Fiscal Year:	FY 2017	**Task Last Updated:**	FY 06/10/2017
PI Name:	McLaughlin, Anne Ph.D.		
Project Title:	Creating a Taxonomy of Variables Affecting Cognitive Aid Design via an Investigation of Hybrid Aids		
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 (2) **Medical Conditions**:Risk of Adverse Health Outcomes and Decrements in Performance Due to Medical Conditions that occur in Mission, as well as Long Term Health Outcomes Due to Mission Exposures		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Zip Code:	27695-7650	**Congressional District:**	4
Comments:			
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:	08/09/2016	**End Date:**	02/01/2019
No. of Post Docs:	0	**No. of PhD Degrees:**	0
No. of PhD Candidates:	1	**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
Contact Monitor:	Williams, Thomas	**Contact Phone:**	281-483-8773
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Flight Program:			
Flight Assignment:	NOTE: Extended to 2/1/2019 per NSSC information (Ed., 9/5/18) NOTE: Element change to Human Factors & Behavioral Performance; previously Space Human Factors & Habitability (Ed., 1/19/17)		
Key Personnel Changes/Previous PI:	June 2017 report: Dr. Aniko Sandor, the original co-Investigator, left her position at KBRWyle in late 2016. We have been working with substitute co-Is and currently are working with Vicky Byrne, a specialist in medical human factors, who is now listed as Co-Investigator.		
COI Name (Institution):	Byrne, Vicky M.S. (KBRWyle)		
Grant/Contract No.:	NNX16AP91G		
Performance Goal No.:			

Performance Goal Text:

Task Description:

This proposal addresses the NASA Research Announcement for Human Exploration Research Opportunities (HERO), NNJ15ZSA001N-FLAGSHIP Appendix A, Interactive Cognitive Aids. Onboard crewmembers, similarly to operators from other industries, complain about using current checklist-like procedures. Issues include procedures having too much or too little detail and poor usability. Due to these, mistakes still occur and time to accomplish procedures is misestimated. NASA crew presently use static paper or electronic "cue cards" (PDFs) and procedures that provide guidance on both nominal and off-nominal tasks. Existing tools may not account for the lack of recent training, may not be optimized for the task, may not be optimized for the number of users, and may not be resilient to resumption after interruption. A more interactive cognitive aid can overcome the limitations of these cue cards and procedures by matching task, individual, team structure, and environment.

This proposal addresses the Risk of Inadequate Critical Task Design of the Human Research Program (HRP), specifically the SHFE-TASK-02 gap: What model-based HF (human factors) Tools can assist with the design and evaluation of spacecraft systems and task procedures. A toolkit is needed to support dynamic task design, particularly for design by non-programmers who would be making the procedures. There exists no taxonomy of cognitive aid design and task type nor standards for interactive cognitive aids to drive development. A cognitive aid should provide guidance to support efficiency and success while minimizing cognitive workload, but it is not yet clear what attributes, such as adaptability, the aid should contain.

The proposal also addresses the HRP's Risk of Performance Errors Due to Training Deficiencies, specifically the TRAIN-03 gap: We need to develop guidelines for effective onboard training systems that provide training traditionally assumed for pre-flight. (Previously: SHFE-TRAIN-03 - How can onboard training systems be designed to address Just in Time (JIT) and recurrent training needs for nominal and off nominal scenarios?). To contribute to the closure of this gap, the research proposed will investigate cognitive aids for non-expert operators.

Our goals in this proposal are two-fold: The first goal is to investigate a new form of cognitive aid that incorporates the beneficial attributes of static, adaptable, adaptive, and dynamic aids into a hybrid aid. We see the benefit of this hybrid aid to be:

1. a technology able to be immediately deployed (unlike augmented reality or other heavily technology-dependent advances),

2. a technology able to be used by non-programmers as they design aids for crewmembers (the audiences would be procedure designers and scientists creating procedures for in-flight experiments),

3. a form of aid that offers the beneficial attributes of a dynamic aid that responds to each step in a procedure with the security of a static or adaptable aid that does not require functioning sensors for performance.

We will iteratively design a prototype of a hybrid aid for medical equipment maintenance tasks, while at the same time building a library of tools to create similar aids for other procedures. Second, we will develop a taxonomy of cognitive aid design that considers the most important variables affecting performance with aids: user knowledge and experience, resources demanded by the task and sub-tasks, time pressure on performance, and the number of operators expected to interact with the aid.

Rationale for HRP Directed Research:

Research Impact/Earth Benefits:

The results of the proposed work will provide guidelines for the development of cognitive aids in any number of areas, including aviation, automobiles, manufacturing, nuclear power plants, and medical procedures. Reducing error rate in many of these circumstances can save lives. Reducing duration spent on the task could reduce costs. A system that is no longer cumbersome or distracting will encourage adherence, one of the major flaws of current procedures and checklists.

