ASSESSMENT OF EXPLORATION EXERCISE CONCEPTS AND OPERATIONS METHODOLOGY IN A BAA HABITAT TEST ENVIRONMENT

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Introduction

- NASA is developing habitation systems for the lunar Gateway mission program
- NextSTEP Broad Agency Announcement (BAA) Habitat Assessment Program is in place to ensure that NASA incorporates concepts from industry to meet the requirements of these future habitat designs
- Integrated Power, Avionics, and Software (iPAS) facility is a test environment designed to integrate mature technologies into capabilities within a hardware/software and operations environment representative of the lunar Gateway space habitat
- Exercise systems will be a critical part of this habitat and need to be assessed for operational feasibility from a hardware and software perspective
- iPAS facility allows for feasibility and acceptability of the exercise system from a scheduling, operational volume, and multi-system collaboration perspective to ensure a fully integrated vehicle design (Figures 1 and 2)

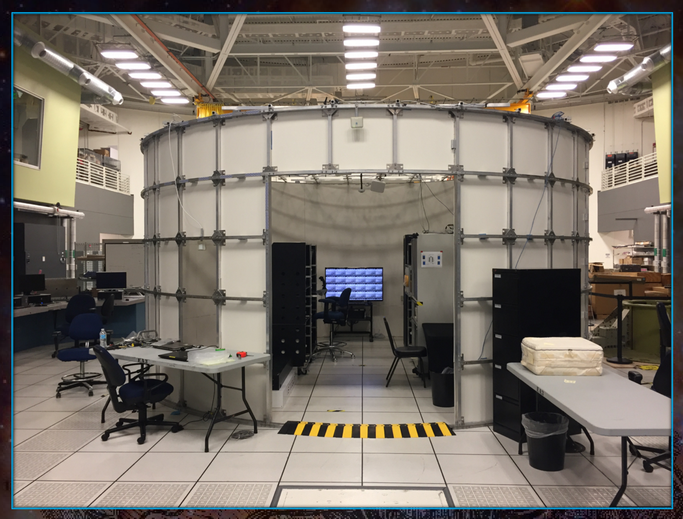

Figure 1: Initial Habitat Test Platform

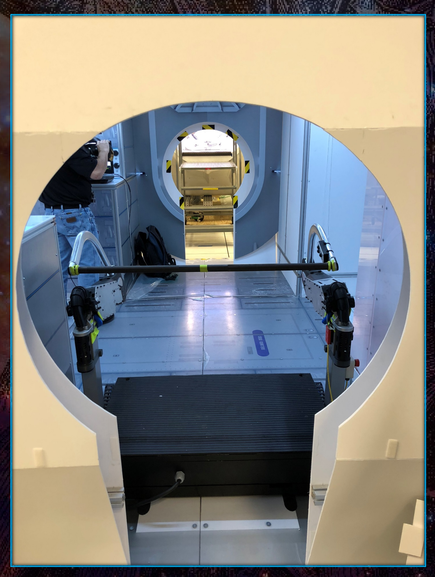

Figure 2: Hopper Exercise Equipment integrated into Habitat Mockup

Objectives

- Primary: To assess the feasibility of a crewmember performing exercise in a habitat environment to identify potential interference with other habitat activities
- Secondary: To test the exercise user interface (OnePortal software) for both user feedback and connectivity through the Medical Data Architecture system being developed for space exploration (Figure 3)

Figure 3: Software Interface to Exercise Equipment

Methods

- Sixteen subjects participated in pre-simulation exercise hardware/software familiarization and in-flight exercise sessions in a habitat mockup
- During the in-flight exercise sessions other activities, such as experiments and logistics, were simultaneously performed during exercise sessions simulating a mission scenario
- To date, two different devices have been used during 3-day habitat mock-up simulations (Figures 4 and 5) for resistive exercise:
  1. Hybrid Ultimate Lifting Kit, “HULK”, (NASA Glenn Research Center, Cleveland, OH)
  2. Hopper (IHMC, Pensacola, FL)
- Subjects completed space-flight applicable exercises
- Subjects completed a questionnaire regarding exercise feasibility and acceptability
- Exercise sessions were monitored from a simulated Mission Control environment with subject matter experts (Figure 5)

Figure 4: HULK Ground Testing

Figure 5: Hopper used during Simulation in Habitat Mockup

Figure 6: Collaboration with Flight Control Team

Figure 7: View of Habitat Activities from Simulation Mission Control Displays

Conclusions

- All crewmembers successfully completed exercise within the timeline without interference of other mission tasks (Figures 6 and 7)
- Recommendations for location of user tablet interface and supporting equipment were provided
- OnePortal user interface was used during exercise with the Hopper equipment and software updates were generated
- End-to-end testing of the OnePortal software identified improvements necessary for smoother user workflow
- Successful data flow, from the tablet to the habitat networks and ultimate retrieval by ground systems, was demonstrated
- Preliminary habitat assessments provide critical information for commercial habitation development regarding integration of multiple hardware and software systems with the expectation of simultaneous use of exercise equipment during mission timelines