

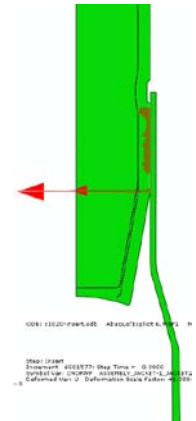
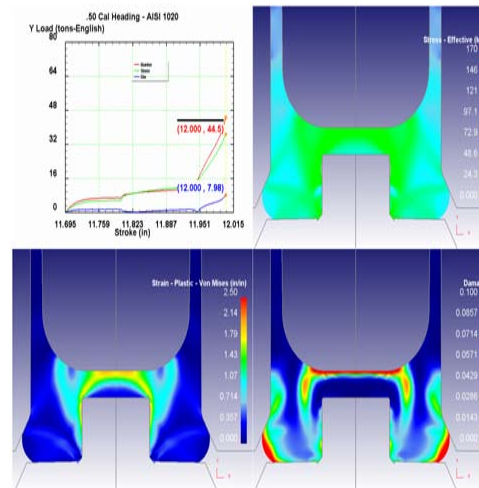
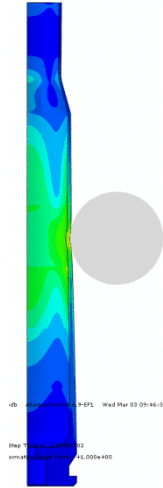
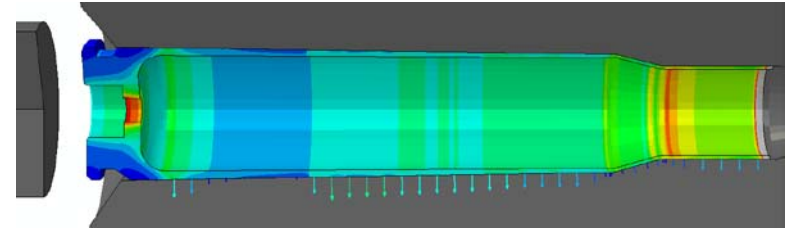
Modeling and Simulation of the Manufacturing and Ballistic Performance of Low Carbon steel, Small-caliber Cartridge Cases

Mark Lee
Dr. Justin Mach (formerly of)
ATK
Small Caliber Systems
Lake City Army Ammunition Plant
Independence, MO

Design Considerations

Brass is the Baseline

- Interior ballistics
- Material Selection
- Handling
- Loading
- Manufacturing

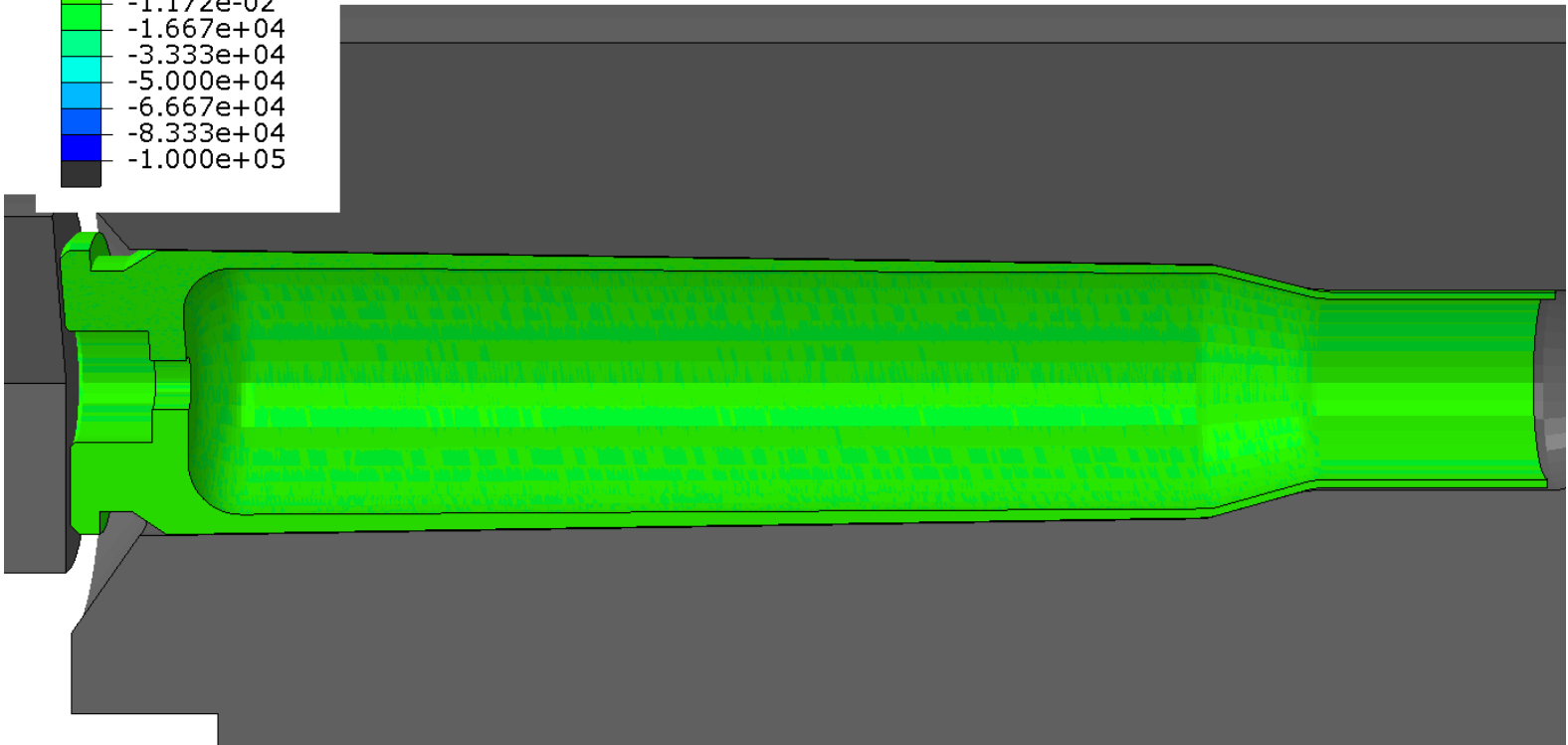
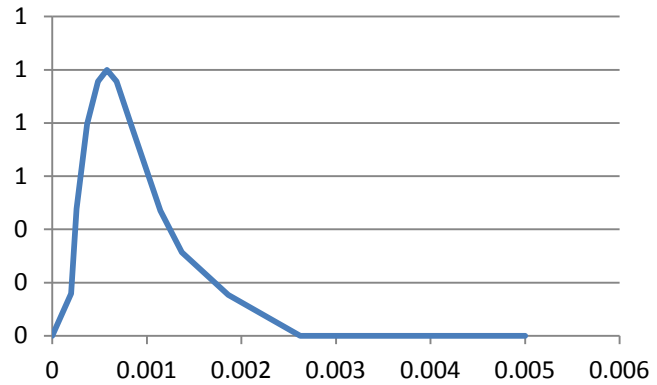
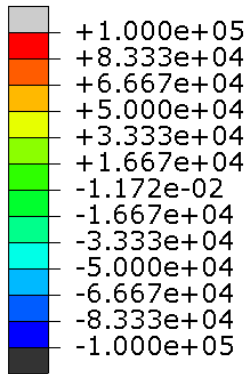


