VEHICLE MASS REDUCTION WITH THE HELP OF 3G+ OPTIMIZATION TECHNIQUE – A FINITE ELEMENT STUDY

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DEP
DEP MeshWorks

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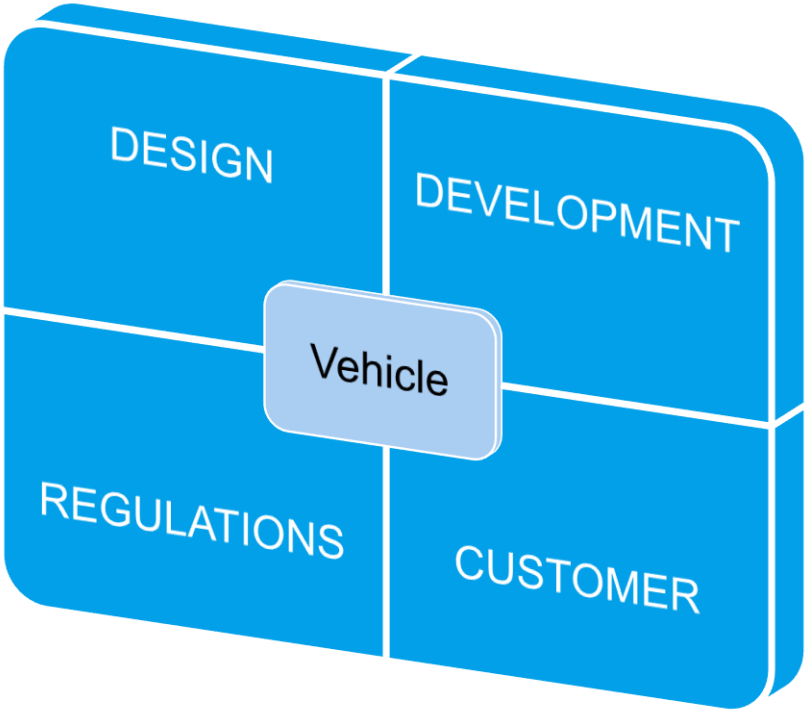
INTRODUCTION

Future of Motor Vehicles

- More Elegant Design and Development
  - Customer Centric
    - Optimized in Shape/Size
    - Quality/Quantity/Affordable
- Stringent and Complex Safety Targets
  - New Regulations: NHTSA, IIHS
    - Excellent Structure
    - Good Occupant Response
- Fuel Efficient
  - Great Mileage
    - Mass Reduction
    - Low Cost
- Self Driving Vehicles
  - Fully Autonomous

