Fiscal Year:	FY 2020	**Task Last Updated:**	FY 02/28/2020
PI Name:	Marquez, Jessica Ph.D.		
Project Title:	HCAAM VNSCOR: Crew Autonomy through Self-Scheduling: Guidelines for Crew Scheduling Performance Envelope and Mitigation Strategies		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:			
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **HFBP**:Human Factors & Behavioral Performance (IRP Rev H)		
Human Research Program Risks:	(1) **HFBP HARI**:Risk of Inadequate Design of Human and Automation/Robotic Integration (IRP Rev J) (2) **HFBP HCI**:Risk of Inadequate Human-Computer Interaction (IRP Rev J) (3) **HFBP Team**:Risk of Performance and Behavioral Health Decrements Due to Inadequate Cooperation, Coordination, Communication, and Psychosocial Adaptation within a Team (IRP Rev J) (4) **MPTASK**:Risk of Inadequate Mission, Process and Task Design (IRP Rev H)		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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PI Organization Type:	NASA CENTER	**Phone:**	650-604-6364
Organization Name:	NASA Ames Research Center		
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City:	Moffett Field	**State:**	CA
Zip Code:	94035	**Congressional District:**	18
Comments:			
Project Type:	GROUND	**Solicitation:**	2017 HERO 80JSC017N0001-BPBA Topics in Biological, Physiological, and Behavioral Adaptations to Spaceflight. Appendix C
Start Date:	04/15/2019	**End Date:**	04/14/2023
No. of Post Docs:		**No. of PhD Degrees:**	
No. of PhD Candidates:		**No. of Master' Degrees:**	
No. of Master's Candidates:	2	**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:		**Monitoring Center:**	NASA JSC
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Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:	February 2020 report: Mr. Steven Hillenius (Co-Investigator) left NASA. Dr. Tamsyn Edwards is replacing Mr. Hillenius as Co-I. Dr. Tamsyn works at NASA Ames as part of San Jose University Research Foundation.		
COI Name (Institution):	Bresina, John Ph.D. (NASA Ames Research Center) Gregory, Kevin M.S. (San Jose State University Research Foundation) Zheng, Jimin M.S. (San Jose State University Research Foundation) Edwards, Tamsyn Ph.D. (San Jose State University Research Foundation)		
Grant/Contract No.:	Internal Project		
Performance Goal No.:			

Performance Goal Text:	
Task Description:	This task is part of the Human Capabilities Assessments for Autonomous Missions (HCAAM) Virtual NASA Specialized Center of Research (VNSCOR). As NASA considers long-duration exploration missions (LDEMs), it is envisioned that crew will behave more autonomously as compared to low-Earth orbit missions. In this space environment, crew will have better and more timely insight as to how best to manage their own schedule, minimizing idle time as they wait for Mission Control Center (MCC) to respond or react to a delay in activity execution. Moreover, crew must be able to self-schedule: reschedule their own timeline without creating violations. NASA currently has not characterized crew performance for self-scheduling; specifically, non-expert human performance for the task of planning and scheduling has not been characterized experimentally. The focus of this proposal is to quantify crew performance envelope for the task of planning and scheduling as a function of plan complexity, and develop mitigations that are aimed at improving performance in the face of complex planning requirements. With regards to crew performance, we will study the relationship between planning efficiency, effectiveness, crew situation awareness, trust in planning software, and plan complexity. Once a performance envelope has been identified, we will shift our research emphasis to develop and evaluate countermeasures that mitigate adverse effects on performance. These mitigations will be evaluated in analogs and recommended countermeasures will be put forward if crew performance improves as compared to the baseline. Finally, based on research results, we will recommend corresponding standards and guidelines appropriate for autonomous crew in LDEMs.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	NASA currently has not characterized crew performance for self-scheduling; specifically, non-expert human performance for the task of planning and scheduling has not been characterized experimentally. As a result of this research, we will quantify the user performance envelope for the task of planning and scheduling, which impacts many jobs both on Earth and in spaceflight. The knowledge gained from our research can be generalized to benefit our understanding on how to improve roles that require planning and scheduling, such as project planning, personnel scheduling, and operational management. Our research will also contribute to developing the next generation of planning, scheduling, and execution software tools for NASA.
