TDC-106 Lunar & Mars Surface Habitat Module Manufacturing

TEXAS STATE UNIVERSITY
Mechanical Engineering

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TEXAS SPACE GRANT CONSORTIUM
DESIGN CHALLENGE

Project Description

NASA's plans for Lunar and Martian exploration require sustainable surface habitat modules that are not only safe and functional, but are also manufacturable, modular, and adaptable to extreme conditions. This project envisions the design of a scalable habitat module, conditioned for both Lunar and Martian surfaces that will balance crew safety, manufacturability, product longevity, and efficient transport from the Earth to the Moon or Mars.

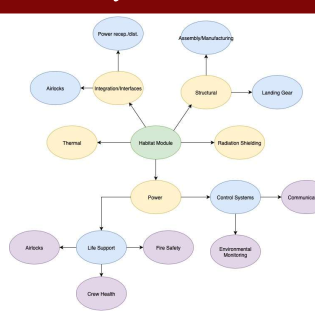
Module Functions

- Provide habitable pressurized volume
- Protect crew from external hazards
- Enable surface operations, crew mobility, scalability, and modularity
- Maintain thermal control
- Distribute power and data
- Allow safe assembly, deployment, and operation
- Allow efficient maintenance and repair

Constraints

Mass Limit: ≤ 10 metric tons for launch configuration
Surface Size per Module: ~50-80 m^2 useable floor area
Thermal Range: Survive -130°C to +120°C(lunar), -90°C to +20°C(Mars)
Radiation Protection: At least 10 g/ cm^2 equivalent shielding
Assembly Time: < 30 days with crew and/or robotic systems
Power Interface: 5-20 kW(e) capability, battery or fission ready
Airlocks/Birthing Ports: Designs should be standard or novel

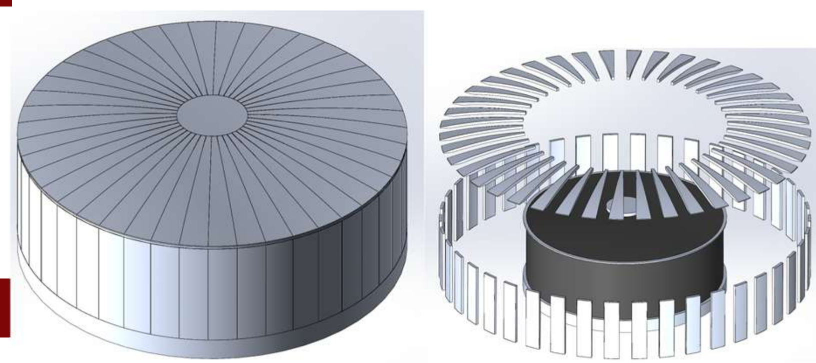
Subsystem Breakdown



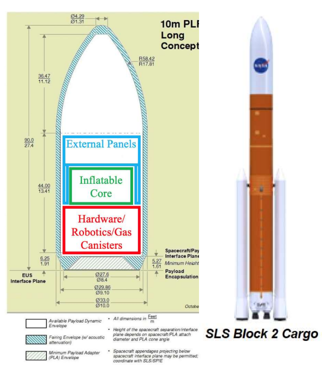
System Architecture

Subsystem Solutions:

- **Power:** Nuclear Reactor
- **Thermal:** MLI layer and ECLSS
- **Radiation:** MMOD external and MLI Internal Layer
- **Integration/Interface:** NASA Quest Airlock and Common Berthing Mechanism
- **Structural:** External MMOD shielding layer with an inflatable bladder.



Launch and Assembly

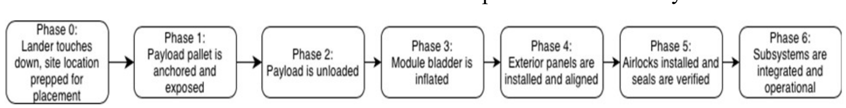


Hybrid Method: Combined approach with an inflatable core interior and rigid exterior shell, using a "clip-on" panel mechanism, allowing for compact stowing, ease of assembly, and repair and maintainability.

Fastening: A variety of temporary fastening techniques can be employed, such as:

- Ball and socket
- Magnetic fasteners
- Wedge-lock fastener

Assembly Time: Each phase of the assembly can be completed within 1-2 days.



Weight

Item	Weight (kg)	Material
Inflatable Interior	305	Nomex, Rubber, Vectran, MLI
Compressed Air Tanks	726	Steel
HAB Module Base	3740	Aluminum 2090
HAB Module Floor	1357	Aluminum 2090
MMOD External Wall	1632	Aluminum 2090, Nextel, Kevlar
MMOD External Roof	1392	Aluminum 2090, Nextel, Kevlar
Total	9152	

Conclusions

The habitat designed meets the constraints set out by NASA and will work in a Lunar or Martian environment. The modular structure provides a balance between crew safety and ease of assembly. It also provides a way for the external structure to be repaired without losing pressure in the module. Future plans include testing using finite element analysis on a digital twin to verify the structural integrity of the module. Manufacturing a 3-D printed scale model for a physical representation will follow.

Next Steps

- Continue creating detailed CAD model
- Complete detailed FEA analysis
- Assess weight reduction possibilities
- Packaging and assembly optimization
- Assess manufacturing and ISRU options
- Prototyping

Acknowledgements

We would like to thank the following for their support on the project:
NASA Mentor: Mr. Robert Nuckols
TXST Faculty: Dr. Karim Muci-Kuchler, Dr. Austin Talley, Dr. Leah Ginsberg
NASA and the Texas Space Grant Consortium