Fiscal Year:	FY 2018	**Task Last Updated:**	FY 11/07/2017
PI Name:	Somers, Jeffrey M.S.		
Project Title:	ATD (Anthropomorphic Test Dummy) Injury Metric Sensitivity and Extensibility Study		
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) **Dynamic Loads**:Risk of Injury from Dynamic Loads		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
PI Email:	jeff.somers@nasa.gov	**Fax:**	FY
PI Organization Type:	NASA CENTER	**Phone:**	281-483-6010
Organization Name:	KBR/NASA Johnson Space Center		
PI Address 1:	2400 NASA Parklway		
PI Address 2:	MAILCODE: WYLE/HAC/37C		
PI Web Page:			
City:	Houston	**State:**	TX
Zip Code:	77058	**Congressional District:**	36
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	Directed Research
Start Date:	01/01/2016	**End Date:**	03/31/2019
No. of Post Docs:	0	**No. of PhD Degrees:**	0
No. of PhD Candidates:	5	**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
Contact Email:	thomas.j.will1@nasa.gov		
Flight Program:			
Flight Assignment:	NOTE: End date corrected to 3/31/2019 per B. Gore/HRP and PI (Ed., 6/26/19) NOTE: End date changed to 10/1/2019 (actually 9/30/2019; using 10/1/2019 for reporting purposes) per PI (Ed., 11/6/18) NOTE: Element change to Human Factors & Behavioral Performance; previously Space Human Factors & Habitability (Ed., 1/10/17) NOTE: End date changed to 9/30/2018 (original end date 3/31/2016 and then 1/3/2018) per E. Connell/HFBP/HRP/JSC (Ed., 11/17/17) NOTE: Period of performance changed to 1/1/2016-1/3/2018 due to refinement of and delays in starting this task (original period of performance was 7/2/2015-3/31/2016), per E. Connell/JSC HRP (Ed., 5/24/16) NOTE: End date changed to 1/3/2018 (original end date 3/31/2016) per PI (Ed., 2/16/16)		

Key Personnel Changes/Previous PI:	November 2017 report: PI information=Jeffrey T. Somers, MS, KBRwyle, 2400 NASA Pkwy., Houston, TX 77058 ; Co-I(s) Name(s), Affiliation, Contact Information: Ashley Weaver, Ph.D., Virginia Tech-Wake Forest University Center for Injury Biomechanics, Wake Forest University Health Sciences, Winston-Salem, NC 27101, asweaver@wakehealth.edu, 336.716.0944. Derek Jones, MS, Virginia Tech-Wake Forest University Center for Injury Biomechanics, Wake Forest University Health Sciences, Winston-Salem, NC 27101, derjones@wakehealth.edu, 336.713.1247. Jacob B. Putnam, MS, KBRwyle, 2400 E NASA Pkwy., Houston, TX 77058, 281.244.6938, jacob.b.putnam@nasa.gov. Nathaniel Newby, MS, KBRwyle, 2400 E NASA Pkwy., Houston, TX 77058, 281.483.7749, nathaniel.newby@nasa.gov.
COI Name (Institution):	Newby, Nathaniel M.S. (KBRwyle) Putnam, Jacob M.S. (KBRwyle) Jones, Derek M.S. (Wake Forest University) Weaver, Ashley Ph.D. (Wake Forest University)
Grant/Contract No.:	Directed Research
Performance Goal No.:	
Performance Goal Text:	
Task Description:	Currently, injury assessment reference values (IARV) are based on volunteer and post-mortem human subjects tested in non-spaceflight setups specific to the environment of interest. In automotive research, the occupant is put in the "super-slouched" position and is subjected to either frontal or side impacts at specific velocities with a 3-point restraint and airbags. In military research, test configurations are commonly based on ejection seats. These tests employ seating geometries, restraint, and loading directions that are not consistent with spaceflight configurations. Acute seat pan angles, non-extended legs (fetal position), combined axis loading, as well as other seat, restraint, and loading conditions may induce unforeseen changes in injury risk. Because the current data available do not account for these variations, a sensitivity and extensibility study is needed. Aims: 1. Validate the response of each finite element model against matched physical ATD tests in the baseline seat from existing datasets. 2. Quantify ATD and human numerical model response variance and sensitivity to a limited set of small perturbations in seat, and restraint initial conditions. 3. Quantify the effects of spacecraft-specific seating and restraint configurations on ATD and human numerical model responses.
Rationale for HRP Directed Research:	This task meets the criteria for a Directed Task because of insufficient schedule available to solicit this work. Based on the approved Path to Risk Reduction, this task is required to be completed by the end of FY16 in order to meet the Orion CDR date.
