# Human Factors Lessons Learned International Space Station

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AIAA Lunch and Learn

NASA-Johnson Space Center, Houston, Texas

December 17, 2002

# INTRODUCTION

## Operational Habitability Project Tasks:

*(Habitability & Human Factors Office/SF3, NASA-JSC)*

- **ISS missions HF & Hab Information Collection**
  - ***Post-flight debriefs*** ←
  - *In-flight Reporting* ←
  - In-situ assessments
- **HF & Hab Information Resource**
  - Evaluations & White Papers (generated to address "current topics")
  - Expedition Lessons Learned Log & Phase 1 Lesson Learned Database
- **Recommendations & Improvements**
  - Enhancements to ISS; Input to future programs


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# PROCESS

- Conducted a dedicated Habitability & Human Factors Debrief with all 4 ISS crews to date
- Allocated ½ to 1 hour with US crew members only approximately 4 weeks after return
- Included standard as well as mission-specific questions

| | |
|---|---|
| Sleep/rest | Workload & Timeline |
| Dining | Crew Equipment & Hardware |
| Personal Hygiene | Architecture |
| Self & equipment restraint | Environmental Conditions |
| Displays & Controls, HCI | Accessibility |

- Also attended all other debriefs and recorded human factors comments


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# CAVEATS

- It is advisable to communicate with specific subsystem and hardware owners to get details on the systems mentioned herein
- Some comments from crew are being addressed or have been addressed already by the program
- These comments do not necessarily represent issues that have been endorsed by any organization (crew, human factors, etc)
- Results from subjective feedback are always limited by our interpretation of what the crewmember said & meant
- A lack of a comment does not mean there is a lack of a problem


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# SUMMARY

- Scheduling and Time Management
- Procedures
- Warning Information
- Inventory Management Information
- Other Information Needs
- Some Display Usability Issues
- Team Interaction
- Communication
- Some Habitability Stressors

***BUT FIRST…***

***An idea of what it is like to live and work on ISS…***


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**Cosmonaut Sergei Y. Treschev (foreground) and astronaut Peggy A. Whitson, both Expedition Five flight engineers, are photographed in the Zvezda Service Module on the International Space Station (ISS). Treschev represents Rosaviakosmos.**

