National Aeronautics and Space Administration

Johnson Space Center (JSC) / White Sands Test Facility (WSTF)

Common Habitat for Long Duration Transit and Surface Operations

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Technology Area (TA): TA6.1 Environmental Control and Life Support Systems and Habitation Systems; TA6.3 Human Health and Performance; TA7.2 Sustainability and Supportability; TA7.4 Habitat Systems

TRL: start 2 / current 3

ICA PROJECT OVERVIEW

This concept is based on the Skylab II concept, which proposes using a SLS propellant tank as the primary structure of a habitat. Common Habitat takes this a step further, proposing an interior architecture that is equally viable as a lunar surface hab, transit hab, and Mars surface hab, thus enabling a single development to support all three long duration habitat roles. Common Habitat has been pursued by the PI and co-investigators at MSFC and other centers in a spare time / funding available basis, often with heavy student intern support. Student resources have developed preliminary concepts, but these models must be refined to reflect accurate vehicle subsystems, utilities, stowage, workstations, and other crew systems. This investigation applies NASA civil servant and contractor expertise to correct errors in the most recent student concepts in order to prepare them for future human-in-the-loop evaluations to determine the most viable configuration for a Common Habitat.

In prior studies there was never an opportunity to trade both crew size and internal orientation. Prior work has been a series of point designs with inconsistent design constraints, making apples to apples comparisons impossible. The most recent student work produced CAD models of four habitat variants for future use in a trade study, but the student products contain model construction and geometry errors, inaccurate subsystems design and placement, and unrealistic structural elements and outfitting. These must be corrected before the models can be moved into a VR environment for human-in-the-loop testing. Through consultation with SMEs throughout the Agency, the fidelity of these designs will be upgraded to a level of quality sufficient to make a comparative analysis of crew size sensitivity and internal orientation.

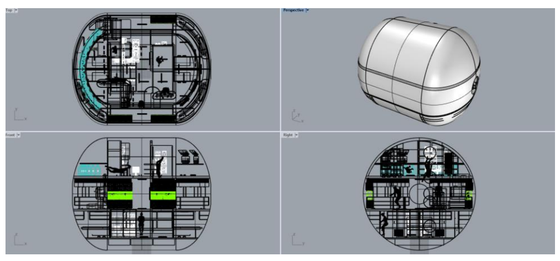
The product of this activity is four upgraded CAD models, each reflecting a different configuration of the Common Habitat. One is a horizontal configuration using the full length of the SLS LOX tank. One is a vertical configuration using the same tank dimensions. The third is a horizontal configuration using a truncated SLS LOX tank (half the barrel length). The fourth is a vertical configuration of the half-length SLS LOX tank.

INNOVATION

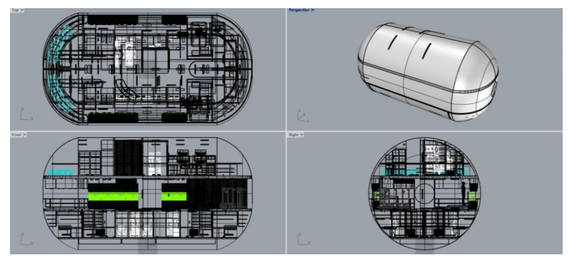
Traditionally, each habitat is a unique design with its own program offices and development efforts, often with timelines in excess of a decade from concept to operational status. A significant return to the Moon and human travel to Mars will require at least three different long duration space habitats: lunar surface, Mars surface, and Mars transit. A common habitat approach combines these into one development effort with three identical units, one for each destination, potentially saving decades of time and tens of billions of dollars. But it is not known if a common design can be made acceptable from a subsystems or human performance perspective. This investigation will make progress towards collecting objective test data to determine the viability of a common hab approach. If successful, it may enable the human lunar return to go beyond brief surface stays and may accelerate the availability of deep space habitats for Mars.

OUTCOME

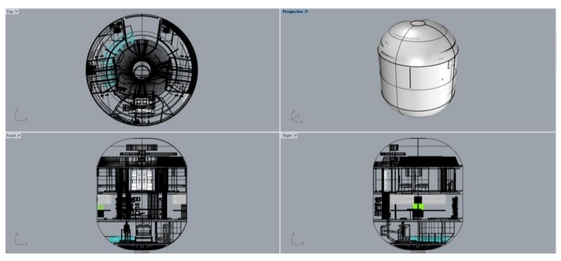
- Corrected CAD models of four variants of the Common Habitat: conversion of Meshes to NURBS, correction of overlapping geometries, correction of inaccurate dimensions, and use of Rhino's block instancing.
- Virtual Reality Questionnaire development
- Functional Analysis Matrices development
- This technology holds the potential to significantly reduce the costs to develop long duration habitats for the Moon and Mars.



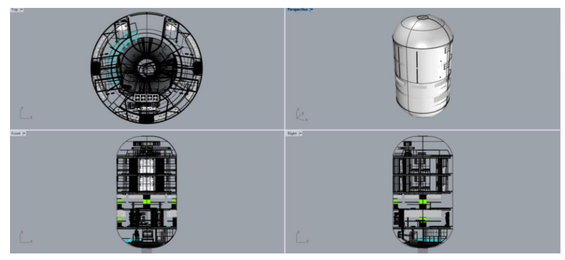
Horizontal Habitat, 4 Crew



Horizontal Habitat, 8 Crew



Vertical Habitat, 4 Crew



Vertical Habitat, 8 Crew

PARTNERSHIPS / COLLABORATIONS

Sasakawa International Center for Space Architecture

Jet Propulsion Laboratory, California Institute of Technology

Participating NASA Centers include Johnson Space Center, Marshall Space Flight Center, Goddard Space Flight Center, Ames Research Center, and Langley Research Center

FUTURE WORK

Forward work includes eight analyses to compare the four Common Habitats to determine which variant provides the best value for human space exploration: Crew Time Assessment, Logistics Analysis, Function Capabilities Analysis, Science Productivity Analysis, Maintenance Capacity Analysis, Contingency Responsiveness Analysis, Radiation Exposure Analysis, and Virtual Reality Questionnaire. Following the down-select of a single Common Habitat, additional forward work includes design modifications based on the aforementioned analyses and additional subsystems and crew systems design maturity. The resulting habitat will then be compared with recent design concepts for Mars transit habitats, lunar surface outposts, and Mars surface outposts.