# New Mexico Research Spotlight Forum

3/5/2019

Engineering Mechanics & Dynamics

# Dynamic Impact Hazards and Material Failure

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## Capability Overview

Sandia National Laboratories | THE UNIVERSITY OF NEW MEXICO | NM STATE UNIVERSITY | NEW MEXICO TECH SCIENCE • ENGINEERING • RESEARCH UNIVERSITY

SAND2019-2161PE

SAND2018-14303.O

# ABOUT US

Department 9432 focuses on developing safe processes for maintaining complex systems.

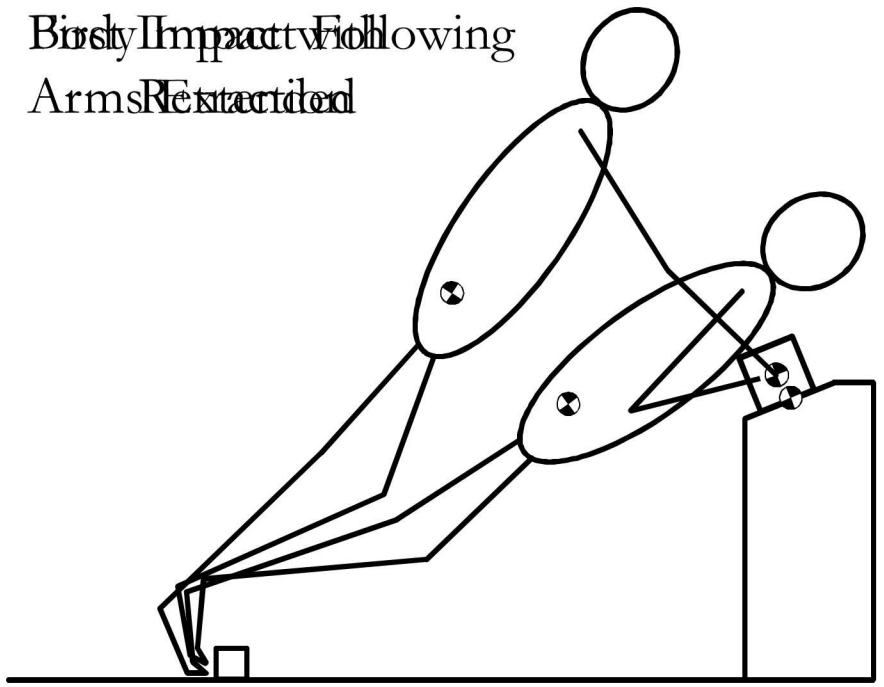
- Nine members with degrees from U of U, UT Austin, USU, USC, UNM, U of I, UE, Purdue University, NMT, NMSU, MIT, CSUN, Colgate University, and BYU
- Experience in safety engineering, electromagnetism, electronic component failure, robotics, hydrodynamics, thermosiphons, clean energy, material characterization, mathematics, astronomy, physics, education, additive systems analysis, explosive effect analysis, MEMS, aircraft structural analysis, satellite component design, machine design and analysis, and manufacturing
- Research interests include design for safety, ductile fracture mechanics, failure of composites, failure of weldments, multi-physics simulations