Interior Ballistics

Pressure History Applied

Hoop Stress and Contact Force

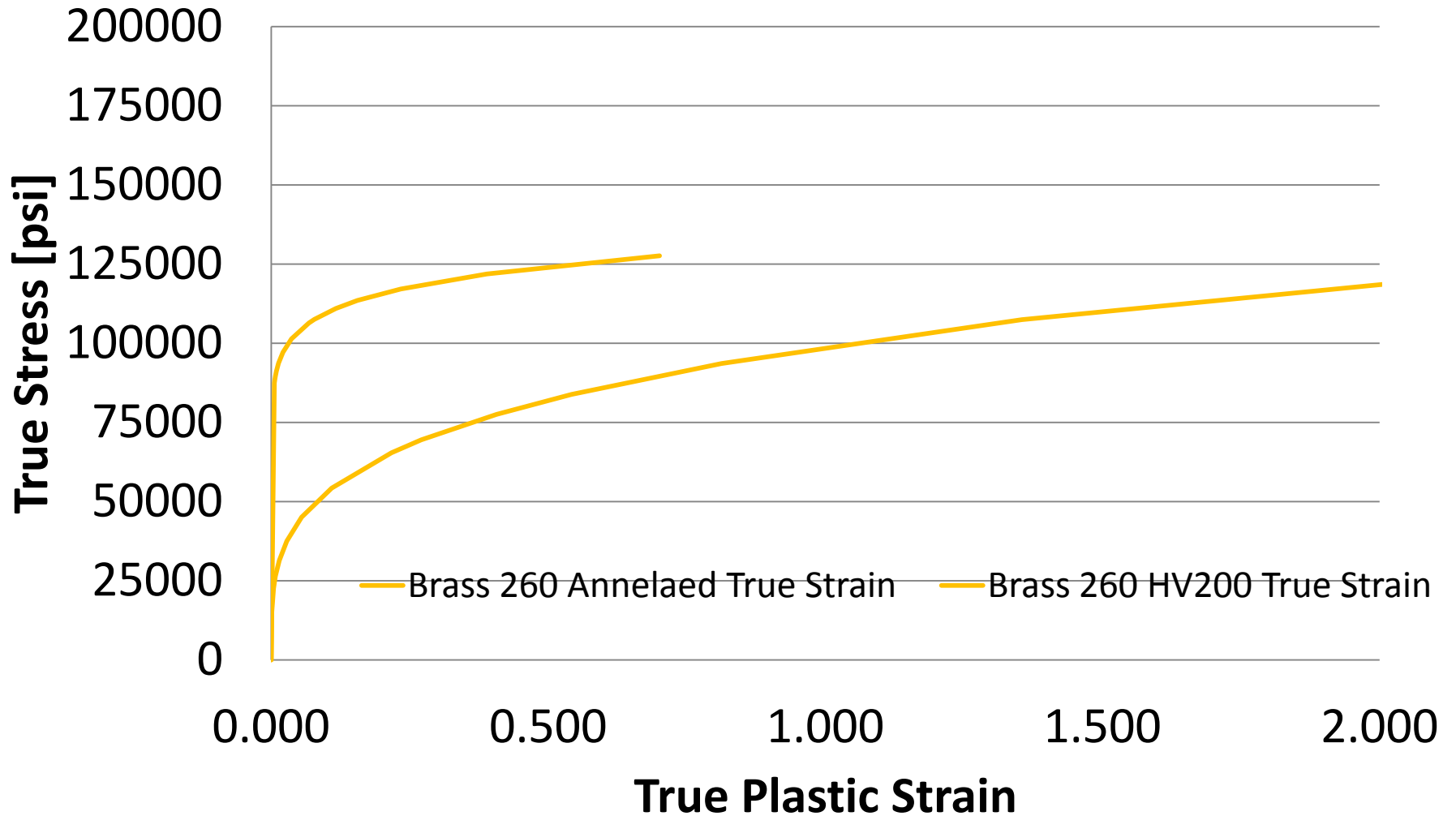
S, S33
(Avg: 75%)