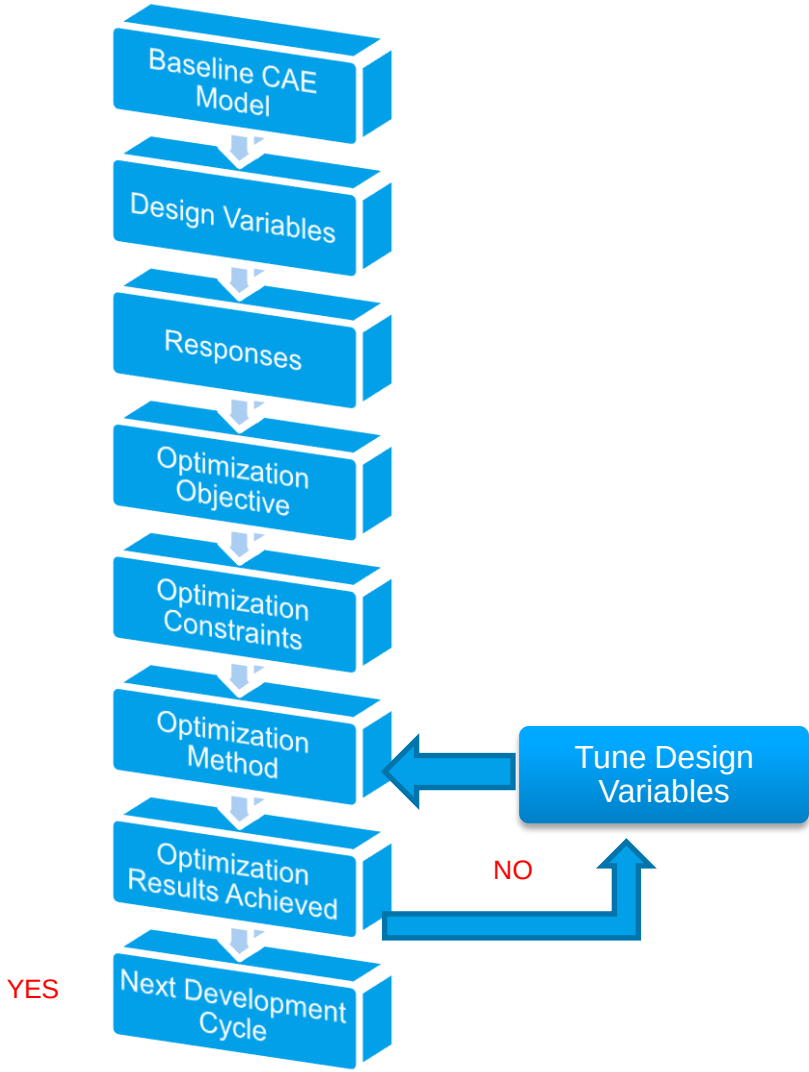


INTRODUCTION – CONT'D

- Computer Aided Engineering
  - CAE
    - Repetitive
    - Robust
    - Rapid

    } 3R

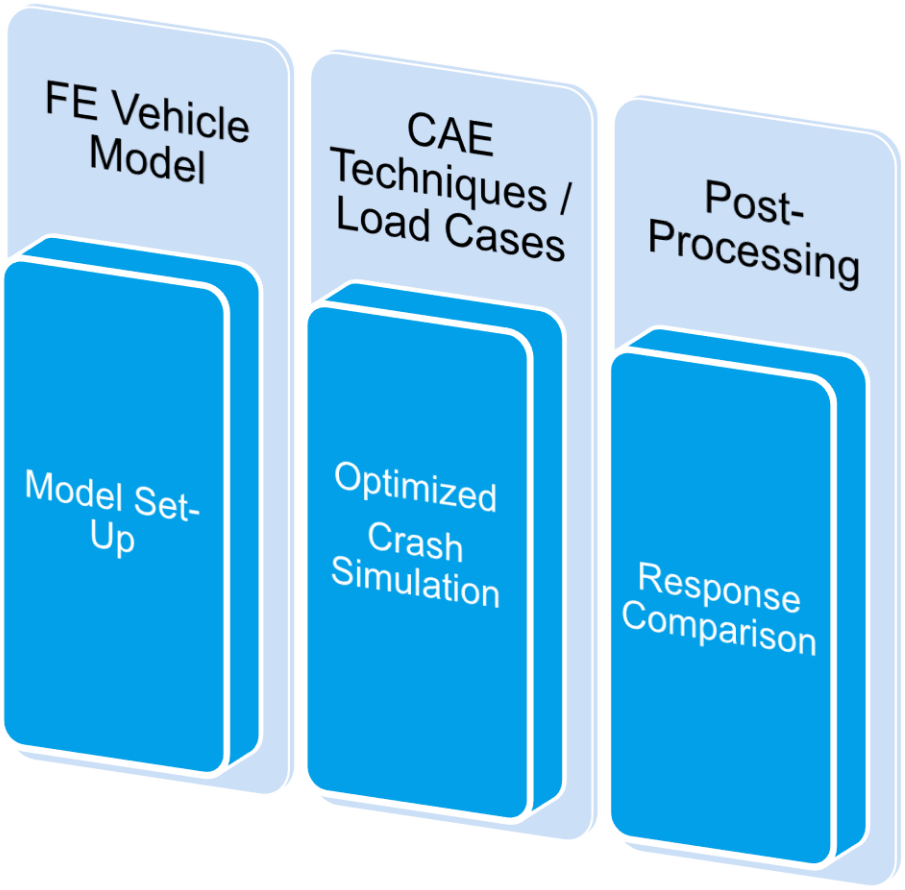
- CAE Methodologies/Techniques
  - Optimization Process
    - One Time Execution
    - Single-Disciplinary Optimization (SDO)
    - Multi-Disciplinary Optimization (MDO)



OBJECTIVE

MASS REDUCTION

- CAE Techniques
- Finite Element (FE) vehicle model
- Crash Load Cases
  - Frontal
  - Side
  - Rear
- Vehicle Parameterization
  - Sub-Systems
  - Vehicle Region of Interest
- Comparing Vehicle Mass and Responses
- Baseline v/s Optimized Model



