

Fiscal Year:	FY 2017	Task Last Updated:	FY 05/15/2017
PI Name:	Somers, Jeffrey M.S.		
Project Title:	ATD (Anthropomorphic Test Dummy) Injury Metric Development		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Space Human Factors Engineering		
Joint Agency Name:	TechPort:	Yes	
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		
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Comments:			
Project Type:	GROUND	Solicitation / Funding Source:	Directed Research
Start Date:	07/01/2015	End Date:	09/30/2019
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
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Flight Program:			
Flight Assignment:	<p>NOTE: Element change to Human Factors & Behavioral Performance; previously Space Human Factors & Habitability (Ed., 1/19/17)</p> <p>NOTE: End date changed to 9/30/2019 per E. Connell/HFBP/JSC (Ed., 11/17/17)</p> <p>NOTE: Change to start date per E. Connell/SHFH/HRP (Ed., 2/3/16)</p> <p>NOTE: Added "Development" to title, per E. Connell/SHFH/HRP (Ed., 10/7/15)</p> <p>NOTE: Change in title to "ATD Injury Metric" from "THOR Injury Metric Development" per E. Connell/SHFH HRP (Ed., 8/19/15)</p> <p>NOTE: Period of performance changed to 5/1/2015-9/30/2017 (previously 7/3/2014-10/31/2016) due to delayed start, per E. Connell/JSC SHFH element (Ed., 4/15/2015)</p>		
Key Personnel Changes/Previous PI:	<p>June 2016 report--Additional CoInvestigators: Jessica Wells, Lockheed Martin Information Systems and Global Solutions, 2625 Bay Area Blvd, Houston, TX 77058, 281.483.7216. jessica.a.wells@nasa.gov ; Narayan Yoganandan, PhD, Medical College of Wisconsin, 9200 West Wisconsin Ave., Milwaukee, WI 53226. (414) 384-3453. yoga@mcw.edu ; John Humm, MS, Medical College of Wisconsin, 9200 West Wisconsin Ave., Milwaukee, WI 53226. jhummm@mcw.edu ; Additional Key Personnel: Jacob Putnam, Wyle Science Technology and Engineering Group.</p>		