**Expedition 3 Crewmembers Vladimir Dezhurov and Mikhail Tyurin plan a vehicle maneuver**

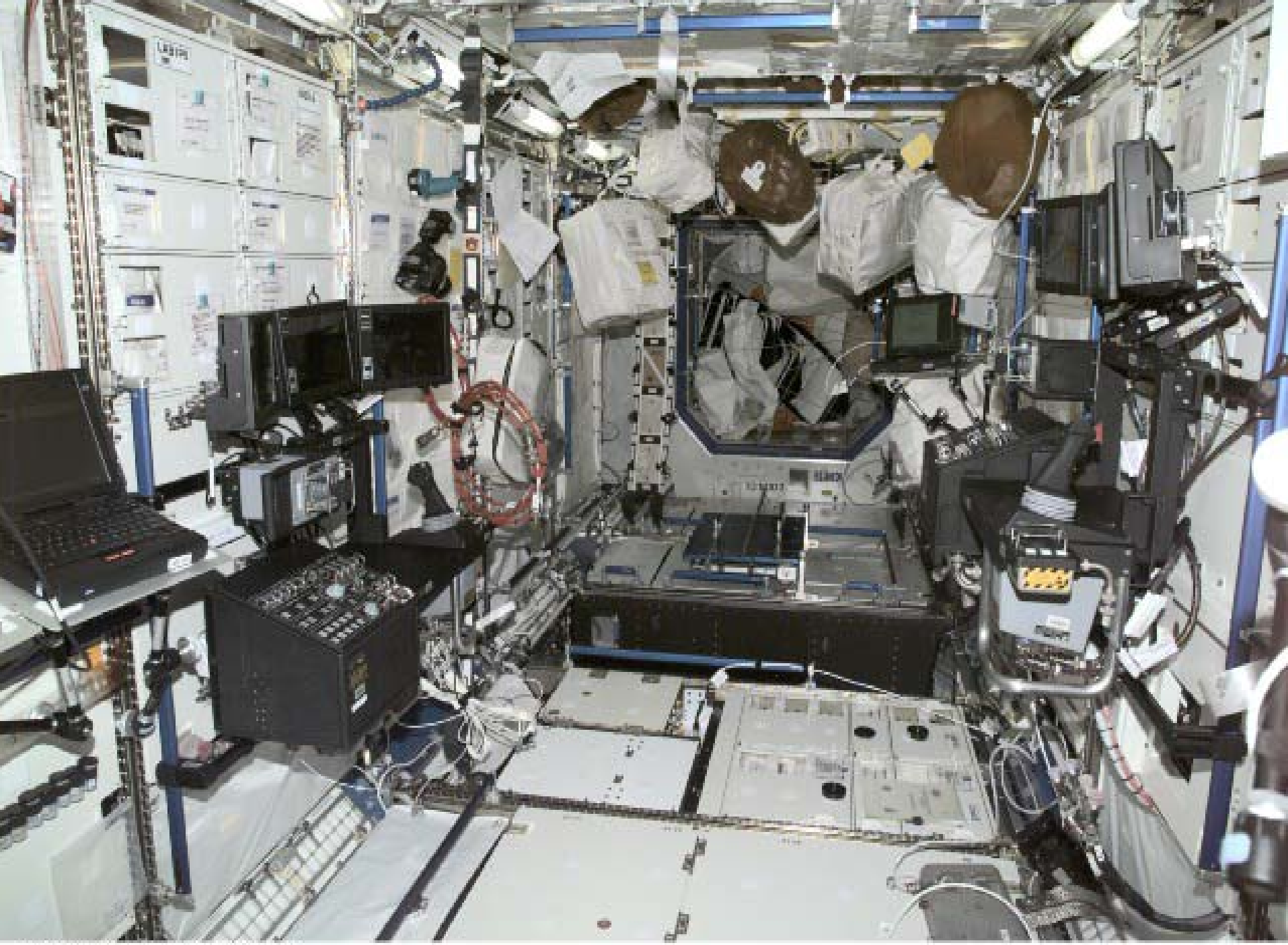
**Expedition 2 Crewmember Yuri Usachev works in his Russian Service Module Crew Quarter**

**Cosmonaut Sergei Y. Treschev, Expedition Five flight engineer representing Rosaviakosmos, checks stowage boxes in the functional cargo block (FGB), or Zarya, on the International Space Station (ISS).**


**Cosmonaut Sergei Y. Treschev, Expedition Five flight engineer, works with various tools in the Unity node on the International Space Station (ISS). Treschev represents Rosaviakosmos.**

**Astronaut Peggy A. Whitson, Expedition Five NASA ISS science officer, floats near an upper portion of an Extravehicular Mobility Unit (EMU) spacesuit stored in the Quest Airlock on the International Space Station (ISS).**

**Astronaut Peggy A. Whitson, Expedition Five flight engineer, moves equipment in the Destiny laboratory on the International Space Station (ISS).**



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**Expedition 3 Commander Frank Culbertson at the Robotic Work Station (RWS) in the US Lab**

**Astronaut Peggy A. Whitson, Expedition Five flight engineer, works near the Microgravity Science Glovebox (MSG) in the Destiny laboratory on the International Space Station (ISS).**

# Scheduling & Time Management

Long duration missions require more flexibility and control

- Planning (task time & workload estimation)
- Prediction of impacts from changes (modeling)
- Real time information sharing regarding schedule

- ✓ Task List allowed crew to get ahead of schedule and the crew picked items on Task List that they liked to do.
- ✓ Task List not appropriate for joint ops with Shuttle.
- ✓ Allowing crew to give feedback on the OSTPV[1] gave crew flexibility to make own changes real time and a sense of control over workload.
- ✓ When items are rescheduled for the next day, ground needs to make sure the impact on the regularly scheduled activities is minimal.

[1] On-orbit Short Term Plan Viewer


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# Procedures

Long duration missions require a different procedure approach

- More graphics and means of communicating information immediately
- Variety of displays accommodate different types of tasks and personal work strategies
- Accommodation of multiple languages and increased time since training

- ✓ "If you want to get someone's attention, you don't give them 3 pages of cautions"
- ✓ Long and complicated; tasks could be completed in less time than it required to read procedures
- ✓ Need more graphics
- ✓ Electronic procedures navigation must be improved
- ✓ Language on Periodical Health Status (PHS) exams was "very medical" and difficult to understand.


