AETHER

TDC-106 Lunar & Mars Surface Habitat Module Manufacturing

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Introduction

The objective is to develop a fully prefabricated Lunar and Martian surface habitat module, designed for rapid deployment and sustainability under NASA's Moon-to-Mars Architecture. The Aether Module leverages advanced manufacturing methods such as friction stir welding and modular aluminum-titanium structures to minimize on-site assembly, reduce mission risk, and support four astronauts for extended surface operations.

Background

The Humans to Mars Program aims to enable human habitation beyond Earth by the 2030s. Current extraterrestrial habitats lack manufacturing efficiency and depend heavily on on-site assembly. Aether addresses this challenge by designing a habitat that can be manufactured, configured, and pressurized on Earth, transported within the Falcon Heavy fairing, and deployed ready-for-use on the lunar or Martian surface.

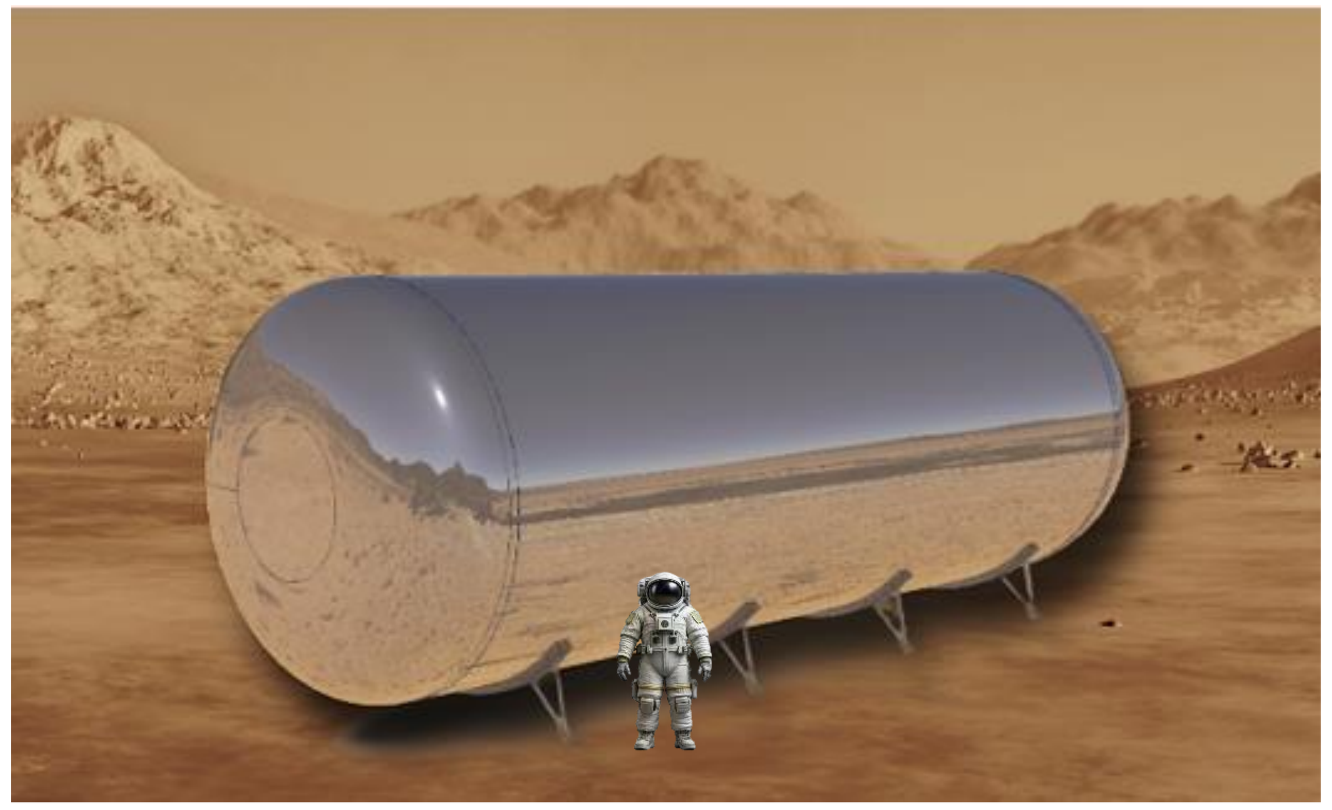
Objective

1. Design and manufacture a pressure-sealed extraterrestrial habitat module capable of supporting four crew members.
2. Ensure dual-environment compatibility for Lunar and Martian missions.
3. Develop a module that is fully prefabricated on Earth and operational immediately upon deployment.

Specifications

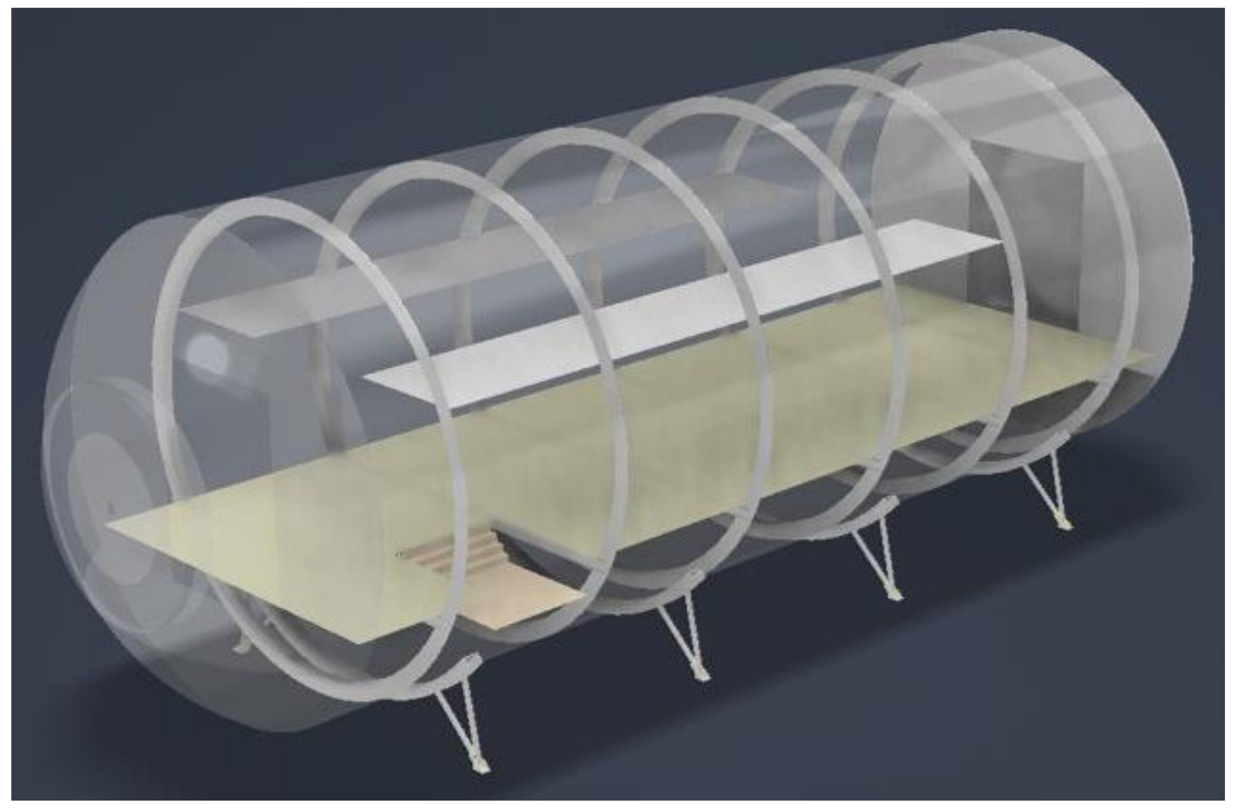
Parameter	Description	Criteria
Launch Mass	Maximum per module	≤ 10,000 kg
Usable Interior Area	Floor area available	50–80 m²
Internal Pressure	Operational Cabin Pressure	70–101 kPa
Temperature range	Surface Conditions	−130°C to 120°C
Radiation Shielding	Crew Protection	≥10 g/cm²
Crew Capacity	Habitants	4
Assembly Time	Deployment and setup timeframe	≤ 30 days
Corrosion Resistance	Material degradation	≤5% mass loss