COI Name (Institution):	Wells, Jessica B.S. (Leidos) Yoganandan, Narayan Ph.D. (Medical College of Wisconsin) Humm, John M.S. (Medical College of Wisconsin)
Grant/Contract No.:	Directed Research
Performance Goal No.:	
Performance Goal Text:	
Task Description:	<p>Data from the Hybrid III and THOR (Test Device for Human Occupant Restraint), anthropomorphic test devices (ATD) currently available to test the Occupant Protection requirements, are not well correlated to low-injury risk, as these ATDs were designed for automotive use. Automotive research is directed at preventing severe injuries in very low probability events. NASA vehicles require a lower risk of injury because the vehicles will land every time, making that a high probability event. The objective of this study is to develop injury risk functions for the Hybrid III and THOR ATDs. Matched pair tests between postmortem human surrogates (PMHS) and each ATD will be used to determine ATD-specific injury criteria. The merit of the matched pair design is the one-to-one correspondence of the results from external loads to both surrogates. Injury outcomes from PMHS tests will be used with region-specific data, such as forces and moments either individually or in combination, to derive ATD-specific injury criteria.</p> <p>Specific Aims</p> <ol style="list-style-type: none"> 1. Identify appropriate datasets for ATD comparison 2. Test Hybrid III 50th percentile male and THOR in same conditions as historical testing 3. Use historical human data to establish tolerance and injury risk focusing on lateral responses and sex differences 4. Use Bayesian analysis combined with survival analysis along with human tolerance to estimate injury risk. Use results of prior data mining and existing literature as prior distribution 5. Develop new Injury Assessment Reference Values (IARVs) based on the new statistical analysis. <p>Historical human data will be selected from the Medical College of Wisconsin (MCW) database. The data will be selected based on loading dynamics and subject demographics. Once these data are selected, the Hybrid III 50th percentile male and THOR ATDs will be tested in identical conditions. A Bayesian analysis along with survival analysis will be used to relate the resulting ATD responses to improve injury risk predictions. The results of the Occupant Protection (OP) Data Mining and Modeling Task will be used as prior distributions.</p>
Rationale for HRP Directed Research:	<p>This task meets the criteria for a Directed Task due to schedule constraints and the requirement of using the same test facilities used in the original human testing. Based on the approved Path to Risk Reduction, this task is required to be completed by the end of FY17 in order to meet the Orion schedule for EM-2. Because of this accelerated schedule, there is insufficient time to solicit this work. In addition, the testing in this task must be conducted to best replicate the original human test conditions. Because of this, testing will need to be conducted at the original test facility, excluding the ability to solicit the work.</p>
Research Impact/Earth Benefits:	<p>The outcome of this research will be improved Injury Assessment Reference Values (IARVs) for Anthropomorphic Test Devices or crash test dummies. By improving the quality of IARVs at low severity impacts in multiple directions, automotive vehicle designers can create safer cars and trucks and have the tools needed to show that a design is actually safer.</p>
Task Progress:	<p>Specific Aims:</p> <ol style="list-style-type: none"> 1. Identify appropriate datasets for ATD comparison. Work started in February 2016 with the Medical College of Wisconsin (MCW) selecting appropriate matched pair datasets from their test laboratory. Datasets selected include those eliciting low-level AIS injuries in the neck and include a high number of female test data to allow study of sex differences in injury outcome. Datasets were chosen to examine lateral impact neck tolerance, vertical impact neck tolerance, and pelvic/acetabulum injury criteria. PMHS injury data will be used to develop risk curves in a similar process as seen in the 2017 paper "Load-Based Lower Neck Injury Criteria for Females from Rear Impact from Cadaver Experiments." Additionally, historical human volunteer test data collected at the Air Force Research Laboratory (AFRL) at Wright-Patterson Air Force Base (WPAFB) can be added to the PMHS injury data to further refine the injury risk curves. Matched pair testing will then be performed with the Hybrid III 50th and THOR ATDs to develop injury risk curves for each. 2. Test Hybrid III 50th percentile male and THOR in same conditions as historical testing. The MCW is documenting match pair tests already completed with the Hybrid III ATD and determining what tests will be required to supplement the existing Hybrid III dataset. The OP team is drafting a Space Act Agreement (SAA) with the National Highway Traffic Safety Administration (NHTSA) to use the THOR ATD for testing at MCW. The MCW has begun ATD match pairing testing for lower-neck shear criteria. Currently, the THOR ATD is unavailable for use until the Summer 2017. 3. Use historical human data to establish tolerance and injury risk focusing on lateral responses and sex differences. Established injury risk function for the PMHS for the lower-neck shear force bending moment. Work to establish injury risk function for Hybrid III 50th and THOR will begin after match pair testing is complete. 4. Use Bayesian analysis combined with survival analysis along with human tolerance to estimate injury risk. Use results of prior data mining and existing literature as prior distribution. This work will begin after match pair testing is complete. 5. Develop new Injury Assessment Reference Values (IARVs) based on the new statistical analysis. This work will begin after match pair testing is complete.

Bibliography Type:	Description: (Last Updated: 12/29/2020)
Abstracts for Journals and Proceedings	Wells JA, Somers JT, Newby NJ, Putnam JB, Siders BA. "ATD Injury Metric Development." Presented at the 2017 Human Research Program Investigators' Workshop, Galveston, TX, January 23-26, 2017. 2017 Human Research Program Investigators' Workshop, Galveston, TX, January 23-26, 2017. , Jan-2017
Abstracts for Journals and Proceedings	Wells JA, Somers JT, Newby NJ. "ATD Injury Metric Development." Presented at the 2016 NASA Human Research Program Investigators' Workshop, Galveston, TX, February 8-11, 2016. 2016 NASA Human Research Program Investigators' Workshop, Galveston, TX, February 8-11, 2016. , Feb-2016
Articles in Peer-reviewed Journals	Yoganandan N, Pintar FA, Banjeree A. "Load-based lower neck injury criteria for females from rear impact from cadaver experiments." Ann Biomed Eng. 2017 May;45(5):1194-203. Epub 2017 Jan 13. http://dx.doi.org/10.1007/s10439-016-1773-5 ; PubMed PMID: 28091968 , May-2017