National Aeronautics and Space Administration

Technology Needs in Human Factors and Human Systems Integration

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Human Factors and Human Systems Integration (HSI)

- Human Systems Integration (HSI) is a robust process by which to design and develop systems that effectively and affordably integrate human capabilities and limitations.
- Human factors is a major component of HSI, dealing with the specific hardware and software portions of the system as well as the detailed ways in which the interaction between the human and the system occurs.
- This study of the interaction of humans and systems therefore includes an inherent focus on multiple technologies, from the perspective of designing systems as well as in the assessment of their capabilities, functionality, and usability.
- This presentation will share some of the key technologies NASA is interested in from an HSI and human factors point of view, and how they may help to address both research and system design needs.

Key System Design and Research Activities

- System Design
  - Orion Multi-Purpose Crew Vehicle (MPCV)
  - Multi-Mission Space Exploration Vehicle (MMSEV)
- Research
  - Human Research Program (HRP) maintains a list of risks to human spaceflight and associated knowledge gaps
  - Risks and gaps are numerous, but these are some that have inherent technology needs:
    - Habitability
    - Training
    - Human Automation/Robot Interaction
    - Human-Computer Interaction

Orion Multi-Purpose Crew Vehicle (MPCV)

- **MPCV Synopsis**
  - A capsule solution designed for human space exploration beyond low Earth orbit (e.g., near-Earth objects, Lagrangian points, Luna, Mars)
- **Human-Related System Design Technology Needs**
  - Displays and controls
    - Orientation, layout, resolution, switches, buttons, hand controllers, alerts (lighting and audio)
  - Seating
    - Shock absorber, g-load reduction, design
  - Assessment needs
    - Net habitable volume, stowage, training, human-automation interaction, anthropometrics, biomechanics, human-computer interaction, workload, attention / vigilance, usability

Image source: nasa.gov

Multi-Mission Space Exploration Vehicle (MMSEV)

- **Synopsis**
  - A flexible design used both for in-space missions and for surface exploration of planetary bodies, including near-Earth asteroids and Mars.
- **Human-Related System Design Technology Needs**
  - Displays and controls
    - Orientation, layout, resolution, switches, buttons, hand controllers, alerts (visual and aural)
  - Assessment needs
    - Net habitable volume, stowage, training, human-automation interaction, anthropometrics, biomechanics, human-computer interaction, workload, attention / vigilance, usability

Image source: nasa.gov

Research

- **Habitability Technology Needs**
  - Space Utilization Data Collection and Modeling
    - Net habitable volume assessment
    - Tracking time / location data
      (crew, stowage, resources)
    - Biomechanical posture
  - Stowage
    - Location
    - Frequency of access
  - Measurement of the natural and induced environment (e.g., vehicle / habitat architecture, acoustics, vibration, lighting)
  - Assessment of human physical capabilities and limitations (e.g., body size and shape, range of gross movement)

Image source: nasa.gov

Research

- **Training Technology Needs**
  - Objective training measures to determine operator proficiency during and after ground training
  - Training methods and tools for applications when time is minimal
  - Design of onboard training systems to address Just-in-Time (JIT) and recurrent training needs for nominal and off-nominal scenarios

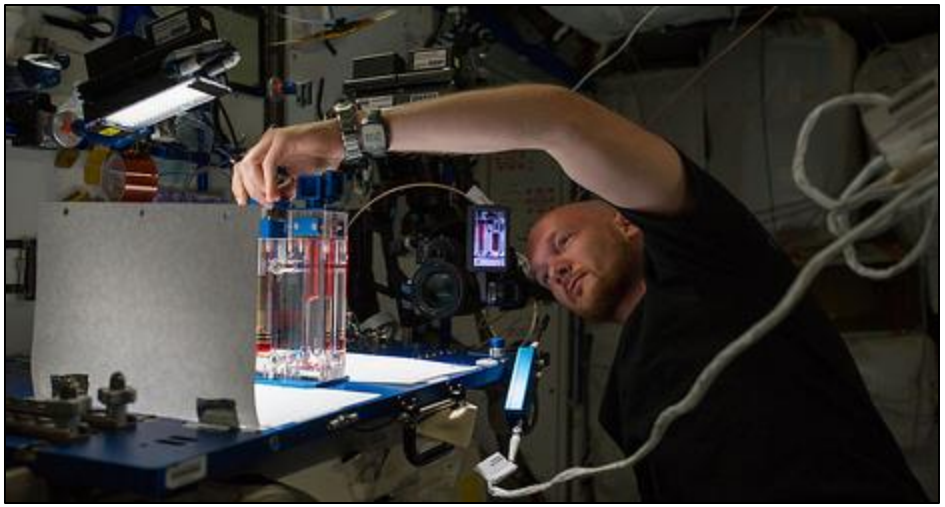


Image source: nasa.gov

Research

- **Human and Automation/Robot Integration Technology Needs**
  - Tools to conduct systematic task/needs analyses at an appropriate level of detail to allocate work among humans, robots, and automation
  - Methods for effective information sharing between humans and automation, to maintain appropriate trust and situation awareness
  - Methods for appropriate task automation and the effective allocation of tasks between humans and automation
  - Assessment of the effects of delays typical of different mission regimes on teleoperations and ways to mitigate such effects

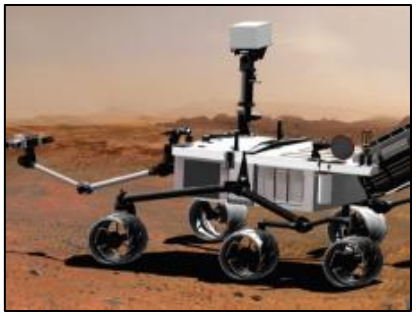


Image source: nasa.gov

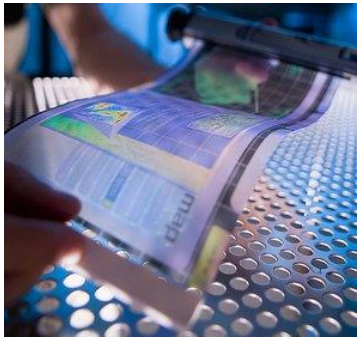
Research

- **Human-Computer Interaction Technology Needs**
  - Measurement of the effects of vibration and acceleration on crew task performance
  - Assessment of cognitive function change during long-duration missions and how this affects task performance
  - HCI guidelines (e.g., display configuration, screen-navigation) to mitigate the performance decrements due to the spaceflight environment
  - How emerging multi-modal and adaptive display and control technologies are best applied to the design of HCI for proposed long-duration Design Reference Mission (DRM) operations
  - Standard measurement techniques and metrics for evaluating the quality of user interfaces with specific attention to the usability of an interface
  - Ability to ensure that crewmembers receive all information required to accomplish necessary tasks in a timely fashion, even when operating autonomously
  - Assessment of crewmember spatiomotor abilities, and countermeasures and training techniques developed to mitigate spatial disorientation during spaceflight

Image source: nasa.gov

Specific Identified Technology Needs

- **Specific Needs**
  - Human / automation / robot interfaces
  - Robotic mode awareness
  - Low power, advanced display technologies
  - Flexible displays
  - Hands-free computing technologies
  - Adaptive systems
  - Environment sensing / smart technologies
  - Unobtrusive workload technologies
  - Wearable electronics
  - Haptic devices
  - Voice input, gestures, touchscreens
  - Radiation hardened computers and components
  - Human performance-enhancing technologies



Images source: Wikipedia.com and pbs.org

Questions ?

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