ENGINEERING VICTORY

ARDEC

Modeling and Simulation as a Management Tool

National Defense Industrial Association

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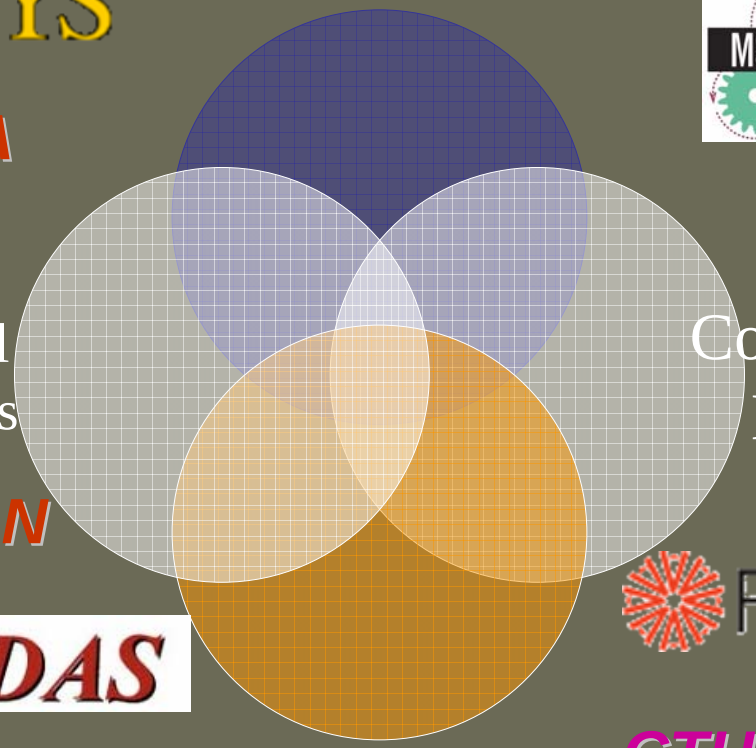
Toolbox

Includes Latest DOE Models

- **Mechanism Modeling**
- **Weapon Dynamics**
  - Feed
  - Chamber
  - Fire
  - Extract
  - Eject
- **Interior Ballistics**
  - Ammunition
  - Engraving
- **Terminal Ballistics**
  - Hard Targets
  - Soft Targets
- **Component Design**



PRO-E

GLO/CALE

ABAQUS

ALE3D

ANSYS

MSC.ADAMS

LS-DYNA

LSTC Livermore Software Technology Corp.

FLOWTRAN

FLUENT

PRODAS

CTH

CHEETAH

PAFRAG

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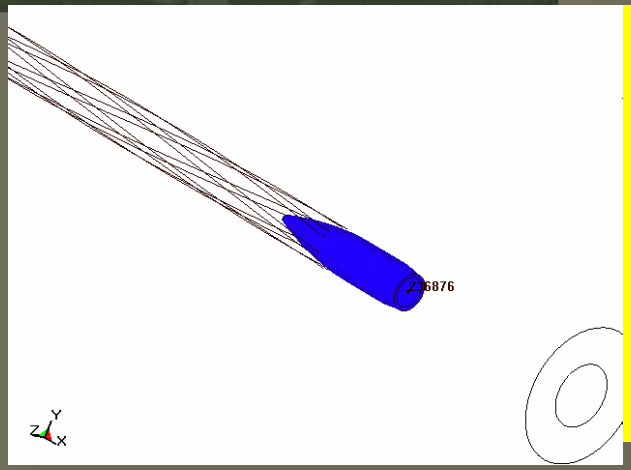
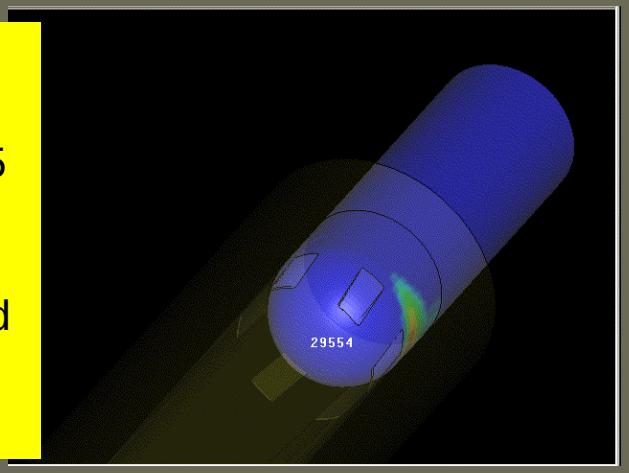
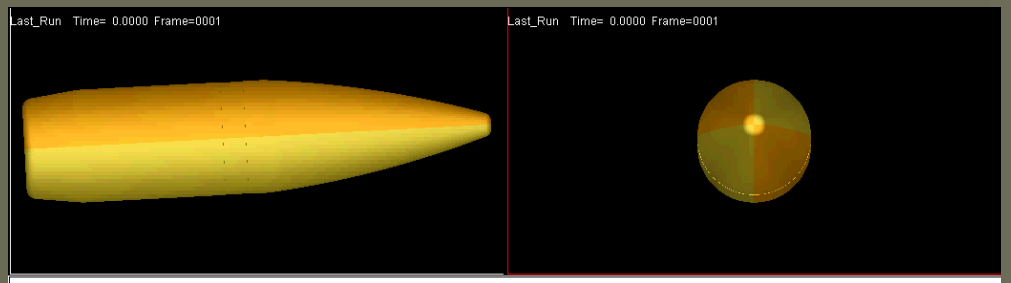
Interior & Exterior Ballistics – Firing

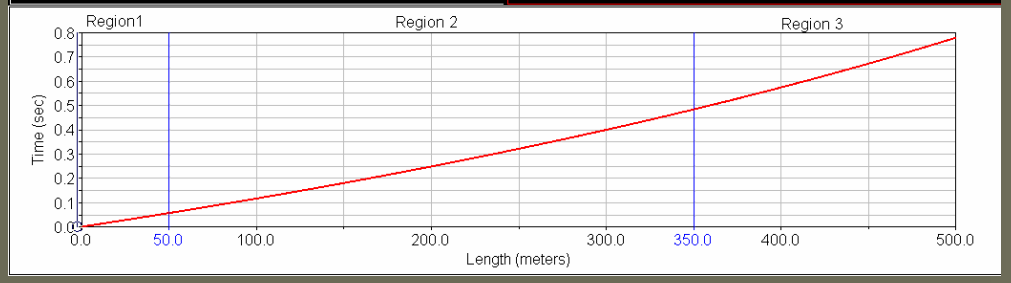


Purpose: Study Engraving forces on 5.56 mm ammunition. Program: M855 & others. Customers: PM MAS and PM SW Result: Saved several prototype and test cycles and associated costs.



