Title: Evaluation of Mid-Size Male Hybrid III Models for use in Spaceflight Occupant Protection Analysis

Authors: Jacob B. Putnam[1], Jeffrey T. Sommers[1], Jessica A. Wells[2], Nathaniel J. Newby[1], Nancy J. Currie-Gregg[3], Chuck Lawrence[4]

[1]KBRwyle, Houston, TX, USA
[2]Lockheed Martin, Houston, TX, USA
[3]NASA, Houston, TX, USA
[4]Analytical Mechanics Associates Inc., VA, USA

Introduction: In an effort to improve occupant safety during dynamic phases of spaceflight, the National Aeronautics and Space Administration (NASA) has worked to develop occupant protection standards for future crewed spacecraft. One key aspect of these standards is the identification of injury mechanisms through anthropometric test devices (ATDs). Within this analysis, both physical and computational ATD evaluations are required to reasonably encompass the vast range of loading conditions any spaceflight crew may encounter. In this study the accuracy of publically available mid-size male HIII ATD finite element (FE) models are evaluated within applicable loading conditions against extensive sled testing performed on their physical counterparts.

Methods: A series of sled tests were performed at the Wright Patterson Air force Base (WPAFB) employing variations of magnitude, duration, and impact direction to encompass the dynamic loading range for expected spaceflight. FE simulations were developed to the specifications of the test setup and driven using measured acceleration profiles. Both fast and detailed FE models of the mid-size male HIII were ran to quantify differences in their accuracy and thus assess the applicability of each within this field.

Results: Preliminary results identify the dependence of model accuracy on loading direction, magnitude, and rate. Additionally the accuracy of individual response metrics are shown to vary across each model within evaluated test conditions. Causes for model inaccuracy are identified based on the observed relationships.

Discussion: Computational modeling provides an essential component to ATD injury metric evaluation used to ensure the safety of future spaceflight occupants. The assessment of current ATD models lays the groundwork for how these models can be used appropriately in the future. Identification of limitations and possible paths for improvement aid in the development of these effective analysis tools.