Fiscal Year:	FY 2017	**Task Last Updated:**	FY 12/01/2017
PI Name:	Duda, Kevin R Ph.D.		
Project Title:	Real-Time Estimation of the Effects of a Simulated Long-Duration Exploration Mission on Flight Performance, Workload, and Situation Awareness		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Behavior and performance		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **HFBP**:Human Factors & Behavioral Performance (IRP Rev H)		
Human Research Program Risks:	(1) **Bmed**:Risk of Adverse Behavioral Conditions and Psychiatric Disorders (2) **Sleep**:Risk of Performance Decrements and Adverse Health Outcomes Resulting from Sleep Loss, Circadian Desynchronization, and Work Overload (IRP Rev F)		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Zip Code:	02139-3539	**Congressional District:**	7
Comments:			
Project Type:	GROUND	**Solicitation:**	2015-16 HERO NNJ15ZSA001N-ILSRA. Appendix F: International Life Sciences Research Announcement
Start Date:	07/19/2016	**End Date:**	01/18/2020
No. of Post Docs:	0	**No. of PhD Degrees:**	0
No. of PhD Candidates:	0	**No. of Master' Degrees:**	0
No. of Master's Candidates:	1	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	0	**Monitoring Center:**	NASA JSC
Contact Monitor:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:	NOTE: Extended to 1/18/2020; in addition, start date should be 7/19/2016, all per K. Ohnesorge/JSC HRP (Ed., 5/24/18) NOTE: Change in period of performance to 7/01/2016-12/31/2018 (previously 7/22/16-10/21/18 and then 7/19/2016-10/18/2018), per NSSC information (Ed., 12/15/17) NOTE: Change in period of performance to 7/19/2016-10/18/2018 (previously 7/22/16-10/21/18), per K. Ohnesorge and D. Risin/JSC (Ed., 3/29/17) NOTE: Element change to Human Factors & Behavioral Performance; previously Behavioral Health & Performance (Ed., 1/18/17)		
Key Personnel Changes/Previous PI:	April 2017: Original CoInvestigator D. Handley left Draper Laboratory for a position with another company and no longer has a role with the project.		
COI Name (Institution):	Stankovic, Aleksandra Ph.D. (Charles Stark Draper Laboratory)		
Grant/Contract No.:	NNX16AO29G		

Performance Goal No.:	
Performance Goal Text:	
Task Description:	Human spaceflight often requires long-term isolation of crewmembers in extreme environments. These environments introduce stressors to both crewmember physiology and psychology. Specific human-factors stressors include long-duration isolation, sleep loss, circadian desynchronization, and high workload. These stressors present a real risk of performance decrement during a spaceflight mission. Research done in spaceflight analogs such as the NASA Human Exploration Research Analog (HERA) provide a unique opportunity to study these effects and develop essential metrics to identify and prevent performance decrements in an operationally-relevant setting. In the field of human spaceflight, real-time performance metrics, and quantification of performance during operationally-relevant tasks and scenarios has the potential for making existing operations safer and more efficient, as well as for improving the design of future vehicles. The identification of critical performance decrements, either in measures of task performance, workload, or situational awareness, may be used to alter the human-automation task allocation or suggest changes to crew resource management. These metrics have been previously developed for the following operationally relevant tasks: • Piloted lunar landing using a generic lunar lander design. • Manual control of SAFER (simplified aid for EVA rescue) during an inspection of a solar panel by an EVA (extravehicular activity) crewmember. • Manual control of SAFER during a simulated self-rescue flight back to the International Space Station (ISS). • Manual control of the MPCV/Orion vehicle during docking with the ISS. Future missions may be operating with delayed communication, or in extreme cases, without communication to Earth for ground-based support. In addition, all of the environmental parameters likely will not be known in advance (e.g., asteroid spin rate). A simulation capability that can be used to assess operational performance can be used to inform temporal function allocation (e.g., performance benefit/cost of human performing all the tasks vs. auto to start and then allow human to takeover at the end). This can help to inform mission design and crew resource management as a function of mission duration, sleep state, circadian synchronization, and workload. Real-time performance metrics are a valuable tool for quickly identifying performance decrements, and for determining the performance impact of delayed or sparse communication. We have integrated the Draper-developed configurable and portable simulation platform for use during HERA missions. This platform can simulate multiple operationally-relevant scenarios—a generic piloted lunar landing task, ISS EVA SAFER inspection of a solar array, ISS EVA self-rescue, and MPCV/Orion docking with the ISS. This simulation platform will be used to characterize real-time performance metrics including flight performance, workload, and situation awareness during piloted lunar landing and ISS EVA SAFER solar array inspection tasks in HERA during Campaign 4, and the results will be correlated with mission timeline events and NASA Behavioral Health and Performance (BHP) Standard Measures.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	The integration of flight performance, workload, and situation awareness metrics in a real-time estimation algorithm and combining those metrics with several operationally relevant spaceflight piloting scenarios is impactful for spaceflight operations and has many Earth-based benefits. A truly novel aspect of this project is real-time situation awareness estimation, which does not require simulation freezes/pauses or post-simulation questionnaires. This method could be applied to any land, sea, or space-based systems where there is a need to continually assess operator performance, workload, and situation awareness over time, and use those metrics to alert them to deviations. As an example, these metrics were integrated with a flight simulation environment under a study for the Air Force Research Laboratory. We are also working closely with the NASA Behavioral Health and Performance community to ensure that these metrics are relevant to the cohort of Standard Measures that are part of their ongoing and planned future studies.
