X12.02 Long-Duration Space Human Factors

lead Center: JSC

Participating Center(s): ARC

The long-term goal of this subtopic is to enable planning, designing, training, and executing long-duration human space missions that are up to 5 years without re-supply and real-time communications to Earth. Specifically, the focus of this subtopic is on the development of innovative crew equipment, technologies for human performance assessment/modeling/enhancement, and design tools for engineers to incorporate human factors engineering requirements into hardware and software. Proposals that aim at developing and addressing the following specific technology needs are solicited.

Technologies are needed for monitoring and maintaining human performance non-intrusively. Specifically, the technologies we seek are (1) minimally invasive and un-obtrusive devices and techniques to monitor the behavior and performance (physical, cognitive, perceptual, etc.) of individuals and teams during long-duration space flights or analog missions, as well as (2) embedded measures to detect significant changes in crew readiness to perform physical or cognitive tasks.

Methods and models are needed for predicting human performance. The particular technologies we seek are (1) methods and models for predicting effects on physical performance by encumbrances of clothing, space suits, etc., (2) models for predicting effects of physical environment (e.g., lighting, noise, temperature, contaminants) on human performance, (3) models to simulate and optimize interactions between humans and equipment/vehicle, (4) capability to implement time-delay algorithm and functionality into simulations for higher fidelity and effectiveness, and (5) models for predicting performance due to the effects of cognitive changes.

Cost-effective and reliable tools are needed for aiding the design and evaluation of human-system interfaces for speed, accuracy, and acceptability. The particular tools we seek shall (1) provide automated analysis of computer-user interfaces for complex display systems to conduct objective review of displays and controls, (2) determine compliance with guidelines and standards, and/or (3) offer quantitative measures of the effectiveness of user interfaces for task-sensitive evaluations.

Tools are needed to facilitate user interface design for human computer interfaces, procedures, labels, and instructions. These tools shall assist the designer in incorporating contextual information such as the user's task, the user's knowledge, and the system's limitations.
Tools are needed to build just-in-time system and operational information software that aid human users to conduct routine and emergency operations and activities. Such tools shall be either (1) effective and efficient job aids (e.g., "intelligent" manuals, checklists, and warnings) to support designing flexible interfaces between users and large information systems, or (2) methods for developing "facilitators" (procedures, labels, etc.) adapted for developing space vehicle and payload applications.

Acoustic monitoring systems are needed to accurately and autonomously monitor acoustic sound pressure and noise exposure levels in long-duration space vehicles. These technologies shall provide (1) acoustic sensor systems consisting of fixed and/or crew-worn transducers, (2) sound pressure level information as a function of frequency and/or time, (3) typical sound level meter and acoustic dosimeter functionality, and (4) the capability for autonomous operations and data transfer. Operation and data acquisition parameters of such systems shall be controllable either by ground personnel or the crew.

Innovative acoustic flight materials are needed for noise abatement. These materials shall function as acoustic absorbers, barriers, vibration isolators, dampers, spacecraft wall treatments, transparent containment, or combinations of these. These materials must be shown to satisfy space flight material requirements, such as off-gassing and flammability, and shall be easy to apply to hardware. The acoustic properties of these materials' shall be demonstrated through absorption or transmission loss testing, or by other standard acoustic testing techniques.