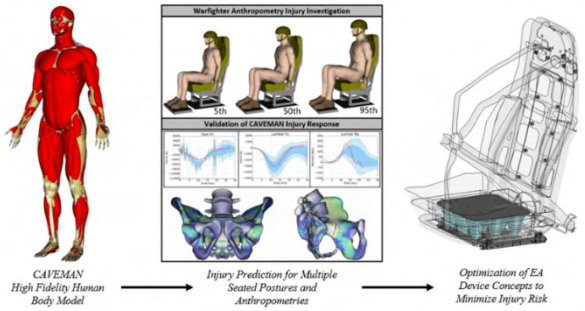
Optimized Energy-Attenuating Seat Design for Ground Vehicles

Corvid Technologies
Mooresville, NC
www.corvidtec.com



Contact:
Kevin Lister
Computational Analyst
Corvid Technologies
kevin.lister@corvidtec.com

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SYSCOM: Marine Corps Systems Command (MCSC)

Program Sponsor: USMC PEO Land Systems (PEO LS)

Other Potential Programs:
Program offices across the DOD with specific needs related to Warfighter safety could benefit from the developed high-fidelity human body injury prediction tools.

Current TRL: 6
Projected TRL: 7 / Q3 2024

Keywords:
Injury biomechanics, finite element, underbody blast, injury prediction

THE CHALLENGE

Ground vehicle underbody blast events that occurred during Operation Iraqi Freedom and Operation Enduring Freedom resulted in many mounted warfighters sustaining injuries to their pelvis and lumbar spine structures. As a result, many ground vehicle programs have incorporated blast-mitigation technologies within their vehicles to try to protect warfighters against such injuries. However, current blast mitigation technologies are typically only designed to protect a 50th percentile male occupant. Since military vehicle occupants encompass a wide range of anthropometric variability, there is a high likelihood that many are not being protected with the current technologies. Effectively informing energy-attenuating seat design for vehicle accelerative loading events requires an understanding of how changes in occupant size, gender, posture, and anthropometry affect how injuries present. It also requires a thorough understanding of pelvis and lumbar fractures in addition to potential ligament, organ, and vascular damage.

THE INNOVATION

The Computational Anthropomorphic Virtual Experiment Man (CAVEMAN) model, a family of high-fidelity virtual human body models, is being leveraged to develop and deliver a tool for the United States Marine Corps (USMC) to accurately predict pelvis and lumbar spine injuries for warfighters to improve energy attenuating (EA) seat design and performance. The CAVEMAN system provides a means for injury prediction with the virtual underbody blast environment for male warfighters across the 5th-95th percentile anthropometric range in any seated posture. Parallel efforts are underway to add equivalent injury assessment capabilities for female warfighters with additional virtual human body models based on female-specific anatomy.

THE NAVY BENEFIT

Use of the CAVEMAN model provides a pathway for virtual EA seat safety analysis, creating the means for quicker and more extensive seat development and testing capabilities for the USMC. The final family of CAVEMAN models will improve safety for warfighters by including variations in body size, gender, and posture in the vehicle safety assessment, thus promoting protection for all warfighters.

THE FUTURE

The CAVEMAN model is available for license by the Government, industry, and academia. In addition to underbody blast, the CAVEMAN virtual human body model has been used for less-than-lethal munitions testing; aircraft crash safety; aircraft ejection and high-G maneuvers; personal protective equipment design; and human-robot interaction safety. It is well suited for human body injury prediction in high-rate dynamic environments or could be the starting point for accelerated model development for additional injury biomechanics research.

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