

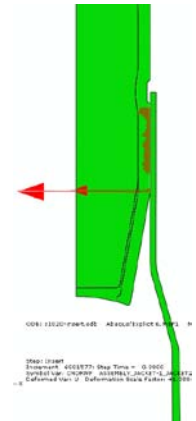
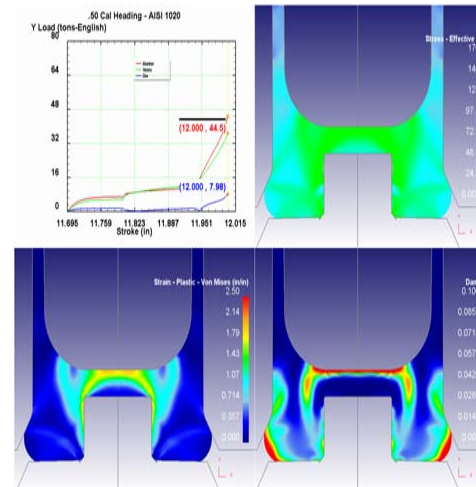
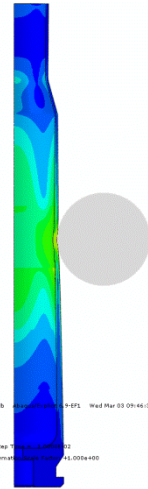
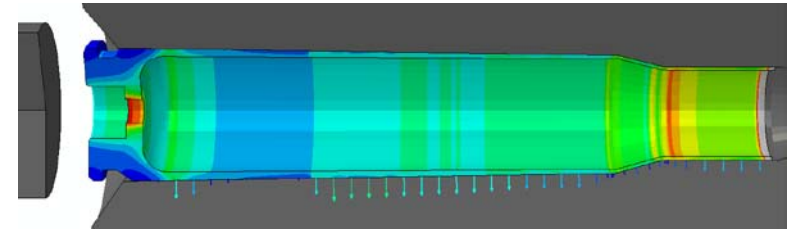
# Modeling and Simulation of the Manufacturing and Ballistic Performance of Low Carbon steel, Small-caliber Cartridge Cases

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

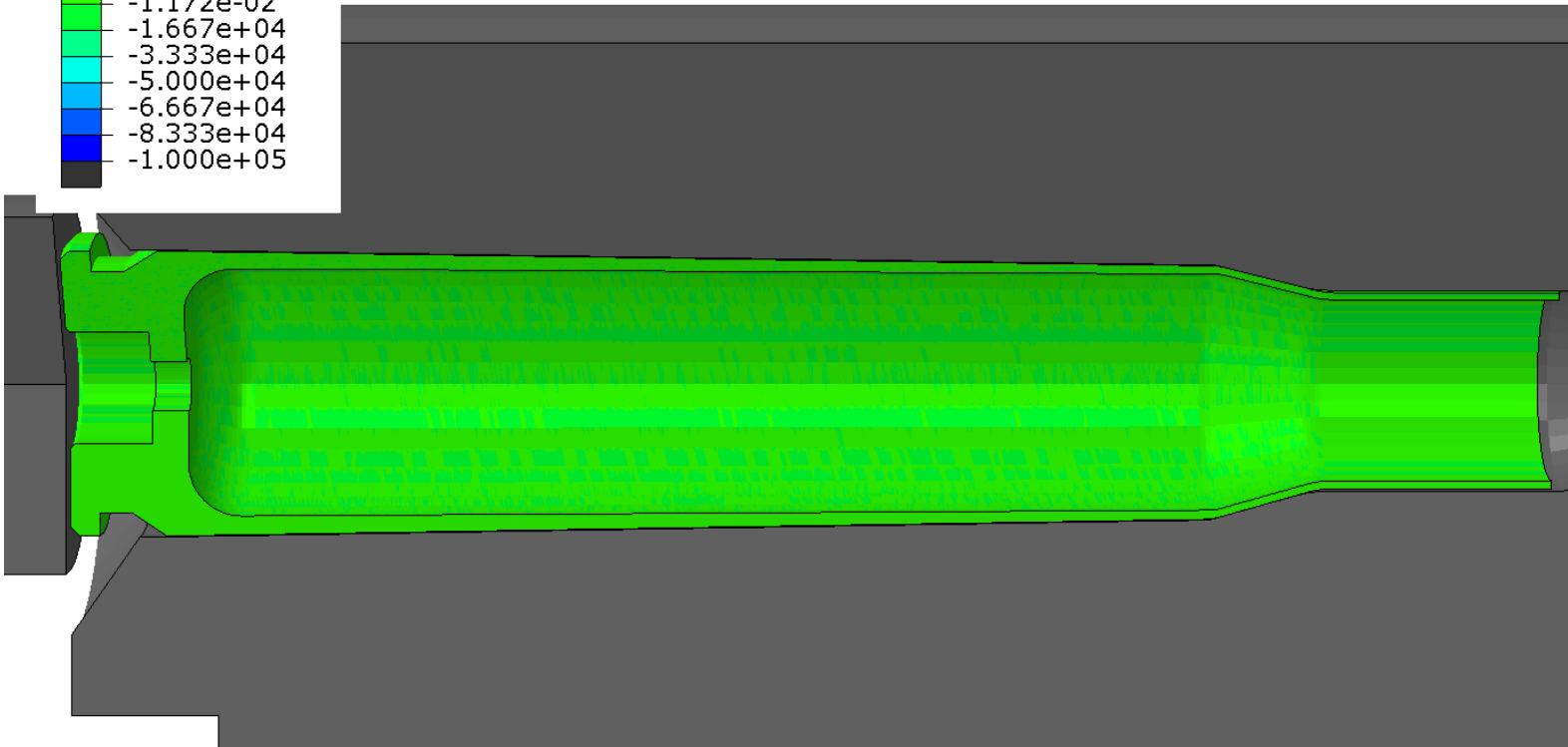
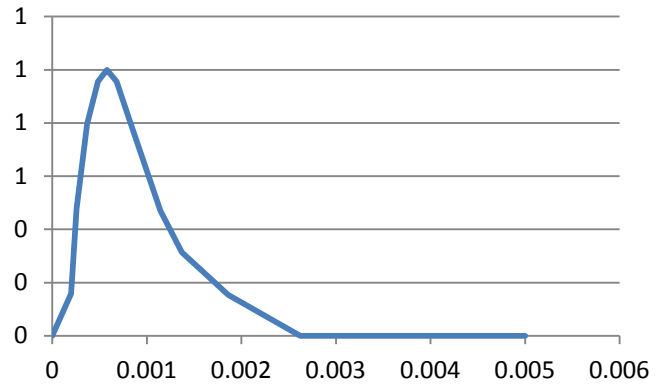
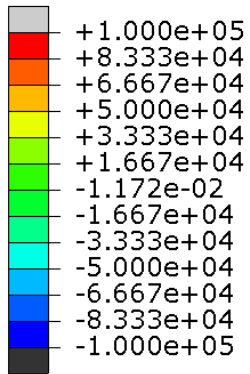