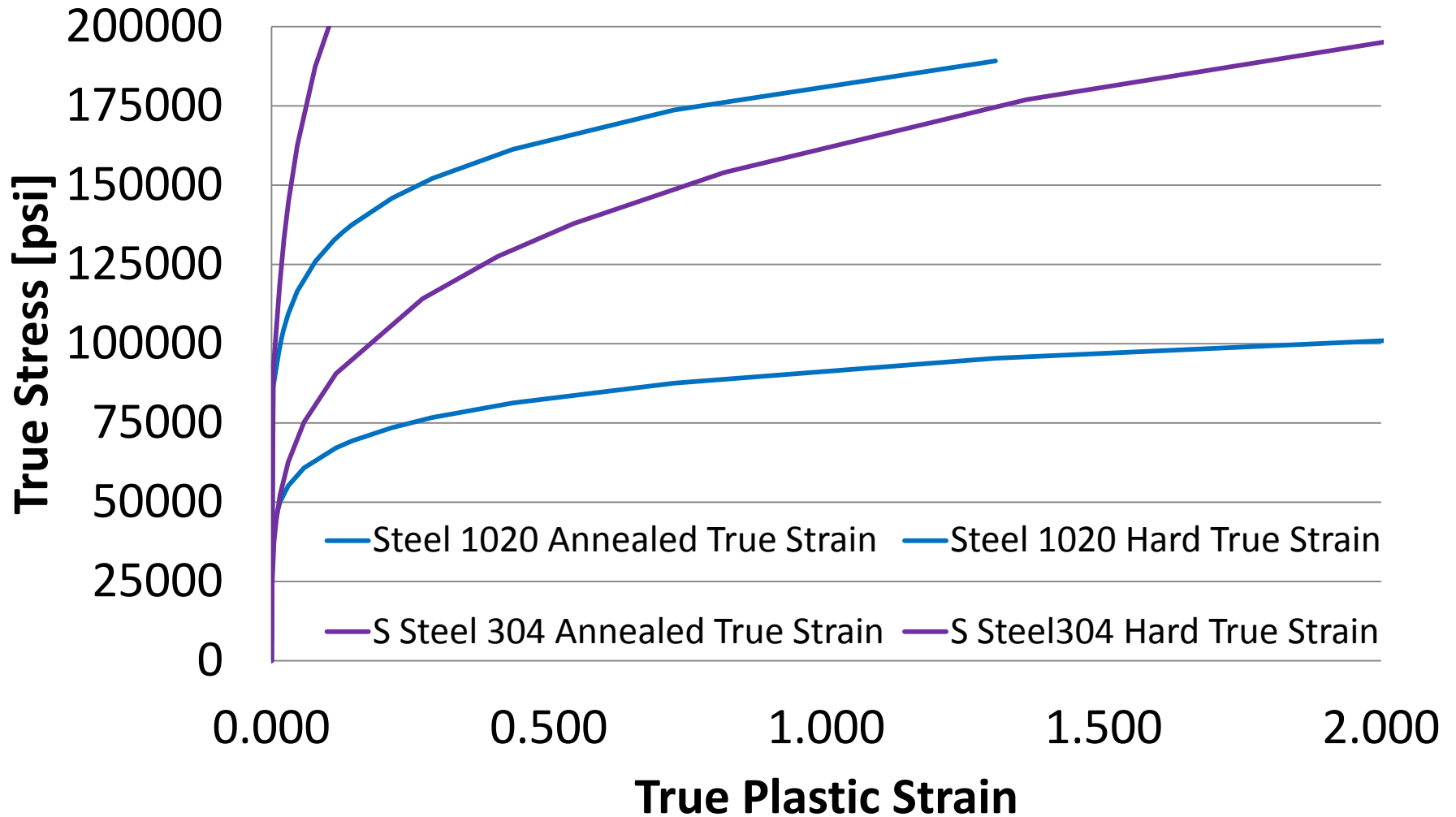
Material Selection

- Soft enough for forming
- Work hardened enough for firing
- Work hardened enough for volume reduction