Purpose: Study Flight characteristics of M855 Program: M855 Lethality Customer: PMMAS Result: Visualized yaw characteristics of M855 ammunition, served as input to further lethality modeling efforts.





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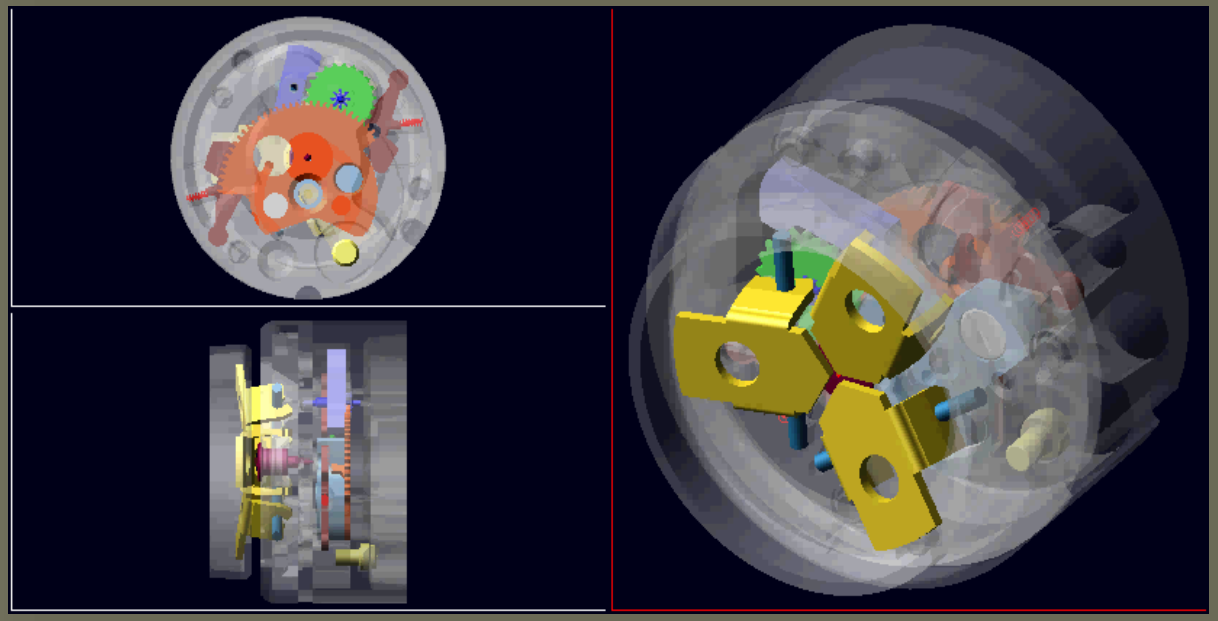
Interior Ballistics Component Design



Purpose: Initial used as a training aid, this M549 model is a design tool used to modify arming distance. Program: 30mm Ammo. Customers: PM MAS Result: Saved several prototype and test cycles and associated costs.

Similar efforts conducted for PM SW and PM MAS ACSW efforts recognized by fuze manufacturer for “total command” of the analysis methods.

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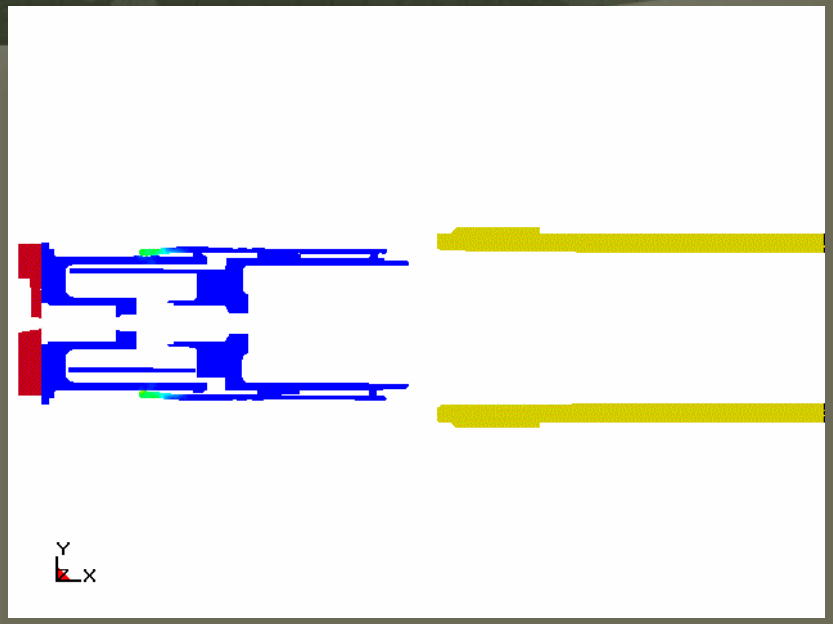
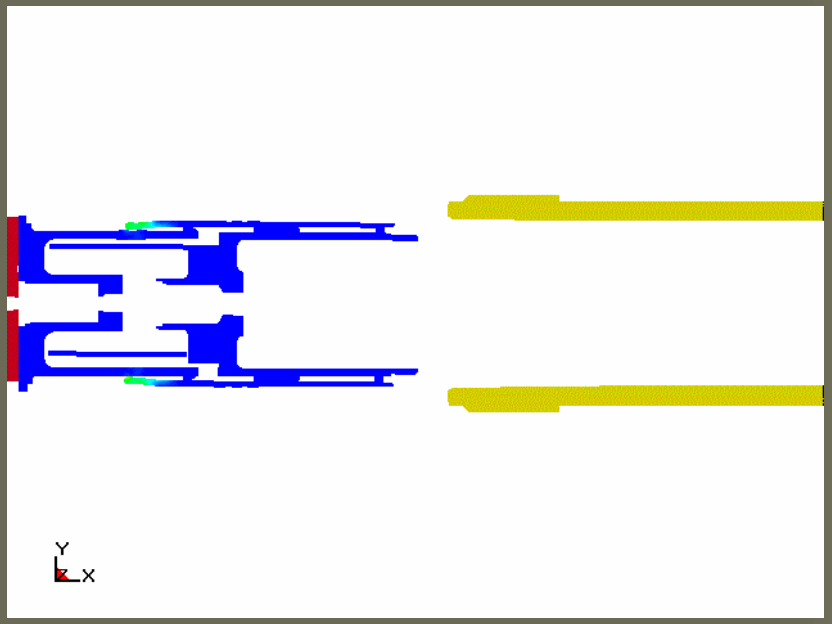
Interior Ballistics Ammunition