Research Impact/Earth Benefits:	This research directly impacts life on Earth by improving analytical tools for developing safer vehicles.
Task Progress:	Specific Aims: 1. Validate the response of each FE model against matched physical ATD tests in the baseline seat from existing datasets. Two hundred and twelve human volunteer tests, 35 Hybrid III, and 26 THOR tests were chosen to validate each respective model. Seat and restraint configuration models matching chosen test configurations were developed. Each unique test condition was simulated and model response was evaluated. Simulation results showed each model accurately captured the response of their physical counterparts across the variety of loading conditions chosen to encompass spaceflight conditions. Validation work was completed on 6/31/17. 2. Quantify ATD and human-numerical model-response sensitivity to a limited set of perturbations in seat and restraint initial conditions. An acceleration pulse-generating algorithm was developed to create a range of loading conditions, based on preliminary capsule based vehicle landing load estimates, using finite load variables. Seat and restraint initial condition perturbations have been defined by restraint interaction, occupant positioning, and gravitational direction. Developmental simulations have been run to determine appropriate bounds for these load and environmental condition variables. Currently 390 Latin Hypercube Design (LHD) derived cases are being simulated with each occupant model to evaluate the sensitivity to these conditions. Simulation completion is expected by 11/30/17. 3. Quantify the degree to which ATD and human numerical model responses track each other over a range of spaceflight-relevant loading conditions in conjunction with several spacecraft-specific seat and restraint configurations. Spacecraft-specific seat and restraint configuration models have been developed. Phase III will continue once model-response sensitivity is complete.
Bibliography Type:	Description: (Last Updated: 12/29/2020)
Abstracts for Journals and Proceedings	Stitzel J, Jones D, Gaewsky J, McNamara K, Weaver A, Gayzik S, Putnam J, Somers J, Wells J, Newby N. "Assessing the Sensitivity and Extensibility of Anthropomorphic Test Device Response in Spaceflight Configurations." 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	McNamara K, Jones D, Gaewsky J, Gayzik S, Weaver A, Stitzel J. "Validating FE Hybrid III, THOR, and GHBMC M50-OS for Future Spaceflight Configuration Testing." Presented at the 13th Annual Ohio State University Injury Biomechanics Symposium, Columbus, OH, May 22, 2017. 13th Annual Ohio State University Injury Biomechanics Symposium, Columbus, OH, May 22, 2017. , May-2017

Abstracts for Journals and Proceedings	Gaewsky J, Jones D, McNamara K, Ye X, Saffarzadeh M, Koya B, Gayzik S, Stitzel J. "Validation of GHBMC M50-OS for Spaceflight Configuration Testing." GHBMC (Global Human Body Models Consortium) Users' Workshop, Plymouth, MI, June 4, 2017. GHBMC (Global Human Body Models Consortium) Users' Workshop, Plymouth, MI, June 4, 2017. , Jun-2017
Abstracts for Journals and Proceedings	Jones D, Gaewsky J, Gayzik S, Saffarzadeh M, Weaver A, Putnam J, Somers J, Wells J, Newby N, Stitzel J. "Validation of FE Hybrid III, THOR, and GHBMC M50-OS for Spaceflight Configuration Testing." 2017 SB3C Summer Biomechanics, Bioengineering & Biotransport Conference, Tucson, AZ, June 21-24, 2017. 2017 SB3C Summer Biomechanics, Bioengineering & Biotransport Conference, Tucson, AZ, June 21-24, 2017. , Jun-2017
Abstracts for Journals and Proceedings	Ye X, Jones D, Gaewsky J, Koya B, McNamara K, Saffarzadeh M, Gayzik S, Weaver A, Stitzel J. "Validation of a Finite Element Human Body Model for Spaceflight Testing Configurations." 2017 BMES (Biomedical Engineering Society) Annual Meeting, Phoenix, Arizona, October 11-14, 2017. 2017 BMES (Biomedical Engineering Society) Annual Meeting, Phoenix, Arizona, October 11-14, 2017. , Oct-2017
Abstracts for Journals and Proceedings	McNamara K, Jones D, Gaewsky J, Ye X, Saffarzadeh M, Koya B, Gayzik S, Weaver A, Stitzel J. "Validating FE Hybrid III and THOR for Future Spaceflight Configuration Testing." 2017 BMES (Biomedical Engineering Society) Annual Meeting, Phoenix, Arizona, October 11-14, 2017. 2017 BMES (Biomedical Engineering Society) Annual Meeting, Phoenix, Arizona, October 11-14, 2017. , Oct-2017