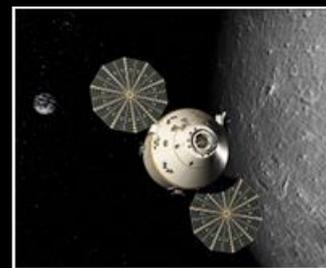




ISS Habitability Data Collection and Preliminary Findings

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Human Factors and Behavioral Performance (HFBP)
Element





Background

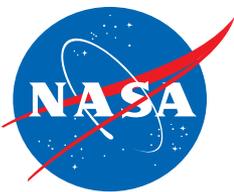


Human Research Program

- Habitability is the relationship between an individual and their surroundings (i.e. the interplay of the person, machines, environment, and mission)
- The purpose of this study is to assess habitability and human factors on the ISS to better prepare for future long-duration space flights
- Scheduled data collection sessions primarily require the use of iSHORT (iPad app) to capture near real-time habitability feedback and analyze vehicle layout and space utilization



Risk of Incompatible Vehicle/Habitat Design



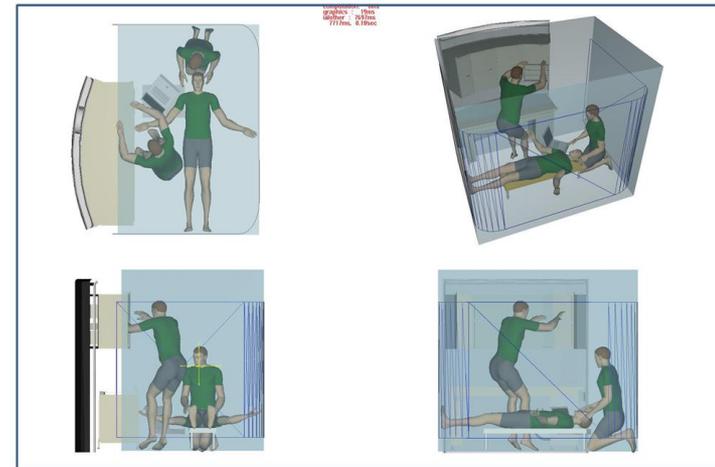
Research Objectives

Human Research Program

- To characterize the current state of ISS habitability
- To document/characterize details about how crewmembers currently utilize the space on ISS

Make recommendations for future vehicle/habitat designs

- Specific focus areas include:
 - Private personal areas
 - e.g., sleep stations, hygiene, toilet ops
 - Group activities
 - EVA prep & post activities including suit don & doff
 - Crew health and medical procedures
 - Stowage
 - Food preparation and meals



Of particular interest is data contributing to an improved understanding of minimum acceptable habitable volume needs for exploration vehicles.



Methods



Human Research Program

- Study is currently taking place aboard ISS
- Total of 6 subjects with durations ranging from standard ISS mission length to 1-year
- Data collection began March 2015
 - Completed data collection for 5 participants
 - Data collection planned to complete in 2017
- Participants collect the majority of the data on an iPad using custom-developed apps
 - Space Habitability Observation Reporting Tool (iSHORT)
 - Question and Answer (iQ&A)





iSHORT



Human Research Program

iPad 09:16 100%

iSHORT: New Observation [Previous Observations](#)

From: **Test User PIN** Not you? [Log Out](#)

Date: **17 Nov 2016** [Change Date](#)

Observation: This is an iSHORT observation.

Priority: **Must be addressed** Nice to have No change needed

Tags: Cameras, Spacesuits, Racks

Recipient: **Habitability Study** [Change Recipient](#)

[Submit](#)

Media

[Audio](#) [Photo](#) [Video](#)

Audio 2 - 8.20s [Play](#) [Close](#)

Photo 1 [Close](#)

Video 1 [Close](#)



iQ&A



Human Research Program

iPad 10:16 95%

< Back **iQ&A: Example Survey 1**

* Text field example - Please enter your name: (*required)

Radio button example - Choose one:

- Answer 1
- Answer 2

Checkbox question - Choose one or more:

- Answer 1
- Answer 2
- Answer 3

Media question example - enter audio, video, and photos

Audio Photo Video

Audio 1 Audio 2 Photo 1 Video 1



Data Collection

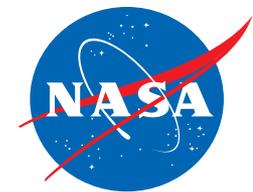


Human Research Program

- Habitability and Human Factors Observations
 - Timelined once every two weeks
 - Can be text, audio, video, photo, or a combination of media types
 - Document observations with iSHORT from the previous 1-2 weeks related to human factors and habitability
 - Topics at crew discretion, with optional prompts provided by study team
- Habitability Narrated Task Videos
 - Timelined once per month
 - Document observations with iSHORT during a task (e.g., food preparation) and provide insights related to human factors and habitability
 - Topics provided in execute notes in crew schedule



