Fiscal Year:	FY 2017	**Task Last Updated:**	FY 06/02/2017
PI Name:	Salas, Eduardo Ph.D.		
Project Title:	Evidence-based Metrics Toolkit for Measuring Safety and Efficiency in Human-Automation Systems--NNX15AR28G		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Space Human Factors Engineering		
Joint Agency Name:		**TechPort:**	Yes
Human Research Program Elements:	(1) **HFBP**:Human Factors & Behavioral Performance (IRP Rev H)		
Human Research Program Risks:	(1) **HARI**:Risk of Inadequate Design of Human and Automation/Robotic Integration		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
PI Email:	eduardo.salas@rice.edu	**Fax:**	FY
PI Organization Type:	UNIVERSITY	**Phone:**	713-348-3917
Organization Name:	Rice University		
PI Address 1:	Department of Psychology		
PI Address 2:	6100 Main Street MS25		
PI Web Page:			
City:	Houston	**State:**	TX
Zip Code:	77005	**Congressional District:**	7
Comments:	NOTE: Previous affiliation was University of Central Florida, until mid-2015		
Project Type:	GROUND	**Solicitation / Funding Source:**	2012 Crew Health NNJ12ZSA002N
Start Date:	08/01/2015	**End Date:**	06/30/2018
No. of Post Docs:	0	**No. of PhD Degrees:**	1
No. of PhD Candidates:	1	**No. of Master' Degrees:**	0
No. of Master's Candidates:		**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	1	**Monitoring Center:**	NASA ARC
Contact Monitor:	Gore, Brian	**Contact Phone:**	650.604.2542
Contact Email:	brian.f.gore@nasa.gov		
Flight Program:			
Flight Assignment:	NOTE: End date change to 6/30/2018 per NSSC information and E. Connell/HRP (Ed., 5/3/18) NOTE: End date change to 4/30/2018 per NSSC information (Ed., 8/9/17) 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):			
Grant/Contract No.:	NNX15AR28G		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	NOTE: Continuation of "Evidence-based Metrics Toolkit for Measuring Safety and Efficiency in Human-Automation Systems," grant #NNX13AO51G with Principal Investigator (PI) Eduardo Salas, Ph.D., due to PI move in mid-2015 to Rice University from University of Central Florida. Specific aims of this proposal are threefold: (1) develop a framework for human-systems integration requirements, (2) identify and develop a metrics criteria in which safety and efficiency can be characterized in human-automation teams, and (3) design, develop, and validate a theoretically-driven, empirically-based metrics toolkit that characterizes the safety and efficiency of human automation interactions. This proposal meets NASA goals and objectives by mitigating the risk of inadequate design of human and automation/robotic integration through the development of safety and efficiency metrics for human-automation systems. The proposal is divided into three primary phases. Phase 1 will consist of synthesizing and translating findings from the extant literature relevant to human automation/robotic integration. The result of this effort will be the development of objective metrics generalizable to individual and team levels that characterize the safety and efficiency of a human automation interaction. The final outcome of Phase 1 will be the development of a human automation interaction metrics (HAIM) toolkit. Phase 2 will involve in-depth preparation for scientifically sound experiments. Phase 2 ensures adequate time and methodology for meaningful outcomes for Phase 3. The central outcome of Phase 2 will be the final development of the experimental testbed and experimental protocol. Phase 3 will involve preparation for, and execution of, experiments. This will include the design and execution of a set of multi-level empirical studies aimed at validating the metrics toolkit. The validation studies will focus on testing different aspects of human automation interaction (e.g., levels of automation, task complexity, and the number and configuration of system operators). The outcome of the proposed effort will provide NASA a set of evidence-based, empirically-validated guidelines and a measurement toolkit for mitigating the risk of inadequate design of human and automation/robotic integration as it pertains to the development of safety and efficiency metrics for human automation systems.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	
Task Progress:	The Rice University research team continues to work to provide a tool guiding the evaluation of human-automation systems. Research and design efforts throughout the life-cycle of this project have focused on developing best practices for human-automation system measurement and incorporating these best practices into a web-based decision aid tool for providing system designers with practical guidelines and recommendations for how to evaluate their systems. Recent progress has focused on development of this online tool, called HASMAT: Human Automation System Measurement and Assessment Toolkit. Development of HASMAT has followed an iterative design and development process including multiple phases of prototype design, testing, and revision. Major accomplishments during this year have included (1) transitioning the toolkit decision tree architecture, which was developed in the previous year, into the design of the first HASMAT prototype, (2) testing the prototype using validated usability evaluation techniques, (3) developing a second HASMAT prototype based on results from initial evaluations, (4) testing of the second prototype in a structured laboratory based usability study utilizing NASA SMEs (subject matter experts), (5) development of a vast database of measurement information, guidelines, and tips to incorporate into the toolkit (in-progress), and (6) development of the final, fully automated, HASMAT prototype (in-progress). Research efforts this year began with the refinement of the toolkit decision tree architecture, which was developed during the previous year. Once refinement of this architecture was complete, it was used as a basis of the first toolkit prototype. This initial prototype was created using Axure prototyping software. The main goal for this initial prototype was to incorporate all decision tree questions, determine the most appropriate visual delivery method for the questions, and develop and ideal organization and flow of the questions within the decision tree. Once this initial prototype was complete, initial evaluation techniques were conducted by the Rice research team to evaluate all aspects of the initial prototype's design, flow, and support features. The results of these evaluations informed revisions to the toolkit. The second HASMAT prototype incorporated all recommendations for improvement that resulted from evaluations of the initial prototype. The purpose of this prototype was to provide a semi-functional prototype that could be tested with potential end-users. This prototype was still lacking automated measure selection features, but the decision tree architecture had been refined in this prototype and other features were added. Therefore, usability testing of this prototype with NASA SMEs focused on obtaining input as to how the decision tree architecture could be improved as well as the content that had already been incorporated into this version of HASMAT. Results from the structured usability studies aimed at evaluating the second HASMAT prototype were very enlightening and led to an extensive overhaul of the entire toolkit design. Additionally, this extensive update of HASMAT, which is currently in progress, is also aimed at adding in full functionality including automation of the dynamic measure selection feature that allows the toolkit to provide customized measurement recommendations based on system and contextual information provided by the toolkit's users during their completion of the decision tree questions. Once complete, this final HASMAT prototype will be tested in a final round of usability testing using NASA SMEs, followed by completion of necessary revisions, and resulting in delivery of the final HASMAT prototype to NASA. Overall, major progress on the development of the final HASMAT prototype has been made in year 4 and will continue to be made through the end of July.
Bibliography Type:	Description: (Last Updated: 06/10/2021)
Articles in Peer-reviewed Journals	Stowers K, Oglesby J, Sonesh S, Leyva K, Iwig C, Salas E. "A framework to guide the assessment of human-machine systems." Hum Factors. 2017 Mar;59(2):172-88. https:// ; PubMed PMID: 28324673 , Mar-2017
Articles in Peer-reviewed Journals	Woods A, Iwig C, Dinh J, Salas E. "Informing the development of a safety and performance metric selection toolkit: Subject matter experts weight in." Proceedings of the Human Factors and Ergonomics Society Annual Meeting. 2016 Sep;60(1):1354-8. (2016 Annual Meeting of the Human Factors and Ergonomics Society, Washington, D.C., September 19-23, 2016.) https:// , Sep-2016