Task Progress:	As NASA considers long-duration exploration missions (LDEMs), it is envisioned that crew will behave more autonomously as compared to low-Earth orbit missions. In this space environment, crew will have better and more timely insight as to how best to manage their own schedule, minimizing idle time as they wait for MCC to respond or react to a delay in activity execution. Moreover, crew must be able to self-schedule: reschedule their own timeline without creating violations. NASA currently has not characterized crew performance for self-scheduling; specifically, non-expert human performance for the task of planning and scheduling has not been characterized experimentally. The focus of this research is to quantify crew performance envelope for the task of planning and scheduling as a function of plan complexity, and develop mitigations that are aimed at improving performance in the face of complex planning requirements. With regards to crew performance, we will study the relationship between planning efficiency, effectiveness, crew situation awareness, trust in planning software, and scheduling task complexity. Once a performance envelope has been identified, we will shift our research emphasis to develop and evaluate countermeasures that mitigate adverse effects on performance. These mitigations will be evaluated in analogs and recommended countermeasures will be put forward if crew performance improves as compared to the baseline. Finally, based on research results, we will recommend corresponding standards and guidelines appropriate for autonomous crew in LDEMs. For Year 1 (4/2019 – 4/2020), this research completed a first pilot study evaluating human scheduling performance, completed a usability test assessing human scheduling strategies, and developed an analog experiment for Human Exploration Research Analog (HERA) Campaign 6. The pilot study (9 subjects) evaluated the scheduling performance on naïve users using Playbook as the scheduling platform. This is the first controlled experiment of its kind on this platform and significant effort was undertaken in order to support it (as Playbook is an operational software tool, not a research platform). Participants were naive to scheduling tasks and Playbook scheduling software. The sample was self-selected as participants volunteered to take part. The study utilized a 3x3 design. The independent variables were the number of activities to be scheduled and percentage of activities to be scheduled that had constraints. Participants received four training sessions, totaling to around 30 minutes that focused on how to use Playbook prior to experimental trials. Participants were then tasked to complete nine self-scheduling trials on an iPad. For each trial, participants answered Situation Awareness questions and completed a subjective workload assessment (NASA TLX). At the end of the experiment, participants completed a trust and usability survey (UEQ). Throughout the trial, data was collected in order to measure human performance. Initial findings were presented at the Human Research Program (HRP) Investigator Workshop (1/2020). Results suggest that increasing the number of activities decreases human performance and increases workload. Percentage of activities with constraints also significantly contributed to scheduling efficiency. In collaboration with San Jose State Research Foundation and Center for Human Factors in Advanced Aeronautics Technology (at California State University, Long Beach), we conducted a usability test whose objective was to assess if different scheduling strategies emerged from Playbook naive users. Leveraging previously generated scheduling problems, we gave ten users three scheduling tasks, increasing in difficulty. The design of the user test was a modified Think Aloud Protocol, adapted to collect data on strategies implemented specifically. Users were not guided to select or develop a particular scheduling strategy. Seven scheduling strategies emerged from just these three scheduling problems. This is more diverse than expected. Users stuck with strategies even when aspects of the task had changed which make the current strategy no longer effective. Users with some background in scheduling (e.g., experienced registered nurse and project manager) tended to perform better in terms of completion time. Lessons learned will be incorporated into the future experiment. During the Face-to-Face, VNSCOR HCAAM team agreed to participate in the HERA Campaign 6. As part of this requirement, we have requested and received NASA Johnson Space Center (JSC) Institutional Review Board (IRB) approval. We have also developed a research plan and experiment design for HERA analog as well as submitted the Science Requirement Document (SRD), software deliveries, and required procedures.
Bibliography Type:	Description: (Last Updated: 03/09/2020)

Abstracts for Journals and Proceedings	Marquez JJ, Lee C, Torr A, Edwards T, Bresina J, Gregory K. "Crew Autonomy through Self-Scheduling: Guidelines for Crew Scheduling Performance Envelope and Mitigation Strategies." 2020 NASA Human Research Program Investigators' Workshop, Galveston, TX, January 27-30, 2020. Abstracts. 2020 NASA Human Research Program Investigators' Workshop, Galveston, TX, January 27-30, 2020. , Jan-2020
Articles in Peer-reviewed Journals	Marquez JJ, Hillenius S, Zheng J, Deliz I, Kanefsky B, Gale J. "Designing for astronaut-centric planning and scheduling aids." Proceedings of the Human Factors and Ergonomics Society Annual Meeting. 2019 Sep;63(1):468-9. (63rd International Annual Meeting of the Human Factors and Ergonomics Society, Seattle, WA, October 2019.) https:// , Sep-2019
Papers from Meeting Proceedings	Marquez JJ, Hillenius S, Healy M, Silva-Martinez J. "Lessons Learned from International Space Station Crew Autonomous Scheduling Test." 11th International Workshop for Planning and Scheduling for Space, Berkeley, CA, July 8-10, 2019. 11th International Workshop for Planning and Scheduling for Space, Berkeley, CA, July 8-10, 2019. Paper ARC-E-DAA-TN70121. , Jul-2019