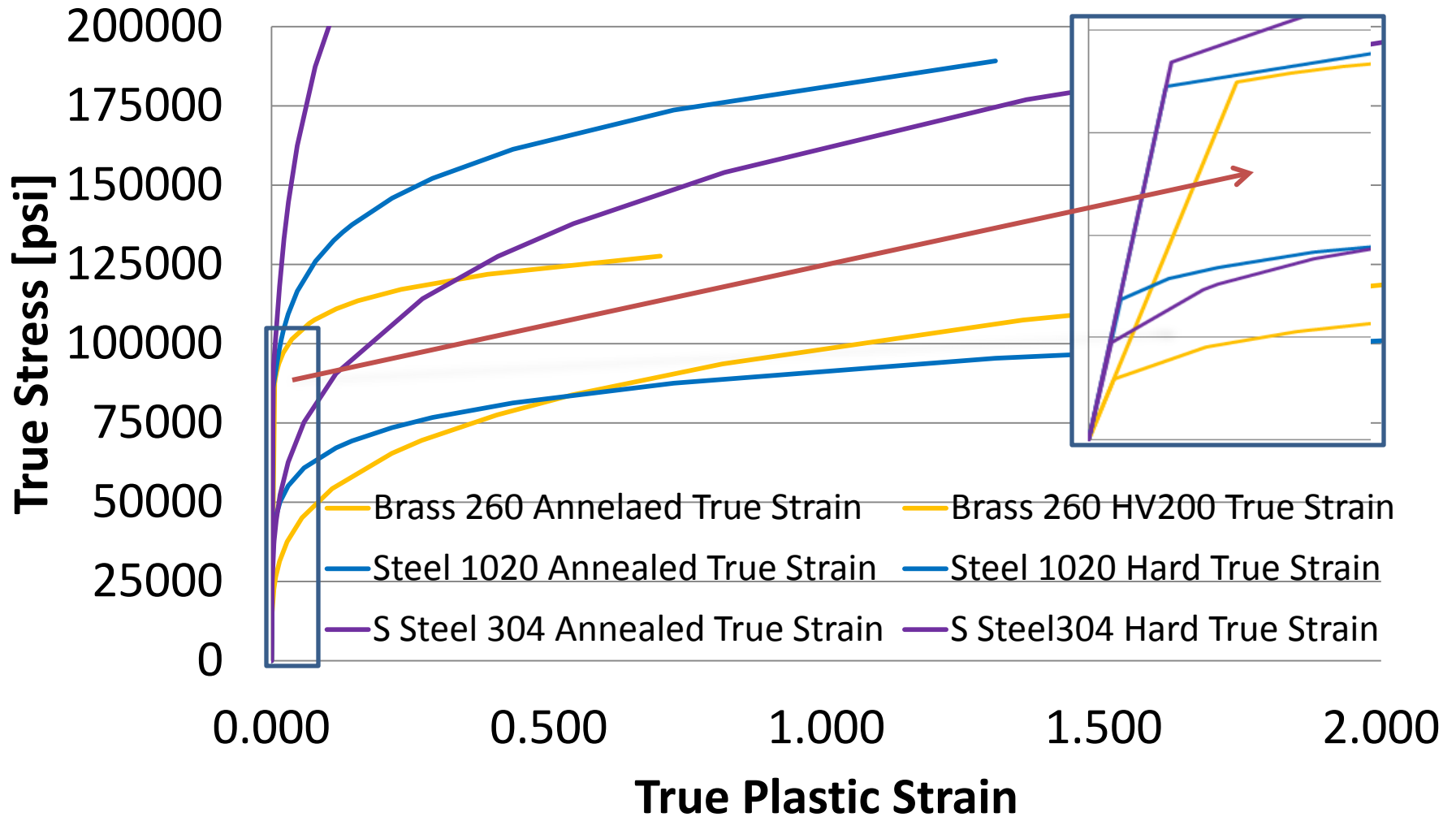
Hard and Soft Brass



Hard and Soft Steels

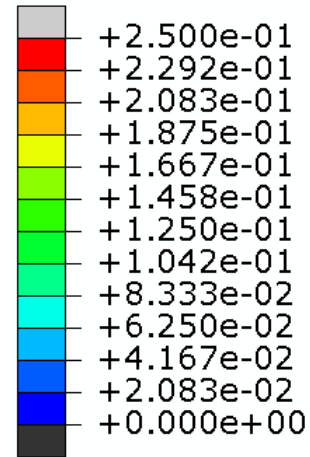


Hard and Soft Case Materials



Post Firing

PEEQ
(Avg: 75%)



