Human Factors in Training:
Space Medical Proficiency Training

Human Research Program - Space Human Factors & Habitability
Space Human Factors Engineering Project
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OVERVIEW

The early Constellation space missions are expected to have medical capabilities very similar to those currently on the Space Shuttle and the International Space Station (ISS). For Crew Exploration Vehicle (CEV) missions to the ISS, medical equipment will be located on the ISS, and carried into CEV in the event of an emergency. Flight surgeons (FS) on the ground in Mission Control will be expected to direct the crew medical officer (CMO) during medical situations. If there is a loss of signal and the crew is unable to communicate with the ground, a CMO would be expected to carry out medical procedures without the aid of a FS. In these situations, performance support tools can be used to reduce errors and time to perform emergency medical tasks.

The space medical training work is part of the Human Factors in Training Directed Research Project (DRP) of the Space Human Factors Engineering (SHFE) Project under the Space Human Factors and Habitability (SHFH) Element of the Human Research Program (HRP). This is a joint project consisting of human factors team from the Ames Research Center (ARC) with Immanuel Barshi as Principal Investigator and the Johnson Space Center (JSC). Human factors researchers at JSC have recently investigated medical performance support tools for CMOs on-orbit, and FSs on the ground, and researchers at the Ames Research Center performed a literature review on medical errors. Work on medical training has been conducted in collaboration with the Medical Training Group at the Johnson Space Center (JSC) and with Wyle Laboratories that provides medical training to crew members, biomedical engineers (BMEs), and to flight surgeons under the Bioastronautics contract.

One area of research building on activities from FY08, involved the feasibility of just-in-time (JIT) training techniques and concepts for real-time medical procedures.

Human Patient Simulator

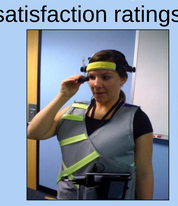
A second area of research involves FS performance support tools. Information needed by the FS during the ISS mission support, especially for an emergency situation (e.g., fire onboard ISS), may be located in many different places around the FS's console. A performance support tool prototype is being developed to address this issue by bringing all of the relevant information together in one place. The tool is designed to include procedures and other information needed by a FS during an emergency, as well as procedures and information to be used after the emergency is resolved. Several walkthroughs of the prototype with FSs have been completed within a mockup of an ISS FS console. Feedback on the current tool design as well as recommendations for existing ISS FS displays were captured. The tool could have different uses depending on the situation and the skill of the user. An experienced flight surgeon could use it during an emergency situation as a decision and performance support tool, whereas a new flight surgeon could use it as JITT, or part of his/her regular training.

The work proposed for FY10 continues to build on this strong collaboration with the Space Medical Training Group and previous research.

JUST-IN-TIME-TRAINING & REFRESHER TRAINING TECHNIQUES

Aim: Investigate Just-in-time training techniques and concepts for medical procedures.

In **Phase 1**, preliminary feasibility data were gathered for two types of prototype display technologies: a hand-held PDA, and a head-mounted display (HMD). The PDA and HMD were compared while performing a simulated medical procedure using the ISS flight-like medical equipment. Based on the outcome of Phase 1, including data on user preferences, in FY09 further testing was completed using the PDA only. **Phase 2** explored a wrist-mounted PDA, and compared it to a paper cue card. For each phase, time to complete procedures, errors, and user satisfaction ratings were captured.



Head Mounted Display

Phase 2 Evaluation
Subjects:
9 subjects with prior space medical equipment and procedures experience (Within-Subjects design).

Method:
Each phase of research was conducted with subjects using a human patient simulator to perform simulated just-in-time medical procedures using International Space Station (ISS) flight-like equipment.

Objectives and Outcome:
1. Evaluate means of information presentation to perform real time medical procedures
   - Three different procedures were evaluated using participants with some knowledge of medical equipment and procedures. Participants identified unclear areas where additional steps/information would be helpful.
   - Paper cue card provided access to the complete procedure; the PDA required some scrolling.
2. Explore the potential benefits of auditory presentation of instructions combined with graphic figures
   - The auditory + graphics condition allowed for systematic serial completion of procedures.
   - The graphics were bigger and reported to be more helpful than when presented with text.
   - The rate of the auditory presentation was identified as an issue by participants. Subjectively, it slowed down the completion of the procedure and did not allow for a 'big picture' view of the entire procedure (i.e. know how far into the procedure one was).
3. Gather feasibility information about wrist mounting a PDA to allow two-handed operation of medical procedure.
   - Seven of the nine participants reported no issues with the wrist-mounting used for the PDA conditions.
   - The exact sizing was not appropriate for all participants, but only minor adjustments were observed during the scenarios.
   - Method of securing PDA worked very well since the unit never slipped.