Data Collection (continued)



Human Research Program

- Walk-through videos
 - Timelined once per month
 - Document observations of an area (e.g., crew quarters) and provide insights related to human factors and habitability
 - Topics provided in execute notes in crew schedule
- Questionnaires
 - Timelined 3 times per mission (early, middle, late)
 - Complete questionnaires in iQ&A addressing behavioral health, habitability, and human factors topics
- PI Conference
 - Timelined 3 times per mission, following questionnaire
 - PI Team communicates via voice (1-way video from crew) to ask follow-up questions based on inputs to date



Results



- Data analysis is still in early stages, so high level results are provided
- Data collection to-date:

Data Type	Total
Human Factors and Habitability Observation	85
Narrated Task Videos	31
Walk-Through Videos	29
Questionnaires	16
PI Conferences	16

**As of Jan. 13, 2017*



Preliminary Findings



Human Research Program

- Data collected to date is of high value to:
 - Human factors and behavioral performance community
 - ISS operations community
- The following slides provide details regarding preliminary high level recommendations derived from the Habitability study
 - Following analysis, more comprehensive findings will be compiled
- Preliminary high level recommendations are provided here as examples:
 - Provision of designated hygiene task areas
 - Importance of optimized labeling
 - Behavioral health and performance impacts of windows on ISS

Preliminary findings are derived from ISS Habitability participants and do NOT represent an Astronaut Office official position



Preliminary Findings: Hygiene Task Areas



Human Research Program

Hygiene areas should be separate from toilet operations for future vehicles, and as much as possible onboard ISS.

- The ISS US Operating Segment (USOS) crew conducts toilet operations in the Waste & Hygiene Compartment (WHC) located in Node 3.
 - WHC provides volume to accommodate hygiene tasks
 - Many ISS crewmembers have indicated conducting hygiene tasks in the WHC is not ideal.
- Recent crew onboard have carved out areas for themselves to keep hygiene supplies and gym clothes.
 - According to post-flight debriefs, locations vary per crewmember and crew often used local restraints and hung a mirror to shave or brush their teeth. Some brush their teeth in their crew quarters.



Preliminary Findings: Hygiene Task Areas

Human Research Program

- ISS Habitability participants emphasized the following:
 - Use of the WHC for hygiene activities like brushing your teeth and washing your body and hair is in close quarters with the toilet.
 - Hygiene in the WHC is not ideal because it limits use of the waste facilities for the other 3 crewmembers while someone is conducting hygiene inside the WHC.
- Comments collected during ISS Habitability include:
 - *“It is very critical for future vehicles to ensure that there is a place to do hygiene, but that place to do hygiene is not the toilet, and that there's some place — each crewmember has their own individual station.”*
 - *“...the issue with using this [WHC] for hygiene like brushing your teeth and washing, it's very close quarters to your toilet. It would kind of be like doing that type of activity in a port-a-john like one of those blue toilets, not very nice.”*
 - *“...over the years [we] have used makeshift places and that has caused consequent issues with the growing of mold or fungal growth because of moisture. So in future designs, of course, we want to have a place that's specifically designed for hygiene...”*



Preliminary Findings: Hygiene Task Area

Human Research Program



A screenshot from a video about hygiene activities showing an improvised area in the Permanent Multi-purpose Module (PMM), which is designed for stowage.

Preliminary findings are based on individual ISS Habitability participant's opinions and do NOT represent the feelings of an entire crew and are NOT Astronaut Office official position



Preliminary Findings: Optimized Labeling



Human Research Program

Labels need to be clear, visible, and accessible from multiple viewing angles.

- Labeling is subject to standards and requirements aboard ISS, which helps drive good labeling practices.
 - Variations in implementation may occur based on the specific hardware or payload
 - Unique items or process may also drive the need for different labeling practices
- Issues with labeling may lead to frustration, increased crew time, and errors
 - Crewmembers are reliant on clear, visible, and accessible labels to optimize their task performance

Preliminary findings are based on individual ISS Habitability participant's opinions and do NOT represent the feelings of an entire crew and are NOT Astronaut Office official position.