# Interior Ballistics

Pressure History Applied

Hoop Stress and Contact Force

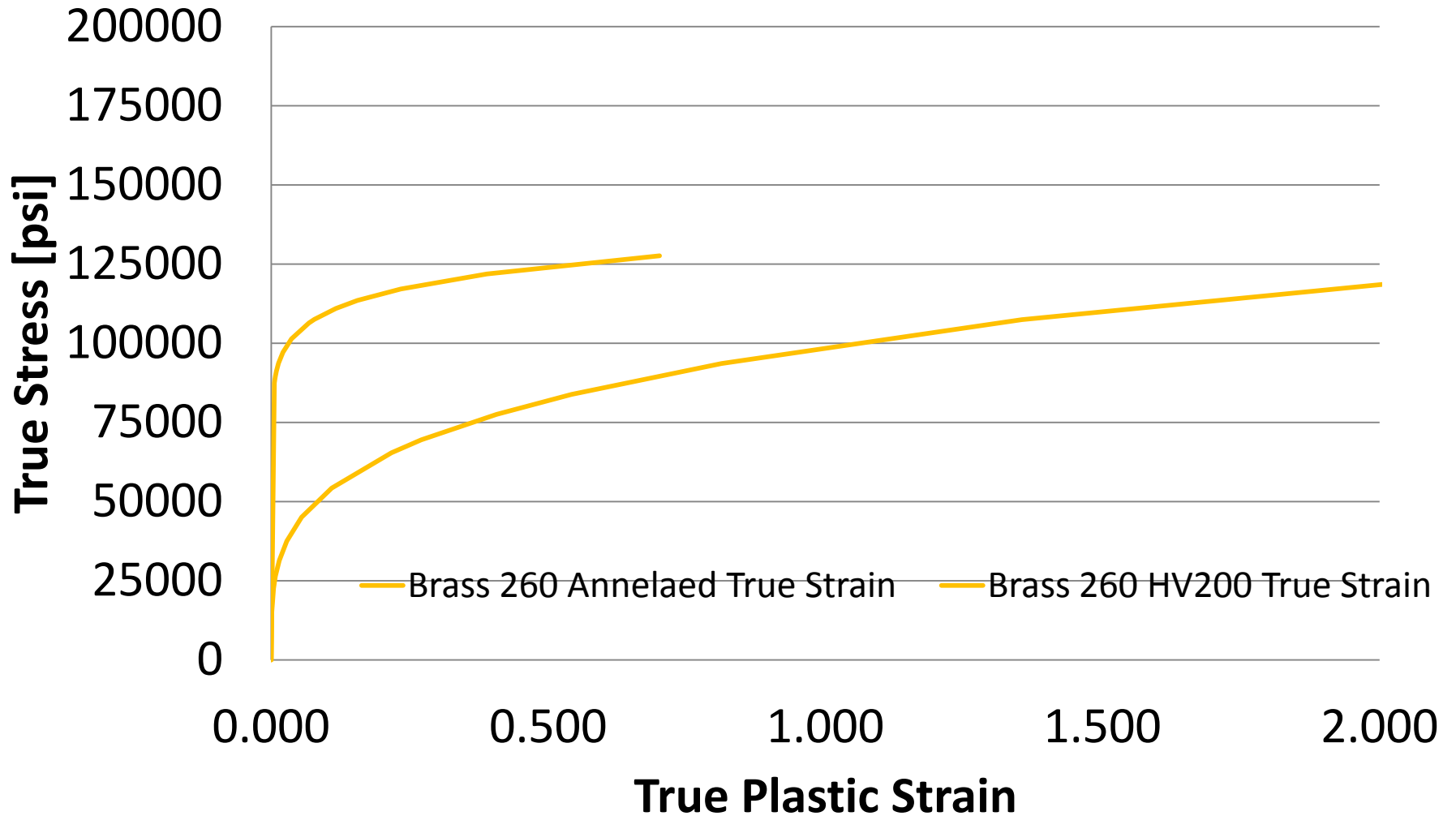
S, S33  
(Avg: 75%)