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# Warning Information

Caution & Warning system is crew's primary vehicle health status monitor – very complex system for long duration mission

- Information communication & control must be clear and immediate
- Provide all necessary info but do not overload
- Enable sharing of workload between Flight and Ground crew
- Crew time should not be consumed by C&W monitoring

- ✓ Acknowledging C&W messages takes long time when multiple alerts have occurred (possible 20 at a time) – Maybe ground to determine status of C&W message instead of crew
- ✓ Add messages that explain the reason for alarms
- ✓ Enable means to acknowledge multiple alerts at once
- ✓ Enable means to view sorted & grouped subsets of alerts
- ✓ Too many false alarms and alarms that require no crew action


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# Inventory Management Information

Long duration missions need more supplies on-orbit & re-supply

Inventory management is only means for ground to support inventory needs and for crew to locate needed items

- Time to locate items is currently a "time sink" – needs to be minimized
- Database should enable user input of information (very easy to enter data), accurate input (standardized), and comprehension of contents
- Enable sharing of workload between Flight and Ground crew

- ✓ The Inventory Management System is only as good as it's database; crew has to take the time to keep it updated
- ✓ The database has usability issues associated with navigation
- ✓ Missing, ambiguous, or inconsistent identification and/or barcode labels undermine inventory management
- ✓ Barcode reader misreads labels - possibly due to scratched label


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# Other Information Needs

Crews need additional contextual information with ready availability during long duration missions

Increased situational awareness enables an autonomous crew to react more effectively to changes and emergencies

Crew identified several additional pieces of information that could be continually available to the crew

- ✓ Time
- ✓ Earth observation events reminders
- ✓ Docking times
- ✓ PAO events
- ✓ Shuttle launches
- ✓ Time to next comm opportunity and type of comm available


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# Some Display Usability Issues

ISS Crews have reported several display usability & HCI issues

These are not specific to a space environment or mission but they do reflect a need to continue evaluation and improvement

Tools and processes for enabling good user-centered design are needed

- ✓ CDs don't have scene selection capability; crew has to fast forward to find stopping point when a failure occurs mid-CD
- ✓ Crew experienced PC card failures when data collection cards filled up and data was overwritten – PC cards should display status of capacity
- ✓ Displays in general hard to navigate – too many screens and levels
- ✓ Displays designed to look like windows applications but don't always behave like windows


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# Team Interaction

Team interaction issues are not directly identified in debrief comments

Such issues are especially relevant to long duration missions with "host" and "visiting" crews

Additional issues are associated with interaction with the ground

- ✓ Ground does not seem to have a good understanding of what it requires to complete a task (e.g., inventory staging)
- ✓ Crew interrupted by ground several times while operating arm. Solution was to structure timeline so crew doesn't divide time between other tasks during arm ops
- ✓ Soyuz visitors activities should be synchronized with ISS like Shuttle
- ✓ Visiting crews can cause more "friction"
- ✓ Visiting crews are like "your whole family showing up in a Winnebago and asking if they can come over for dinner"


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# Communication

Communication between crews and with ground is vital to the mission.

Issues such as interface and hardware design and noise impact quality of communication and operational efficiency

- ✓ Hard to communicate in flight with hearing protection
- ✓ Need wireless communication systems
- ✓ Intercomm systems (Audio terminal Units) are complex, features aren't used, or features are inadvertently used


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# Some Habitability Stressors

Habitability stressors can effect crew fatigue, moral, and interaction.

The following issues current characterize ISS habitability

- ✓ In adequate volume for and means of stowage
- ✓ No dedicated and private hygiene facility
- ✓ High levels of constant and intermediate noise
- ✓ Crowded conditions, especially in the living quarters
- ✓ Low area lighting and poor portable lighting
- ✓ No privacy door for crew quarters in the Russian module
- ✓ Limited accessibility to hardware for maintenance


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# CONCLUSION

This has been an overview of only a subset of the feedback

Crews have also reported practices and characteristics that have worked well (e.g., On Board Training, Payload Displays)

Although the feedback suggests that ISS is demanding a lot from the crew, it is providing an excellent opportunity to identify optimal vehicle and mission designs for long duration human space missions

**Please feel free to contact me with any questions.**

**THANK YOU!**


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