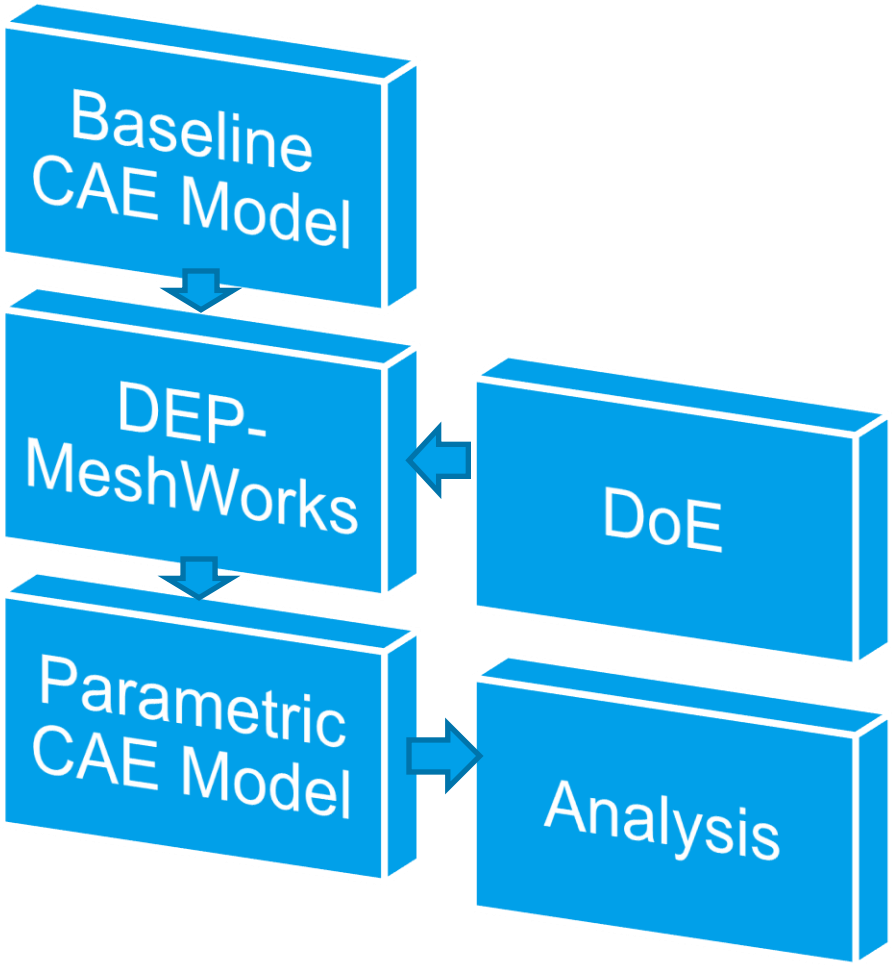
METHODOLOGY

Detroit Engineered Products (DEP) MeshWorks – 3G+

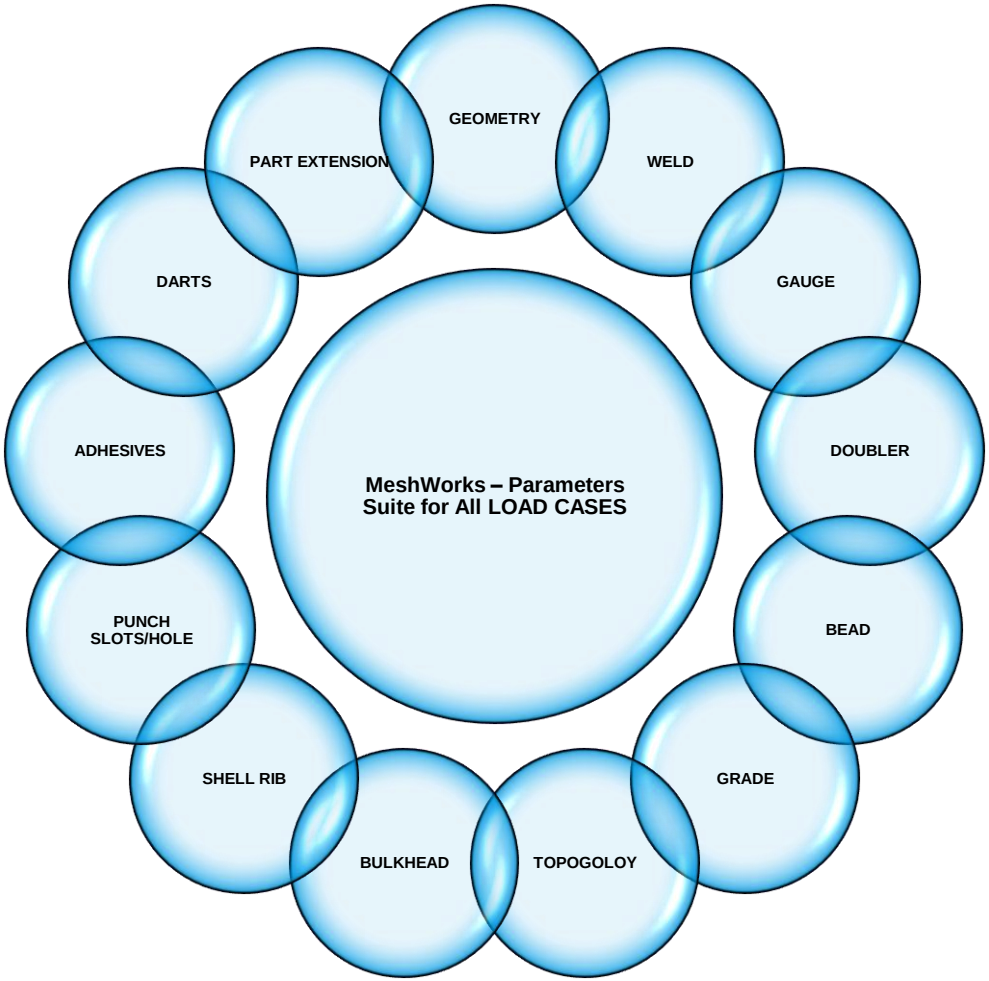
- Unique Approach
  - Parameters
    - Geometry
    - Grade
    - Gauge