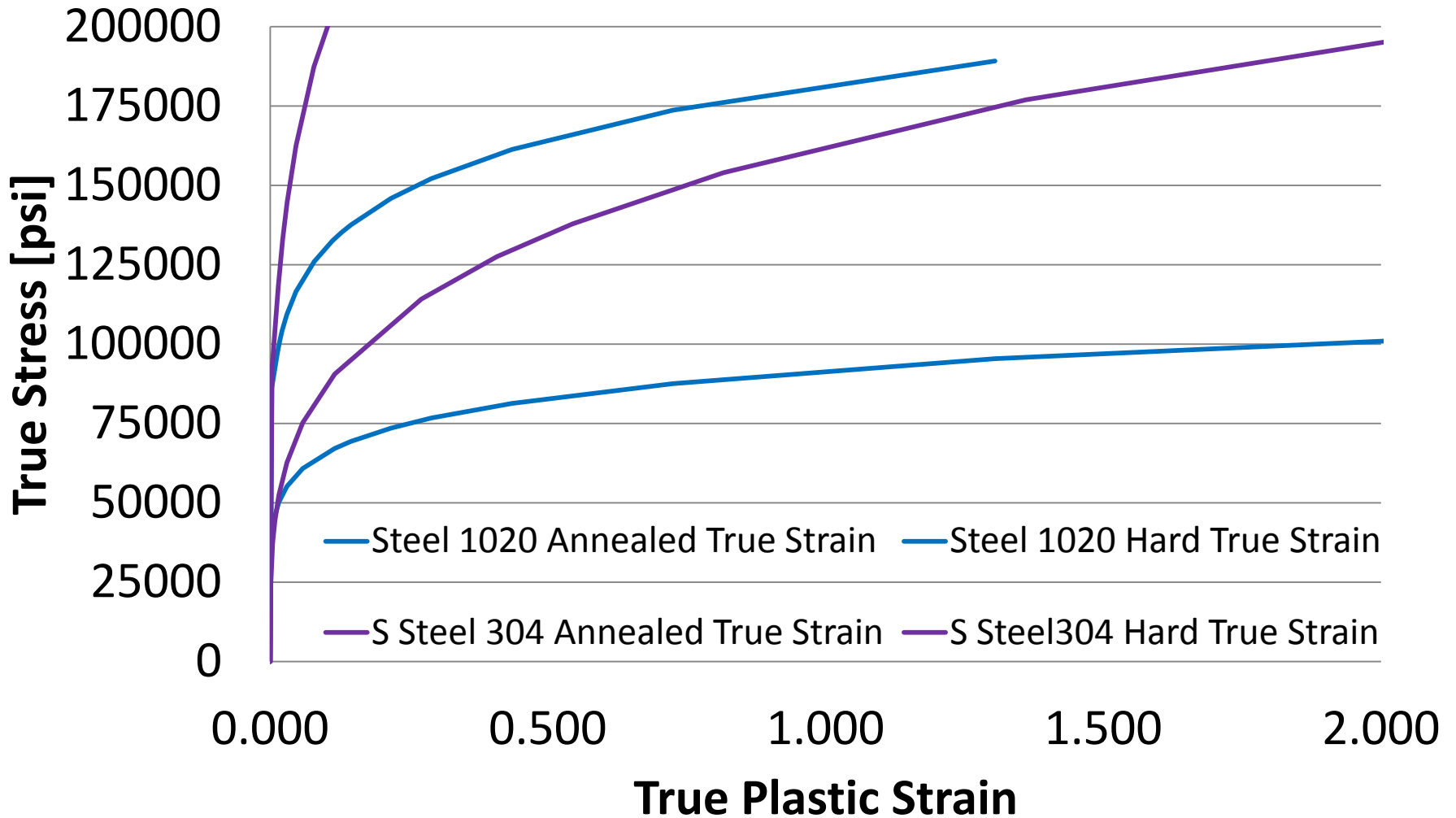
# Material Selection

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

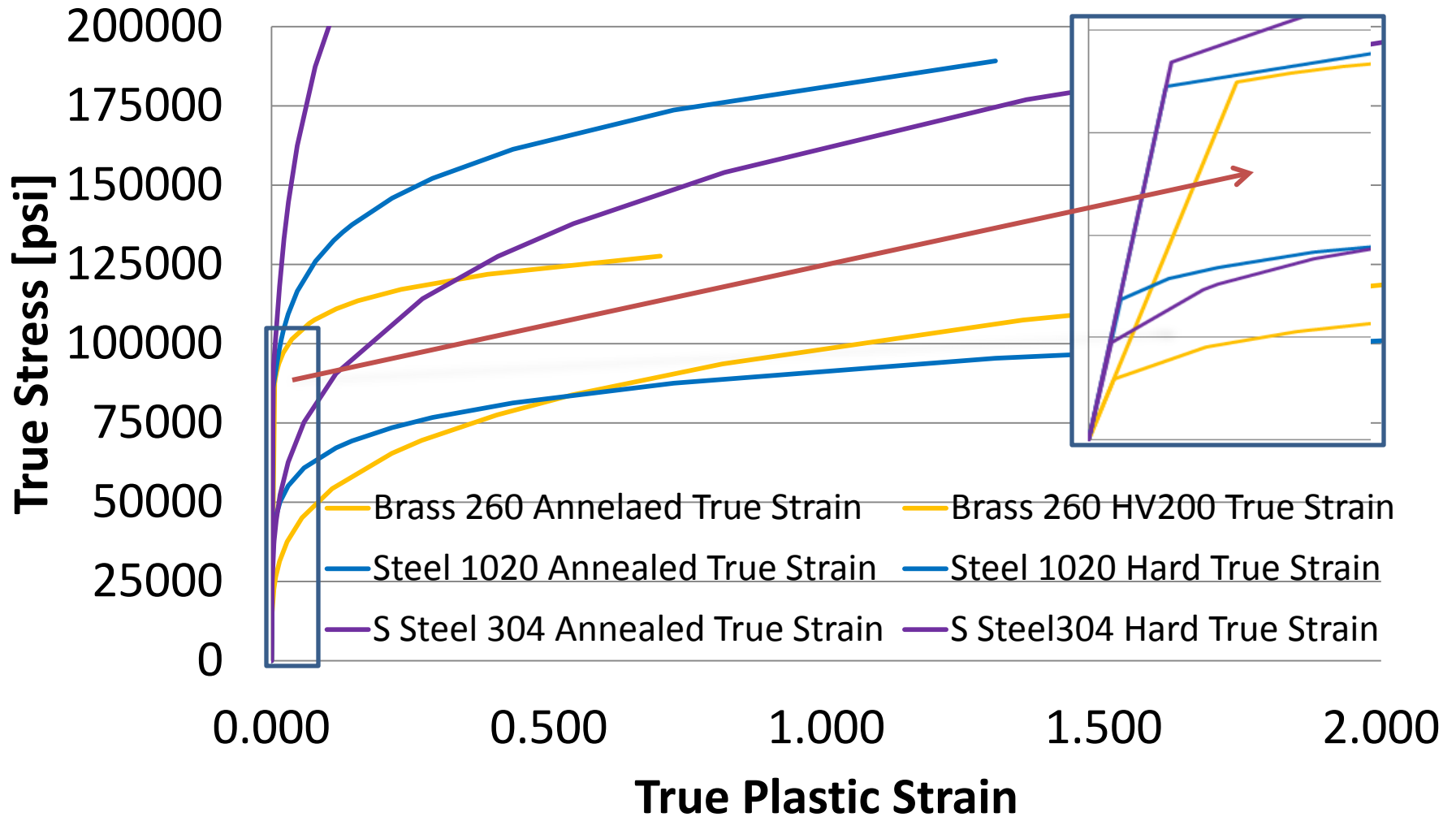
# Hard and Soft Brass



# Hard and Soft Steels

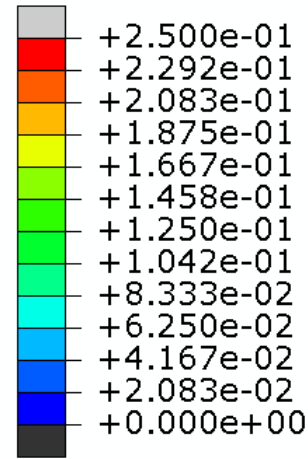


# Hard and Soft Case Materials



# Post Firing

PEEQ  
(Avg: 75%)



