Fiscal Year:	FY 2016	**Task Last Updated:**	FY 07/20/2016
PI Name:	Robinson, Stephen K. Ph.D.		
Project Title:	Customized Refresher and Just-In-Time Training for Long-Duration Spaceflight Crews		
Division Name:	Human Research		
Program/Discipline:	NSBRI		
Program/Discipline--Element/Subdiscipline:	NSBRI--Human Factors and Performance Team		
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		
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Zip Code:	95616-5270	**Congressional District:**	3
Comments:			
Project Type:	Ground	**Solicitation / Funding Source:**	2013 HERO NNJ13ZSA002N-Crew Health (FLAGSHIP & NSBRI)
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No. of PhD Candidates:	2	**No. of Master' Degrees:**	0
No. of Master's Candidates:	1	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	3	**Monitoring Center:**	NSBRI
Contact Monitor:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:	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):	Oman, Charles Ph.D. (Massachusetts Institute of Technology) Liu, Andrew Ph.D. (Massachusetts Institute of Technology) Byrne, Vicky (Lockheed Martin Astronautics) Mindock, Jennifer (Wyle Laboratories, Inc.)		
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Task Description:	Original Project Aims/Objectives: Astronauts on long-duration missions are certain to be faced with critical and complex tasks for which they have either not recently trained, or have never been trained. In addition, in-flight crew hours are among the most precious of resources in human spaceflight, so onboard training efficiency is of prime importance. The question is how best to bring an inflight astronaut up to evaluated readiness to perform a complex and critical task, after a significant period since final ground-training. We are testing the hypothesis that astronaut training which is customized for the specific crewmember can be more efficient than traditional, generic training for the same measured effectiveness. The overall objectives of our research are addressed in two parts: Part A: Self-Produced Refresher training for re-acquisition of expert performance. Part B: Customized Just-in-Time training for tasks that have not been specifically trained previously, but require the integration of existing astronaut skills. The second (current) year (2015/16) of the grant has addressed Part A studies only. Part B will be the focus of Year 3. Part A is therefore reported upon herein. Our research considers two spaceflight-appropriate tasks, one requiring the repair of a complex electro-mechanical system representative of those found aboard spacecraft, and the other requiring manual control of a simulated International Space Station (ISS) robotic arm. This project was launched in the Fall of 2014, and is organized with systems repair studies at University of California (UC) Davis and robotics studies at Massachusetts Institute of Technology (MIT), with the two teams working concurrently and in close contact. During Part A, for both tasks, we developed training materials which follow the NASA style of briefings, procedures, demonstration, and hands-on practice. 18 subjects each at UC Davis and at MIT received initial training with these materials, and their baseline performance was evaluated. Per our experiment design, after training and final evaluation (at peak of expertise) half of each group was asked to make a short summary video of themselves describing their training. After a period of about 6 months, subjects will return to the lab, review the training materials (with half of each group viewing the refresher video they made six months previously), and be re-evaluated on how well they have retained or re-acquired their task skills. Key Findings for Part A (Refresher Training): For the system-repair task at UC Davis, we spent significant effort developing lab logistics, selecting the spacecraft-system surrogate, writing and testing procedures, and developing training materials. 18 subjects completed the first phase of testing in November 2015, and are about to return (after 6 months) for the refresher phase, beginning May 9, 2016. During the six months between subject testing phases, the UC Davis team has been developing techniques to objectively quantify subject performance on the basis of time, accuracy, and hand-movements. A formal hierarchical task analysis was undertaken, resulting in the segmentation of each subject's performance into a collection of timed subtasks with associated hand-acceleration statistics binned by subtask. In-process errors are also recorded by type, influence, and duration. The development of these performance quantification techniques have given us an objective (independent of the evaluator) toolset for collecting performance statistics that may then be compared over a variety of experimental independent variables, such as training method, subject background, or training environment. For the robotics task at MIT, an experimental apparatus (robot-arm simulator) was pre-existing, so the Part A experiment design was executed and 18 subjects underwent initial training, a 6-month delay, and re-evaluation as described above. Statistical analysis of subject performance results is now underway, and will soon be complete as the graduate student (Lynne Geiger) completes her thesis. Preliminary results suggest that the self-made refresher video improved performance for at least one robotic sub-task, but with mixed results for other sub-tasks. Impact of key findings on hypotheses, technology requirements, objectives, and specific aims of the original proposal: During the course of Year 2, preliminary findings have raised the following experiment design issues: - How best to instruct a subject in self-producing a refresher video (specific instructions, time limit, editing limits, standardization across subjects). Based on the MIT experiences, which came first, the entire team developed strict guidelines for the above. - How to organize and sequence re-training after the 6-month break – the result was a specific strategy to minimize uncontrolled variables and document subjects' use of training materials as they refresh. - For the systems repair team at UC Davis, we added (at Lynne Geiger's suggestion) instrumentation to characterize subjects' hand movement via glove-mounted accelerometers. Although not included in the original proposal, literature showed that surgeons' hand-movements were correlated with training state, and so the additional measurement class was added here. Proposed research plan for the coming year: Complete Part A, Phase 2 (refresher training) subject testing for complex system repair (UC Davis, 18 subjects) ; Complete performance analysis and hypothesis evaluation for Part A, both tasks ; Based upon Part A results, modify and execute Part B (Just-in-Time Training) subject testing at UC Davis (system repair) and at MIT (robotics). Publications: planned journal submittals in 2016: Human performance quantitative evaluation for spaceflight (combined UC Davis and MIT) ; Part A results (UC Davis) ; Part A results (MIT).
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Human exploration of space, especially with reduced real-time ground support due to increased distance from the Earth, will require training capabilities to support autonomous reacquisition of skills. Inadequate states of training are commonly related to skill-based errors such as task execution mistakes. Even in the highly trained military aviation environment, more than half of accidents in a multi-year meta-analysis have been shown to be associated with skill-based errors, and human error in general is widely accepted to contribute to 70% to 80% of all aviation accidents. This research will lead to the reduction of the likelihood of such errors and accidents due to inadequate training. The reduction in error-likelihood directly supports the mitigation of the Human Research Program's Risk of Performance Errors Due to Training Deficiencies. Development, maintenance, and re-acquisition of expertise is central to many types of human endeavor, especially safety-critical ones such as aviation, medicine, human/machine interaction in hazardous environments. Research gains from investigations such as this may thus be broadly applicable outside the world of human spaceflight.

Task Progress:	The following milestones in the original proposal were scheduled to be complete by 4th quarter, calendar 2016, so we are somewhat ahead of schedule: Baseline Skills Training Development (parallel at UC Davis & MIT) ; Procure Equipment Hardware/Software ; Devel Procedures Development Instructor Prep Study A ; Refresher Training (parallel at UC Davis & MIT) ; Task Definition Briefing & Procedure Development ; Select Subjects Learning Style Assessment & Generic Skills Training Task ; Training & Evaluation ; Make Refresher Video (Self or Instructor) 6 months wait ; Refresher training & Evaluation w/ Refresher Video.
Bibliography Type:	Description: (Last Updated: 04/23/2025)