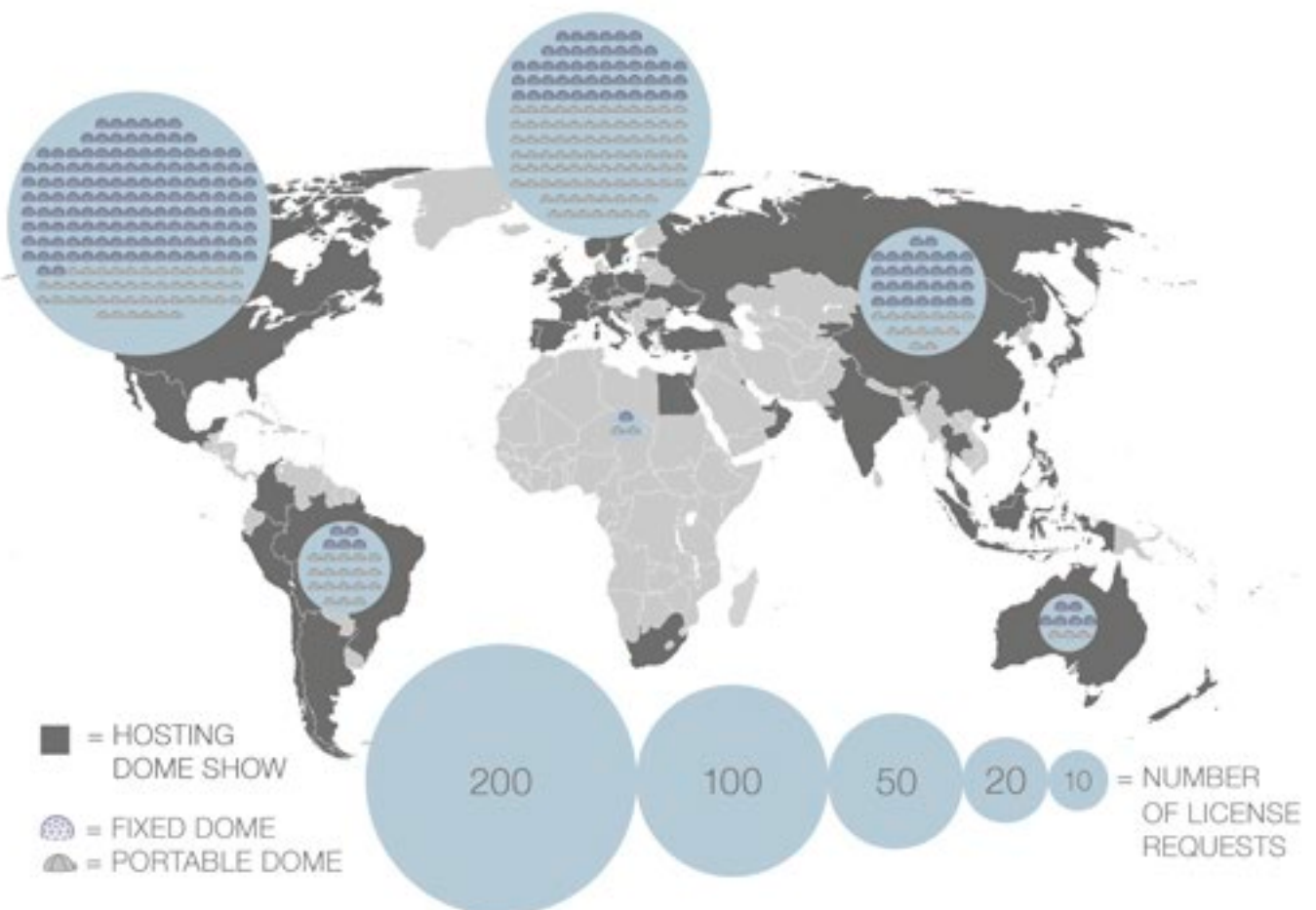


Figure 2. Geographical distribution of venues requesting licences to show Back to the Moon for Good with the breakdown of portable versus fixed domes. Credit: Google Lunar XPRIZE

astronomy clubs, universities and schools (Petersen, 2014).

In January 2013, XPRIZE contracted NSC Creative¹³ to produce a 24-minute digital fulldome show that chronicles the history of lunar exploration, introduces the Google Lunar XPRIZE and tells the story of some of the people attempting to win the competition.

Ryan Wyatt, Director of the Morrison Planetarium at the California Academy of Sciences, wrote the script and the show was narrated by the actor Tim Allen. *Back to the Moon for Good (BTTMFG)* was premiered at the National Space Centre in Leicester, UK, in November 2013.

A sign-up sheet and marketing material for planetariums interested in hosting the show are available from the Google Lunar XPRIZE website. The lease for the show is free of charge and the only costs incurred by planetariums are for the hard drive and its shipment.

Back to the Moon for Good — Promotion and reach

The show was promoted through two planetarium lists¹⁴ and through adverts in the *Planetarian Journal*¹⁵. In addition, XPRIZE contacted directly all the digital planetariums listed in the Fulldome Compendium, a list of thousands of digital planetariums in 70 countries¹⁶.

XPRIZE set a goal of having the show screened in at least 10% of the world's planetariums. In the first year, 2014, 408 planetariums in 49 countries signed licences for *BTTMFG*, already meeting that target. At the time of writing, new enquiries average ten per week. To date, the show is available in 18 languages and XPRIZE has provided the audio for the show in non-narrated format to allow for regionalisation. The script has been translated thanks to the generosity of volunteers working in planetariums around the world. In 2014, the show won awards at the FullDome Festival Jena and Macao Fulldome Film Festival.