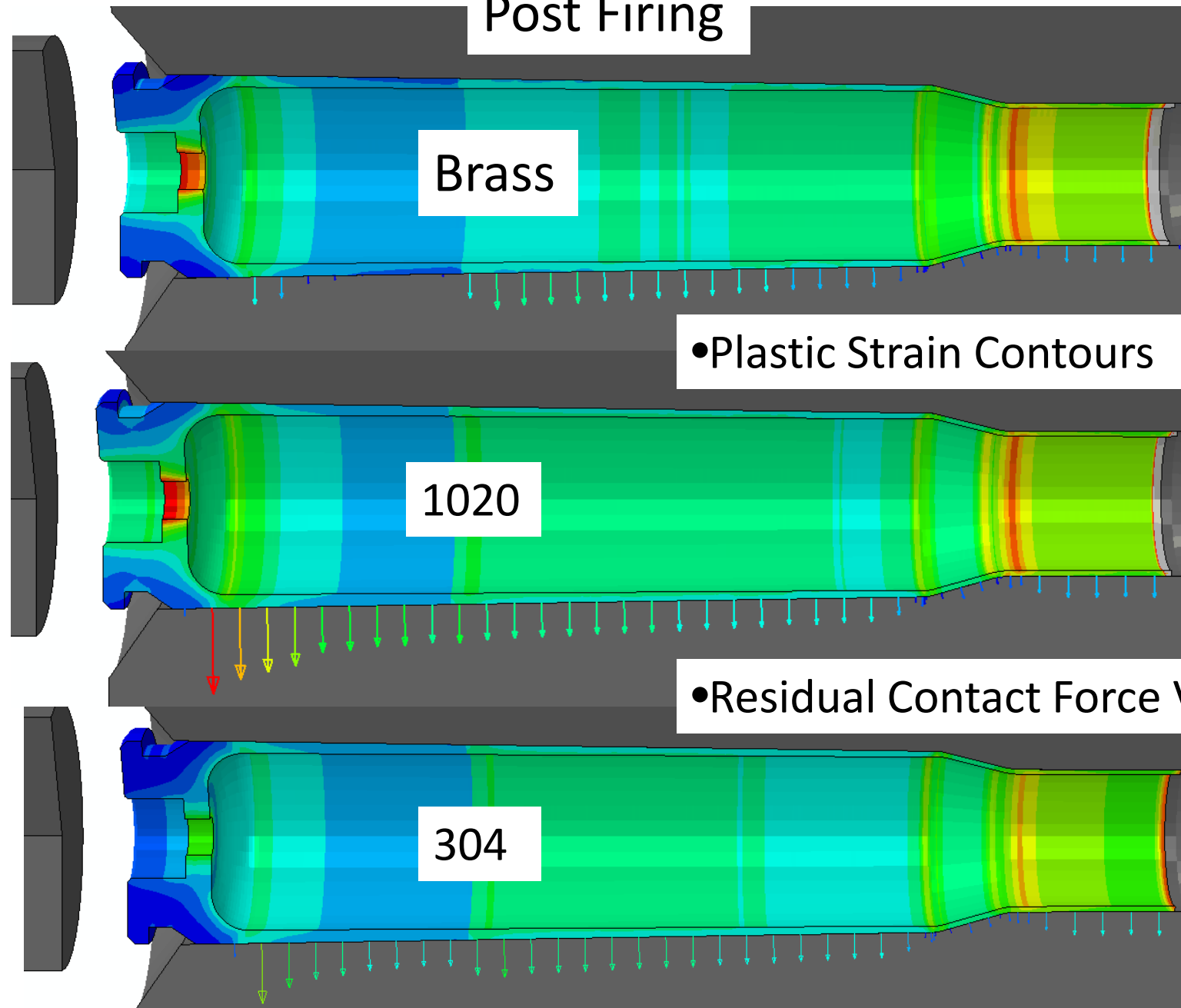
Brass

• Plastic Strain Contours

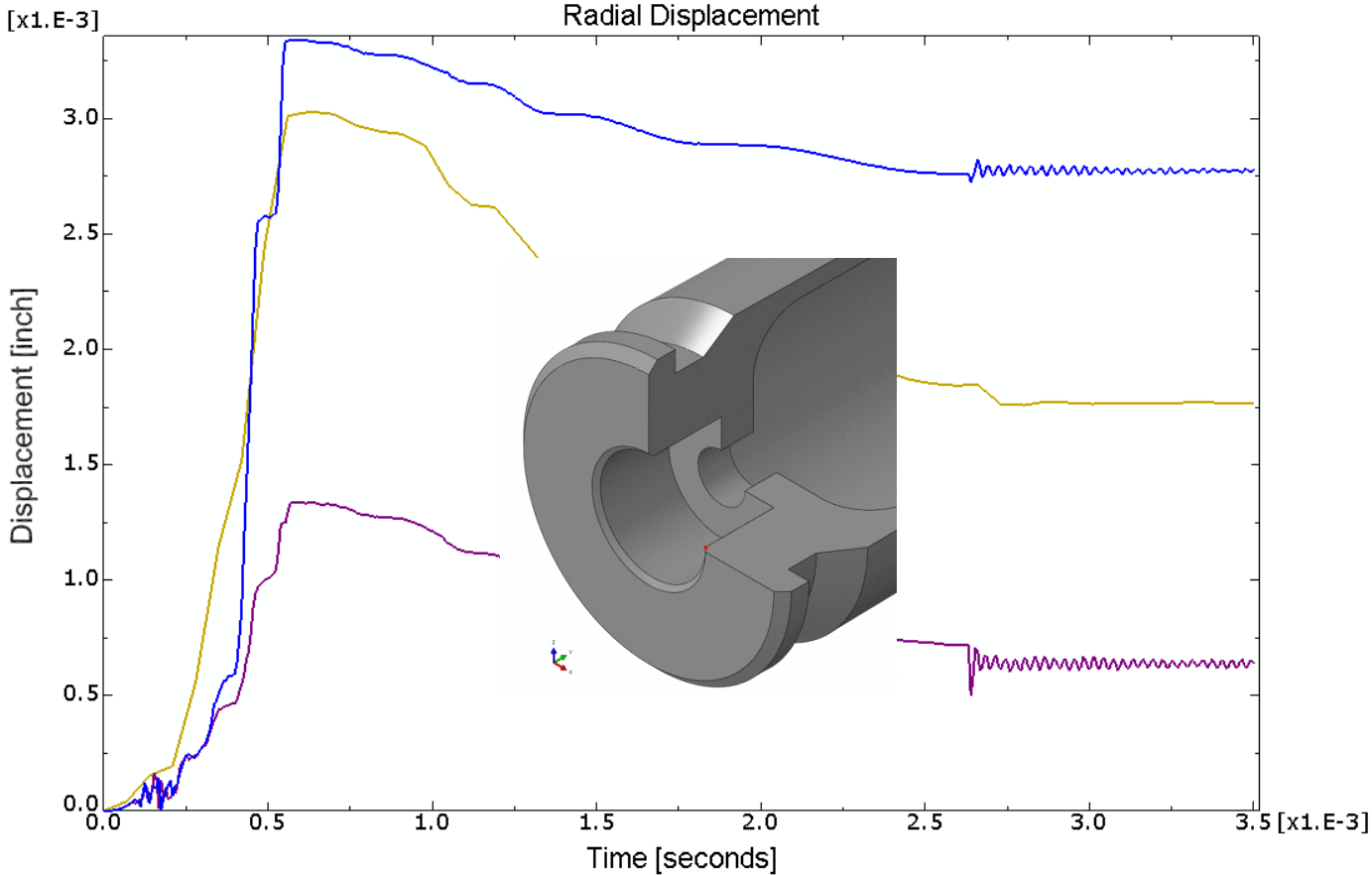
1020

