Fiscal Year:	FY 2013	**Task Last Updated:**	FY 07/07/2013
PI Name:	Fischer, Ute Ph.D.		
Project Title:	Protocols for Asynchronous Communication in Space Operations: Communication Analysis		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Behavior and performance		
Joint Agency Name:		**TechPort:**	Yes
Human Research Program Elements:	(1) **BHP**:Behavioral Health & Performance (archival in 2017)		
Human Research Program Risks:	(1) **HSIA**:Risk of Adverse Outcomes Due to Inadequate Human Systems Integration Architecture (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		
PI Email:	ute.fischer@gatech.edu	**Fax:**	FY
PI Organization Type:	UNIVERSITY	**Phone:**	404-894-7627
Organization Name:	Georgia Institute of Technology		
PI Address 1:	School of Literature, Communication and Culture		
PI Address 2:	686 Cherry Street		
PI Web Page:			
City:	Atlanta	**State:**	GA
Zip Code:	30332-0165	**Congressional District:**	5
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	2011 Crew Health NNJ11ZSA002NA
Start Date:	09/06/2012	**End Date:**	09/05/2015
No. of Post Docs:		**No. of PhD Degrees:**	
No. of PhD Candidates:		**No. of Master' Degrees:**	2
No. of Master's Candidates:	8	**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:	2	**Monitoring Center:**	NASA JSC
Contact Monitor:	Leveton, Lauren	**Contact Phone:**	
Contact Email:	lauren.b.leveton@nasa5.gov		
Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Mosier, Kathleen (California State University, San Fransisco)		
Grant/Contract No.:	NNX12AR19G		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Effective and efficient communication between Mission Control and space crews is essential for successful task performance and mission safety. The importance of team communication is heightened when unforeseen problems arise, such as system failures that are time-critical and require extensive coordination and collaboration between space and ground crews. During long duration missions and missions beyond Low Earth Orbit, space-ground communications will involve delays up to 20 minutes one way, a reality that poses a formidable challenge to team communication and task performance. This project will determine how transmission delays impact team communication, teamwork, and task performance in relation to varying task demands and media constraints. A series of four studies will be conducted involving laboratory experiments and research in space-analog environments. The overall aim of the proposed research is to develop and validate protocols supporting Mission Control–space crew communication and collaboration during long-duration space missions. Specific project goals are: (1) Determine the impact of communication delays on communication, teamwork, and task performance in relation to varying task demands, i.e., procedural tasks vs. tasks requiring analysis and decision making, and different communication media (voice vs. text). (2) Develop and validate measures to assess and characterize team communication effectiveness and task performance in relation to different operational tasks. (3) Develop and validate communication protocols to support joint problem solving and decision making by mission controllers and space crews during periods of asynchronous communication.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Our research will result in communication protocols and/or procedures that will support collaborative problem solving and decision making by teams that are distributed across Earth and space and communicating asynchronously. Communication protocols resulting from this research could also be used to support collaborative work within on-ground distributed synchronous teams, for instance during military operations or in telemedicine.
Task Progress:	Our goals for Year 1 were to conduct two empirical studies addressing Objective 1: Determine the impact of communication delays on communication, teamwork, and task performance in relation to varying task demands, i.e., procedural tasks vs. tasks requiring analysis and decision making, and different communication media (voice vs. text). Study 1 consists of an analysis of crew-ground communications under various transmission delays. These data were collected during the Autonomous Mission Operations (AMO) study conducted in the Deep Space Habitat (DSH) at JSC in May/June 2012. Study 2 is a laboratory experiment examining the impact of transmission delay on team communication under different media conditions and in relation to different task characteristics. Despite delays in initial funding, we are on target with respect to both of these goals: Study 1 has been completed; Study 2 is ongoing and will be completed by end of Year 1. Moreover, our costs have remained within the projected budget. Study 1: Exploratory Communication Analysis of AMO Simulation Data. Our analysis of the AMO communication data examined how transmission delays of 50 sec and 300 sec impacted the interactions between flight controllers and space crews during routine and off-nominal tasks. There were four teams; each consisting of eight flight controllers and four space crewmembers. Audio-recordings of space-ground communications were transcribed and their structure (turn taking and sequence) and content examined. Our analysis addressed communication problems as well as communication strategies that may have helped the flight controllers and space crews establish and maintain common ground (i.e., mutual task and situation awareness). Transmission delay, irrespective of length, disrupted the structure of space-ground communications as contributions by flight controllers and astronauts overlapped or were out of sequence. Both types of disruptions likely increase team members' cognitive workload. The former necessitates that speakers repeat their contributions while the latter requires team members to keep track of multiple open issues. Transmission delays were also associated with several problems of communication content: (a) Space crewmembers and flight controllers did not consistently identify themselves or their addressee at the beginning of a turn; (b) they frequently failed to mark the end of their turn, for instance by using phrases such as over; and (c) they tended to provide minimal or ambiguous evidence of their understanding, or failed to respond altogether to a partner's communication. While dropped identifiers apparently did not hamper space-ground communications in our sample, this behavior could potentially impair mutual understanding as partners may mistake the identity of the speaker or recipient of a communication and ultimately may misunderstand its intended meaning. Inadequate listener feedback, such as we