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 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 contracts.

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.

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, 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.

**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 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.

### 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.

**Results:**

<table>
<thead>
<tr>
<th>Participant Comment</th>
<th>Human Factors Observation and Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td> Update prototype (possibly developing alternatives layouts for further testing)</td>
<td></td>
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<tr>
<td> Maintain separate versions of interfaces.</td>
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<tr>
<td> Visual design of the Remote Monitor used on the console should be clearer for more intuitive use.</td>
<td></td>
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<tr>
<td> Need for current display.</td>
<td></td>
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<tr>
<td> Need for a more comprehensive state of the art display.</td>
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<tr>
<td> Human factors issues: privacy of information, privacy of medical data is a concern.</td>
<td></td>
</tr>
<tr>
<td> Flight Surgeon console needs to be designed for ease of use.</td>
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</tr>
</tbody>
</table>

**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**

There were multiple contributors to this work and are acknowledged in this section. The Phase 1 evaluation team consisted of Melanie Hamel, Aniko Sandor, Vicky Byrne, and Kerry McGuire. The Phase 2 evaluation team consisted of Ronald Archer, Carlton Donahoo, and Erin Connell. The Flight Surgeon Performance Support evaluation was conducted by Vicky Byrne and Kerry McGuire. All work was reviewed and edited by Immanuel Barshi. We would also like to thank David Ham and Victor Hurst for the use of the Wyle Medical Simulation Laboratory and human patient simulators and their support during evaluations.