    } 3G
  - Design Enablers
    - Bulkhead
    - Doubler
    - Welds
    - Adhesives
    - Beads
    - Darts
    - Shell Rib
    - Part Extension
    - Punch Slot

    } +

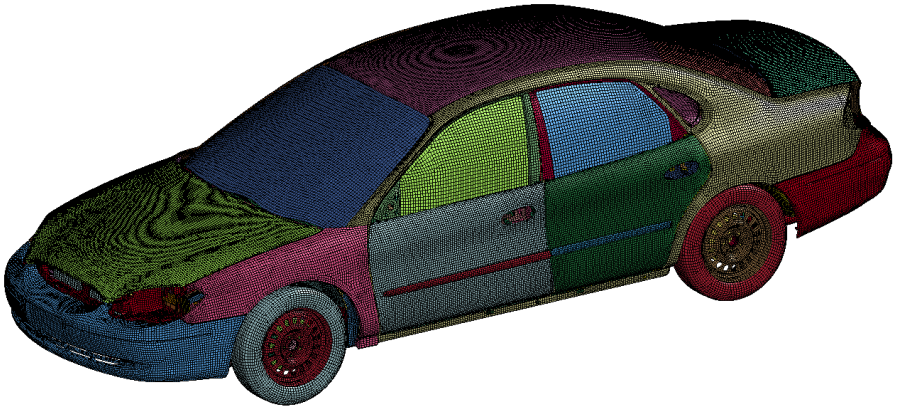


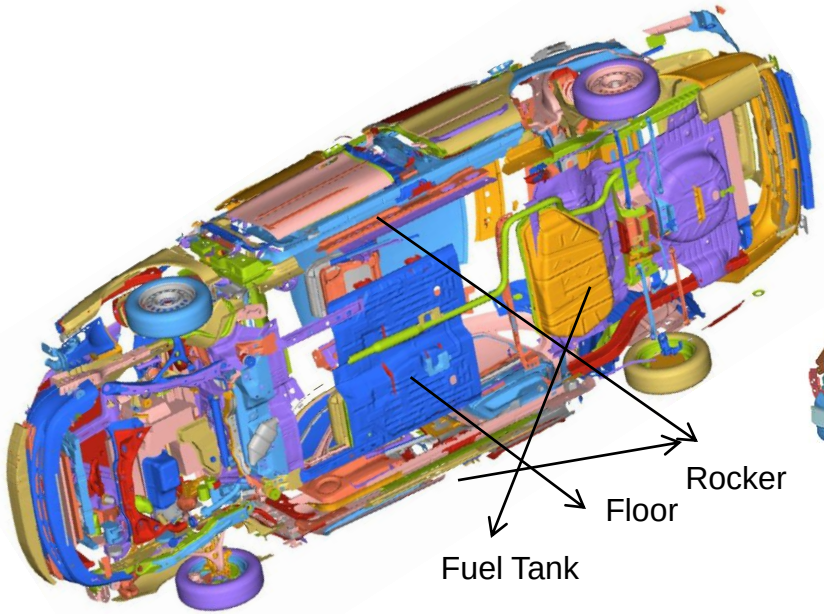
Meshworks Parameters

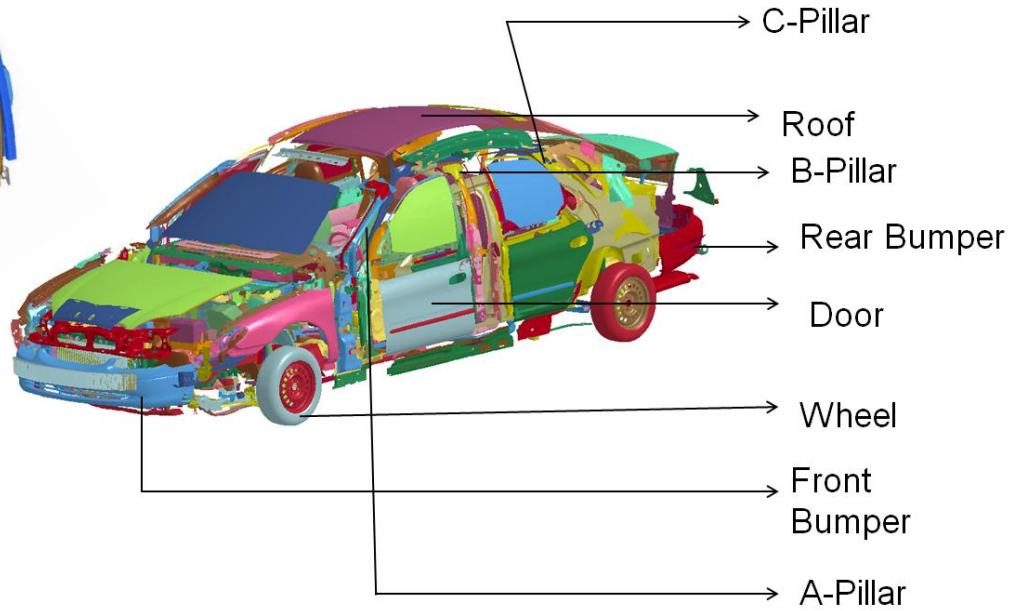


CAE MODEL AND BARRIER CONTENTS

- Ford Taurus 2001