copy all, or we copy your last (after several transmissions by the same speaker), indicate receipt of a message but deprive speakers of the opportunity to verify that their message was understood as intended. Omissions of identifiers and inadequate listener feedback were observed under both transmission delay conditions. Our analysis also underscored the importance of several strategies that could support team communication under time-delayed conditions. Turn taking seemed to be facilitated if speakers announced specific times at which their addressees could expect a transmission. Mutual understanding may also be enhanced when speakers specify the topic of a message, present complex messages in meaningful chunks, and repeat crucial information. Listeners, in turn, need to provide evidence of their understanding so that problems of hearing and comprehension are detected and repaired as quickly as possible. Study 1 provided first insights into the effects of transmission delays on team communication; however, it is limited by its small sample and the fact that there was no synchronous condition included in the experimental design. Study 2 was designed to build on our analysis in Study 1 by conducting a lab experiment to investigate team communication under synchronous and asynchronous conditions with a larger sample. Study 2: Impact of Communication Delay on Teamwork and Task Performance. The overall aim of Study 2, currently being conducted at San Francisco State University, is to determine the impact of transmission delay on team communication and task performance in relation to varying task demands (procedural vs. ill-defined), and different communication media (voice vs. text). Spatially distributed teams of three collaborate in a computer-based task environment and communicate either by voice-over-internet or via a texting tool. The micro-world for the study is AutoCAMS 2.0 (Manzey et al., 2008) which simulates the life support system of a spacecraft and requires team members to monitor and control different subsystems, and to diagnose and repair failures. Each team is required to perform procedural and problem solving tasks during one synchronous and one asynchronous (5-min delay) flight segment. The experiment extends through two days: day 1 involves 2-3 hours of position-specific (Flight System Engineer, FSE, or Pioneer Crewmember) task training; day 2 consists of two 90-minute experimental sessions. Task performance measures (i.e., interactions with the AutoCAMS system) are collected by the computer-based

	experimental task. Task performance measures include time to task completion, thoroughness of diagnosis and of procedure, and accuracy on main and secondary tasks. Communication measures. Team members' voice communications are recorded on the time-delay server as mp3 files and transcribed for coding; team members' email messages are simply uploaded. Team members are also video-recorded as visual data provides contextual information facilitating communication analyses. The analysis of team members' voice and text-based communications includes the same process and content variables examined in Study 1. Predictions: Communication media and transmission delay will significantly impact communication strategies and task performance. We hypothesize that transmission delay will be associated with decrements in task performance, less explicit and less structured communication, more misunderstandings, and more conflict compared with synchronous communication. These effects are predicted to be most evident when team members perform ill-defined (problem solving) tasks and rely on voice communication. To date, 19 teams have completed the experiment. Data collection and analysis is ongoing and expected to be completed by the end of Year 1. Preliminary analyses of task performance data indicate that diagnoses and correct repairs were accomplished more quickly when there was no time delay compared to legs with time delay, and suggest that team collaboration may be facilitated by voice communication during synchronous conditions while as hypothesized, text-based communication may enhance task performance during asynchronous conditions. Problems concerning the structure and content of team members' communications have been identified, as well as strategies that may support mutual understanding. Once data collection is complete, statistical analyses will be conducted to relate communication delay and media conditions to task characteristics, team performance and team communication measures. Reference: Manzey, D., Bleil, M., Bahner-Heyne, J. E., Klostermann, A., Onnasch, L., Reichenbach, J., & Röttger, S. (2008). AutoCAMS 2.0 Manual. Berlin: Technical University of Berlin.
Bibliography Type:	Description: (Last Updated: 03/22/2024)
Abstracts for Journals and Proceedings	Fischer U, Mosier K, Orasanu J. "Issues of Grounding and Team Coordination in Asynchronous Communication." Presented at the 11th International Conference on Naturalistic Decision Making, Marseille, France, May 22-24, 2013. 11th International Conference on Naturalistic Decision Making, Marseille, France, May 22-24, 2013. , May-2013
Abstracts for Journals and Proceedings	Mosier K, Fischer U, Munc A, Reich K, Fox D, Swarts J, Maurath D, Carucci L, Orasanu J. "Asynchronous Communication in Space Operations." Presented at the 2013 San Francisco State University Graduate Studies Showcase, San Francisco, CA, May 2, 2013. 2013 San Francisco State University Graduate Studies Showcase, San Francisco, CA, May 2, 2013. , May-2013
Books/Book Chapters	Fischer U, Mosier K, Orasanu J. "Issues of grounding and team coordination in asynchronous mission control-space crew interactions." in "Proceedings of the 11th International Conference on Naturalistic Decision Making." Ed. H. Chaudet, L. Pellegrin, N. Bonnardel. Paris, France : Arpege Science Publishing, 2013. p. 193-196., May-2013
Papers from Meeting Proceedings	Fischer U, Mosier K, Orasanu J. "The impact of transmission delays on Mission Control-Space Crew Communication." 57th Annual Meeting of the Human Factors and Ergonomics Society, San Diego, CA, September 30-October 4, 2013. Proceedings of the 57th Annual Meeting of the Human Factors and Ergonomics Society. In press, as of July 2013. , Jul-2013
Papers from Meeting Proceedings	Fischer U, Mosier K, Morrow D, Miller C, Veinott B, Orasanu J. "Exploring Communication in Remote Teams: Issues and Methods." 57th Annual Meeting of the Human Factors and Ergonomics Society, San Diego, CA, September 30-October 4, 2013. Panel organized for the meeting. Proceedings of the 57th Annual Meeting of the Human Factors and Ergonomics Society. In press, as of July 2013. , Jul-2013