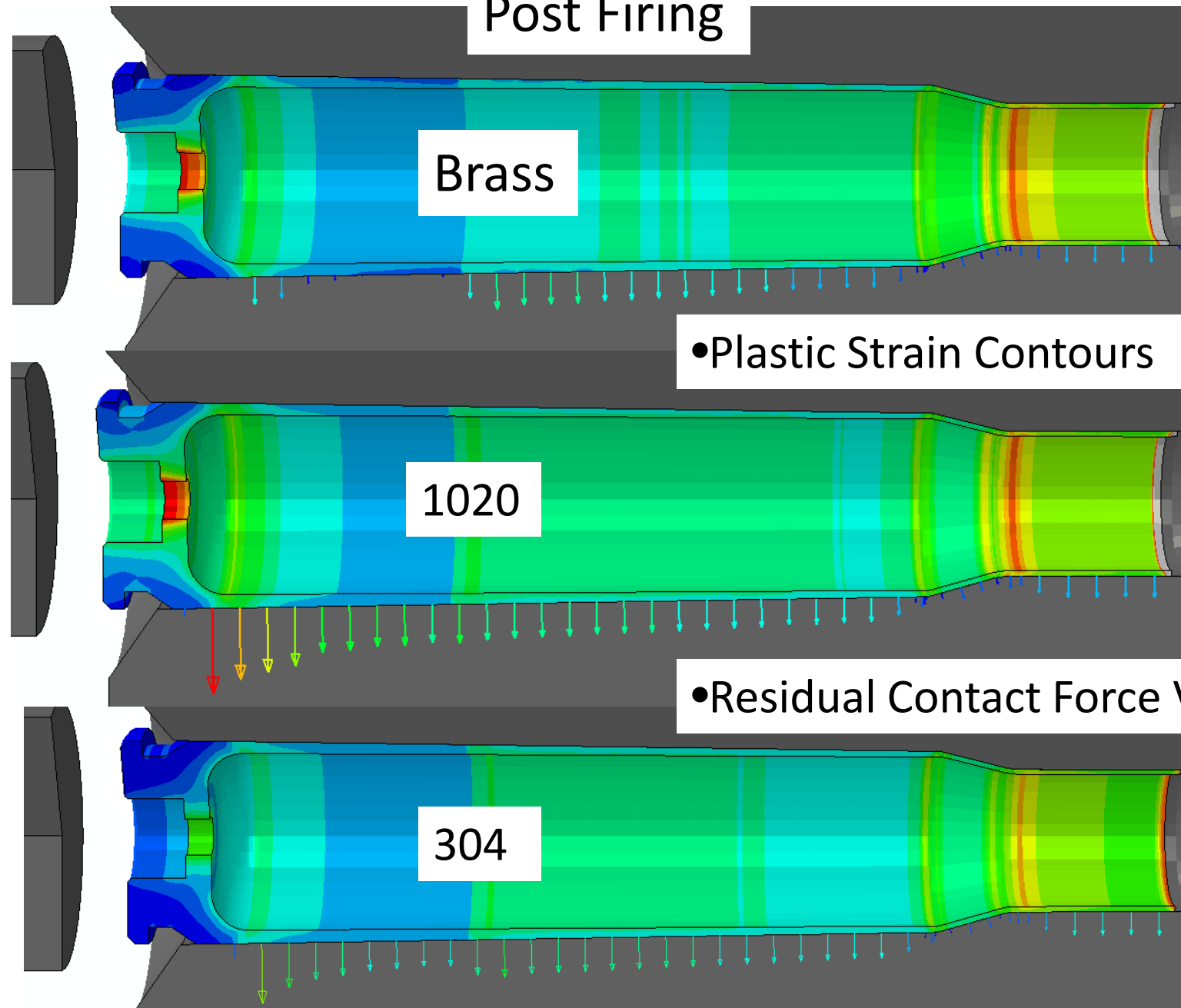
Brass

• Plastic Strain Contours

1020

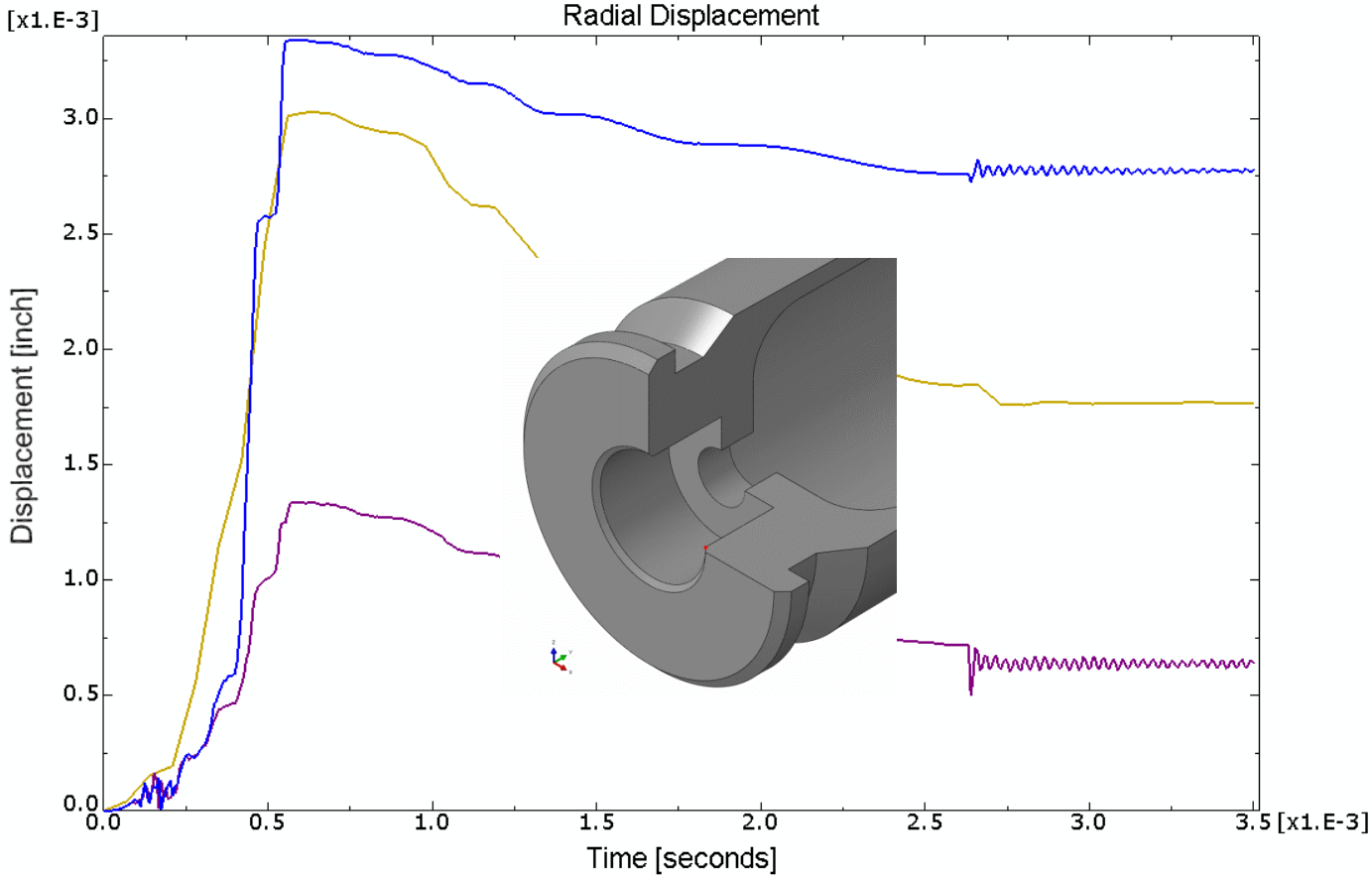
