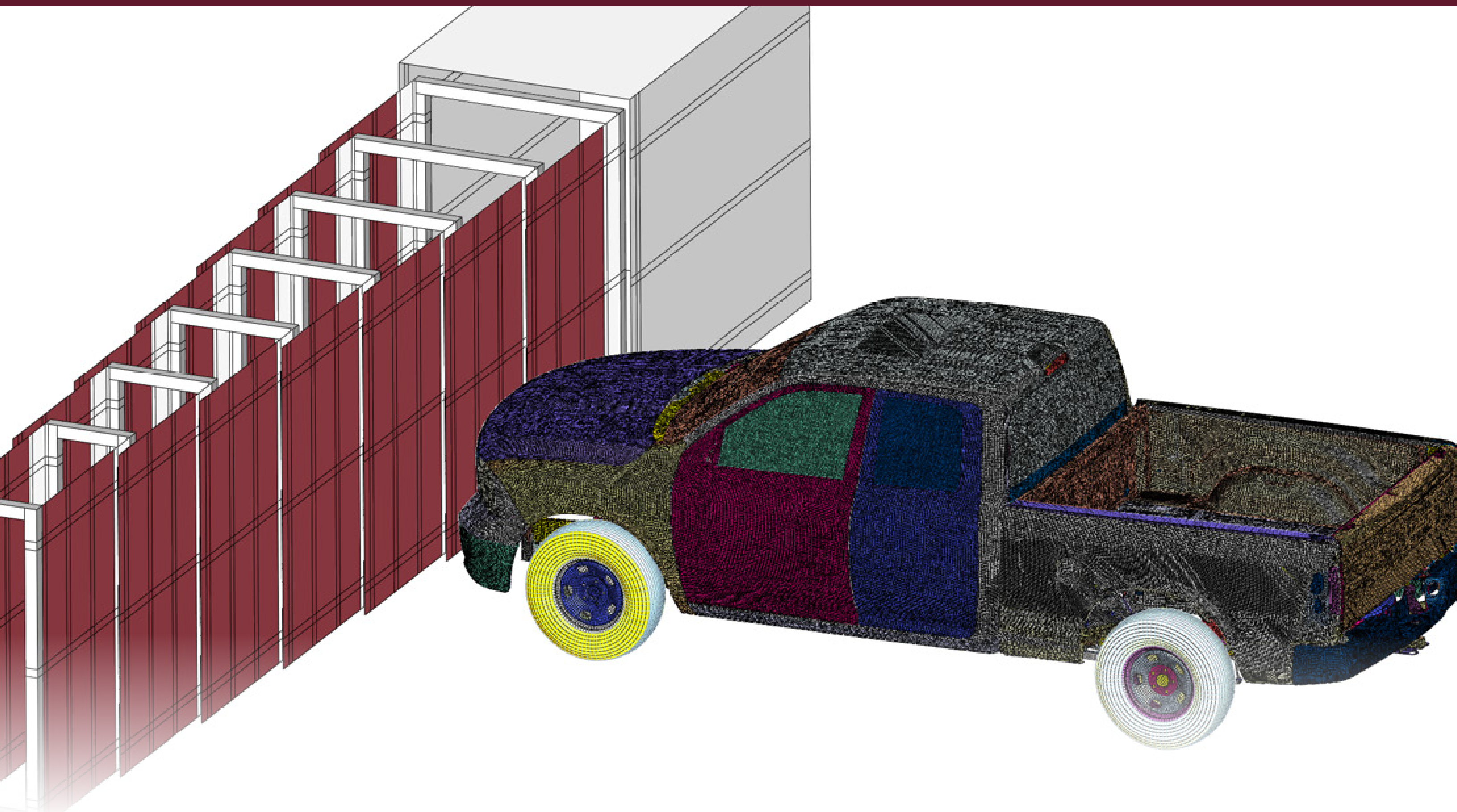
MISSISSIPPI STATE UNIVERSITY™
CENTER FOR ADVANCED VEHICULAR SYSTEMS



# COMPUTATIONAL ENGINEERING MECHANICS

## ABOUT CEM

Computational Engineering Mechanics (CEM) brings together mechanics, applied mathematics, and computer science to develop new methods for solving computationally challenging problems in science and engineering. Computational modeling research at the Center for Advanced Vehicular Systems covers a variety of emerging engineering problems by using state-of-the-science numerical algorithms and high-performance computing technology resources housed at MSU. Our researchers are developing solutions in relevant high-impact research areas, such as vehicular lightweighting and crashworthiness analysis, multiscale materials model development, traumatic brain injury and vibration injury mechanisms, hypersonic materials, ballistic impact studies, surrogate modeling, and machine learning and optimization.