Failure to Chamber



Successful Chambering

Purpose Study failure of XM1057 cartridges. Program: XM1057 Customer: PM MAS Results: Demonstrated failure mode and failure parameters. Effort reduced from 8 months for physical testing to four weeks analysis. Costs were reduced from at least $300K to $20K.

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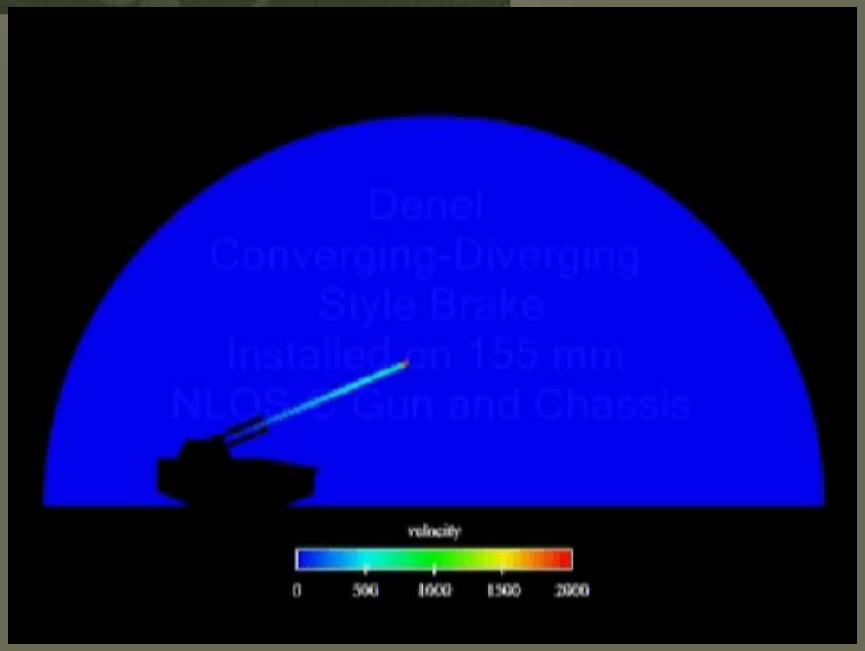
Computational Fluid Dynamics Large Caliber – Muzzle Devices



Computational Fluid Dynamics Work for FCS. Significantly reduced costs for prototype development and testing

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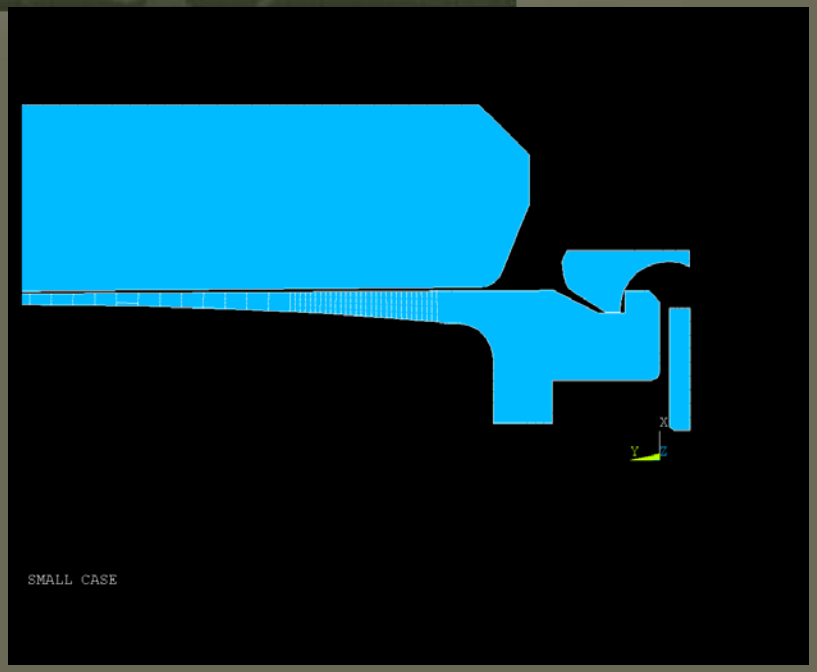
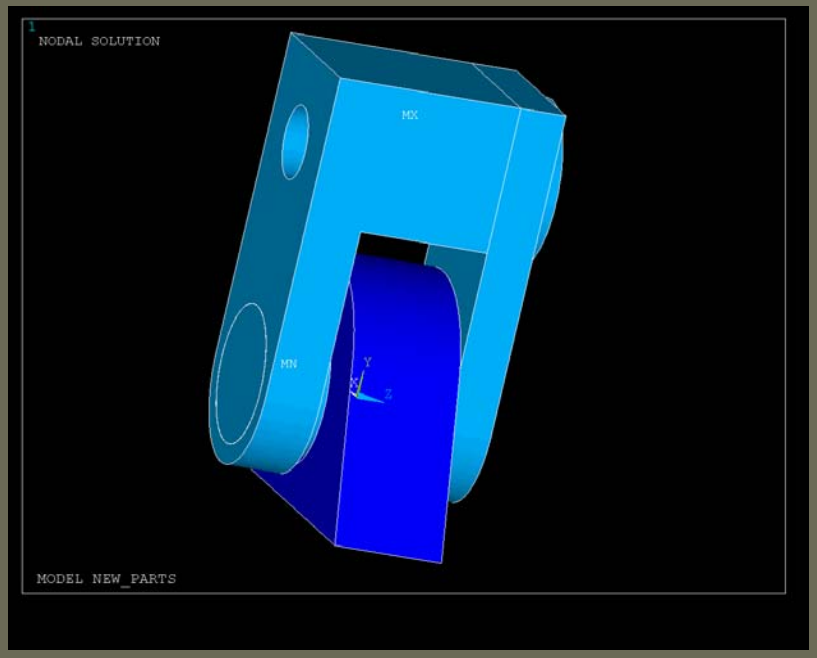
Failure Analysis Ammunition/Weapon