Wrist mounted PDA

Paper cue card

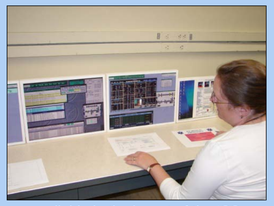
FLIGHT SURGEON PERFORMANCE SUPPORT TOOL

Objectives:
- Compile detailed information on Flight Surgeon on-console tasks
- Gather feedback from multiple Flight Surgeons on current draft prototype
- Update prototype (possibly developing alternatives layouts for further testing)

Subjects:
Five certified Flight Surgeons (All had both ISS and Shuttle On-Console Experience)

Method:
For each interview session, a participant was asked to perform a walk-through of a 'Fire On-board ISS' emergency scenario. Flight Surgeon Console Mockup has been created to facilitate walk-thru. Topics covered included: Flight Surgeon experience; nominal beginning/ending shift activities; off-nominal fire emergencies as compared with other emergencies;

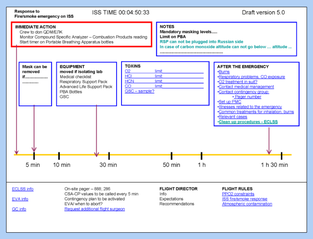
The duration of each interview session was approximately one hour. The interviewer met individually with each Flight Surgeon in the Usability Testing and Analysis Facility. The facility was set up with foam board mock-ups of the displays and hard-copy resources available in the layout of the ISS Flight Surgeon console. Interviews were audio recorded and notes were taken by the interviewer and an assistant when available.



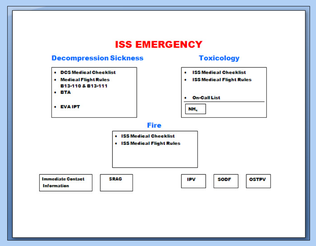
Mock-ups of displays and hard-copy resources available in the layout of the ISS Flight Surgeon console

Results:

Participant Comment	Human Factors Observation and Recommendations
Do not look at the Surgeon Daily Tasks page or the Panic button page information. Some participants were unaware of the information and some mentioned that it was not up to date.	These current displays contain valuable information that is also covered in the Flight Surgeon Performance Support Tool prototype. Recommendations include: •Reorganize existing displays (e.g. clearly separate ISS Emergency vs. Medical Emergency) •It is important to know what information is available as a resource and this could be done in Flight Surgeon Training, during mentoring, or refresher training.
There is so much information that it could be easy to overlook pieces if focused too narrowly on the support tool. A lot of the needed current information is gathered by talking with other groups in the control room (e.g. BME and ECLSS). Recommended by participants to emphasize support tool – not a substitute for Flight Rules and Procedures.	One possible approach is to make the focus of the Performance Support Tool as a Checklist (e.g. priming questions as to who to ask for what information). Facilitate increasing level of situation awareness by listing the considerations, and pointers to what to be thinking about.
Keep resources in formats that are easy to update. It should be possible for Flight Surgeons for a specific Increment/Crew to configure the displays based on their known mission constraints.	It is noted that this might be the way to keep current information available. But some information may always be needed, and if so, it should stay in the same location on the screen to reduce scanning time.
There are different levels of information needed for the paper version and electronic versions of the Flight Surgeon Performance Support Tool. Generate a simple prototype if used as a paper reference if the Flight Surgeon will immediately be driving in to Mission Control for an emergency (Recommend Contacts, Set up PMC?, List of Flight Rules to ask for)	Next step will be to generate a streamlined version of the current paper prototype to reduce the amount of information and update the prototype to enhance the electronic design.
Privacy of medical data is a concern, some of the console set-up and display designs call attention to the data.	Display designs should make things legible for Flight Surgeons, but not legible from a distance. Other means of privacy were not explored here, but could be investigated further.



Flight Surgeon one pager prototype



An example computer display concept drafted by a Flight Surgeon participant as an alternative to the 'Panic Button' display

FY10 ACTIVITIES CURRENTLY IN WORK

The work focuses on three efforts that include:
- Determine the feasibility of a computer implementation of the paper prototype Flight Surgeon Performance Support tool developed in FY09;
- Determine the state-of-the-art in medical training technologies;
- Determine correspondence between current Computer-Based Training (CBT) standards and NASA CBT guidelines.

PROJECT TEAM & ACKNOWLEDGEMENTS

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