**Keywords:**

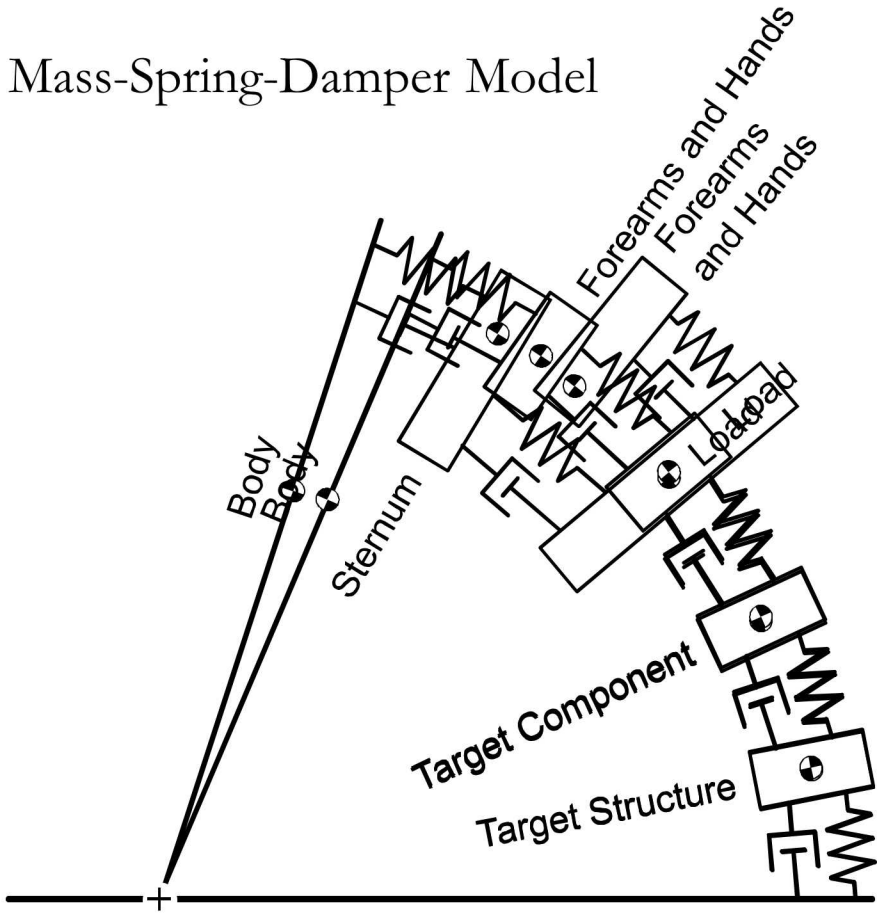
Safety, Surety, Impact, Puncture, Materials, Plasticity, Fracture, Damage Evolution, Weldments, Electrostatic Discharge, Lightning, Heat Transfer, Finite Element Analysis, Multi-physics Analysis