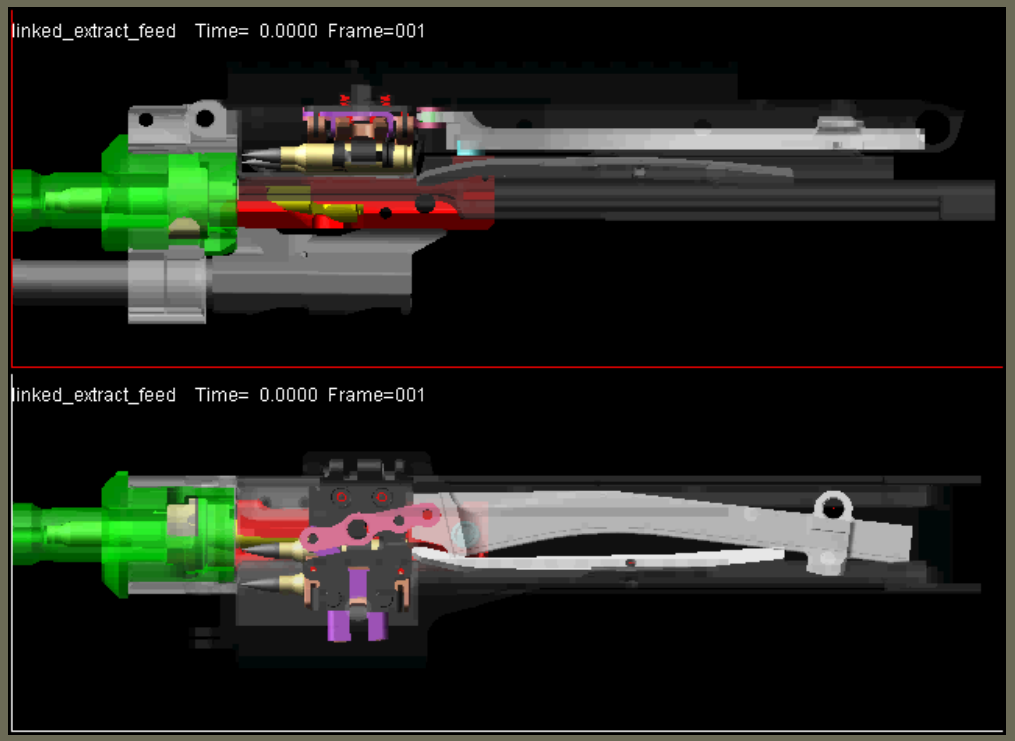


Headspace issue studied and resolved using Finite Element Analysis. Issue cannot be determined in live fire testing, for PM MAS.

M249 Sling failures, issue solved in three days with no need to “build and break” for PM SW.

Weapon Kinematics

- **M249 Weapon Modeled in MSC.ADAMS**
- **Model used as a base to study all aspects of stresses on weapon and ammunition components**
- **Customers: PM SW, PM-MAS past projects both lead to current maturity.**



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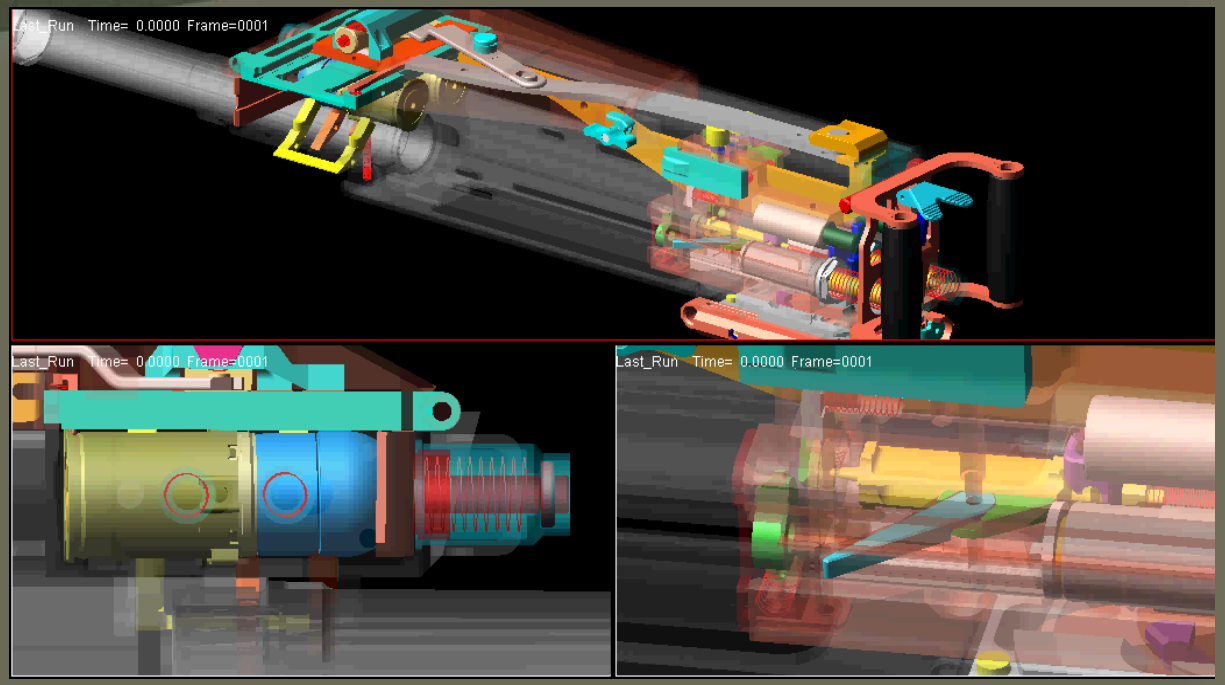
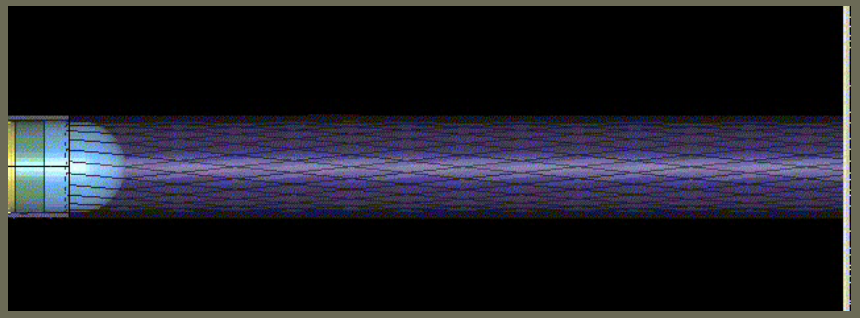
Weapon Dynamics

