Planetary Resource and In-Situ Material Habitat Outfitting for Space Exploration (PRISM-HOUSE)
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Introduction: The PRISM-HOUSE team participated in the NASA Moon to Mars Exploration Systems and Habitation (X-Hab) challenge for 2022 [1] on behalf of the Colorado School of Mines. Our task was to design a system to deploy, outfit, and operate a habitat on the surface of the Moon, while utilizing in-situ lunar resources as much as possible. We proposed a design, identified the requirements, and investigated significant considerations, analysis, and technical capabilities of interest. The team is currently producing deliverables and conducting tests to evaluate design feasibility. The primary objective of the system is to provide a safe and livable habitat near the lunar south pole with an optimized balance between delivered material and utilization of in-situ resources. A preliminary systems engineering design has been completed and reviewed by NASA, key system risks identified, and test plans defined to mitigate some of these risks. These test plans will be executed over the next several weeks and results evaluated to determine final risks to the system and recommendations for next steps.

Project Aim: Produce a design study of feasible concepts to deploy, outfit, and sustain a lunar habitat for up to four astronauts utilizing in-situ lunar resources to maximize on-site additive manufacturing, by leveraging expertise of industry partners in each key area.

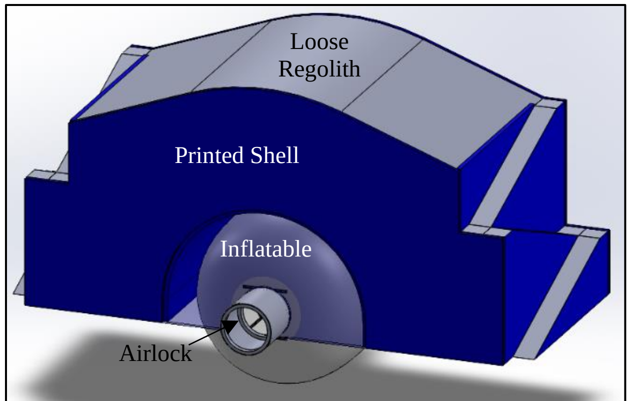
System Preliminary Design: The PRISM-HOUSE overall system has been divided into three primary focus systems for the purposes of this project.

External Structures & Environmental Protection

Consisting of a shell structure created using additive manufacturing with lunar regolith as the feedstock, loose regolith material backfilled into the shell structure, and openings designed to allow ingress and egress, the ESEP system provides protection from radiation and micrometeorites.

Human Interior Goods

Objects interior to the habitat used by human occupants, including floors, walls, chairs, tables, small tools, utensils, and replacement parts for other systems. These objects are created utilizing additive manufacturing techniques with regolith feedstock and binding agents.



PRISM-HOUSE Overall System Concept

ECLSS & Remote Outfitting

Environmental Control and Life Support as well as rovers and other automation equipment which allows the system to be fully deployed, operational, and life-sustaining prior to astronaut arrival.

Test Plan: Scaled external deployment test, using lunar-rated rover prototype to simulate transport and placement of external equipment, chemical leaching test of regolith-simulant printed objects to determine suitability for use with food and water to be consumed by astronauts, design and strength test of free-form 3D printed interior structures, habitat 3D model and simulation of daily activities, and 3D printing tests of external shell using regolith simulant.

Anticipated Results: Reduction of key risks and support of quantitative metrics for subsystem masses, installation and commissioning times, habitat configuration, concept of operations, and expected percentage of system mass which can be provided through the use of in-situ materials. Also identified will be critical assumptions made with supporting documentation and associated recommendations for next steps to determine overall design feasibility.

References: [1] NASA (2021) https://www.nasa.gov/exploration/technology/deep_space_habitat/xhab.