# CURRENT WORK IN ENGINEERING MECHANICS & DYNAMICS

**Model Human Body Impacts on Structures**

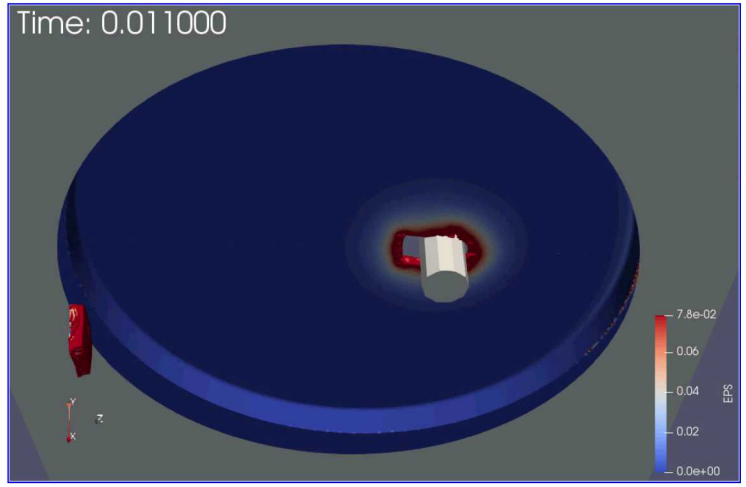



Mass-Spring-Damper Model



# CURRENT WORK IN ENGINEERING MECHANICS & DYNAMICS

## Validate Advanced Constitutive Models and Failure Criteria for Ductile Metals




0.25-Inch Cylindrical Punch

0.065 Inches of 7075-T651 Aluminum

Johnson-Cook Constitutive Model

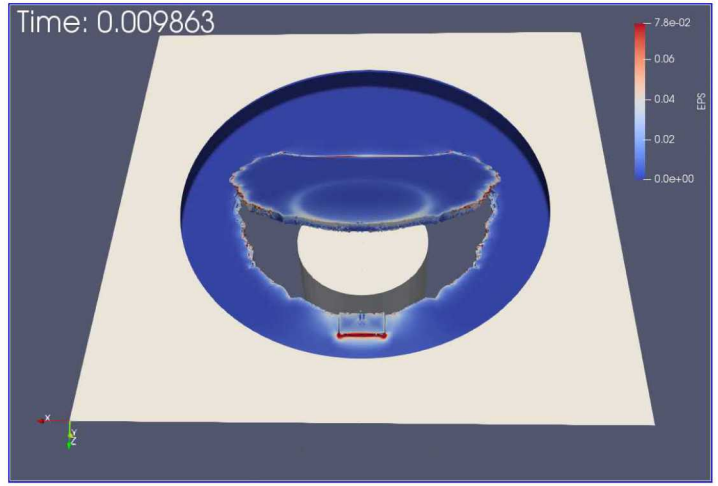
Strain Energy Density Failure Criterion

1-Inch Cylindrical Punch

0.065 Inches of 7075-T651 Aluminum

Johnson-Cook Constitutive Model

Wellman Failure Criterion




# CURRENT WORK IN ENGINEERING MECHANICS & DYNAMICS

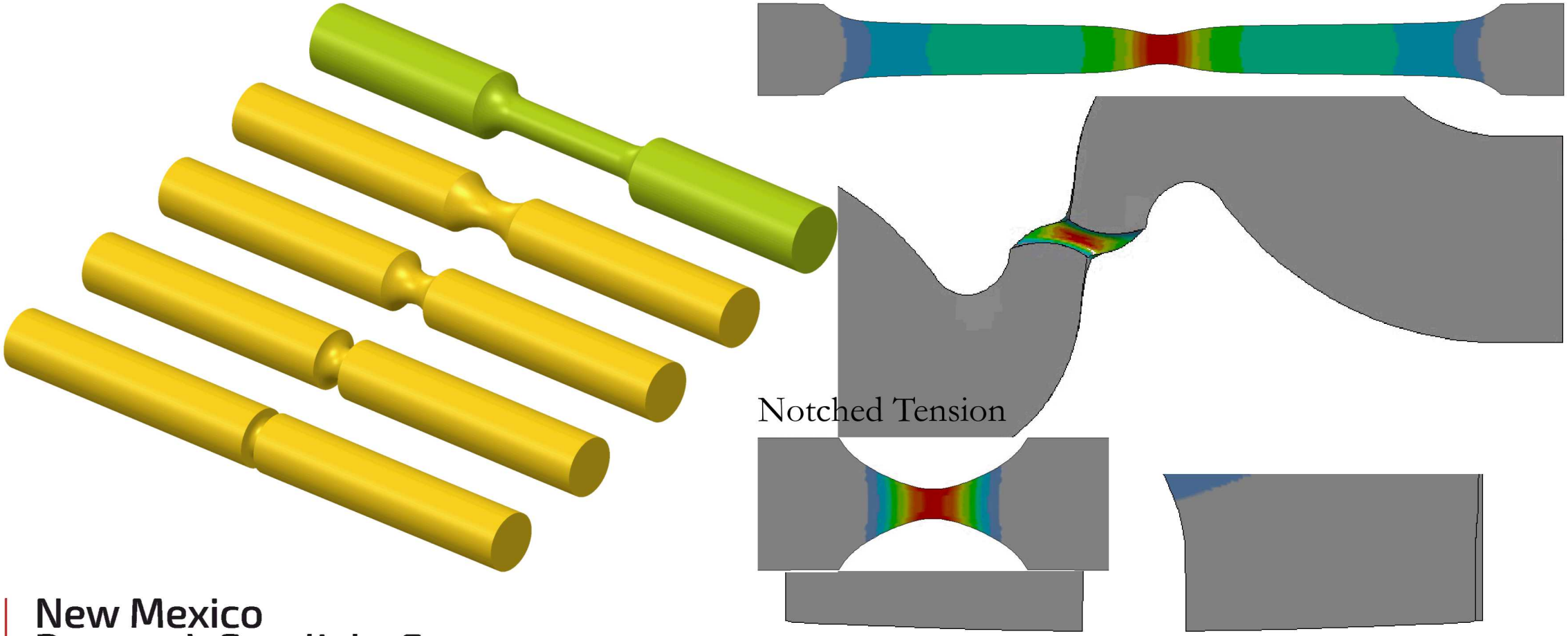
**Design Specimens for Measuring Failure Criteria over a Wide Range of Triaxiality Factors**

Combined Tension and Shear

Shear

Notched Compression

Notched Tension



# FUNDING SOURCES

Department of Energy:

- National Nuclear Security Administration

Collaboration Supporting Students:

- TAMU
- UNM

# RESEARCH NEEDS

Strength tests of materials and joints

- Strength of spot weld in 304L steel
- Tension tests of 7049-T7352 aluminum
- Tension and compression tests of Tape-Wound Carbon Phenolic (TWCP)
- Bending test of TWCP on aluminum substrate

Puncture tests for various materials and thicknesses with punches of different shapes and sizes

- 6061-T651
- 304L
- 17-4PH
- 15-5PH
- TWCP

Predictive failure criteria in finite element or meshless simulations of these materials