Fiscal Year:	FY 2022	**Task Last Updated:**	FY 04/25/2022
PI Name:	Fischer, Ute Ph.D.		
Project Title:	Understanding Key Components of Successful Autonomous Space Missions		
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 Cognitive or Behavioral Conditions and Psychiatric Disorders (2) **Team**:Risk of Performance and Behavioral Health Decrements Due to Inadequate Cooperation, Coordination, Communication, and Psychosocial Adaptation within a Team		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Comments:	NOTE: The NSSC also lists the PI as Ute Fischer-Loss (Ed., March 2025).		
Project Type:	Ground	**Solicitation / Funding Source:**	2015-16 HERO NNJ15ZSA001N-Crew Health (FLAGSHIP, NSBRI, OMNIBUS). Appendix A-Crew Health, Appendix B-NSBRI, Appendix C-Omnibus
Start Date:	06/29/2016	**End Date:**	03/31/2024
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:	0	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	0	**Monitoring Center:**	NASA JSC
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Flight Program:			
Flight Assignment:	NOTE: End date changed to 3/31/2024 per NSSC information (Ed., 7/12/21) NOTE: End date changed to 6/28/2021 per NSSC information (Ed., 5/21/2020) NOTE: End date changed to 6/28/2020 per L. Juliette/HRP (Ed., 2/19/2020) NOTE: Element change to Human Factors & Behavioral Performance; previously Behavioral Health & Performance (Ed., 1/18/17)		
Key Personnel Changes/Previous PI:	May 2020 report: Dr. Tofighi withdrew as Co-Investigator from the project effective July 1, 2019.		
COI Name (Institution):	Mosier, Kathleen Ph.D. (Teamscape LLC)		
Grant/Contract No.:	NNX16AM16G		
Performance Goal No.:			

Performance Goal Text:	
Task Description:	Exploration space missions will require that space crews manage tasks more autonomously than in current operations, although they will continue to be part of the multi-team system (MTS) comprised of members in space and on the ground. The overall goal of the proposed research is to develop countermeasures that will enhance the ability of MTS members to maintain effective team performance and manage autonomous operations during Long Duration Exploration Missions (LDEMs). We will use NASA Life Sciences Data Archive (LSDA) data collected in space analogs and the International Space Station (ISS) to develop models of the individual- and team-level relationships between crew autonomy, emergent states, and team performance. Additionally, several simulations will be conducted in space analogs to assess the impact of different autonomy implementations on MTS performance in long-duration missions. Data from this study will be used to refine the individual- and team-level models, and to create a MTS-level model of the autonomy-performance relationship. Our approach is comprehensive in that we will examine different implementations and levels of autonomy, experience with interdependent and autonomous operations, individual and team process variables as well as varying task constraints. A set of products to support space and mission control teams during long-duration exploration missions will be delivered. These include: a validated model of factors related to team autonomy and team performance in LDEMs; recommendations for how team autonomy should be managed within a MTS during LDEMs, including countermeasures to mitigate potential negative effects; and recommendations for future research on autonomous team functioning.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Multiteam collaboration is not a unique feature of spaceflight operations but common to many organizations, as is the question of how best to implement task autonomy within a multiteam system. We therefore expect that our research findings not only generalize to other isolated and confined extreme (ICE) environments, such as Antarctica, but also apply to any organization that require the collaboration by different work units.
