Fiscal Year:	FY 2021	**Task Last Updated:**	FY 02/12/2021
PI Name:	Marquez, Jessica J. 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:	None		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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City:	Moffett Field	**State:**	CA
Zip Code:	94035	**Congressional District:**	18
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	2017-2018 HERO 80JSC017N0001-BPBA Topics in Biological, Physiological, and Behavioral Adaptations to Spaceflight. Appendix C
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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
Contact Monitor:	Whitmire, Alexandra	**Contact Phone:**	
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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. February 2021 report: Dr. John Karasinski is now a Co-I.		
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) Karasinski, John Ph.D. (NASA Ames Research Center)		
Grant/Contract No.:	Internal Project		
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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:	TASK PROGRESS SUMMARY YEAR 2 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 how to best 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—that is 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 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 2 (4/2020 – 4/2021), we completed interviews with human spaceflight planning and scheduling subject matter experts (SME), designed a larger human-in-the-loop experiment, started data collection for said experiment, re-evaluated previous analog scheduling research, and continued preparations for an analog experiment for Human Exploration Research Analog (HERA) Campaign 6. Our team has published pilot study results from Year 1, preliminary results from the current experiment, presented in the Human Research Program Investigator Workshop, and contributed to two book chapters. Seven SMEs were interviewed in order to acquire subjective assessment on what makes a plan complex to schedule and what makes a good plan for astronauts. The SMEs were experienced human spaceflight flight controllers, mostly current or recently former planners from International Space Station and Shuttle programs. Based on these interviews, our team prioritized experimental design factors for scheduling task complexity and received insight into appropriate measures for situation awareness as well as “plan goodness.” Our main focus for Year 2 is the completion of a large human-in-the-loop experiment evaluating human scheduling performance as a function of scheduling task complexity. An experiment was designed and software was developed in order to conduct this experiment completely remotely (as required by the on-going pandemic circumstances). Our custom experimental testing platform called ESSEX (Environment for Self-Scheduling Experiment) enabled our research team to collect objective and subjective data on remote participants while completing experimental tasks on Playbook (scheduling software platform). Power analysis showed we need 30 participants for a mixed factorial design 2 x 2 x 4 experiment design. One between-subject factor is type of task (scheduling and rescheduling), while there are two within-subject factors: percent of activities with constraints (low and high) and type of activity constraints. Dependent variables include: efficiency (e.g., time on task), effectiveness (e.g., number of violations), situation awareness, workload, trust, and usability. Additionally, we have developed and implemented an algorithm to evaluate the scheduling tasks in order to rank and compare against human performance measures. While recruiting remote participants is slower than anticipated, data collection will be completed by end of Year 2. Due to the pandemic, data collection for the experiment in HERA Campaign 6 has been postponed. Limited work on this experiment focused on: completing data sharing agreements, developing “plan goodness” survey for analog participants, and improving our data collection methods for analog environment. In lieu of this research, we conducted a retrospective, exploratory analysis of scheduling tasks performed by HERA Campaign 3 analog crewmembers. Because previous research focused on usability only, this exploratory analysis emphasized performance. Several factors have limited our analysis: inconsistent use of scheduling task complexity factors, data log inconsistencies, and missing data logs. However, we were able to identify at least three measures: time on task, number of violations left in the timeline, and subjective ratings of difficulty. We have learned that while subjective ratings are useful, they do not necessarily correlate with objective scheduling performance measures. Both are critical for the evaluation of human performance in

	an analog environment. Subjective ratings tend to be aligned with time on task, though there is insufficient data for statistical analysis.
Bibliography Type:	Description: (Last Updated: 03/21/2024)
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