Conceptual analysis completed of new round of ammunition in four weeks as compared to a year of traditional effort, at an associated cost reduction from $300K to $20K.

Customer: PM-SW, PM MAS





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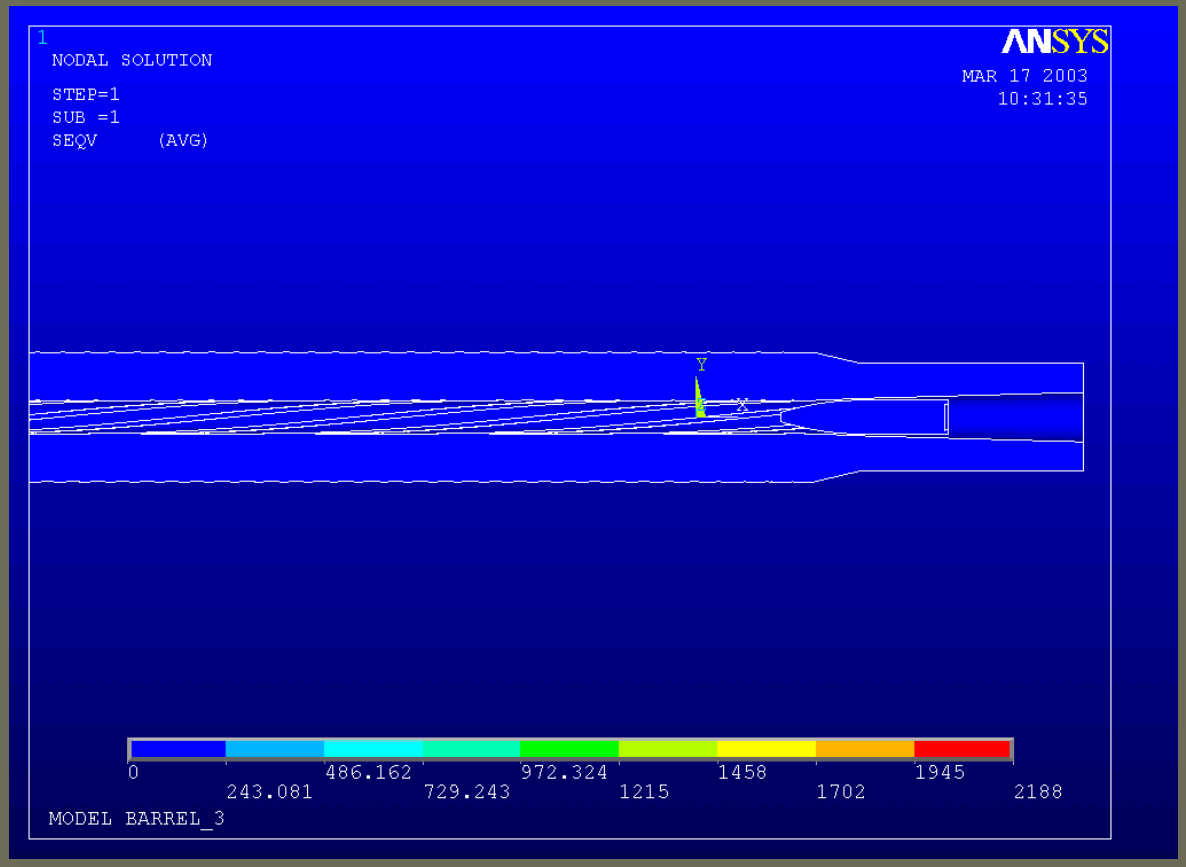
Interior Ballistics Firing



Purpose: Study land and groove stresses in gun barrels due to a firing event. Program: M249. Customer: PM SW Result: Modeling demonstrated stress levels and residual stress levels in gun barrels. Result extremely difficult to impossible to obtain via any type of testing.