It is difficult to give a robust estimate of how many people have actually seen the show. Although most domes signing the license agreement give annual visitor



Figure 3. Advertisement for *Back to the Moon for Good* fulldome digital planetarium show.
Credit: XPRIZE/NSC Creative

numbers, *BTTMFG* will only form part of their programme.

XPRIZE has sent out questionnaires on a quarterly basis asking for viewing figures and comments on audience responses. According to 116 responses from the 160 planetariums that initially received the show, approximately 800 000 people viewed *BTTMFG* during the period November 2013 to April 2014. Further numbers for the period April to November 2014 have been requested but the response rate has been low. Extrapolating from the 800 000, we can estimate that more than two million people have seen the show in its first year. More than 90% of planetariums surveyed rated the audience response as “Great” or “Good”.

MoonBots-in-A-Box kit

Feedback from informal consultations at the Ecsite and ASTeC conferences in 2012 suggested that science centres would welcome a way to engage with a MoonBots-style activity outside the competition format and timescale.

In 2013, XPRIZE started to develop a MoonBots-in-a-Box kit that could be used for workshops or on-gallery activity in science centres or other informal education environments. The final kit included a 3D lunar landscape, a LEGO Mindstorms robot, a pre-programmed Raspberry Pi¹⁷ and game pad controller, LEGO bricks and build instructions for models designed for the robot to complete a lunar mission, an instructional video and a demonstration script. Thirty one of these kits have been distributed to science centres and planetariums around the world with priority given

to those that were launching the *BTTMFG* shows. A further seven were shipped to Google Lunar XPRIZE teams; the remaining two were retained by XPRIZE for outreach events.

In March 2014, XPRIZE sent out an evaluation questionnaire and received 12 completed surveys from 11 science centres. All except one had used the kit for at least one event or workshop and most had established it as part of a regular programme. In the period October 2013 to March 2014, the MoonBots-in-a-Box kits were used by 6000 to 10 000 visitors to facilities. The kits have been used in a variety of ways, including to develop curriculum-linked schools, workshops and as an interactive exhibit for the general public.

The Chabot Science Centre reported that due to the kit's popularity we plan to expand it to allow more visitors to use the kit at a time and try to reduce the long lines of people waiting to use it. We are also testing it for use in after-school and outreach programmes.

Conclusions

The aim of Google Lunar XPRIZE's outreach programme is to raise awareness of the competition worldwide. Although the *Back to the Moon for Good* dome show was a significant outlay, with a budget of around 600 000 American dollars, the sizeable visitor numbers for planetariums means that it can be considered to be a very cost-effective way of reaching global audiences.

Assuming two million visitors to planetariums have already seen the show, then the



Figure 4. The MoonBots-in-a-Box kit in action. Credit: XPRIZE

cost per head is only 30 American cents per person.

The audience numbers reached by the MoonBots competition are more modest, but the feedback and the repeat participation suggests that the programme has a high level of engagement from participants and that they retain an interest in both MoonBots and the Google Lunar XPRIZE.

The MoonBots-in-a-Box kits have not only been demonstrated as a useful resource, but have been a helpful way of building working relationships with planetariums and science centres. This will be an invaluable channel for engaging with the public as the Google Lunar XPRIZE teams prepare to launch their missions to the Moon.

Notes

- 1 More information on the Lunar XPRIZE: <http://lunar.xprize.org/>
- 2 More information on MoonBots: www.moonbots.org
- 3 More information on LEGO MINDSTORMS: <http://www.lego.com/en-us/mindstorms/?domainredir=mindstorms.lego.com>
- 4 More information on LEGO education: <http://education.lego.com/en-gb?noredir=true>

- 5 More information on WIRED: www.wired.com
- 6 More information on Geekdad: www.geekdad.com
- 7 More information on Ecsite: www.ecsite.eu
- 8 PSCI-COM mailing list: <https://www.jiscmail.ac.uk/cgi-bin/webadmin?A0=psci-com>
- 9 More information on the Galileo teacher training programme: www.galileoteachers.org/
- 10 More information on First LEGO league: www.firstlegoleague.org/challenge/participationrules
- 11 More information on FIRST: <http://www.usfirst.org/aboutus/nlsept14/first-alliances-corner>
- 12 Tallying the World's Planetarium Attendance: <http://www.lochnessproductions.com/reference/attendance/attendance.html>
- 13 More information on NSC Creative: www.nsccreative.com
- 14 The two planetarium mailing lists used were Dome-L and FullDome.org
- 15 Planetarian Journal: <http://www.ips-planetarium.org/?page=plntrn>
- 16 FullDome Compendium: <http://www.lochnessproductions.com/lfco/lfco.html>
- 17 Raspberry Pi is a system designed to teach basic computer science: www.raspberrypi.org

References

- Petersen, M. C. 2014, State of the Dome Address, IMERSA Summit, available from: <http://www.lochnessproductions.com/reference/2014state/2014stateofthedome.html>
- Welch, A. 2010, Eurasia Journal of Mathematics, Science & Technology Education, 6, 3, 187

Biographies

Anita Heward is European Outreach Manager for the Google Lunar XPRIZE and has spent a career communicating topics in astronomy and space.

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Cynthia Ashley is Project Manager for the *Back to the Moon for Good* show and has a background in both formal and informal education.

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Steven Canvin is a consultant for the MoonBots Challenge and has a background in design, marketing, LEGO and robotics.