TEXAS SPACE GRANT CONSORTIUM DESIGN CHALLENGE

TOPIC # - TDC - 106

LUNAR & MARS SURFACE HABITAT MODULE MANUFACTURING

PROBLEM/DESCRIPTION

Develop an innovative, manufacturable surface habitat or systems module for long-duration missions on the Moon or Mars. This includes structural, thermal, and operational designs optimized for in-situ manufacturing, Earth-to-orbit transport, or hybrid assembly using terrestrial and planetary resources. Competitors will address the technical, logistical, and operational challenges of manufacturing space modules for extraterrestrial deployment.

Competition Goals:

Modular Habitat Design

Develop a robust, scalable surface module that supports human habitation, science labs, life support systems, or energy systems. Must be adaptable for lunar and Martian conditions.

Manufacturability & Assembly

Design with manufacturability in mind: consider on-Earth prefabrication, in-space modular construction, or in-situ resource utilization (ISRU) techniques for 3D printing or regolith-based fabrication.

Mass & Packaging Efficiency

Optimize design for launch constraints—volume and mass reduction through foldable, inflatable, or interlocking module strategies.

Environmental Suitability

Ensure thermal, structural, and radiation protection for surface operations under extreme lunar (±250°C) and Martian (dust, cold, low pressure) conditions.

Modularity & Interface Standards

Enable standardized interconnection across power, data, airlocks, and mechanical linkages—compatible with other Artemis or Mars Design Reference Mission systems.

ISRU (Optional)

Incorporate local regolith or 3D printed composites for radiation shielding, reinforcement, or structure (e.g., regolith-based concrete, sintered walls).

Competition Structure & Requirements:

Phase 1: Concept Design

- Define your module’s purpose, layout, and core systems (structure, thermal, radiation protection).
- Submit architectural schematics and manufacturing philosophy.
- Identify materials and build sequence—what's prefabricated, printed, assembled?

Phase 2: Engineering Analysis & Validation

- Conduct mechanical, thermal, and structural analyses (FEA or equivalent).
- Analyze radiation protection strategies (shield thickness, regolith cover, material selection).
- Assess thermal control during day/night cycles or dust storms.

Phase 3: Deployment & Assembly Plan

- Define launch configuration and deployment on the Moon or Mars.
- Include robotics or EVA-based construction plans.
- Describe interface protocols (mechanical, power, data).
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Phase 4: Prototyping & Demonstration (Advanced/Optional)

- Develop physical scale models or virtual digital twins (CAD/VR).
- Demonstrate assembly process or robotic integration via animation or physical test.
- Test small-scale prints or structural components using regolith simulants.

Key Constraints & Considerations:

- Mass Limit: ≤ 10 metric tons for launch configuration
- Surface Size per Module: ~50–80 m² usable floor area
- Thermal Range: Survive -130°C to +120°C (lunar), -90°C to +20°C (Mars)
- Radiation Protection: At least 10 g/cm² equivalent shielding
- Assembly Time: < 30 days with crew and/or robotic systems
- Power Interface: 5–20 kWe capability, battery or fission-ready
- Airlocks/Birthing Ports: Should include standardized or novel airlock designs

CATEGORY	CRITERIA
Innovation & Technical Merit	Novelty, architectural creativity, modularity
Manufacturing Feasibility	Compatibility with current or near-future 3D printing/ISRU systems
Structural & Thermal Performance	Load-bearing, sealing, insulation, and survivability in surface conditions
Mass & Transport Optimization	Packaging, launch, and deployment strategies
Crew Safety & Habitability	Ergonomics, shielding, redundancy, life-support adaptability
Modular Growth Potential	Ease of scaling and interface compatibility with other surface systems
Sustainability	Minimal Earth-supplied materials, long-term durability, recyclability
System Integration	Interfaces with Artemis, Mars DRA, power/data networks, and mobility platforms

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DESIGN TEAM PROFILE

NASA MENTOR:	Robert Nuckols (robert.s.nuckols@nasa.gov)
LEVEL:	Undergraduate students of any level
MAJOR/DISCIPLINE:	Open to all majors
TEAMS:	All teams eligible
DURATION:	One Semester (Second semester optional)