



ELSEVIER

Contents lists available at ScienceDirect

Acta Astronautica

journal homepage: www.elsevier.com/locate/actaastro

The Penn state lunar lion: A university mission to explore the moon



Michael V. Paul^a, David B. Spencer^{b,*}, Sara E. Lego^c, John P. Muncks^d

^a Penn State Lunar Lion, Applied Research, The Pennsylvania State University, USA

^b Department of Aerospace Engineering, The Pennsylvania State University, USA

^c Applied Research Laboratory, The Pennsylvania State University, USA

^d Department of Aerospace Engineering, The Pennsylvania State University, USA

ARTICLE INFO

Article history:

Received 29 November 2012

Received in revised form

8 November 2013

Accepted 9 November 2013

Available online 22 November 2013

Keywords:

X-PRIZE

Lunar

University

Low-cost

Competition

ABSTRACT

The Penn State Lunar Lion Team plans to send a robotic explorer to the surface of the Moon and, by applying 30 years of technological advancements, win the Google Lunar X Prize. The Google Lunar X Prize aims to showcase the ability of the growing private space industry by having teams pursue the goal of becoming the first private entity to land a spacecraft on another body in the solar system. Through the Team's pursuit of this Prize, Penn State will establish itself as a leader in space exploration. The Lunar Lion Team will win this Prize through the collaboration of faculty and students from multiple disciplines, and the engineering and technical staff at the Penn State Applied Research Lab, as well as strategic collaborations with industry partners. The diversity of technical disciplines required to build a system that can land on the Moon can be found at Penn State. This multidisciplinary project will be not only a means for bringing together personnel from around the University, but also a way to attract faculty and students to these fields. The baseline concept for the Lunar Lion will strictly follow the requirements of the Grand Prize and the Grand Prize only, leading to the simplest possible system for the mission. By achieving the Grand Prize, Penn State will have accomplished what once took the large-scale effort of NASA's early robotic lunar landers or the USSR's space program. While the Bonus Prizes are noteworthy, ensuring their accomplishment will add development and operational risk to the flight system that could jeopardize the Team's ability to win the Grand Prize. The Team will build the simplest spacecraft, with the fewest number of systems and components. This philosophy will shorten the development timeline and result in a robust flight system that is of minimum cost. Wherever possible, the Team will use commercially available products to satisfy the needs of the system. The work of the Team will be efficient systems integration, careful operational planning, and focused mission execution, all with the Grand Prize in mind. By focusing on innovation rather than invention, Penn State will lead the field of competitors and land the next spacecraft on the Moon.

© 2013 IAA. Published by Elsevier Ltd. All rights reserved.

1. Introduction

In 1976, the Soviet Union's Luna-24 [1] spacecraft performed the last soft landing on the Moon. In the following decades, every other spacecraft that is not currently in orbit has crashed into the Moon after their

* Corresponding author.

E-mail address: dbs9@psu.edu (D.B. Spencer)

Table 1
Prize requirements and purses.

Prize name	Requirement	\$ Amt.
Grand prize	Land on the Moon, travel 500 m, 2 Mooncasts, Data Uplink, XPF Payload, by the end of 2015	\$20M
Second prize	Awarded to second Team to meet above requirements; may be awarded if a Team lands but fails to meet all requirements	\$5M
Apollo heritage bonus	Return images of Apollo 11, 12, 14, 15, 16 or 17 mission hardware or other artifacts such as boot prints	\$4M
Heritage bonus	Return images of other man-made artifacts on the Moon, such as discarded US or Russian hardware	\$4M
Range bonus	Travel 5 km on or above lunar surface	\$2M
Survival bonus	Survive 14-day Lunar night and transmit another Mooncast	\$2M
Water detection bonus	Detect water on the surface; publish in a peer-reviewed journal	\$4M
Diversity award	To the team with the greatest attempt to promote diversity; includes educational outreach	\$1M

mission ended. Multiple government initiatives to land on the Moon again have gone unrealized. At the same time, advances in space system technology that have greatly increased our capability for robotic exploration have bypassed the Moon in favor of more distant targets in the Solar System.

The Penn State Lunar Lion Team proposes to once again send a robotic explorer to the surface of the Moon and, by applying 30 years of technological advancements, win the Google Lunar X Prize. Through the Team's pursuit of this Prize, Penn State will establish itself as a leader in space exploration.

The Google Lunar X Prize is a competition run by the X Prize Foundation to set off a new era of lunar exploration, one that is championed by private industry rather than dependent on government funding. The competitors must land a craft on the Moon, return high-resolution images and video, and then move that craft 500 m to a new site and repeat the imaging mission. The first Team to accomplish the mission will win the \$20 M Grand Prize offered by Google through the X Prize Foundation.

The Lunar Lion Team will position Penn State to win this Prize through the collaboration of faculty and students from multiple disciplines, and the engineering and technical staff at the Penn State Applied Research Lab. Along with the Penn State Team are various strategic collaborators, including Lehigh University. (As partners join the Team upon signing the binding Master Team Agreement, we will announce them.) Other industry partners have also joined the Team; details of their participation are competition sensitive, but as these relationships become public, the Team will release details. The diversity of technical disciplines required to build a system that can land on the Moon can be found at Penn State, including expertise in Aerospace Engineering, Information Technology and Structural Acoustics. This multidisciplinary project will be not only a means for bringing together personnel from around the University, but also a way to attract faculty and students to these fields.

The Google Lunar X Prize is being offered in a time of growing international efforts in space exploration, both private and state-sponsored. The highly visible accomplishment of the next Moon landing will take its place in history. As the industry expands and evolves, winning the Prize will position Penn State to open a new area of research and will allow the University to become a leader in space exploration, and a contender for major NASA contracts.

2. Mission goals

The X Prize Foundation (XPF) has established rules and guidelines for the competition that range from technical requirements to public outreach. The main focus is the Moon landing itself, but the X Prize Foundation has made sure that this historic landing is viewed around the world through all media.

The \$20 M Grand Prize will be awarded to the first Team that lands a craft on the Moon and returns the images and video as described in the competition guidelines. In addition to the Grand Prize, there is a Second Prize and several Bonus Prizes. Table 1 summarizes the requirements for each Prize and the purse offered for each accomplishment. Further details on the competition rules can be found at the Google Lunar X PRIZE website.¹

3. Mission concept

3.1. Design philosophy

The baseline concept for the Lunar Lion will strictly follow the requirements of the Grand Prize and the Grand Prize only, leading to the simplest possible system for the mission. By achieving the Grand Prize, Penn State will have accomplished what once took the large-scale effort of NASA's early robotic lunar landers or the USSR's space program. While the Bonus Prizes are noteworthy, ensuring their accomplishment will add development and operational risk to the flight system that could jeopardize the Team's ability to win the Grand Prize. Thus, the secondary prizes are not going to be actively pursued, although should the opportunity arise to insert technology (such as advanced energy storage devices that could be adapted for spacecraft), we will explore that possibility and determine its effects on completing the primary mission.

The Team will build the simplest spacecraft, with the fewest number of systems and components. This design philosophy will shorten the development timeline and result in a robust flight system that is of minimum cost. At present, our estimate of the overall cost of this mission is \$60M

¹ Google Lunar XPRIZE Rules, <http://www.googlelunarxprize.org/prize-details/rules-overview>, date cited 8/7/13.

Download English Version:

<https://daneshyari.com/en/article/1714804>

Download Persian Version:

<https://daneshyari.com/article/1714804>

[Daneshyari.com](https://daneshyari.com)