Fiscal Year:	FY 2010	**Task Last Updated:**	FY 12/03/2010
PI Name:	Allen, Christopher S M.S.		
Project Title:	Space Craft Internal Acoustic Environment		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Space Human Factors Engineering		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **SHFH**:Space Human Factors & Habitability (archival in 2017)		
Human Research Program Risks:	(1) **Hab**:Risk of an Incompatible Vehicle/Habitat Design (2) **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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City:	Houston	**State:**	TX
Zip Code:	77058	**Congressional District:**	22
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	Directed Research
Start Date:	10/02/2006	**End Date:**	09/30/2011
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:	0	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	0	**Monitoring Center:**	NASA JSC
Contact Monitor:	Woolford, Barbara	**Contact Phone:**	218-483-3701
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Flight Program:			
Flight Assignment:	NOTE: End date supposed to be 9/30/2011, per A. Foerster/JSC (5/2010)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Chu, S. Reynold (Lockheed/NASA Johnson Space Center)		
Grant/Contract No.:			
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Acoustic modeling can be used to identify key noise sources, determine/analyze sub-allocated requirements, keep track of the accumulation of minor noise sources, and to predict vehicle noise levels at various stages in the development, first with estimates of noise sources, later with experimental data. Bench testing of isolated systems alone is not sufficient as the installation effects are often not known. Acoustic modeling will be used to determine installation effects, reverberation (room geometry) effects, and will be used to identify propagation paths and possible noise controls, as well as develop an understanding of the resulting acoustic levels in the composite environment. Finally, acoustic modeling will be used to assist with the development and implementation of spaceflight acoustic materials and to predict their effectiveness including sound containment, absorption and vibration isolation. Prior to this project, NASA did not have institutional acoustic modeling capability in regards to space flight vehicles. Through this project, acoustic modeling capability is being developed for application to Orion and other new spaceflight vehicles to ensure a sufficiently quiet environment in which the astronaut crews can work and live. In general, modern acoustic modeling techniques such as Statistical Energy Analysis (SEA), Ray-tracing techniques, and Finite Element Methods have been used effectively to reduce interior noise in automotive, aircraft, and some spacecraft designs. Each method has its own strengths depending on the type of noise being modeled and the assumptions used, but it is clear that these methods have been effective; automotive and aircraft noise levels have been substantially reduced in recent years. Also, the continued development, current sophistication, and rising sales of off-the-shelf acoustic modeling software are indicative of their applicability and success, otherwise the companies that build automobiles and aircraft would not purchase these. See reference 1 for a recent article describing the state of the art in acoustic modeling capabilities, including off-the-shelf acoustic modeling software tools. The objective of this project will be to develop an acoustic modeling capability, based on off-the-shelf software, to be used as a tool for oversight of the future manned spaceflight vehicles to ensure compliance with acoustic requirements and thus provide a safe and habitable acoustic environment for the crews.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Discoveries/advancements on how best to model certain geometrical/physical aspects of enclosed spaces (such as flight vehicles) will be shared with the acoustic modeling community.
Task Progress:	The Acoustics Modeling Project has had several accomplishments during FY'10. These accomplishments included 1) advancing the validation of acoustic modeling techniques, 2) participating in a collaborative acoustic modeling effort on Orion 606g and 606h versions of the Crew Module, and 3) identifying and validating specific noise controls for use in the Orion vehicle. 1) The acoustic modeling method was validated regarding important secondary structure, e.g. closeout panels. In particular, the acoustic transmission properties of the Orion secondary structure partition (that separates the crew habitable volume from the environmental control system's fans and pumps) was modeled and mocked-up inside the Orion Acoustic Mockup with a realistic fan noise source located behind the partition. The predictions and measurements were in good agreement, thus validating the modeling approach. In addition to the panel validation, transmission loss modeling representation of acoustic blocking materials was validated against the model's "mass law" representation. 2) In collaboration with the Orion Prime Contractor, a detailed acoustic model of the Orion Crew Module version 606h was developed. Later in the year this model was collaboratively updated to revision 606g, the latest version of the full-capability Orion Crew Module. This model was used to advocate the development of "system-level" noise treatments (see below) to aide in the global reduction of noise levels in the Crew Module. The benefit of this approach was to enable development of "component noise allocations" that the fan and pump developer could achieve in order to meet the acoustic requirements. 3) Finally, the Acoustic Modeling Project made recommendations of noise treatments, specifically the acoustical sealing of gaps around the closeout partition (mentioned above) and the addition of acoustically absorbent treatments to some surfaces inside the Crew Module. These noise controls were modeled and mocked-up in the Orion Acoustics Mockup and their acoustical advantages were validated. This information, along with further modeling of noise control trade studies, acoustic flight-materials investigations, and implementation studies (performed by Orion Prime) were presented to management in order to obtain mass-budget of 35 lbs, and hardware ownership of the noise treatments in order for their implementation. As a result of the above achievements, the prospect of the Orion Crew Module meeting the stringent acoustic requirements has been greatly increased.
Bibliography Type:	Description: (Last Updated: 08/31/2018)