Task Progress:	Phase-2: Research in Long-duration Exploration Mission Simulations Our research is included in the NASA Human Exploration Research Analog (HERA) Campaign 6 (C6) and the 2021 Scientific International Research In a Unique terrestrial Station (SIRIUS 21) analog at the NEK (Nezemnyy Eksperimental'nyy Kompleks) facility. Both simulations were originally scheduled to start in November 2020 but had to be postponed until fall 2021 due to the Covid-19 pandemic. The first mission of HERA C6 was conducted during September and November 2021; mission 2 during January and March 2022. Missions 3 and 4 are scheduled to commence in May and August 2022, respectively. SIRIUS 21, an 8-month space simulation, started in November 2021 and is still ongoing. In the present report, we summarize data collected thus far and discuss them in relation to the preceding HERA C5 and SIRIUS 19 simulations. The focus of the report is on the crew/mission control center (MCC) multiteam system (MTS); analyses on the team (crew and MCC) and individual level are ongoing and have not been included. HERA C6 – Examining the Impact of Increasing Crew Autonomy on the Crew/MCC MTS The four missions of HERA C6 follow the general mission design implemented in HERA C5 concerning crew size (4 members), duration (45 days), mission objectives (conduct geological operations at a near-Earth asteroid and an array of life science experiments), mission schedule, and presence of communication delays (30sec, 1 min, 3 min, and 5 min, dependent on simulated distance to Earth). They differ from C5 missions insofar as they incorporate a crew autonomy manipulation of increasing autonomy. Crew autonomy is gradually introduced with the onset of delays in space/ground communication and after an initial period of no-autonomy, and involves giving a crew increasing control over the schedule of operational tasks. C6 missions also replicate our study design implemented in C5; that is, the same 8 experimental tasks (for the crew unexpected off-nominal events) were built into a mission and the same surveys administered to crewmembers and mission control personnel. As in HERA C5, surveys explore the team concept held by crewmembers and mission controllers, their perception of task and social cohesion among members of the space/ground multiteam system, and their assessment of the multiteam system's efficacy. Task-related surveys ask crewmembers and mission controllers to evaluate their teamwork on operational tasks, task performance, and the crew's and MCC staff's task contribution. Presently we have collected data from 2 missions involving 8 crewmembers and 9 mission control personnel. Our analysis of HERA C6 data thus far indicate little impact of crew autonomy on relevant team variables –crewmembers' and MCC's team concept; social and task cohesion between crew and MCC; participants' assessment of the efficacy of the crew/MCC MTS and their task management and performance—if they are examined on the team level. MCC personnel and crewmembers in the two autonomous missions examined to date showed responses comparable to those given by participants in missions involving no crew autonomy. Once data collection is complete, multi-level analyses will be conducted to account for individual differences in participants' attitudes towards and responses to autonomy. Moreover, crewmembers indicated in survey responses and the post-mission interview that they had experienced relatively low levels of autonomy throughout a mission which, in turn, may have influenced how they perceived their team and relationship with MCC. Analysis of post-mission interviews with crewmembers and MCC personnel identified several issues that point to specific countermeasures to support space/ground collaboration during exploration missions. While interviews with participants in upcoming HERA missions (M3 and M4) and the SIRIUS 21 crew may provide further insights, critical issues raised thus far were: (1) diverging expectations by crew and MCC concerning their own and the other team's role and responsibilities during autonomous missions, and (2) insufficient trust and communication between members of the crew/MCC multiteam system – issues that could be addressed through team training involving members of both crew and MCC as well as through the modification of existing procedures specifying space/ground collaboration. SIRIUS 21 –Examining the Impact of High Crew Autonomy on the Crew/MCC MTS SIRIUS 21 is currently ongoing, with a scheduled end date of July 2, 2022. This 8-month mission replicates the mission design of the previous 4-month SIRIUS 19 mission and includes extended lunar operations to accommodate the longer mission duration. The multi-national crew of six includes 3 Russian participants, 2 from the US and 1 from the United Arab Emirates (UAE). 23 participants serve as ground support (MCC). The study design replicates our work in SIRIUS 19 as well as HERA C5 and C6 missions, with surveys probing crewmembers' and mission controllers' team concept, and their perception of social and task cohesion among members of the space/ground MTS – and tap their shared

	understanding of task and teamwork. Our analyses indicate that in both SIRIUS simulations divergent perspectives were apparent between SIRIUS crewmembers and mission controllers in their judgment of cohesion in the space/ground MTS and its efficacy. SIRIUS crewmembers perceived less unity with and closeness to mission controllers than vice versa and, more importantly, they also perceived less shared task commitment between members of the multiteam system than mission controllers. Likewise, crewmembers were less confident than mission controllers that their teams were able to communicate and collaborate effectively. One contrast in the SIRIUS missions appeared in their assessment of MCC's importance to task success. SIRIUS 19 crewmembers tended to perceive a bigger role of MCC in task success than crewmembers in SIRIUS 21 who did not attribute much weight to MCC. Because these findings are based on one space simulation and one ongoing simulation involving two teams of crewmembers and mission controllers, it is certainly premature to draw any conclusions about the impact of crew autonomy on the crew/MCC multiteam system. Nonetheless, it is worth pointing out that some of our observations, notably concerning MTS cohesion and efficacy and perceptions of teamwork, are consistent with the hypothesis that crew autonomy may disrupt common ground between crewmembers and mission controllers.
Bibliography Type:	Description: (Last Updated: 03/22/2024)