• Residual Contact Force Vectors

304

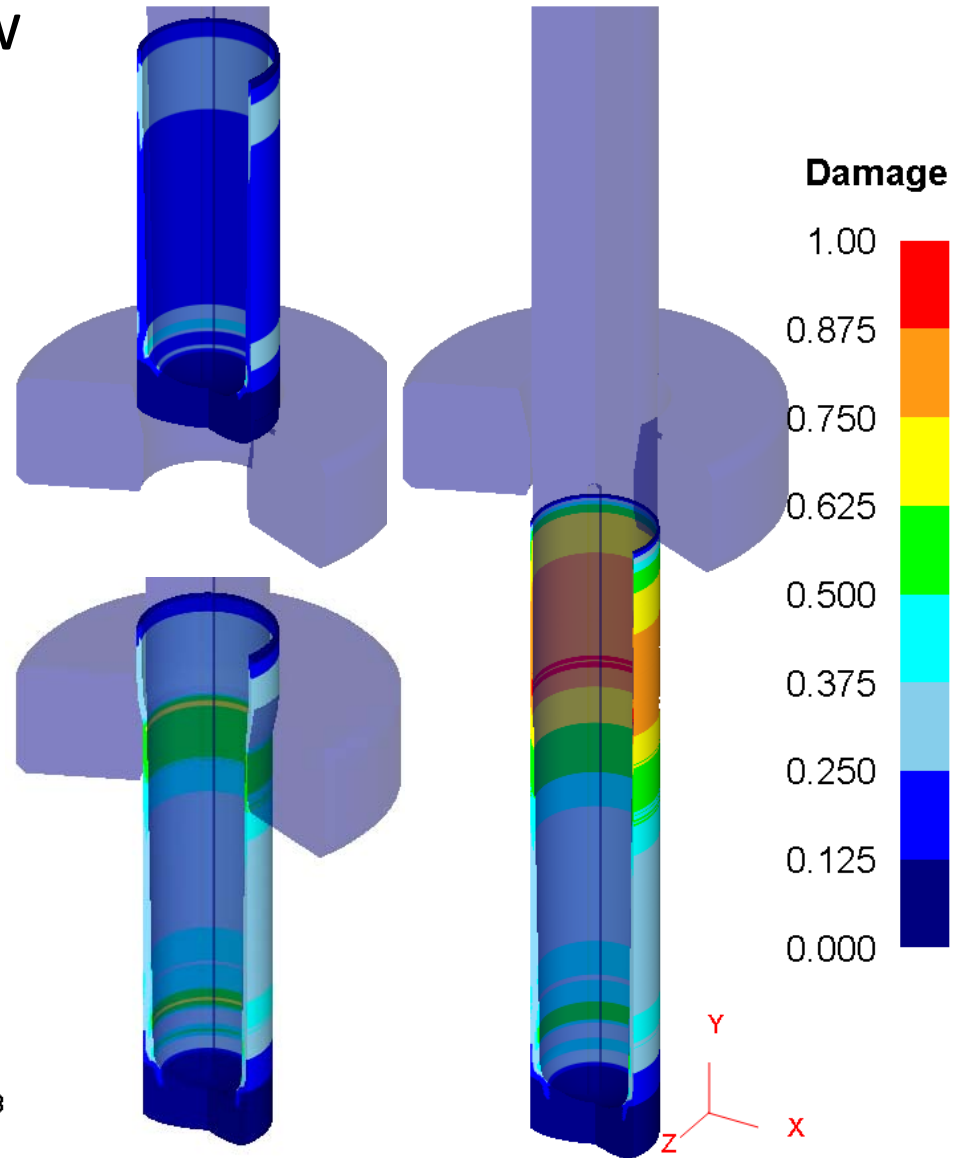
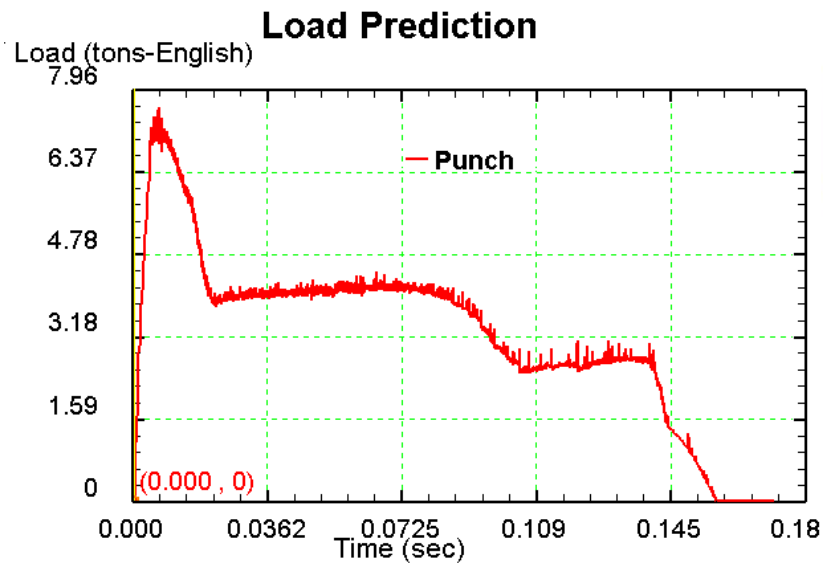


