USING EMPIRICAL RESEARCH AND HUMAN PERFORMANCE MODELING TO PREDICT ASTRONAUT PERFORMANCE IN LONG-DURATION SPACE MISSIONS

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This symposium session consists of four papers describing the Space Performance Research Integration Tool (S-PRINT) project, sponsored by NASA's Human Research Program (HRP). The efforts undertaken as part of this project were to ***develop tools and empirically-based guidelines*** that support human performance researchers, mission planners, automation designers, and astronauts in long-duration missions. The S-PRINT project addresses aspects of the work environment that are characterized by workload transitions that might occur during long-duration missions. Workload transitions are a potential worst-case scenario, in which under-loaded, fatigued astronauts experience automation failures that require immediate diagnosis and intervention.

This current research effort has focused on the underload situation and on the effects that fatigue has on performance, human performance during overload / multitasking situations, and on automation design factors that affect operator performance in anticipating and managing such transitions. In this session, the investigators will present four papers (identified below) that describe different aspects of the research completed to develop the S-PRINT models. The session will show an integrated approach of using empirical research and human performance modeling to predict operator performance in operations that are in the design phase. In part, this panel will highlight the way that the products from this research can be used to help the above-listed users (a) anticipate and avoid potential problems related to unexpected workload transitions by identifying the expected effects of operator fatigue, automation system design, and task factors on overload performance, and to (b) assure systems can be designed in such a way as to optimize performance in space exploration missions, particularly those that are experienced during longer term missions (6+ months).

1) ***Using empirical research and computational modeling to predict operator performance in novel situations*** – this paper will describe the purpose and approach of the S-PRINT research effort to predict operator performance during an unexpected workload transition. The workload transition we investigate includes an underload phase, a sudden transition due to an automation failure, and an overload phase. Each phase has resulted in different models of effects on operator performance. This paper will also present the CODDMAN (Complacency effects on Detection, Diagnosis, and fault MANagement) model of operator performance, and describe the empirical and theoretical underpinnings of a model of the effects of human-automation interaction design on operator performance.

2) ***Effects of sleep restriction, sleep inertia, and overload on complex cognitive performance before and after workload transition: a meta-analysis and two models*** – this paper will provide a summary of the modeling efforts of underload before and overload after workload transition that were based on an extensive literature review and meta-analyses. Several related results were presented at the 2013 HFES conference. Additional results have since been identified and these will be presented. This paper will describe findings regarding the effects of sleep restriction, circadian cycle, and sleep inertia on task completion time and accuracy. The paper will also present a model for task switching in overloaded, multitasking situations.

3***) The effects of automation-induced complacency on fault diagnosis and management performance in process control*** – this paper will describe the methods and results of human-in-the-loop research investigating the effects of automation design factors on operator performance during workload transition, to help inform development of the CODDMAN model presented in paper 1. The work is performed using an environmental process control simulation, AutoCAMS.

4) ***Workload overload modeling: An experiment with MATB II to inform a computational model of task management*** – this paper will describe research investigating operator performance during overload conditions, to help develop the overload model presented in Paper 2. The research specifically investigates the relative impacts of task factors such as salience, engagement, difficulty, and priority on operator task switching behavior.

Participants (speakers) in this session come from three different organizations: Alion Science and Technology (the prime), Colorado State University (research partner), and Dr. Christopher Wickens (independent consultant).

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