Planetary Basalt Construction Field Project of a Lunar Launch/Landing Pad – PISCES/NASA KSC Project Update

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Introduction:

Recently, NASA Headquarters invited PISCES to become a strategic partner in a new project called "Additive Construction with Mobile Emplacement" (ACME). The goal of this project is to investigate technologies and methodologies for constructing facilities and surface systems infrastructure on the Moon and Mars using planetary basalt material. The first phase of this project is to robotically-build a 20 meter (65-ft) diameter vertical takeoff, vertical landing (VTVL) pad out of local basalt material on the Big Island of Hawaii. This VTVL pad is a technology "proof of concept" demonstration project to show how a robotic precursor mission could viably construct a VTVL pad on a planetary surface. Such VTVL pads can mitigate the effects of a lander rocket engine exhaust plume impinging on the regolith surface. Currently, PISCES and the NASA Kennedy Space Center (KSC) have begun the basalt construction of a robotically-built basalt launch and landing pad following the completion of a "lunar sidewalk" construction in March 2015, which proved that raw crushed Hawaiian basalt could be sintered into modular paver elements. The Hawaiian basalt is very similar to materials found on Mars and the Moon. Construction of the VTVL pad is was started in the fall of 2015.

PISCES and NASA KSC have been assessing various in-situ construction methodologies for the2015 VTVL Pad Demonstration using additive construction with Hawaiian basalt regolith, to be completed by the end of calendar year 2015. Using the PISCES robotic rover, Figure 1, as the central platform for construction, the team is evaluating technologies for sintering/stabilizing the basalt surface. Tele-operations are being used to control the robotic rover which simulates operations during an actual space mission.

Overview:

PISCES and the NASA Kennedy Space Center (KSC) Swamp Works began planning and execution of an innovative planetary construction-demonstration project in the State of Hawaii. This task is part of a larger NASA effort called "Additive Construction with Mobile Emplacement" (ACME). The goal of the ACME project is to investigate technologies and methodologies for constructing infrastructure and facilities on the Moon and Mars using in situ materials such as planetary basalt material. By using the indigenous regolith materials on extra-terrestrial bodies, then the high mass and corresponding high cost of transporting construction materials (e.g. concrete) can be avoided. At approximately $10,000 per kg launched to Low Earth Orbit (LEO) this is a significant cost savings which will make the future expansion of human civilization into space more achievable. Part of the first phase of the ACME project is to robotically-build a 20 meter (65-ft) diameter VTVL pad out of basalt material on the Big Island of Hawaii. This will show that two dimensional horizontal planetary construction is feasible with tele-operated robots, using only in-situ materials. In addition the VTVL pad will solve rocket plume regolith erosion issues and will prevent lofted dust which would otherwise cause a large dust cloud, impairing sensing and navigation during precision landings on eth Moon or Mars.

This project is scheduled to be conducted prior to the end of 2015. It involved innovative construction methodologies that can apply to fabricating a vertical takeoff / vertical landing (VTVL) pad for Moon and Mars.

Figure 1 - Robotic leveling and grading