Radial Displacement of Corner Pocket

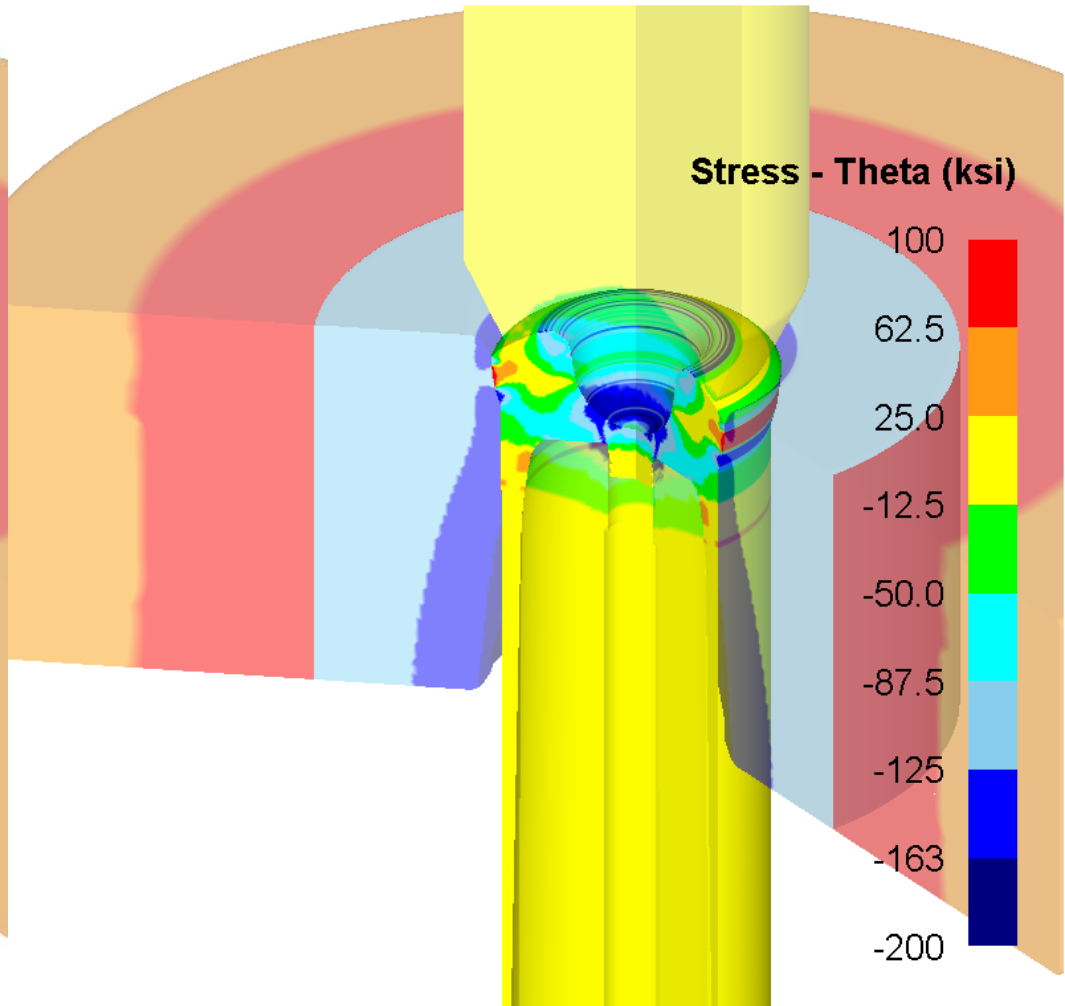
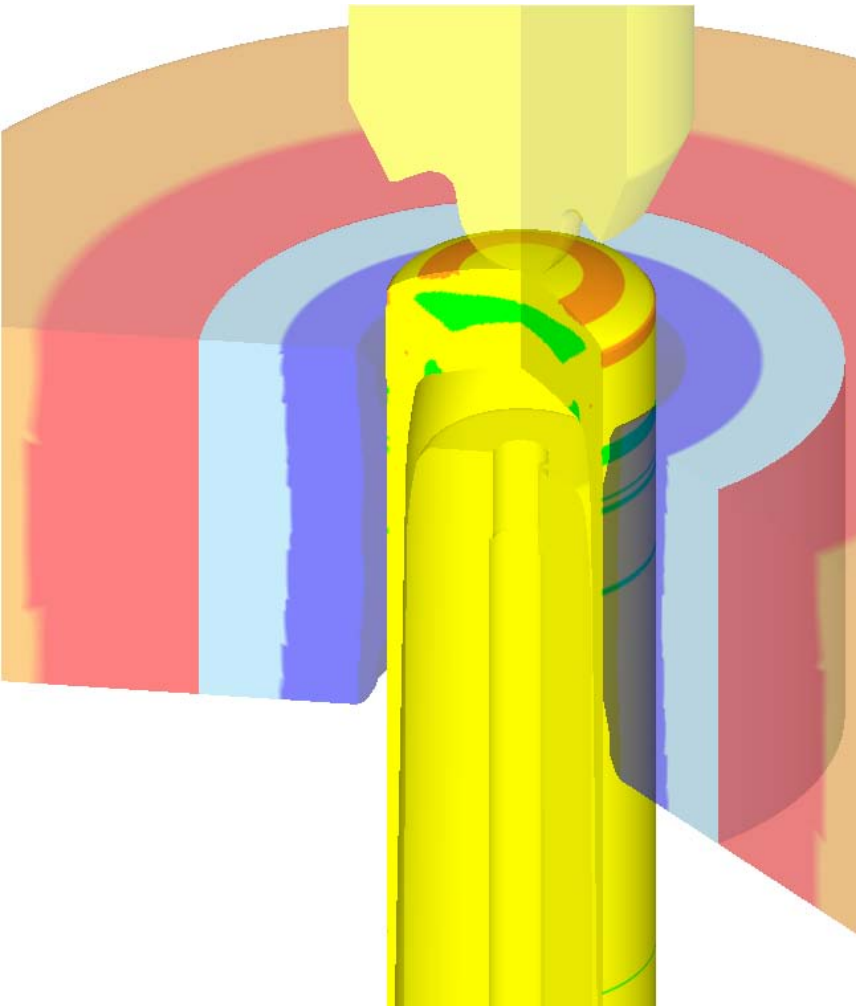