Aether Module

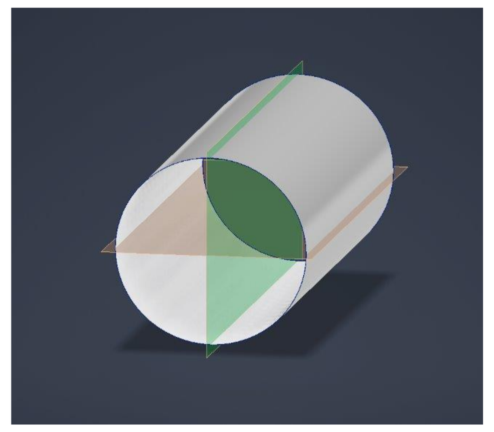


Aether Module Deployed on Mars

Aether Module Internal View

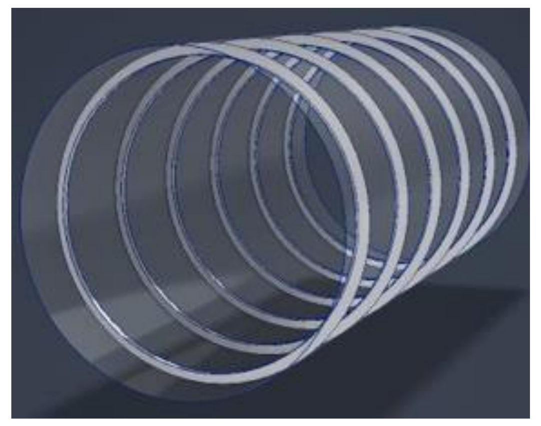


Habitat Module Main Components



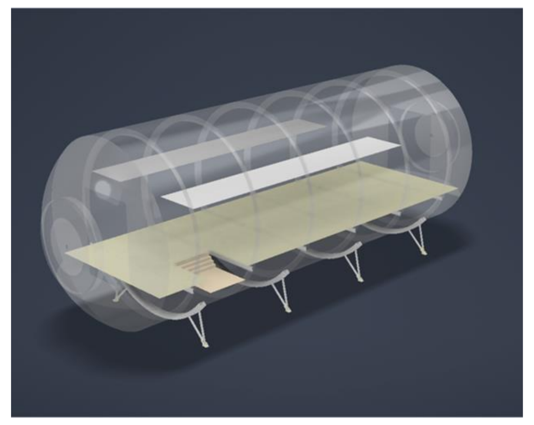
Pressure Shell

Al 2219 pressure hull encases the module, providing airtight corrosion resistant shell



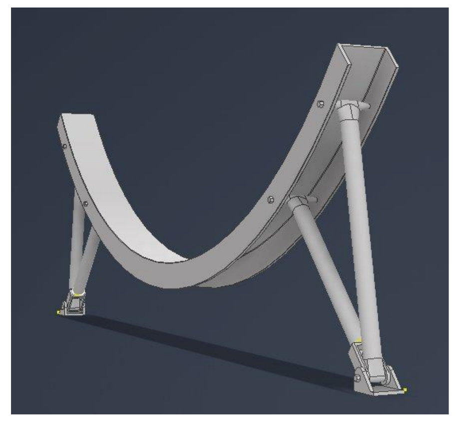
Support Spine

Al 7050 ribbed spine spans the module, resisting hoop stress and transmitting loading forces to support beams and legs



