Fiscal Year:	FY 2019	**Task Last Updated:**	FY 08/13/2019
PI Name:	Stuster, Jack W. Ph.D.		
Project Title:	Generalizable Skills and Knowledge for Exploration Missions		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Space Human Factors Engineering		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **HFBP**:Human Factors & Behavioral Performance (IRP Rev H)		
Human Research Program Risks:	(1) **HSIA**:Risk of Adverse Outcomes Due to Inadequate Human Systems Integration Architecture		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
PI Email:	jstuster@anacapasciences.com	**Fax:**	FY
PI Organization Type:	INDUSTRY	**Phone:**	805-680-1315
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PI Address 1:	1516 Marquard Terrace		
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PI Web Page:	http://www.anacapasciences.com		
City:	Santa Barbara	**State:**	CA
Zip Code:	93101-4967	**Congressional District:**	24
Comments:	New address per PI (12/2012); previous address--301 East Carrillo Street, Santa Barbara, CA		
Project Type:	Ground	**Solicitation / Funding Source:**	2014-15 HERO NNJ14ZSA001N-Crew Health (FLAGSHIP & NSBRI)
Start Date:	09/10/2015	**End Date:**	08/09/2019
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:	Williams, Thomas	**Contact Phone:**	281-483-8773
Contact Email:	thomas.j.will1@nasa.gov		
Flight Program:			
Flight Assignment:	NOTE: Change in grant number to 80NSSC18K0042 per NSSC information (Ed., 6/12/18) NOTE: Change in grant number to NNX16AQ86G by NSSC and grant extended to 8/09/2019, per D. Risin/JSC (Ed., 6/21/17) NOTE: Element change to Human Factors & Behavioral Performance; previously Space Human Factors & Habitability (Ed., 1/19/17)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Adolf, Jurine Ph.D. (NASA Johnson Space Center) Byrne, Vicky M.S. (Lockheed Martin/NASA Johnson Space Center)		
Grant/Contract No.:	80NSSC18K0042 ; NNX16AQ86G ; NNX15AW34G		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	This study addresses the Risk of Inadequate Mission, Process, and Task Design and the Risk of Performance Errors Due to Training Deficiencies by identifying the tasks that will be performed during the first human expeditions to Mars and the abilities and skills that will be required of crew members. The research team developed an inventory of 1,125 tasks that are likely to be performed during the 12 phases of a conjunction-class Mars expedition, from launch to landing 30 months later. More than 60 subject matter experts (SMEs) rated major categories of expedition tasks in terms of (likely) frequency, difficulty to learn, and importance to mission success; a fourth metric was derived by combining the mean ratings of the three dimensions. SMEs also placed the physical, cognitive, and social abilities necessary to perform the tasks in order of importance for the specialist domains identified by the task analysis. The data enabled the research team to identify: 1) Eight occupational specialties needed to perform the 1,125 tasks; 2) The relative importance of 58 abilities and skills for each specialty; 3) Abilities that can be generalized across tasks and specialist domains; 4) Optimum crew size, composition, and personnel-selection issues; 5) Cross-training strategies to minimize crew size; and, 6) Implications of study results to the design of equipment, habitats, and policies for exploration-class space missions. The final report documents all study procedures and presents results of the task and ability analyses; lists of Mars expedition and Gateway tasks are included. NOTE: Change in grant number to 80NSSC18K0042 per NSSC information (Ed., 6/12/18) NOTE: Change in grant number to NNX16AQ86G by NSSC and grant extended to 8/09/2019, per D. Risin/JSC (Ed., 6/21/17)
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	The method that was developed for this project to identify and analyze expected tasks during a three-year expedition to Mars could serve as a model for future human factors research concerning large-scale systems. The number of tasks identified is an order of magnitude larger than that of a typical HF (human factors) analysis, and the complexity of the systems involved and the duration of the expedition render the effort unique.