  - Number of Elements: ~1 million
  - Number of Nodes: >93k
  - Vehicle Mass/Weight: 3604 lb
  - LS-DYNA (LSTC Corp.)



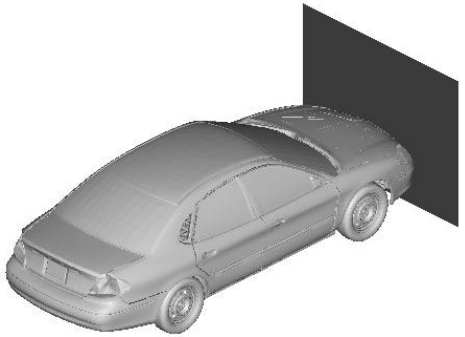




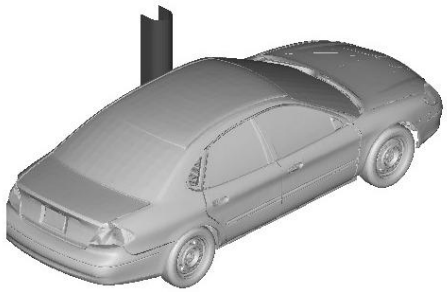
Reference: http:/www.ncac.gwu.edu (NCAC/GWU)

SIMULATION SET-UP AND IMPACT

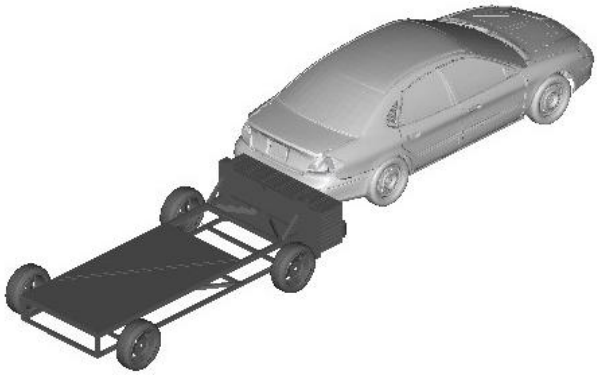
- FRONTAL (NCAP) IMPACT
  - 35 MPH
  - Rigid Wall



