Designing for Safety in Space Medical and Cockpit Operations

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October 22, 2008

Safety Critical Space Operations

- Medical Operations
  - No guarantee that onboard crewmembers will have advanced medical training
    - While some crewmembers are doctors, most receive only 40 hours of medical training before a mission
    - If there is a medical doctor crewmember, he/she may be the one injured
  - Current crews have relatively easy access to medical experts on the ground in the case of an onboard emergency
    - Future missions will travel to the moon and Mars, requiring much greater autonomy from the ground, and requiring onboard crewmembers to deal with medical emergencies themselves
- Cockpit Operations
  - The next generation of crewmembers will be flying and controlling a brand new vehicle called *Orion*
    - Orion is very different from shuttle, and will require training on new equipment and new methods of operation
    - Orion will be controlled almost exclusively with software controls – very different from the space vehicles of the past

NASA/JSC Human Factors Work: Medical Operations

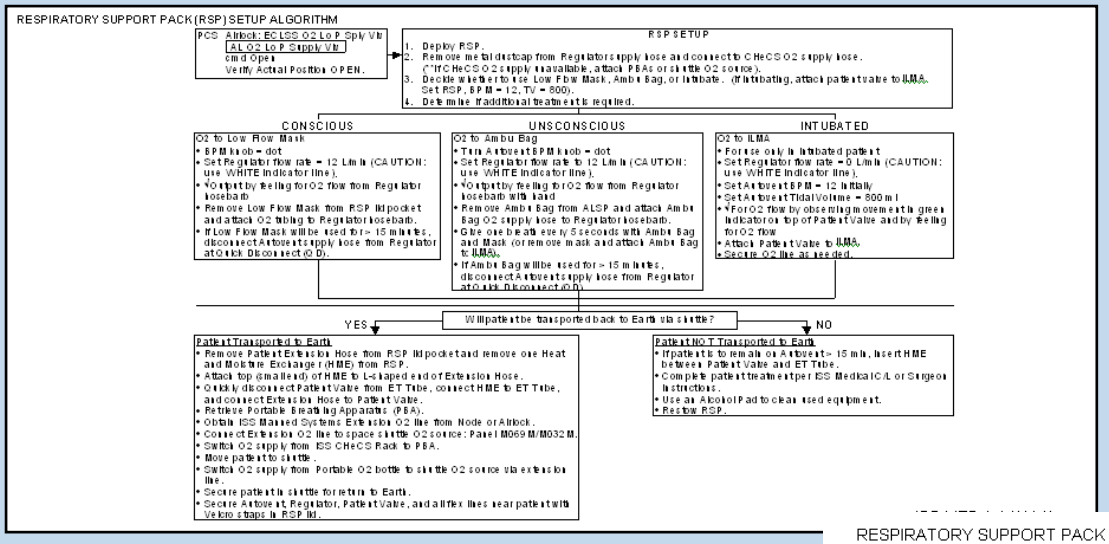
- Medical procedure checklist redesigns
- Medical pack organization and labeling
- Electronic procedure formatting
- Emergency cue card design
  - Respiratory Support Pack (RSP) Cue Card Redesign

Respiratory Support Pack (RSP) Cue Card Redesign

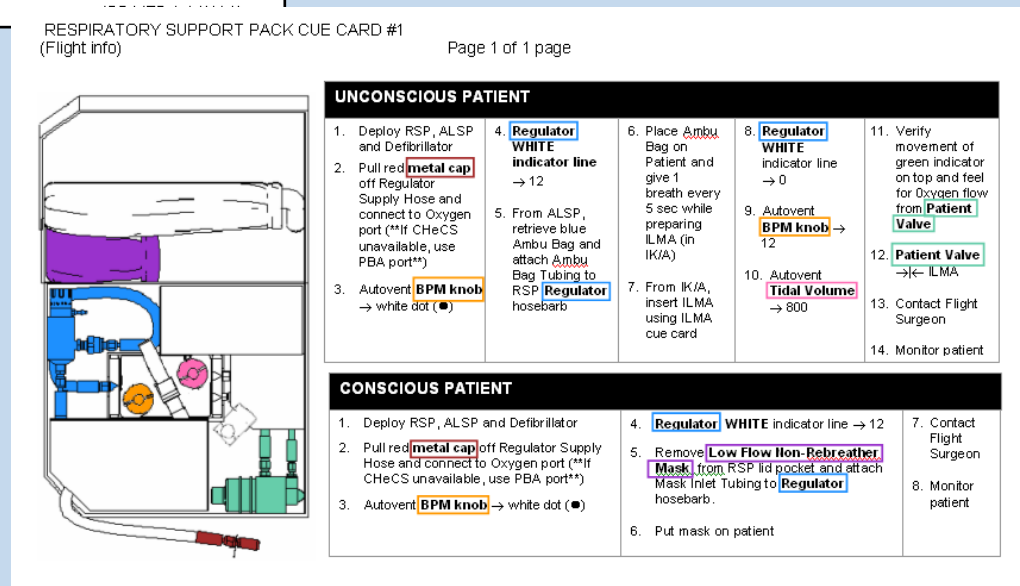
Vicky Byrne and Cynthia Hudy (Lockheed Martin)
Mihriban Whitmore (NASA)

- During training simulations, International Space Station (ISS) crewmembers noted that the RSP cue card was a bit difficult to use due to the large amount of text and arrows
- Three cue card redesigns and three evaluations were completed
- Modifications to cue card
  - Irrelevant or extraneous text removed
  - Schematic of medical pack contents added
  - Color coding tying the procedural steps to the contents shown in the schematic added
- Other modifications
  - Labels for RSP medical equipment within the pack improved