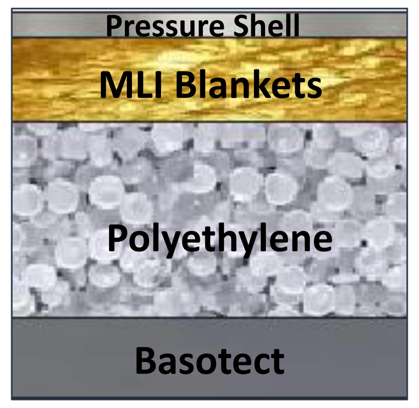
Main Floor & Lofts

Lower level serves as primary workspace, with overhead lofts for bunking. Polypropylene construction aids with damping. Setup yields 50.4m² usable space.



Leg-Saddles

Al 2216 saddles cradle the module. Hollow Ti 10-2-3 legs attach to foot pads and support the saddles.



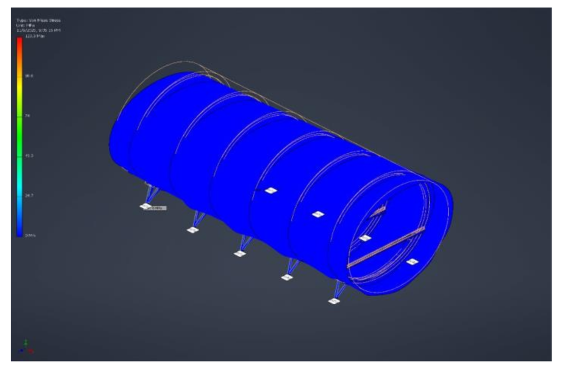
Wall Layers

Polyethylene and MLI blankets absorb radiation and provide thermal insulation. Basotect foam damps vibrations and reducing excess noise.

Calculations

Component Section	Mass
Pressure Hull (Al-2219)	**1800kg**
Flooring and Supports (Floors, Spine, I beams, Leg Saddles)	**617kg**
Wall Layers (HDPE, MLI, Basotect)	**2348kg**
TOTAL Mass: 4765.32	

Section	Area
Main Floor	3.5 x 10 =35 m²
Loft 1	7 x 1.1 = 7.7 m²
Loft 2	7 x 1.1 = 7.7 m²
TOTAL AREA: 50.4 m²	



FEA analysis validated the structural integrity under Lunar and Martian conditions with a safety margin >10.

Key Decisions

- **Prefabrication:** The module is fully manufactured on earth, and stows fully configured during transit, such that it can be immediately deployed on site.
- **Launch Vehicle:** SpaceX Falcon Heavy chosen for its proven Mars-reaching capability.
- **Design Orientation:** Horizontal, maximizing internal volume and stowage efficiency.
- **Modularity:** Enables multiple connected habitats using standardized airlocks.
- **Fabrication:** Utilizes cold rolling and friction stir welding for strength and airtight integrity.
- **Materials:** Aerospace-grade aluminum alloys and titanium ensure high strength-to-weight performance.
- **Thermal Control:** Incorporates multilayer insulation and active radiators to maintain optimal internal temperature under Mars surface conditions.
- **Radiation Protection:** Incorporates layered shielding and strategic water storage placement to minimize crew exposure to cosmic and solar radiation.
- **Structural Integrity:** Reinforced with internal bulkheads and load-bearing frames to withstand launch stresses and surface pressure differentials on Mars.

Future Plans

Future work will focus on validating the Aether Habitat design through additional physical and simulated testing. Fabrication tests will confirm weld integrity, while thermal and impact assessments will ensure environmental durability. Once validated, a full-scale simulated prototype will be developed for NASA subsystem integration and field testing.

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- University of Texas at Tyler, College of Engineering

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