Exercise Equipment Usability Assessment for a Deep Space Concept Vehicle

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With international aspirations to send astronauts to deep space, the world is now faced with the complex problem of keeping astronauts healthy in unexplored hostile environments for durations of time never before attempted by humans. The great physical demands imparted by space exploration compound the problem of astronaut health, as the astronauts must not only be healthy, but physically fit upon destination arrival in order to perform the scientific tasks required of them. Additionally, future deep space exploration necessitates the development of environments conducive to long-duration habitation that would supplement propulsive vehicles. Space Launch System (SLS) core stage barrel sections present large volumes of robust structure that can be recycled and used for long duration habitation. This assessment will focus on one such conceptual craft, referred to as the SLS Derived Habitat (SLS-DH).

Marshall Space Flight Center's (MSFC) Advanced Concepts Office (ACO) has formulated a high-level layout of this SLS-DH with parameters such as floor number and orientation, floor designations, grid dimensions, wall placement, etc. Yet to be determined, however, is the layout of the exercise area. Currently the SLS-DH features three floors laid out longitudinally, leaving 2m of height between the floor and ceilings. This short distance between levels introduces challenges for proper placement of exercise equipment such as treadmills and stationary bicycles, as the dynamic envelope for the 95th percentile male astronauts is greater than 2m. This study aims to assess the optimal equipment layout and sizing for the exercise area of this habitat.

Figure 1 illustrates the layout of the DSH concept demonstrator located at MSFC. The exercise area is located on the lower level, seen here as the front half of the level occupied by a crew member. This small volume does not allow for numerous or bulky exercise machines, so the conceptual equipment has been limited to a treadmill and stationary bicycle. With the most current treadmill aboard the International Space Station (ISS), the Combined Operational Load-Bearing External Resistance Treadmill (COLBERT), being located in

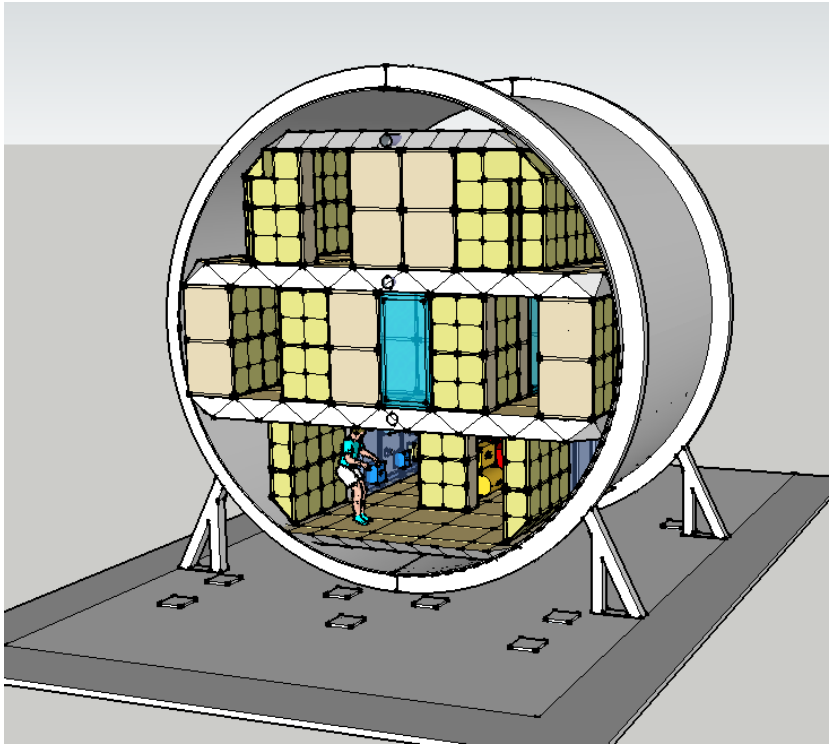

Figure 1

an International Standard Payload Rack (ISPR), the bottom of the conceptual treadmill features a height of 38in. Making the treadmill flush with the floor would be impossible in this rack configuration, as the distance from the outer wall of the spacecraft to the bottom floor would be too shallow. From preliminary sizing, the 38in required for the bottom of the treadmill combined with a 78in operational envelope for a 95th percentile may not be accommodated in the exercise area in a vertical orientation. Figure 2 demonstrates the volume required (in maroon) for an ISPR-bound treadmill in the concept demonstrator. Early indications as seen in this figure indicate that the crew members would contact the ceiling in such an arrangement.

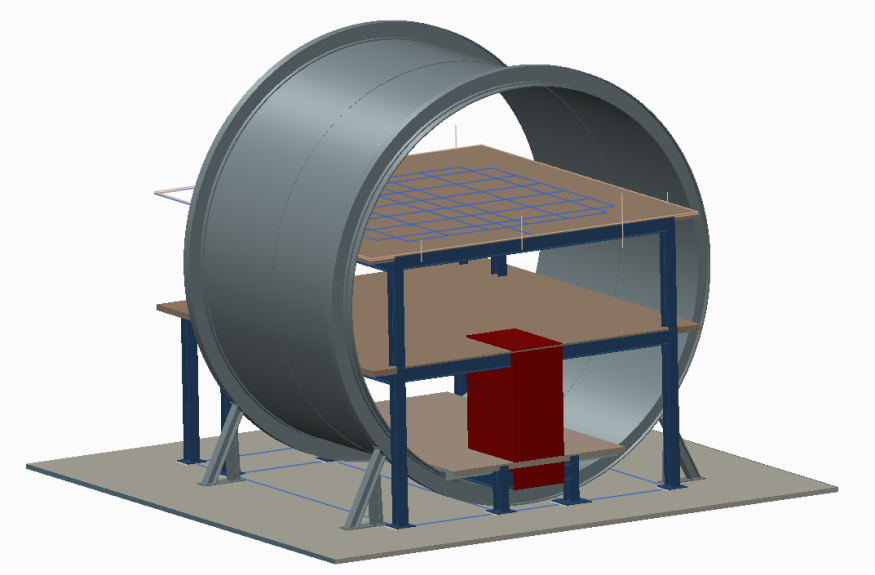

Figure 2

An assessment will be conducted to evaluate various orientations of exercise equipment in the concept demonstrator. Orientations to be tested include putting the bottom of the treadmill on the wall, having the treadmill at an angle in the floor both horizontally and vertically, and having a shorter (non-rack bound) treadmill in a vertical orientation on the floor. This assessment will yield findings regarding sizing of the area and how well participants feel they could exercise in such an environment. Due to the restrictions of assessing a microgravity vehicle in a normal-gravity environment, simulations in MSFC's Virtual Environments Lab (VEL) may be necessary. Final deliverables will include recommendations regarding the location and size of possible exercise equipment aboard the SLS-Derived DSH.