50 Cal Steel Case Final Draw

- Calibrate Damage Criteria with Success and Failure
- Predict Tonnage Requirements



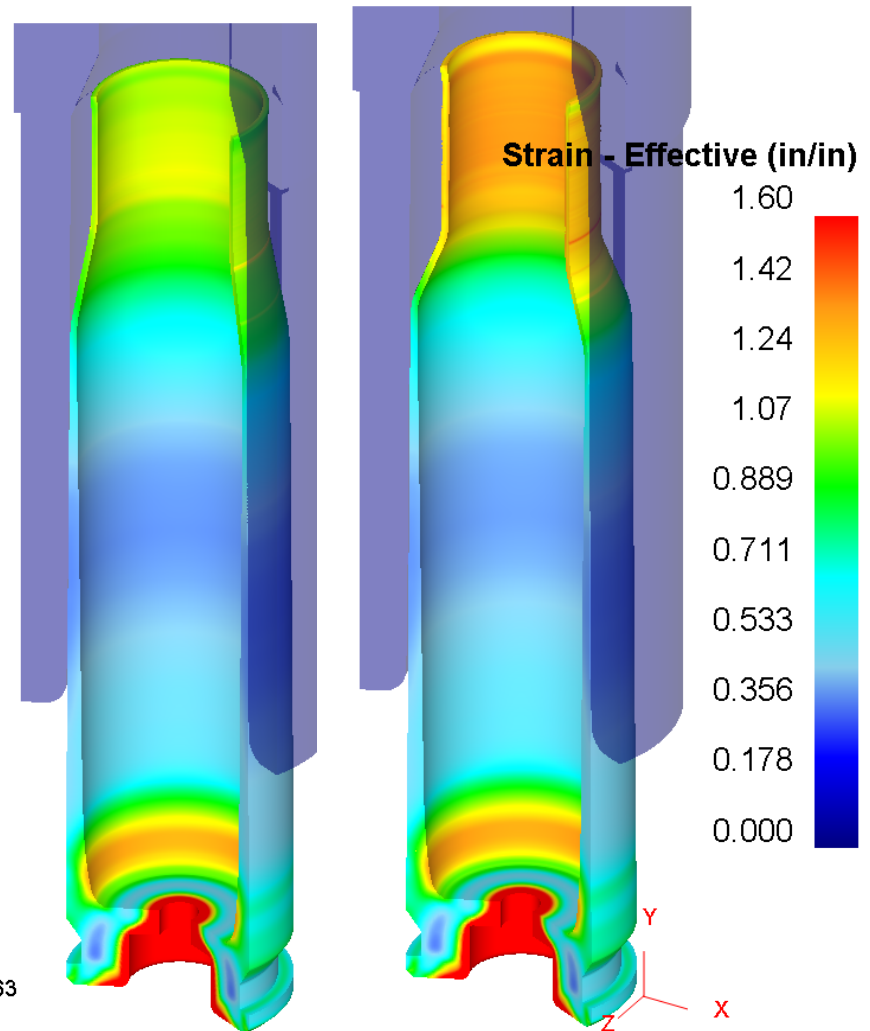
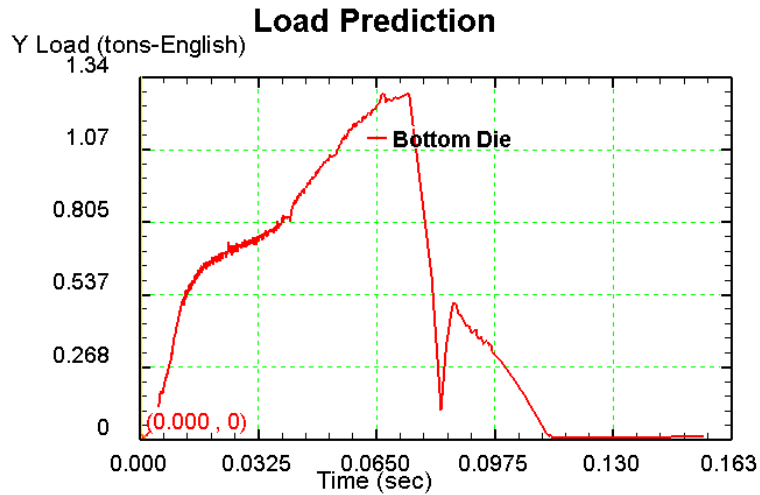
7.62-mm Pocketing Tool Hoop Stress



Accumulated Plastic Strain

Indicates high levels of work hardening

7.62-mm 2nd Taper



50 Cal Demo



Design Evolution via FEA

- Presumed material models
- Predicted Case Function
- Tested selected material
- Guided tooling modification
- Tested final product (via hardness)
- Reaffirmed case function
- Using 50 cal knowledge on other calibers

Mark Lee
816 796-5155
ATK
MarkD.Lee@ATK.com