# CAPABILITIES

## MATERIALS MODELING AND SIMULATION

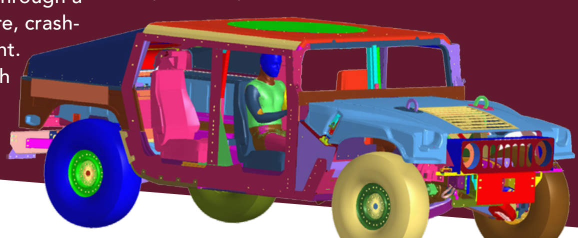
In addition to hands-on material capabilities, CAVS' facilities also include equipment that allows CAVS researchers to model a range of materials, including metals, polymers, bio-materials, and cementitious materials. CAVS' design and optimization abilities allow our researchers to evaluate materials through a variety of tests, including fatigue and fracture, crashworthiness, and corrosion and heat treatment. Then, the materials can be adjusted to reach prime material optimizations.

## HIGH PERFORMANCE COMPUTING

CAVS research in computational engineering mechanics is enhanced by Mississippi State University's high performance computing resources, which allows for large-scale modeling and simulation efforts. MSU ranks among the top universities in the U.S. for supercomputing capability.

## MACHINE LEARNING

Machine learning methods provide a robust way to optimize mechanisms and parts based on desired parameters. Our researchers use machine learning for a variety of problems, including predicting a fuel spray nozzle's spray performance based on fuel properties and ambient conditions or optimizing the length, width, and thickness for a disc to minimize mass and stress while maintaining performance requirements.



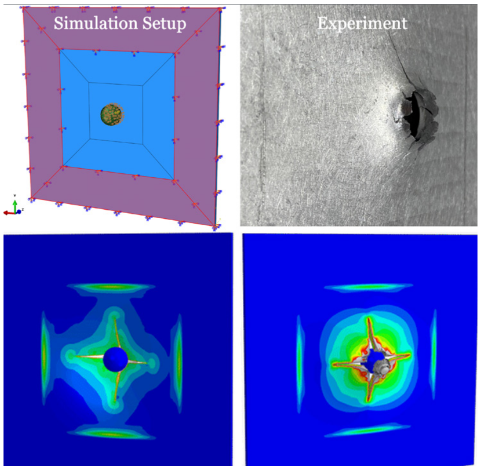
** Before Wreck*

** After Wreck*

# RESEARCH AREAS

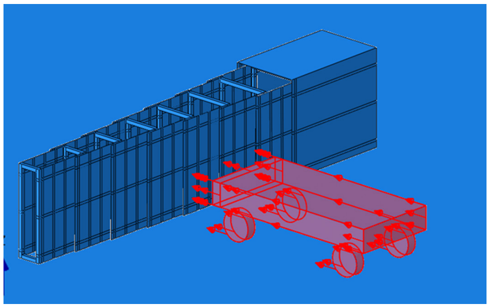
**Ballistic Impact Studies**

CAVS researchers are developing machine learning-based surrogate models for dynamic ballistic impact studies. Surrogate models provide a low-cost alternative to predict outcomes of ballistic impact and penetration scenarios, as well as allow optimization of armor materials to better protect vehicles, structures, and personnel.




**Lightweighting & Crashworthiness Modeling**

CAVS researchers are optimizing (i.e., lightweighting) vehicle components to allow for higher cargo capacities and increased fuel ranges while giving similar or better vehicle performance. The optimized vehicle design is paired with crashworthiness analysis to ensure passenger safety.

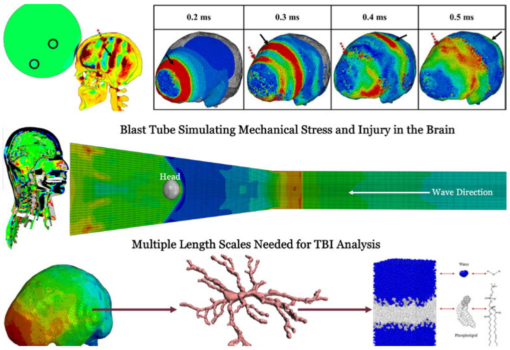


**Mobile Deployable Barriers**

Mobile deployable barriers serve critical security needs. Finite element analysis and machine learning-aided optimization techniques are used to design rapid deployable barriers for impact scenarios and blast mitigation.

**Brain Injury Biomechanics**

CAVS researchers are leading novel research in brain injury biomechanics. Multiscale material models and simulations are being developed to study human injury scenarios, such as traumatic brain injury (TBI) during soccer header impacts and blast exposure, that cannot be tested in living subjects. These models enable scientists to view the effects of injury scenarios at the different length scales to examine different damage mechanisms. Further, they allow a better understanding of these underlying mechanisms, which aids in developing improved treatment methods




**WWW.CAVS.MSSTATE.EDU**

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