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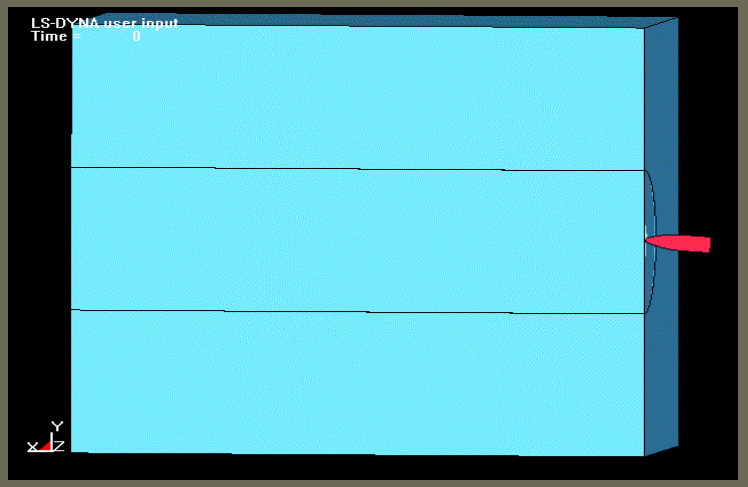
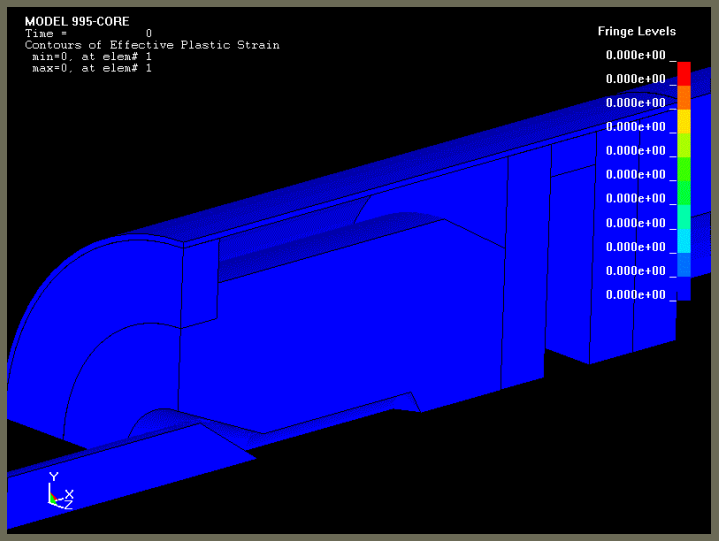
Terminal Ballistics Impact

Gelatin Block modeling and hard target impact modeling driven by PM MAS and M855 Lethality IPT

- Gelatin challenging material to model, early effort shown.
- Hard Target, modeling of GREM bullet trap.





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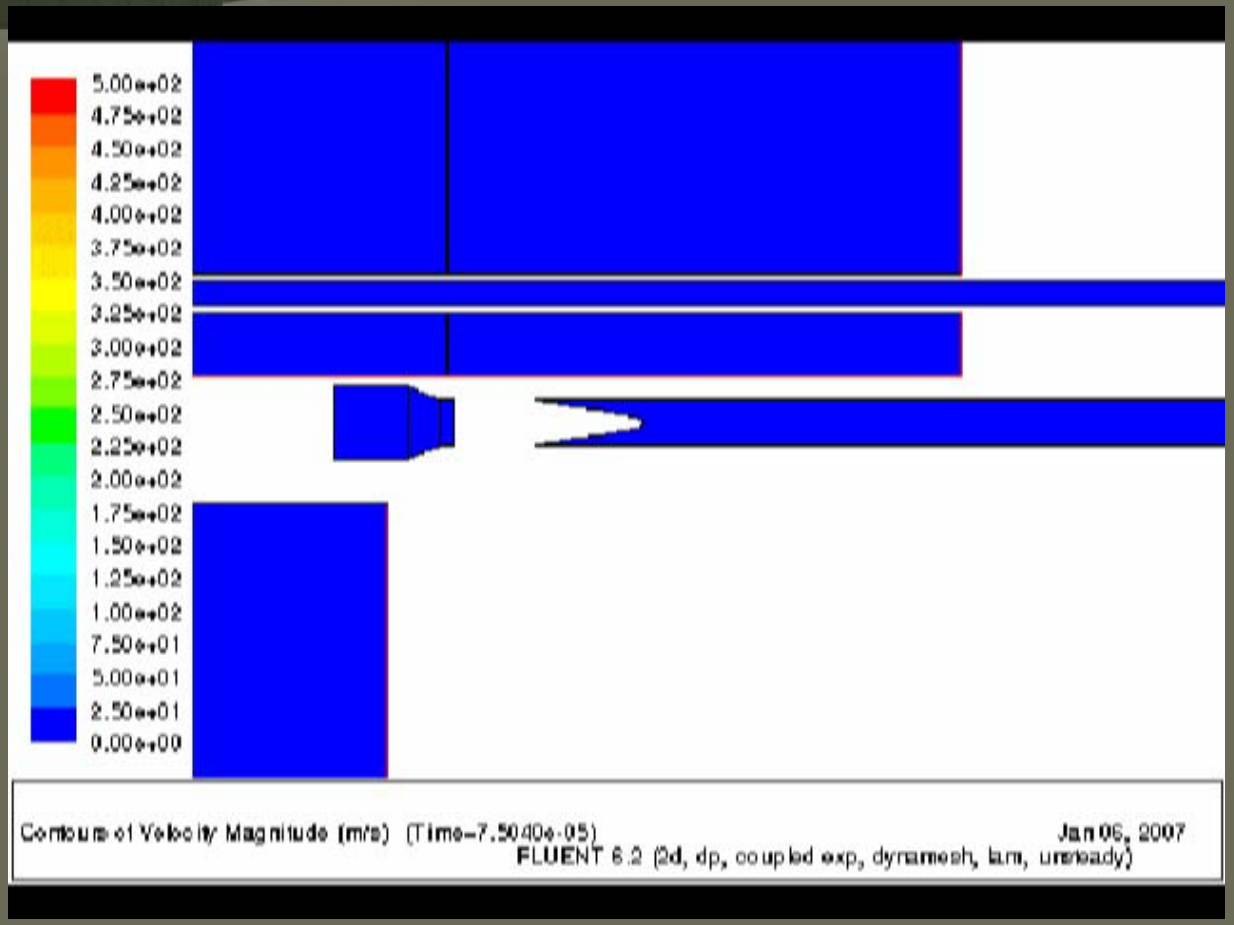
Computational Fluid Dynamics Small Caliber Weapons



