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Human Automation Systems in Spaceflight: The What, When and How of Measurement

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For over 14 years humans have continuously inhabited space through expeditions to the International Space Station. These missions have been characterized by durations of 3-6 months of habitation in a spacious environment in low-earth orbit. However, with the United States space program beginning a transition to future long distance and duration exploration missions (LDDEM) to Mars and beyond, much of what has been learned throughout the past 14 years and 42 expeditions to low earth orbit will not be relevant to these new mission architectures. Specifically, Human-Automation System (HAS) integration will become an even more important topic for research and practice as these types of systems will be crucial to the everyday functioning of spaceflight crews during LDDEM due to increased crew autonomy and reliance on automation (Sandal, Leon, & Palinkas, 2007).

Automation is beneficial to completing tasks in a variety of domains, as it provides an opportunity for increased productivity, efficiency and safety maintenance (Sheridan & Parasuraman, 2005). However, its success is contingent upon the success in which a human operator can interact with it. To fully optimize the implementation of these systems, it is important to measure the various human and automation inputs and processes that influence intended HAS outcomes. By understanding what inputs and processes are necessary to measure, and how they affect outcomes, we can not only choose appropriate measures but we can manage the way in which human automation systems are utilized in an effort to maintain safety, performance, and efficiency. Additionally, by focusing our attention on how these inputs and processes apply to HAS within specific spaceflight contexts, we can present best practices for measurement of such systems for future LDDEM mission architectures.

In order to capture processes and conditions for achieving and maintaining safety and enhancing performance, it is crucial to engage in accurate assessments using reliable and valid measurement methods. As such, in the proposed presentation we will leverage the science of metric development and measurement to discuss the 'what', the 'when', and the 'how' of HAS integration measurement for spaceflight contexts. Specifically, this presentation will (1) identify four potential contexts or tasks that are likely to require significant HAS integration for future LDDEM (2) outline the key characteristics of HAS that are necessary to measure to ensure ideal HAS integration for spaceflight contexts and existing metrics available for measuring the identified HAS components (3) identify the challenges associated with measurement of HAS constructs (4) recommend the optimal methods and associated conditions in which the metrics should be utilized to overcome the described challenges. We will conclude with a discussion of a way forward for HAS measurement for the spaceflight contexts, given the challenges and recommendations outlined in the presentation.

Sandal, G. M., Leon, G. R., & Palinkas, L. (2007). Human challenges in polar and space environments. In *Life in Extreme Environments* (pp. 399-414). Springer Netherlands.

Sheridan, T.B., & Parasuraman, R. (2005). Human-automation interaction. *Reviews of Human Factors and Ergonomics*, *1*, 89-129.