• Residual Contact Force Vectors

304



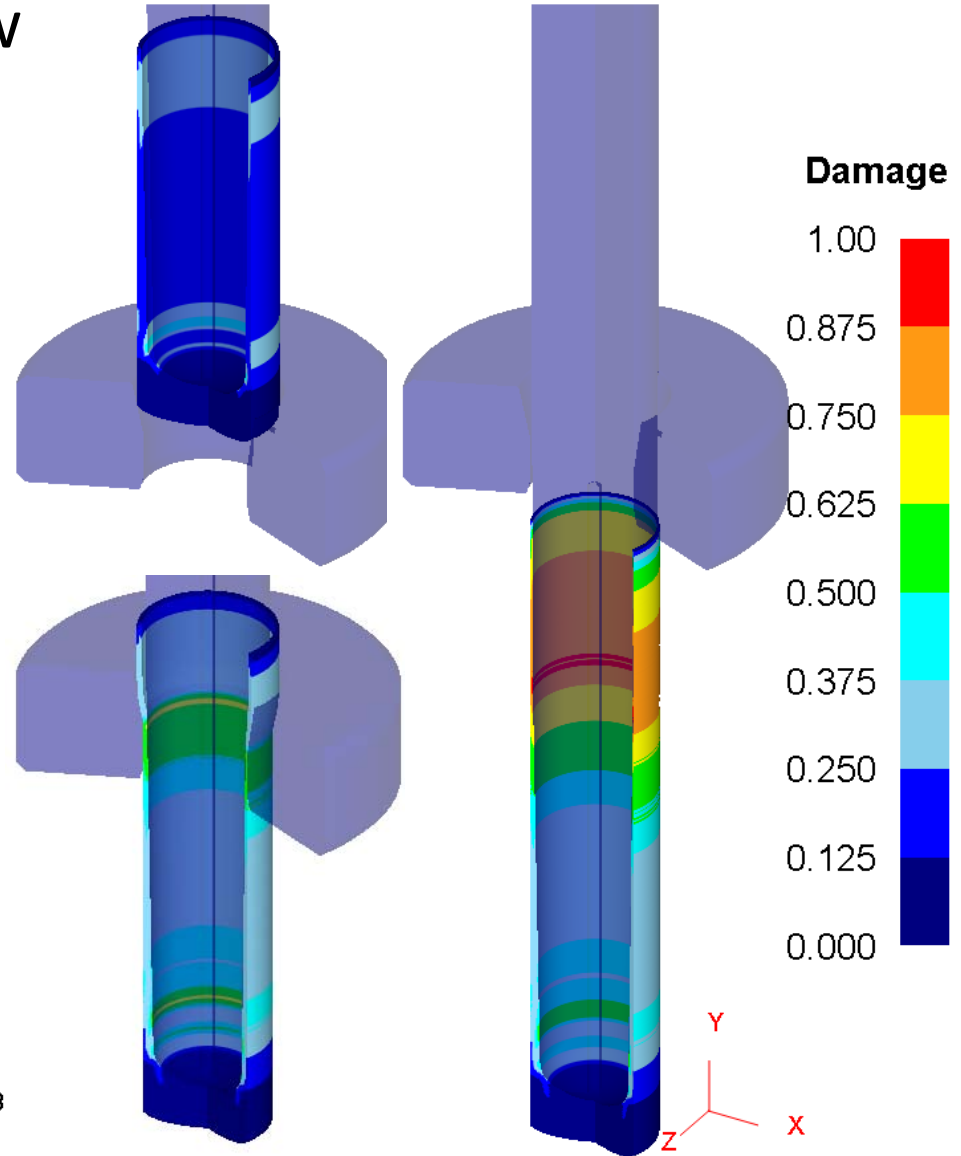
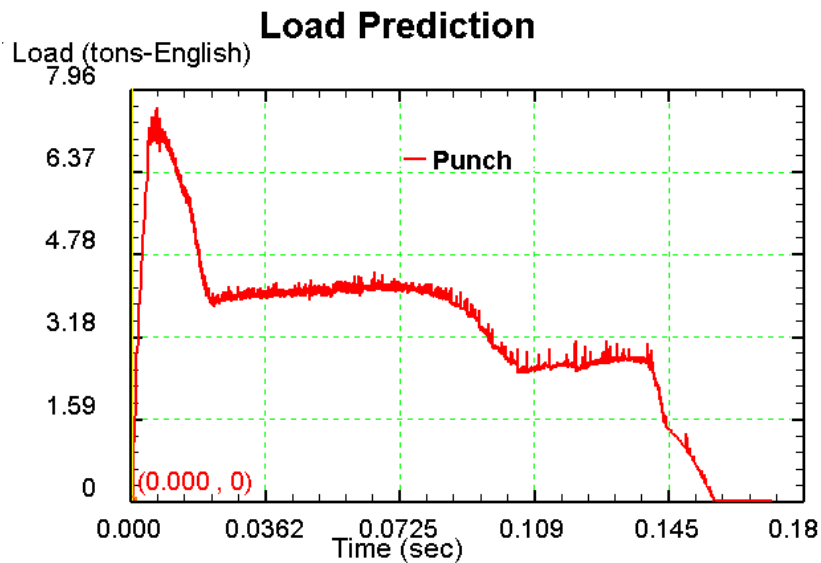