Task Progress:	The report that documents research conducted under Cooperative Agreement 80NSSC18K0042 presents the results of a three-year study to identify the abilities and skills that will be required among the crews of the first human expeditions to Mars. The final report was submitted to NASA in December 2018, on the 50th anniversary of Apollo 8's historic voyage around the Moon; the research team received notice from NASA that the report was published on 16 July 2019, the 50th anniversary of Apollo 11's launch; and, a PDF of the report was sent to nearly 200 subject matter experts who contributed to the study on 20 July 2019 as the world celebrated the 50th anniversary of Apollo 11's landing on the Moon. The report begins with historical information that establishes the context of the research and is followed by a summary of Mars mission planning, from von Braun's Das Marsprojekt to the present. The report then presents an analysis of 1,125 tasks identified by the research and the cognitive, physical, and social abilities needed by crew members to perform the tasks during a 30-month, conjunction-class expedition. The report concludes with data-driven recommendations concerning equipment, procedures, and crew size and composition. A list of 647 tasks that are likely to be performed during a Gateway mission is presented as an appendix. The research was conducted for the Human Factors and Behavioral Performance Element, Human Research Program, located at the National Aeronautics and Space Administration's (NASA) Johnson Space Center. The research addresses the Risk of Inadequate Mission, Process, and Task Design and the Risk of Performance Errors Due to Training Deficiencies during exploration-class space missions by identifying the tasks that will be conducted by human crew during an expedition to Mars and the abilities, skills, and knowledge that will be required of crew members. By focusing on an expedition to Mars, we have considered the extremes of what is possible for human space exploration during the first half of the 21st Century and accommodated the human requirements for missions to asteroids, Cis-Lunar orbit, and a return to the Moon. The study uses research methods that were developed to analyze the work performed by a variety of civilian and military occupational specialties and is consistent with Human Factors methods. The work began by developing a comprehensive inventory of 1,125 tasks that are likely to be performed during the 12 phases of the first human expeditions to Mars, from launch to landing 30 months later. Sixty subject matter experts (SMEs) rated expedition tasks in terms of (likely) frequency, difficulty to learn, and importance to mission success; a fourth metric was derived by combining the mean ratings of the three dimensions. Seventy-two SMEs placed the physical, cognitive, and social abilities necessary to perform the tasks in order of importance for specialist domains identified by the task analysis. The research team then identified, 1) Abilities, skills, and knowledge that can be retained and generalized across tasks; 2) Optimum training strategies; and 3) Implications for crew size and composition. Study results also led to recommendations concerning equipment, habitats, and procedures for exploration-class space missions. The report describes why the study was conducted, describes the research tasks performed and study results, and concludes with a discussion of operational implications and recommendations based on those results. Appendices present details of the procedures used, a complete list of Mars expedition tasks (by mission phase), a list of tasks that are likely to be performed during expeditions to a Cis-Lunar Gateway, and the names of SMEs who contributed to the study. Note: The full-mission task inventory presented in the report was developed during a comprehensive review of documentation and concepts of operations. It is understood by the study team that the tasks are based on currently-available information and that the tools, equipment, propulsion methods, and/or other aspects of actual human expeditions to Mars might be different from those described, as a consequence of technological development and evolving Mars Design Reference Missions.
Bibliography Type:	Description: (Last Updated: 11/13/2019)
NASA Technical Documents	Stuster J, Adolf J, Byrne V, Greene M. "Generalizable Skills and Knowledge for Exploration Missions." Houston, Tex. : NASA Lyndon B. Johnson Space Center, 2019. 188 p. NASA Contractor Report-2018-220445. http://www.spacearchitect.org/pubs/NASA-CR-2018-220445.pdf , Jul-2019

NASA Technical Documents	Stuster J, Adolf J, Byrne V, Greene M. "Human Exploration of Mars: Preliminary Lists of Crew Tasks." Houston, Tex. : NASA Lyndon B. Johnson Space Center, 2018. 54 p. NASA Contractor Report-2018-220043. https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20190001401.pdf , Jun-2018