Result of RSP Cue Card Redesign



Original



Redesign

Respiratory Support Pack (RSP) Cue Card Evaluation Methodology

- Three studies completed
  - Non-medically trained participants used an original, or redesigned RSP cue card to complete two respiratory distress scenarios with a medical mannequin
  - The procedure consisted of locating, connecting, and activating various pieces of medical equipment from the medical pack
  - Completion times, errors, subjective comments, and recommendations were collected

RSP Cue Card Final Results

- The final evaluation showed an improvement in procedure completion time of 3 minutes (approximately 7 minutes reduced to 4 minutes)!
- The results and new recommended design were presented to the ISS program and accepted for deployment on ISS
- A final redesign and evaluation was performed to ensure colors are distinguishable in ISS lighting
- The new cue card is currently in use onboard ISS

NASA/JSC Human Factors Work: Cockpit Operations

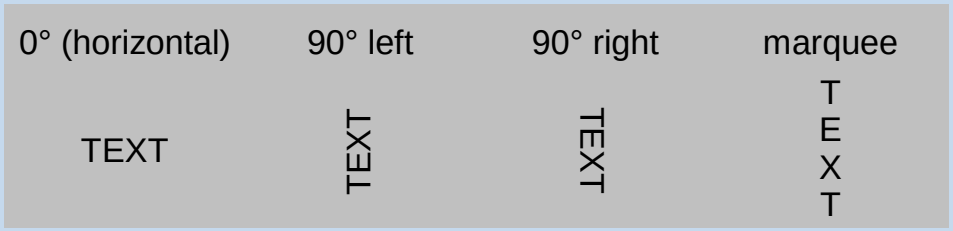
- Orion is the new vehicle under development that will take humans to the moon and Mars
- The vehicle is being developed by the prime contractor (Lockheed Martin) and NASA, working together on many of the issues
- Human Factors personnel are core members of the Cockpit Working Group (CWG)
  - Multidisciplinary group of NASA and prime contractor members working Orion design issues

Orion Cockpit Design Activities

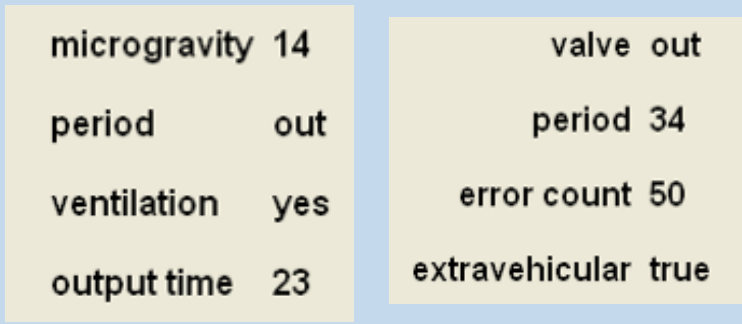
- Orion project funding and research funding supports Human Factors work on Orion
- Example projects
  - Label Design
  - Alarm Design
  - Cursor Control Device Design

Software Label Design Evaluations

Kritina Holden, Aniko Sandor, Shelby Thompson, Jennifer Boyer (Lockheed Martin)



- Two studies completed on label orientation
- Participants were asked to respond to labels in different orientations as quickly as possible
- Results
  - Horizontal labels improve reading time compared to vertical labels
  - Marquee text was less preferred, and in general led to worse performance



- Three studies completed on label alignment
- Participants were asked to respond to labels of different alignments as quickly as possible
- Results
  - For large data groupings, data-alignment is better than left-alignment in terms of response time.
- More research in progress

Research results will yield standards for software label design.

Caution and Warning Alarm Design Evaluations

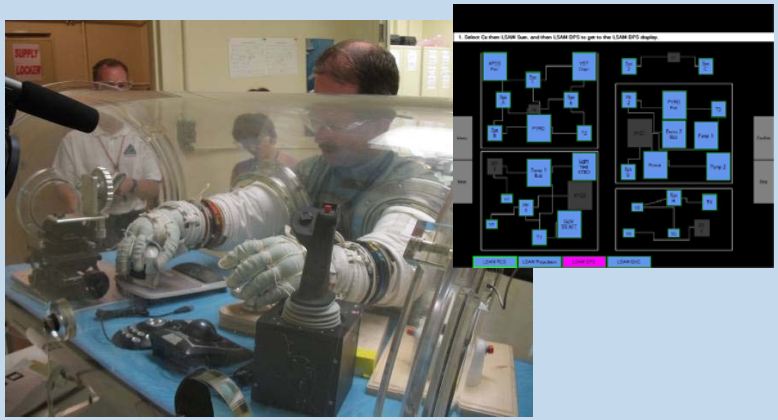
Durand Begault (NASA Ames),Aniko Sandor, Kritina Holden (Lockheed Martin)

- Two studies completed to evaluate appropriateness of current alarm set for future vehicles and rate new options
- New features being considered:
  - “soft start” feature to reduce startle effect
  - Intermittent vs. continuous tones to allow more cognitive processing time
  - Feasibility of speech alarms

Research results will help make design decisions and yield standards for Orion and future vehicle device design.

Cursor Control Device Evaluations

Kritina Holden, Aniko Sandor, Shelby Thompson, Jennifer Boyer (Lockheed Martin)



- GOAL: Identify/design a cursor control device for Orion that works in vibration, high-g and micro-g
  - Developed a Cursor Control Device Test Battery
  - Commercial and proprietary cursor control devices tested with and without Extravehicular Activity (EVA) gloves
  - Five evaluations completed in the lab and pressurized glovebox
  - Preliminary results indicate trackballs are good for gloved operations with a continuous cursor.
  - Where accuracy is important, or for conditions like vibration, a discrete cursor/device works the best.
  - Research is continuing

Research results will help make design decisions and yield standards for Orion and future vehicle device design.