# Radial Displacement of Corner Pocket

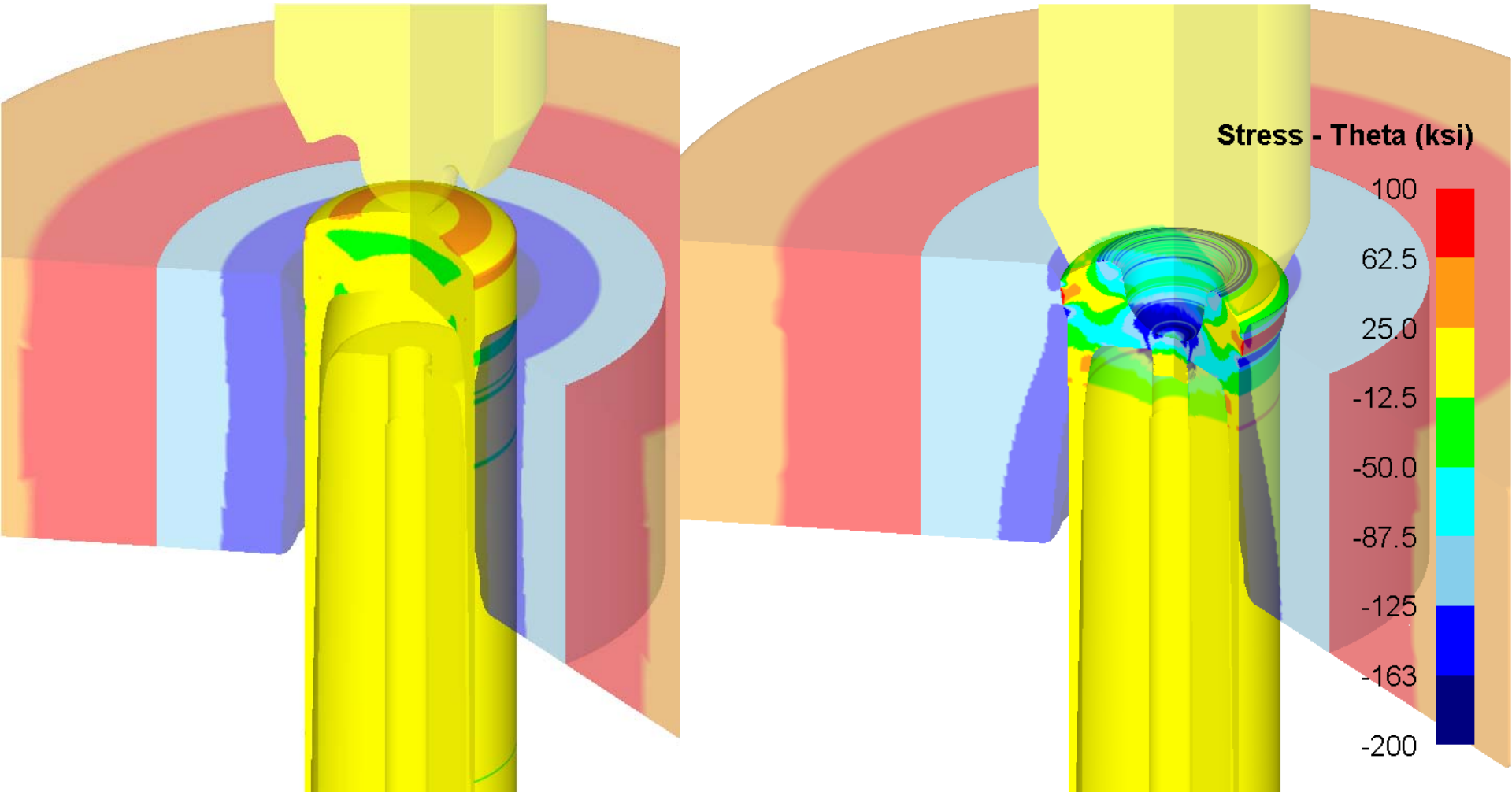


# 50 Cal Steel Case Final Draw

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



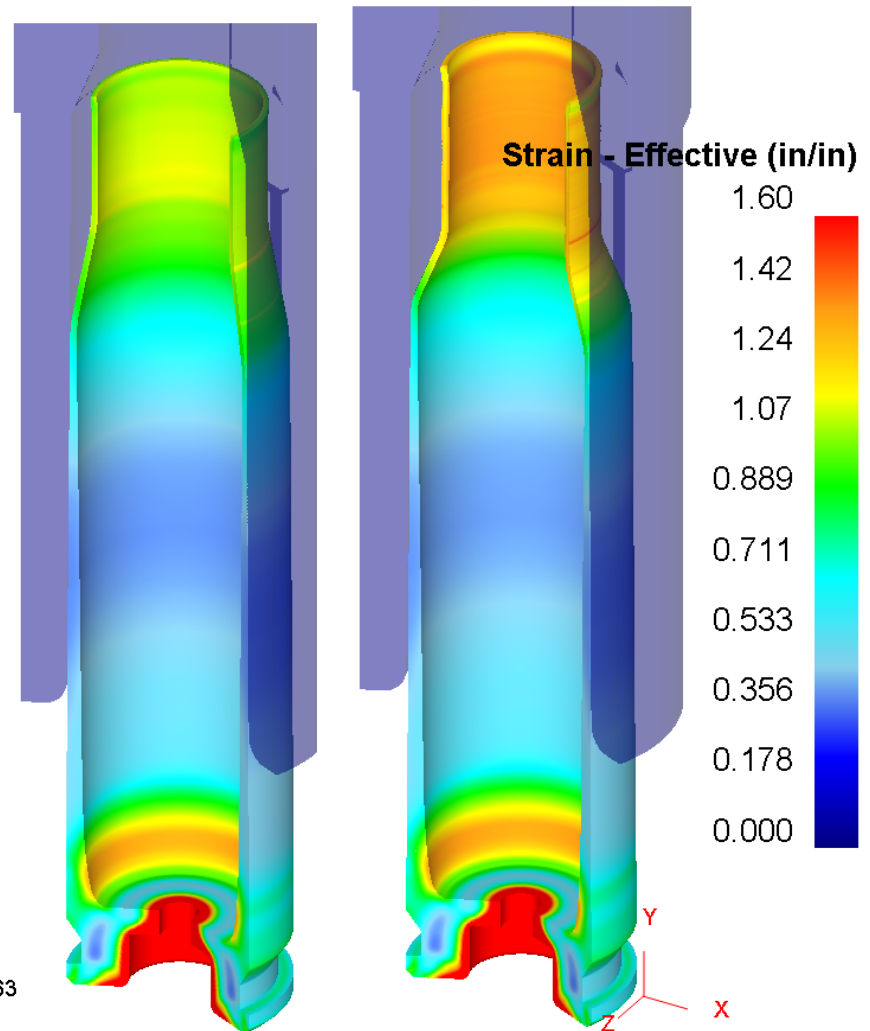
