

2024 NASA LUNABOTICS UNIVERSITY COMPETITION: SITE PREPARATION WITH BULK REGOLITH . Robert P. Mueller¹, Dan Britt², and Joseph A. Minafra³. ¹NASA Kennedy Space Center Swamp Works, Mail Code: UB-E, KSC, FL 32899 (rob.mueller@nasa.gov), ²University of Central Florida, Exolith lab, 532 S Econ Cir, Oviedo, FL 32765 (britt@physics.ucf.edu), ³Joseph A. Minafra, NASA Ames Research Center, Moffett Field, CA 94035-1000 Moffett Field CA 94035-1000 (joseph.minafra@nasa.gov).

Introduction: Lunabotics provides accredited institutions of higher learning students (vocational-technical, college, university) an opportunity to apply the NASA systems engineering process to design and build a prototype robot. This robot would be capable of performing the proposed operations on the Lunar surface in support of future Artemis mission goals.

Lunabotics features a systems engineering design challenge to engage students in the next phase of human space exploration supporting the Artemis missions. This two-semester event encourages students to design and build an autonomous or telerobotic robot designed to traverse the simulated Lunar surface and complete the assigned construction tasks. The number of teams accepted into this challenge is not predetermined but is based on the scores and overall quality of the Project Management Plans received and other factors.

The culmination of the Lunabotics virtual challenge will be the design, build and operation of a functional prototype Lunar robot. Teams are required to submit the following: (1) Project Management Plan, (2) Systems Engineering Paper, a (3) STEM Engagement Report, and a (4) Proof of Life Video. This is an optional item, but to qualify for the grand prize a team must also submit a: (5) Presentation and Demonstration.

Background: The NASA Lunabotics University Competition was first held in 2010 as a follow on to the NASA Regolith Excavation Challenge [1]. The high level of interest and participation from over 50 universities each year has led to a sustained annual competition cadence: it has been held every May for the past 14 years [2,3]. Over 6,000 students have participated and been inspired to pursue Science, Technology, Engineering and Mathematics careers (STEM).

2024 Competition: The necessary lunar surface tasks are evolving to meet the NASA Artemis Mission requirements. In the past Lunabotics challenges we gathered data to support Lunar mining for consumables in the Lunar regolith. Now, in 2024, the task is to gather data on Lunar site preparation and construction by designing and building a robot that will traverse the chaotic Lunar terrain and construct a regolith-based berm. The goal is to build a berm structure which would be useful to the Artemis Mission for blast and

ejecta protection during lunar landings and launches, shading cryogenic propellant tank farms, providing radiation protection around a nuclear power plant and other mission critical uses.

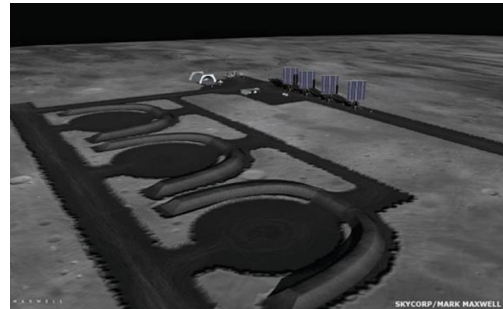


Figure 1. - Typical concept of Lunar Landing Pads with Berms (Source: NASA/ SkyCorp)

Lunabotics will consist of three separate events this year. The first event is NASA's Lunabotics Project Development Challenge, where teams submit various deliverables to be scored by judges.

The second event will be the University of Central Florida (UCF) Lunabotics Qualification challenge, in the Exolith laboratory, where teams will put their designs to the test. The top ten scoring teams from the Qualification challenge are then invited to the third and final event, NASA's Lunabotics On-Site Challenge at Kennedy Space Center in Florida.

This presentation will summarize the results and lessons learned from the NASA Lunabotics University Competition held in May 2024.

References:

- [1] Everingham, M. R., Pelster, N., Mueller, R. P., & Davidian, K. (2008, January). Preparation and Handling Large Quantities of JSC-1A Lunar Regolith Simulant for the 2007 Regolith Excavation Challenge. In AIP Conference Proceedings (Vol. 969, No. 1, pp. 268-273). American Institute of Physics.
- [2] Mueller, R., & Van Susante, P. (2011, June). A review of lunar regolith excavation robotic device prototypes. In AIAA Space 2011 Conference & Exposition (p. 7234).
- [3] Mueller, R. P., van Susante, P., Reinert, E., & Metzger, P. T. (2021). NASA lunabotics robotic mining competition 10th anniversary (2010–2019): Taxonomy and technology review. *Earth and Space* 2021, 497-510.

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Additional Information: The 2024 NASA Lunabotics guidebook, which contains the rules and structure of this year's challenge, can be accessed at:
<https://www.nasa.gov/wp-content/uploads/2023/09/a-lunabotics-2024-guidebook-draft-ver-2.0-09.12.2023.pdf?emrc=32ca54?emrc=32ca54> .