Task Progress:	Human spaceflight often requires long-term isolation of crewmembers in extreme environments. These environments introduce stressors to both crewmember physiology and psychology. Specific human-factors stressors include long-duration isolation, sleep loss, circadian desynchronization, and high workload. These stressors present a real risk of performance decrement during a spaceflight mission. Research done in spaceflight analogs such as the NASA Human Exploration Research Analog (HERA) provide a unique opportunity to study these effects and develop essential metrics to identify and prevent performance decrements in an operationally-relevant setting. In the field of human spaceflight, real-time performance metrics, and quantification of performance during operationally-relevant tasks and scenarios has the potential for making existing operations safer and more efficient, as well as for improving the design of future vehicles. The identification of critical performance decrements, either in measures of task performance, workload, or situational awareness, may be used to alter the human-automation task allocation or suggest changes to crew resource management. We have integrated the Draper-developed configurable and portable simulation platform with the HERA module in support of the upcoming Campaign 4 Missions. This required close coordination with the HERA team and the Flight Analogs team to ensure that the facility could accommodate our hardware in the locations and arrangement that best support the science objectives of our project. Our team delivered an updated set of software to the HERA hardware to enable the crew to operate the simulations and progress through the trials and automatically log and save the data for subsequent download and analysis. This enables individual configurations for each HERA crewmember – Commander, Flight Engineer, Mission Specialist 1, and Mission Specialist 2. In parallel with the software development to support crew autonomous operations of the Draper real-time metrics simulation platform, our team developed a detailed operations manual for the HERA/Flight Analogs team, a crew-operations manual that is focused on the specific procedures for running the study, and a crew training curriculum for training the crew and preparing for baseline data collection. Additionally, to facilitate data analysis and quick-look reports of the data, our team is developing an automated analysis pipeline to analyze the data for the initial key

	parameters of flight performance (e.g., root mean square error of attitude), workload (e.g., secondary task response times), and situation awareness (e.g., scoring of the verbal callouts as recognized by the automatic speech recognition algorithm). This platform has been specifically tailored to simulate two operationally-relevant scenarios—a generic piloted lunar landing task and an ISS EVA SAFER inspection of a solar array. This simulation platform will be used to characterize real-time performance metrics including flight performance, workload, and situation awareness during piloted lunar landing and ISS EVA SAFER solar array inspection tasks in HERA during Campaign 4, and the results will be correlated with mission timeline events and NASA Behavioral Health and Performance (BHP) Standard Measures. Our near-term work will entail supporting the training, baseline data collection, and operations of HERA Campaign 4 Mission 1. Subsequently, we will then analyze the data and prepare for Missions 2, 3, and 4.
Bibliography Type:	Description: (Last Updated: 04/05/2019)
Abstracts for Journals and Proceedings	Duda KR, Stankovic AS, York SP, Handley PM, West JJ, Robinson SK. "Real-Time Estimation of the Effects of a Simulated Long-Duration Exploration Mission on Flight Performance, Workload, and Situation Awareness." Abstract and Poster at the 2017 NASA Human Research Program Investigators' Workshop, Galveston, TX. January 23-26, 2017. 2017 NASA Human Research Program Investigators' Workshop, Galveston, TX. January 23-26, 2017. , Jan-2017