Collaborative Human Engineering Work in Space Exploration Extravehicular Activities (EVA)

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Concept of Operations for Future EVA activities

- Desert Research and Technology Studies (RATS)
- Advanced EVA Walkback Test
- Primary Life Support Subsystem (PLSS) design evaluations
- EVA Information System design evaluations
Desert RATS

• Collaboration with...
  – Other NASA Centers
  – Industry
  – Universities

• Technologies evaluated
  – Head mounted display
  – Speech recognition system
  – Rover usability
  – Backhoe usability
Advanced EVA Walkback Test

- Can a suited crewmember walk back 10 km at Lunar gravity?
- Collaboration with...
  - Multi-disciplinary team from within JSC
    - Exercise Physiology
    - Space Human Factors Labs
    - Engineering
    - Building 9 facility
- Metabolic costs
- Joint biomechanics
- Subjective measurements
  - Rating of perceived exertion (RPE)
  - Modified Cooper-Harper
    - CG stability
  - Discomfort
  - NASA TLX
  - Target tracking task
Walkback Subjective Results

- RPE = 11.8
- Cooper-Harper = 3.5
- Discomfort = 1.5
- NASA TLX
  - Physical demand and Effort – two factors contributing to workload
  - 40%, moderate amount of perceived workload
- Target tracking task
  - Participants gamed the system – were aware it was being used to assess cognitive capability
  - Two participants did not game the system
    - Performance was same pre and post for one
    - Increase in time to completion for the other
Integrated Suit Test 1

• Characterize suit parameters that contribute to metabolic costs of operating in a suit
  – Vary suit pressure
  – Vary suit weight
  – Vary inertial mass
• Currently collecting data – projected completion at the end of May 2007
• Subjective measurements
  – Rating of perceived exertion
  – Modified Cooper-Harper
  – Discomfort
  – Thermal comfort
Portable Life Support Subsystem (PLSS)

- Collaboration with...
  - Other NASA Centers
  - Industry
- Design evaluations for packaging PLSS components
- Human Factors personnel offering input on physical and visual access for maintenance and general good human factors practices
Flex PLSS Design Process

- Basic problem – time and money
- Goal – develop process to minimize schedules for design, efficient in redesign for any changes in future (new technology), utilize most effective tools we can find – reduce verification testing time
- Flex PLSS Packaging method allows for reconfiguration of the design – schematics, new technology, etc
- *Design Structure Matrix (DSM)* - standard representation for system architecture that can be used to address modularity and changeability associated with these criteria
EVA Information System

• Collaboration with Glenn Research Center (GRC)
• Proof of concept for a head mounted display and speech recognition system
• Initial human factors evaluation conducted at GRC in April 2007
  – Data is still being analyzed
EVA Information System

• Initial results – time to complete (min:sec ± min)
  – HMD 1\textsuperscript{st} = 22:24 ± 5
  – HMD 2\textsuperscript{nd} = 17:53 ± 5
  – Cue Cards 1\textsuperscript{st} = 17:18 ± 4
  – Cue Cards 2\textsuperscript{nd} = 11:21 ± 5
  – Geology = 6:26 ± 1
EVA Information System

• Initial recommendations for improvement
  – Improve the system’s ability to recover from errors
  – Improve ease of adjustment on HMD, angular adjustment
  – Improve comfort of HMD – pinched head
  – Decrease wait period between keyword and command
  – Add an indicator to the display that voice commanding is activated
  – Add a zoom feature
  – Filter out background noise to reduce false-positives
  – Add a “mute” option
Thank you!

• Any Questions?