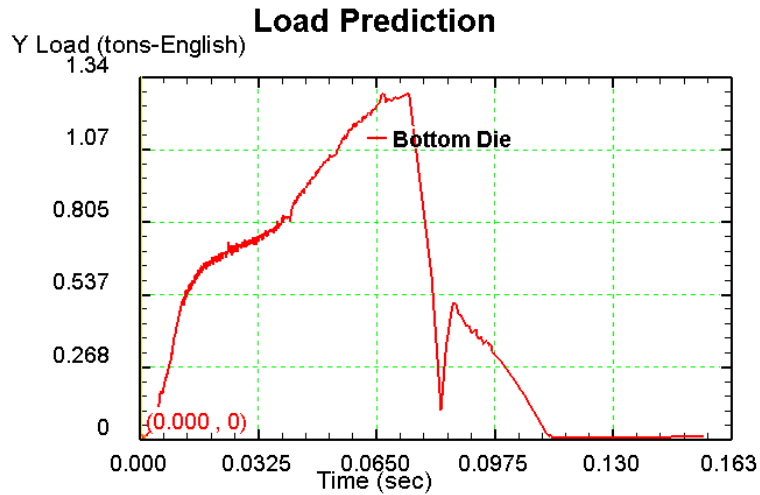
# 7.62-mm Pocketing Tool Hoop Stress



# Accumulated Plastic Strain

Indicates high levels of work hardening

## 7.62-mm 2<sup>nd</sup> 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