Initial Effort M16 Gas System

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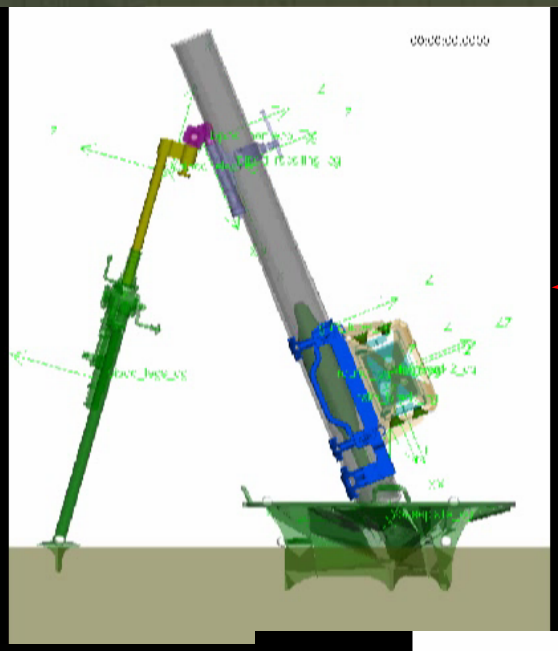
DADS Dynamic Analysis
ONR Mortar Systems

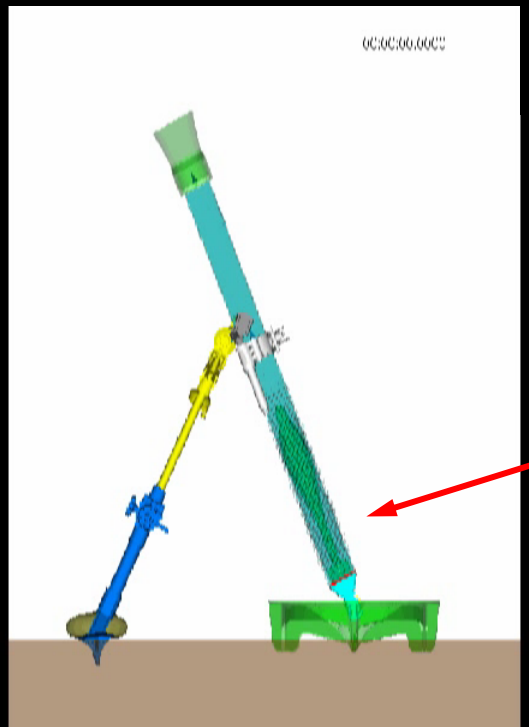
Complete ground-mounted mortar system dynamic models utilizing ProEngineer solid model data, ballistic pressure data and ground reaction simulation. Analyses provided loads and conceptual tests integral to design process.



120mm Mortar SAD Design

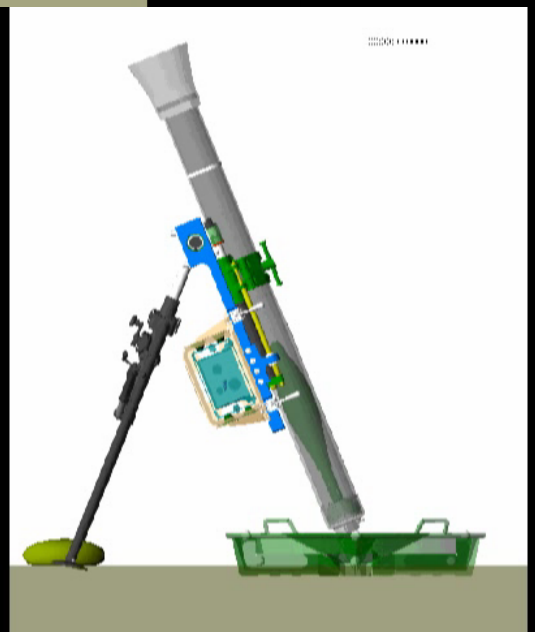
Recoiling TALIN

Decoupled Non-recoiling TALIN



81mm Mortar Lightweight Gun Tube

Analysis of Gun Tube Axial Load



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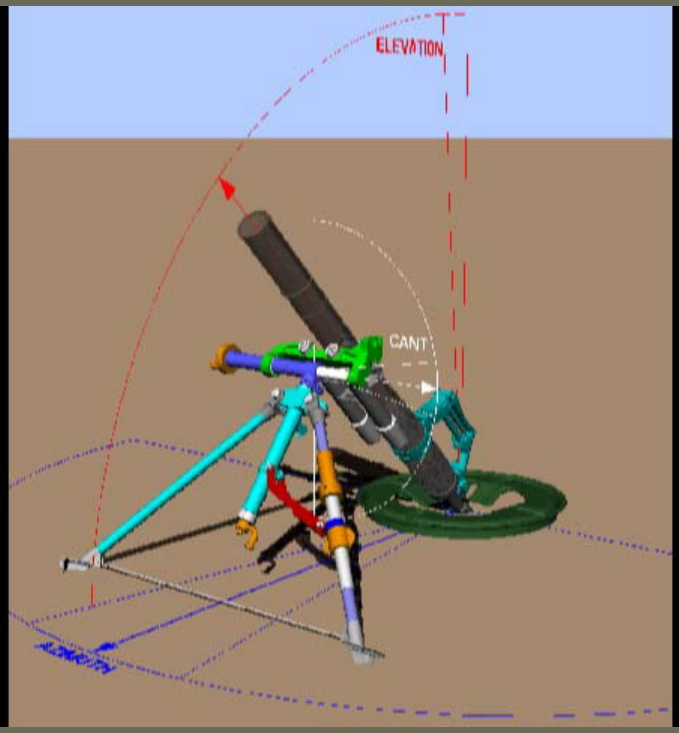
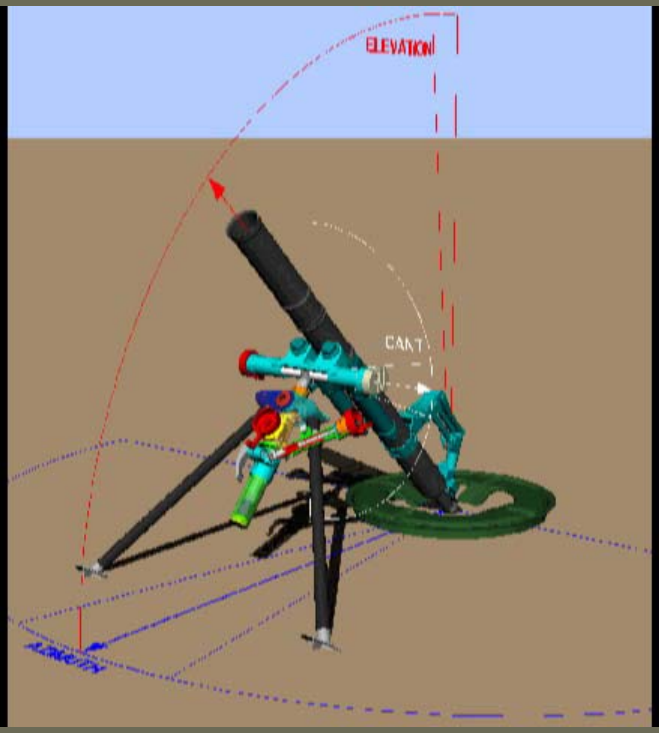
DADS Kinematic Analysis

