TEXAS SPACE GRANT CONSORTIUM DESIGN CHALLENGE

TOPIC # - TDC - 113

Habitat and Crew Worksite Enhancement for Harsh Lunar Surface Operating Environments

BACKGROUND

When astronauts return to the Moon, at the Lunar South Pole, with the goal of establishing a long-term habitat and base of operations, they will find a hazardous environment that challenges daily operational tasks and survival of long duration systems. The Lunar South Pole has a difficult operational lighting environment where there is no significant atmosphere to diffuse sunlight, the Sun may have an elevation from 2 – 10 degrees (landing site specific), and the day-night cycle lasts one Earth month. From a lighting and visibility perspective, this means that external surface tasks will be performed under either a persistent high-contrast-long-shadow work environment, a persistent full darkness environment, or persistent high glare environment. These scenarios challenge human and imagery driven tasks, given the limits on human eye adaptation visible light camera systems. Another hazard that impacts lunar surface tasks and long duration habitation is micrometeorites and ejecta from landers. New research is emerging on potential hazards to habitats, but what about debris that is aloft and encounters the crew may have while on a lunar traverse away from the shelter of their habitats? We could utilize hard materials and regolith to provide an interface of safety, but these materials would contribute to additional high contrast shadowing on the Moon. What if there was a way for a lightweight textile to be deployed that could not only redirect or diffuse collimated light from the Sun, but also serve as a shield to mitigate projectiles? Since it could diffuse sunlight, could it also help with thermal management?

PROBLEM/DESCRIPTION

The project is to perform materials research on textiles and soft goods that not only can protect the crew from a high velocity impact (e.g. bullet), but also allow light to diffusely transmit through the material so that it can diffusely contribute light to a work zone or protect the area around a habitat without increasing the number of shadow hazards for a hypothetical Lunar South Pole operational task being performed by an astronaut or robotic system. A successful project will demonstrate and rate the performance of multiple materials and soft goods ideas, including ease of converting the textiles an easy to deploy shield that can remain handheld or be self-supporting. Because the proposed material may need to be transported in a higher oxygenated atmosphere, analysis that considers flammability is also desired.

BACKGROUND MATERIALS

- Exploration Systems Exterior Lighting Design Guidance - NASA Technical Reports Server (NTRS)
- The Visual Experience at the Lunar South Pole - NASA Technical Reports Server (NTRS)
- EHP-10092 Lunar Surface Integration Phase Lighting & Visibility Specification for Artemis Surface Tasks: this document is available but currently does not have a public facing web site. Document will be provided to students by the mentor upon project start.
- Lunar Robotic Construction System Using Raw Regolith: Design Conceptualization
- Inflatable Airlock for Lunar | Base Radiation Shielding | Beyond Tomorrow
- NASA Cameras on Blue Ghost Capture First-of-its-Kind Moon Landing Footage - NASA
- ASEC_2023_Chambers_PSI.pdf
- DERT IEEE Radar Conf presentation Kemmerer 2023.pdf
- Kemmerer_AIAA_SciTech_2027.pdf
- Earth-and-Space-2022-LASSO-Batcheldor-no-lasso.pdf
- Instrument to Study Plume Surface Interactions (PSI) on the Lunar Surface: Science Motivation, Requirements, Instrument Overview, and Test Plans
- DeStefano_2025LPSC.pdf
- Micrometeoroid and orbital debris (MMOD) testing, ballistic limit equation definition and risk assessment of the Exploration Extravehicular Mobility Unit (xEMU)

TOPIC # - TDC - 113

Habitat and Crew Worksite Enhancement for Harsh Lunar Surface Operating Environments

DELIVERABLES

1st Semester, research and down-select on potential materials. Acquisition of initial materials for trial test runs. Conduct some initial testing. Example testing includes a high velocity impact test, testing on optical transmission properties of material, and ability of the material to lower surface temperatures of objects when used. Provide report, if possible, on potential volatility of the materials in higher oxygenated atmospheres. Standard TSGC reporting on progress.

2nd Semester, extensive additional research, new materials, and can include custom fabrications by team if they have determined custom solution(s) to evaluate. Velocity impact testing, testing on optical transmission properties of materials, and ability of the material to lower surface temperatures of objects when used. Fabrication of at least one full sized example "shield" with demonstration on ease of deployment. Bonus: shield can be deployed by human with thick gloved hands and shield can be deployed with simple robotic manipulator. Provide report, if possible, on potential volatility of the materials in higher oxygenated atmospheres. Standard TSGC reporting on progress, including a training document on how to set up the shield.

DESIGN TEAM PROFILE

NASA MENTOR:	Toni A. Clark (toni.clark-1@nasa.gov)
LEVEL:	JR/SR
MAJOR/DISCIPLINE:	Mechanical Engineering, Optical Engineering, Materials Engineering, Textiles Engineering, Softgoods Development, Thermal Engineering
TEAMS:	2
DURATION:	Work can spread across 2 semesters. Teams should reach final goals as indicated by semester 2.