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Systems and Infrastructures to Implement Sustainable Space Development and Settlement - Systems (2A)

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SUSTAINABLE LUNAR SETTLEMENT DESIGN CHARRETTE: HOW SYSTEM ENGINEERING REQUIREMENTS DRIVE SUSTAINABLE LUNAR HABITAT DESIGN

Abstract

The Off-world Anthropologic Space Infrastructure Settlement (OASIS) project systems engineering entails addressing the flow down of all mission/system-level requirements into every element and distributed system, orchestrating the overall design, and evaluating the efficacy of derived requirements implementation by testing, verification, and validation.

Key Considerations include:

- Orchestrating Symbiosis: shared control between Humans, Robots, and Advanced Autonoma
- In Situ Resource Utilization is learned science, engineering, and art
- Integrated Interoperable Sustainable Systems that translate archology from principle to practice
- Human Landing Systems (HLS) volume and performance metrology

The OASIS systems engineering considerations start with the launch and functional mass of everything that must be transported to the Moon. The payload volumetrics of the NASA HLS further constrain the maximum stowed volume. This resolves to a logistics train with handling requirements and allocatable mass and volume fractions for each manifested flight. The geopolitical considerations mandate that OASIS implement the letter and spirit of the Artemis Accords and maintain compliance with the 1967 Outer Space Treaty.

OASIS shall be scalable by expansion and replication to accommodate, at a minimum, a genetically viable human population (50+ people to combat inbreeding), implement a reasonable division of labor (50+ people to provide all the required skill sets), implement at least two-fault tolerant cross-training (3+ people for any skill set), and the capability to accommodate up to 500 people (to mitigate genetic drift). Until shelter-in-place is assured, at least one Starship per 100 people must be on the lunar surface at a given time.

All elements and distributed systems shall be designed for human, robotic, and advanced autonoma operations, Extra-Vehicular Activity maintenance at the Orbital Replaceable Unit (ORU) level, as well as Intra-Vehicular Activity maintenance at the board/component levels where tractable. Failure modes and effects analysis and supporting discipline analytics shall ensure satisfactory and sufficient margins that allow structural systems to be dynamically stable (self-damping) and maintain integrity (self-supporting). All systems and elements shall be maintainable indefinitely, meet or exceed reliability/availability requirements, be interoperable for all mission-critical functions, implement common board/component sparing, and be designed for scalability. Defined elements include Air/Water Locks, robotics, advanced autonoma, local transport, safe haven, elevators, cranes, storage, landing pads, shielding, and a combination of fixed, unfurlable, and inflatable structures. Distributed Systems include Power, Data, Comm, Thermal, Environmental Control and Life Support Systems, Crew Health, Agricultural, Structures Mechanisms, Ancillary Services, Illumination, and Management Operations Control Architecture applications.