Preliminary Findings: Optimized Labeling

Human Research Program

- ISS Habitability participants emphasized the following:
 - Interactions between the location of the label on the item and the way that the item are packed can lead to difficulties
 - It is important for a label to display the most critical information for the crew in a prominent way
 - The addition of English labels on Russian hardware would be beneficial.
- Comments collected during ISS Habitability include:
 - *“...there's about 130 drinks in each container. I just sorted them all today and it took twice as long as it should have [...] because almost every single drink packet is folded in such a way that you cannot see what the drink is and you have to unfold every packet and [...] only then can you read the label inside that tells you what the drink is.”*
 - *“... there's a bit of a human factors problem here in that the serial numbers are the things that are printed really big on all sides of the packages whereas the date is printed in tiny fonts and it's only on one package [...] So then I have to pull out every single package and I check it for the date.”*
 - *“...So even if we do use Russian hardware, I would suggest from a human factors perspective that we put giant U.S. labels on it and we make it a lot easier to understand. We've done that on some of the hoses on here, but not all of them.”*



Preliminary Findings: Optimized Labeling

Human Research Program

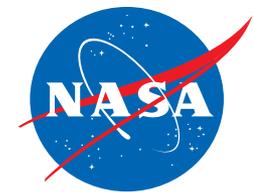


A screenshot from a video about drink stowage and labeling, given by the participant as an example of a system devised to organize and label items.

Preliminary findings are based on individual ISS Habitability participant's opinions and do NOT represent the feelings of an entire crew and are NOT Astronaut Office official position



Preliminary Findings: Windows

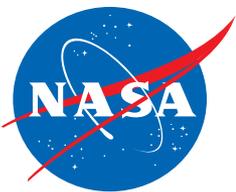


Human Research Program

Windows are an important resource for crewmember recreation as well as specific ops tasks.

- Earth viewing and photography are both timed tasks and recreation for ISS crew
 - Considered to be important for behavioral health
 - The Crew Earth Observation (CEO) payload constitutes a large amount of crew time taking photos of the earth from the windows onboard ISS.
 - For future long-duration missions, if Earth is not viewable from the window the benefits reaped from Earth viewing/photography should be replaced in another manner
- Crews also emphasize the importance of windows being accessible and usable for tasks like EVA and robotics ops and vehicle inspections
- Number, placement, and quality of windows impacts their utility

Preliminary findings are based on individual ISS Habitability participant's opinions and do NOT represent the feelings of an entire crew and are NOT Astronaut Office official position



Preliminary Findings: Windows

Human Research Program

- ISS Habitability participants emphasized the following:
 - Crewmembers value windows for their benefits for recreation and psychological health
 - Scratch panes on windows reduce the quality of viewing and photography
 - Windows have utility for tasks such as CEO, Robotics & EVA Ops, and vehicle inspection
- Comments collected during ISS Habitability include:
 - *“...the main form of recreation is looking out the Cupola. We take pictures. We get interested in CEO targets. We just watch the Earth go by. That's probably I would say our No. 1 form of recreation up here.”*
 - *“I strongly advocate having windows on a vehicle to inspect the rest of your external portion of your vehicle to do observations and for, you know, just the morale of the crew being able to see outside.”*
 - *“It's nice if you've got a long task in here [JEM] just to have the daylight coming into the module. It makes a big difference to the artificial light that we have most of the time, and it has a definite improvement on psychological effect and morale when you're working in here during the daytime with the windows open.”*



Preliminary Findings: Windows



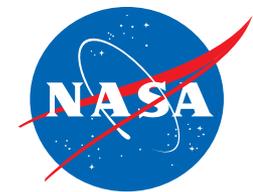
A screenshot from a video showing a scratch pane on an ISS window.

“The irony of having these scratch panes is that the scratch panes are to protect the windows so that they're pristine for photography. But you can't take pristine photography because they're covered with scratches...”

Preliminary findings are based on individual ISS Habitability participant's opinions and do NOT represent the feelings of an entire crew and are NOT Astronaut Office official position



Preliminary Findings

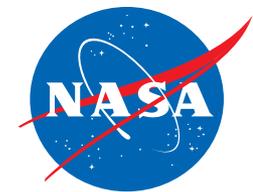


Human Research Program

- ...and many more!
- Other topics discussed include
 - Stowage
 - Lighting
 - Housekeeping activities
 - Work volumes
 - Environmental factors (e.g., CO2 level, temperature, odor)
 - Scheduling
 - Procedures
 - Recreation
 - Team dynamics
 - Exercise
 - Training
 - EVA
 - Cable management
 - Trash management



Forward Work



Human Research Program

- Data collection continues through 2017
- Analysis of data will capture lessons learned that will be integrated into:
 - Current and future research, especially related to task volume needs, and optimizing the environment for behavioral health in future exploration missions
 - Comprehensive study report
 - Updates to Evidence Report
 - Proposed updates to Human Integration Design Handbook (HIDH) and NASA-STD-3001 Volume 2
- Consider means to implement similar data capture as part of standard operations for future programs
 - Quick and easy audio/video/text/photo (currently operational in HERA)
 - PI conferences to close the loop
- Consider working with ISS Program to implement similar data capture as part of operations for ISS



Acknowledgements



Human Research Program

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Questions?