Task Progress:

This is the first report of progress on funded activities from August 10th, 2016 through June 10th, 2017. This overall project addresses Risk of Inadequate Critical Task Design of the Human Research Program (HRP), specifically the SHFE- TASK-02 gap: What model-based HF Tools can assist with the design and evaluation of spacecraft systems and task procedures? A toolkit is needed to support dynamic task design, particularly for design by non-programmers who would be making the procedures. There exists no taxonomy of cognitive aid design and task type nor standards for interactive cognitive aids to drive development. A cognitive aid should provide guidance to support efficiency and success while minimizing cognitive workload, but it is not yet clear what attributes the aid should contain. The first experiment, currently in progress and described here, will draw conclusions about the importance of reducing sensory modality conflict between the cognitive aid and the task. The project also addresses the HRP's Risk of Performance Errors Due to Training Deficiencies, specifically the TRAIN-03 gap: We need to develop guidelines for effective onboard training systems that provide training traditionally assumed for pre-flight. To contribute to the closure of this gap, the research is investigating cognitive aids for non-expert operators. Our original timeline, as produced for the proposal, was to complete Experiment 1, focused on exploration of task sensory modality and cognitive aid modality conflict, before the end of the first year. We also anticipated planning and beginning the second Experiment, focused on team use of cognitive aids. We are on track for both of these experiments including a small follow-up to the first experiment (described below).

In the last year, we have assembled a team at NC State and worked with our colleague at Johnson Space Center to stay on track for the proposed timeline. The team at NC State included one PhD student supported by the project as a research assistant, another PhD student supported by a Provost fellowship but dedicated to the project for research experience, and several undergraduate research assistants working in the lab for experience and course credit. After a thorough task analysis of the medical ventilator and interviews with subject matter experts (SMEs) at the College of Veterinary Medicine, we created a SME-validated simulator that collects data. We have also developed a prototype of the cognitive aid that allows operation through various sensory modalities as prescribed by the experimenter. Further, we have identified a small follow-up to the first experiment that we plan to run as well, with higher-order Wizard-of-Oz audio (voice inputs) interfacing with the cognitive aid than was possible in Experiment 1 (where conditions needed to be kept identical between the auditory and visual aid conditions). The undergraduate and graduate research assistants on this project presented the project development at the North Carolina Cognition Conference (NCCC) and the Southeastern Human Factors Applied Research Conference (SHARC).

We have recruited a sample of veterinary students from the NC State College of Veterinary medicine and several psychology PhD students aged 22-35 into the LACElab at NC State University. This group was sampled due to their similarities to crewmember non-experts: highly educated, highly motivated to perform procedures accurately, often expected to perform in emergencies, yet not experienced in the procedure. Our power analysis indicated a need for 65 participants: we have currently run 58 (10 pilot participants).

Challenges we have faced include turnover of our Co-Investigators (Co-Is) at Johnson Space Center (KBRWyle). Dr. Aniko Sandor was the original co-I who helped to write the proposal, but left her position at KBRWyle in late 2016. Since then we have had great relations with substitute co-Is and currently are working with Vicky Byrne, a specialist in medical human factors, but this has been a change. We are planning an in-person team meeting at NC State for August/September 2107. Another challenge has been hiring a graduate student in computer science to program the Hybrid-Aid Toolkit (HAT). These students generally start their research assistantships in fall, but our funding was not received in time to advertise a position in 2016. We are currently recruiting for a computer scientist to join our team in summer 2017 and continue through summer 2018.

Bibliography Type:	Description: (Last Updated: 07/10/2023)
Abstracts for Journals and Proceedings	Bloomquist E, Sprufera JF, Pryor M, McLaughlin AC. "Benefits of using Axure RP prototyping software for research purposes." Poster presented at the Southeastern Human Factors Applied Research Conference (SHARC), Raleigh, NC, April 1, 2017. Southeastern Human Factors Applied Research Conference (SHARC), Raleigh, NC, April 1, 2017. , Apr-2017
Abstracts for Journals and Proceedings	McLaughlin AC, Sandor A, Sprufera JF, Pryor M. "Creating a taxonomy of variables affecting cognitive aids via an investigation of hybrid aids." 2017 NASA Human Research Program Investigators' Workshop, Galveston, TX, January 23-26, 2017. 2017 NASA Human Research Program Investigators' Workshop, Galveston, TX, January 23-26, 2017. , Jan-2017
Abstracts for Journals and Proceedings	Pietrowski B, McLaughlin AC. "Matching the demands of a physical ventilator simulator by utilizing a task analysis." Southeastern Human Factors Applied Research Conference (SHARC), Raleigh, NC, April 1, 2017. Southeastern Human Factors Applied Research Conference (SHARC), Raleigh, NC, April 1, 2017. , Apr-2017
Abstracts for Journals and Proceedings	Pryor M, McLaughlin AC. "Individual differences in performance on a complex task." First Year Project Poster Presentations, Human Factors and Applied Cognition Program, NC State University, Raleigh, NC, April 2017. First Year Project Poster Presentations, Human Factors and Applied Cognition Program, NC State University, Raleigh, NC, April 2017. , Apr-2017
Abstracts for Journals and Proceedings	Sprufera JF, Pryor M, McLaughlin AC. "Rapid iterative testing in experimental design." Poster presented at the Meeting of the North Carolina Cognition Group, UNC-Greensboro, Greensboro, NC, March 2017. Meeting of the North Carolina Cognition Group, UNC-Greensboro, Greensboro, NC, March 2017. , Mar-2017