ONR Mortar Systems

Complete ground-mounted mortar system kinematic models utilizing ProEngineer solid model data. Analyses provided aiming requirements that delineated screw drive lengths and pitches as well as overall geometry of entire bipod design to match or exceed existing mortar system performance.



M177 60mm Mortar System



ONR Lightweight 60mm Mortar System

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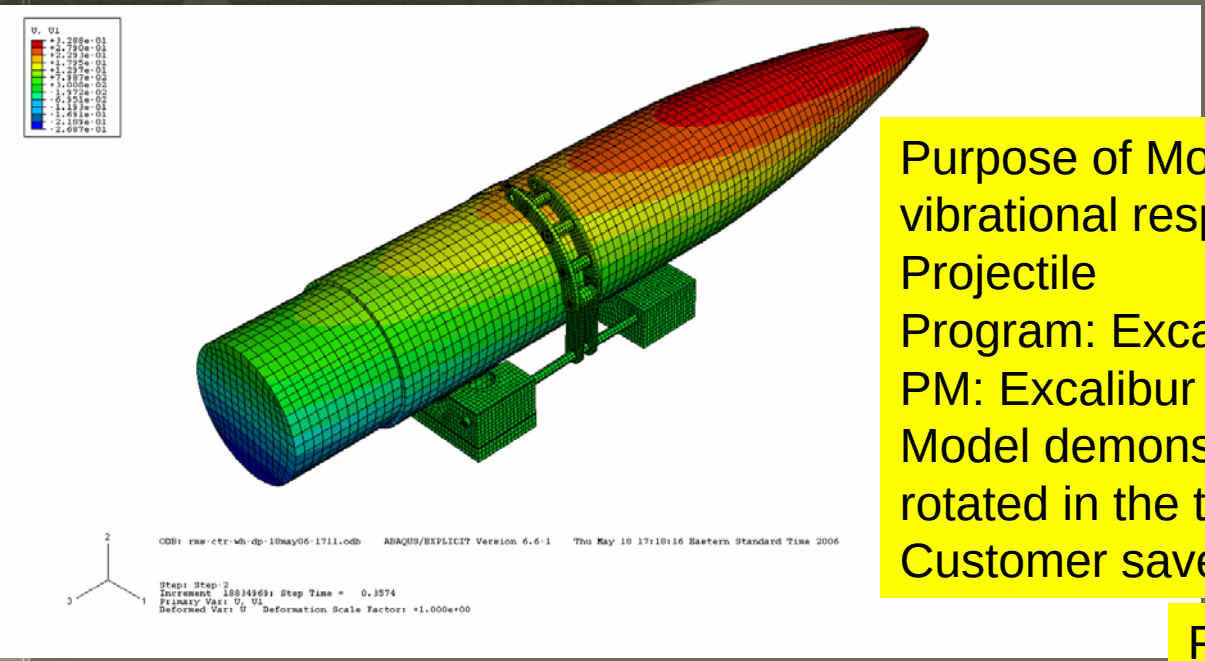
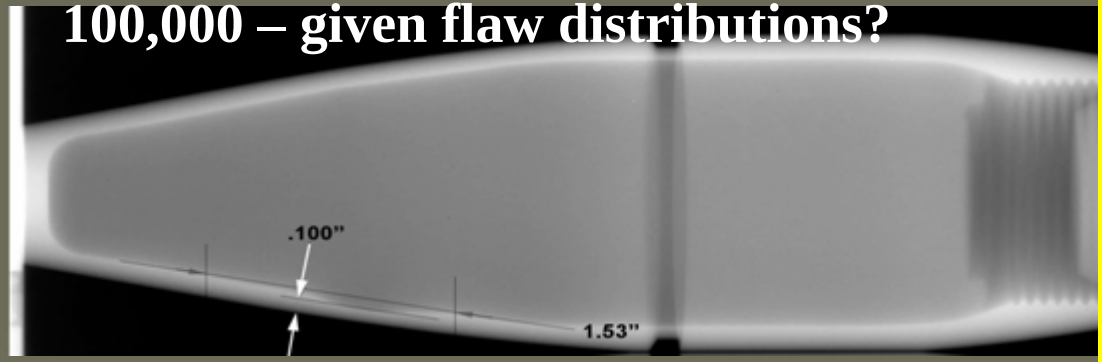
Reliability Predictions

What happens during vibration in a vehicle?



Purpose of Model: Determine vibrational response of Excalibur Projectile
Program: Excalibur
PM: Excalibur
Model demonstrated projectile rotated in the tactical mounting
Customer saved $250,000

What is the reliability of shooting 100,000 – given flaw distributions?



Purpose of Model: Determine if mortar rounds fielded to Afghanistan were safe to fire
Program: M731
PM: Mortars
Model demonstrated: Rounds were safe and did not have to be shipped back and scrapped
Customer saved $ 6M