Project Introduction

The purpose of this study is to assess habitability on the International Space Station (ISS) in order to better prepare for long-duration spaceflight missions of the future. The project deliverables will include information to help prioritize and reduce research gaps, operational inputs to the Human Performance Data Repository, and data for modeling and simulation tool development and validation to use for future designs. The knowledge gained through this project will provide valuable insight into a day-in-the-life of an astronaut as well as providing initial steps to characterize/quantify how we work and live in a microgravity environment during a year-long mission. Thus, it will help address specific research needs identified as part of the Human Research Program’s (HRP’s) 2012 Habitable Volume Workshop and Standing Review Panel comments, and result in recommendations for future vehicle design layout and minimum net habitable volume (NHV). In addition, another potential outcome of the project will be enhancing the current ISS human factors crew debrief processes, resulting in higher quality data with minimal impact on crew time.

This study is led by the Space Human Factors Engineering (SHFE) portfolio under the Space Human Factors and Habitability (SHFH) Element, in collaboration with the Behavioral Health and Performance (BHP) Element.

Specific Aims:

Specific Aim 1: Characterize the current state of ISS habitability using tools to capture data near real-time.

  o Aim 1a: Document/quantify details about crew task performance in a long-duration microgravity environment, including influences from the habitable environment and relationship impacts to the behavioral state of crewmembers.

  o Aim 1b: Determine whether mission duration leads to changes in habitability/human factors reporting by crewmembers.

  o Aim 1c: Assess the cost versus benefit of implementing near real-time tools compared to traditional post-mission debriefs.

Specific Aim 2: Document/characterize details about how crewmembers currently utilize the space on ISS.

  o Aim 2a: Quantify time spent by crewmembers at workstations/habitation areas.

  o Aim 2b: Collect naturalistic data to document movement of crewmembers throughout ISS (e.g., frequency of translations between locations).

  o Aim 2c: Collect evidence to use toward validating estimates of required volume for performance of volume-driving tasks.

  o Aim 2d: Capture changes in strategies for crew tasks such as translation,
stowage handling, etc. throughout the course of the mission.

This ongoing study is continuing to collect data. Results given are based on data collected from the beginning of the spaceflight study in March 2015 through July 24, 2015. One subject has begun data collection as part of the year-long mission, and additional subjects will enroll in late 2015. It should be noted that due to data privacy concerns associated with presenting results for a single subject, results and discussion are kept at a high level in this preliminary report.

The total number of completed sessions for the first enrolled subject includes 5 observations, with 20 remaining; 2 narrated task videos, with 4 remaining; 2 walk-through videos, with 4 remaining; 1 questionnaire, with 2 remaining; and 1 PI conference, with 2 remaining.

Based on the data collected to date, the subject has provided thoroughly detailed and insightful feedback for all data collection types. The subject seems to have a good understanding of the types of details that will be of interest to habitability and human factors experts, and has provided a wealth of information that will be relevant for the design of future space vehicles and habitats. The investigative team anticipates that if data quality continues to be this high, this study will be highly instrumental in characterizing habitability aboard ISS and feeding into future standards and requirements. The opportunity to capture feedback about details such as privacy levels, task volumes, vehicle habitability systems, etc. throughout the course of a mission is unique and is expected to be of great value to the Space Human Factors and Habitability team.

Based on feedback from the ISS Flight Crew Integration team member who serves as a co-investigator for this study, the data gathered to date compares highly favorably to the type of information traditionally gathered in post-mission debriefs. Providing an opportunity for the subject to capture observations while on-orbit allows him/her to give demonstrations and discuss details that are fresh on their mind. Members of the ISS operations community rely on post-mission debriefs for details such as hardware interface issues and reasoning for space utilization preferences, so capturing this information on-orbit could potentially increase awareness of operational issues, enabling the operations community to optimize crew performance, and save crew time by reducing post-mission debriefs.

The most recent observation included feedback from the subject that the request to find any human factors or habitability issues to document for an iSHORT observation is too open-ended after the major issues are exhausted. In order to avoid scheduling observations for subjects who do not have anything to report, the team has worked with ISS Medical Project (ISSMP) to
provide prompts to subjects for each observation moving forward. Prompts may include reminders of recent timeline events that would be expected to impact habitability and human factors as well as specific topics that are of interest, still allowing the subject to provide open-ended responses for any topic of their choosing.

As this work proceeds, data collection will complete for the first subject and begin for an additional 5 subjects. The study team has begun work on an interface to allow for easier analysis of data, including the ability to view photos and videos, paste transcripts of videos, and insert key words related to analysis within a simple interface. As more data is collected it will be compiled into a database, and future reports will include de-identified summaries of topics. This will allow for progress toward the completion of Aim 1, related to assessing details of crew task performance collected throughout the course of a mission.

Aim 2, which pertains to details of space utilization, will be addressed as much as possible based on spaceflight data collection; however, it should be noted that the original proposal hoped to take advantage of technology existing on ISS to capture details such as crew location. No such technology is currently available. Aim 2 may be addressed in the future using tools currently under development outside of this project, including a Small Business Innovative Research (SBIR) grant aimed at automating the process of capturing space utilization metrics from video footage and two NASA Research Announcement (NRA) grants related to crew-worn devices and 3-dimensional camera use for tracking space utilization metrics.

**Anticipated Benefits**

The project deliverables will include information to help prioritize and reduce research gaps, operational inputs to the Human Performance Data Repository, and data for modeling and simulation tool development and validation to use for future designs. The knowledge gained through this project will provide valuable insight into a day-in-the-life of an astronaut as well as providing initial steps to characterize/quantify how we work and live in a microgravity environment during a year-long mission.
Primary U.S. Work Locations and Key Partners

<table>
<thead>
<tr>
<th>Organizations Performing Work</th>
<th>Role</th>
<th>Type</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>🌟Johnson Space Center(JSC)</td>
<td>Lead Organization</td>
<td>NASA Center</td>
<td>Houston, TX</td>
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Project Website:

https://humanresearchroadmap.nasa.gov/