Fiscal Year:	FY 2011	**Task Last Updated:**	FY 08/10/2011
PI Name:	Cooper, Maya M.S.		
Project Title:	Integration of Product, Package, Process, and Environment: A Food System Optimization		
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:	None		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Zip Code:	77058	**Congressional District:**	22
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	Directed Research
Start Date:	10/01/2010	**End Date:**	10/01/2014
No. of Post Docs:		**No. of PhD Degrees:**	
No. of PhD Candidates:		**No. of Master' Degrees:**	
No. of Master's Candidates:		**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:		**Monitoring Center:**	NASA JSC
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Flight Program:			
Flight Assignment:	NOTE: End date is 10/1/2014 per M. Perchonok/JSC (Ed., 8/17/2011)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Catauro, Patricia (NASA Johnson Space Center/Lockheed Martin) Glass, John (MEI Technologies)		
Grant/Contract No.:	Directed Research		
Performance Goal No.:			
Performance Goal Text:			
	The NASA vision includes a manned mission to Mars, demanding that astronauts survive extra-terrestrially for a minimum of three years. To promote human performance and survival during long duration missions, a food system is required that is safe, acceptable and nutritious but efficiently balances appropriate vehicle resources such as mass, volume, power, water, and crew time. The current crew member diet is completely supplied through shelf-stable food items produced on Earth. Some items are commercial food products; others are produced solely for space provisioning. The quality of most space foods declines sharply two years after production due to enzymatic changes, oxidation, nutrient degradation, moisture migration, and other chemical and biological processes. The extended duration of future missions requires that the space foods maintain quality for up to five years so that the food can be prepositioned on the Martian surface prior to crew arrival if necessary. This product life requirement is beyond the capability of the current		

Task Description:	stabilized food system used on the International Space Station. The objective of this project is to determine how to best integrate the product recipe formulation, process, package, and storage environment to achieve a five-year shelf life across the broad space menu spectrum. Because the mode of product shelf life failure varies according to the food matrix, this optimization will be defined according to individual menu items. Identifying the most advantageous combination of recipe, processing method, package, and storage for each food will be accomplished by: 1. Examining the available packaged food technologies that would offer significant barrier or antioxidant property improvements for existing products. 2. Performing a risk-benefit analysis on the usage of the space environment for cold food storage. 3. Leveraging existing evidence with regards to shelf life, nutrient degradation, packaging technology, and storage impacts to recommend the formulation changes, processes, packages, and environments for each space product that would result in a five-year shelf life for that product. 4. Identifying the technology needs associated with delivering any of the aforementioned integration recommendations. Aim A. To summarize the available packaged food technologies that would offer significant barrier or antioxidant property improvements over current space packaging. Aim A will be addressed through a literature review and market survey of available package technologies. Study A will proceed with researchers reviewing literature articles on smart packaging, active packaging, nanotechnologies associated with packaging, modified atmosphere packaging, and other relevant packaging breakthroughs. Once viable avenues to improving space food packaging are identified, market representatives and packaging experts will be contacted to assess the technology readiness level, specific potential food applications, and other considerations to implementation. Study A will conclude with a matrix of available packaging technologies, the space food menu items or food groupings to which each technology has benefit, and the potential shelf life improvement offered through the packaging technology implementation (estimate based upon packaging technology impact to shelf life mode of failure). Aim B. To complete a risk-benefit analysis on the usage of the space environment for cold food storage. Aim B will be addressed through a literature review on extraterrestrial environmental conditions, including Martian surface conditions, and the impact of ultra-cold temperatures on packaging materials and food structure. Study B will proceed with a literature review for available information on Martian surface temperature profiles and other extraterrestrial body data. Additional focus will be placed on the impact of cold storage and ultra-cold storage on food structure and quality and packaging integrity. If necessary, a proof of concept test may be conducted to assess how the thermostabilized, pouched products and freeze-dried products withstand ultra-cold temperatures. Current space foods will be placed into a cryogenic freezer for one month. Packaging integrity will be assessed using standard strength and seal integrity evaluations; the food organoleptic properties pre- and post-freeze will be determined by internal panel. Aim C. To provide recommendations as to formulations, processes, packages, and environments for each space food product that would result in a five-year shelf life for each product. Aim C will be addressed in the delivery of a final summary report which details the recommended formulation, process, package, and storage as well as the subsequent shelf life of each space food product. Representative foods will be processed and stored according to the theoretical postulations on how to extend shelf life and then undergo comparison to the current space products. Specific comparison criteria between the products will be chosen based on the expected mode of shelf life failure but may include aspects such as color/browning, hexanal, turgidity, water activity, microbial load, and sensory attributes. Should the comparison contradict expectations, then the recommendation on shelf life extension will be revised accordingly. Learnings from the representative foods will be extended to the remainder of the space food system as applicable. Aim D. To identify the technology needs associated with delivering any of the aforementioned integration recommendations. Aim D will be addressed in the delivery of a final summary report, specifically in a section focused on implementation hurdles. Each technology and/or ingredient will be classified according to their commercial availability (widespread – 3 or more suppliers, limited commercially – 1-2 suppliers, lab models/prototypes only). Additionally, each technology and/or ingredient will be analyzed to determine if auxiliary technologies (packaging film for high pressure processing, e.g.) are necessary to raise the viability of the recommendation. By the completion of this study, a recommendation on how to move the current food system to a five-year shelf life will be presented. The recommendations for new ingredient, process, package and storage technologies will be clearly identified, and products with little chance of meeting the five-year shelf life hurdle are delineated for replacement or removal from long duration menus. Future work could include the technology development as identified and the development of new products necessary to fill gaps in the long duration menu.
Rationale for HRP Directed Research:	This research is directed because it contains highly constrained research, which requires focused and constrained data gathering and analysis that is more appropriately obtained through a non-competitive proposal.
Research Impact/Earth Benefits:	
Task Progress:	New project for FY2011.
Bibliography Type:	Description: (Last Updated: 04/23/2019)