- SIDE POLE (FMVSS 214) IMPACT
  - 20 MPH
  - Rigid Pole



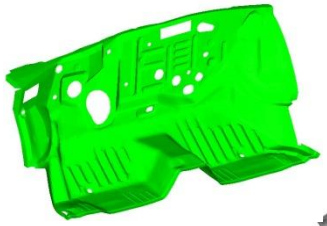
- REAR (FMVSS 301) IMPACT
  - 50 MPH
  - 70% Offset
  - Moving Deformable Barrier (MDB)

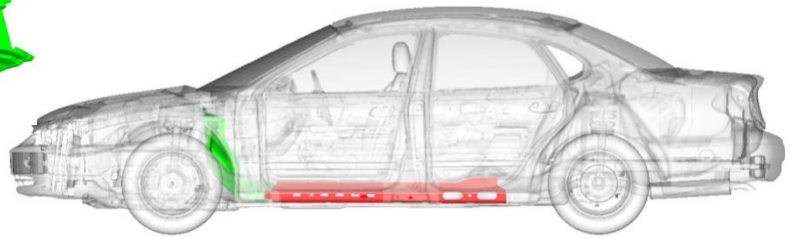


Reference: All the barrier models were procured from LSTC website

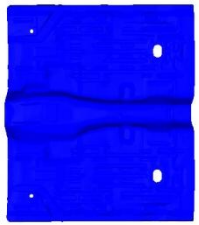
VEHICLE RESPONSES FOR DIFFERENT IMPACT SCENARIOS

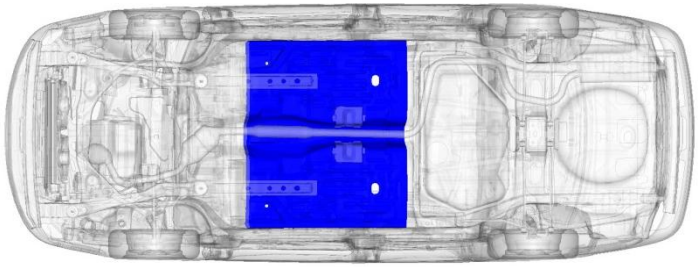
- FRONTAL (NCAP) IMPACT
  - Vehicle Acceleration at L Rocker Inner
  - Dash Intrusion (Dynamic)



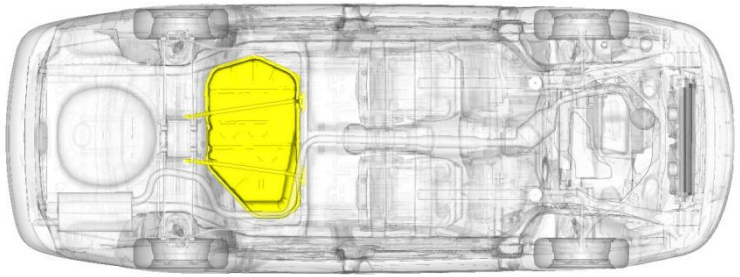


- SIDE POLE (FMVSS 214) IMPACT
  - Floor Intrusion
  - Beltline Intrusion



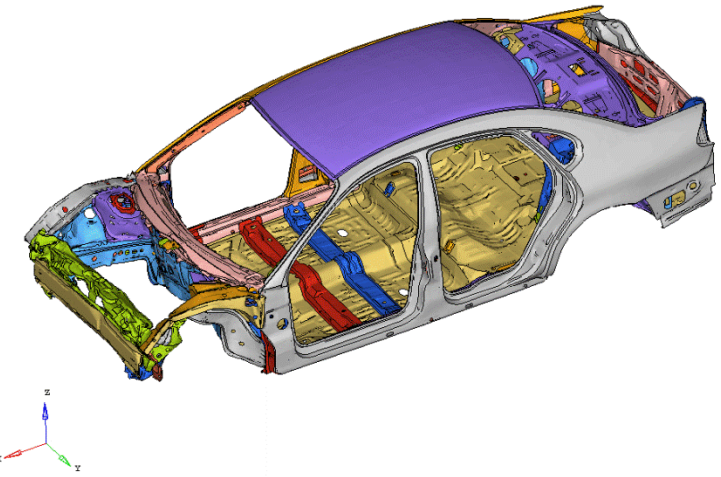


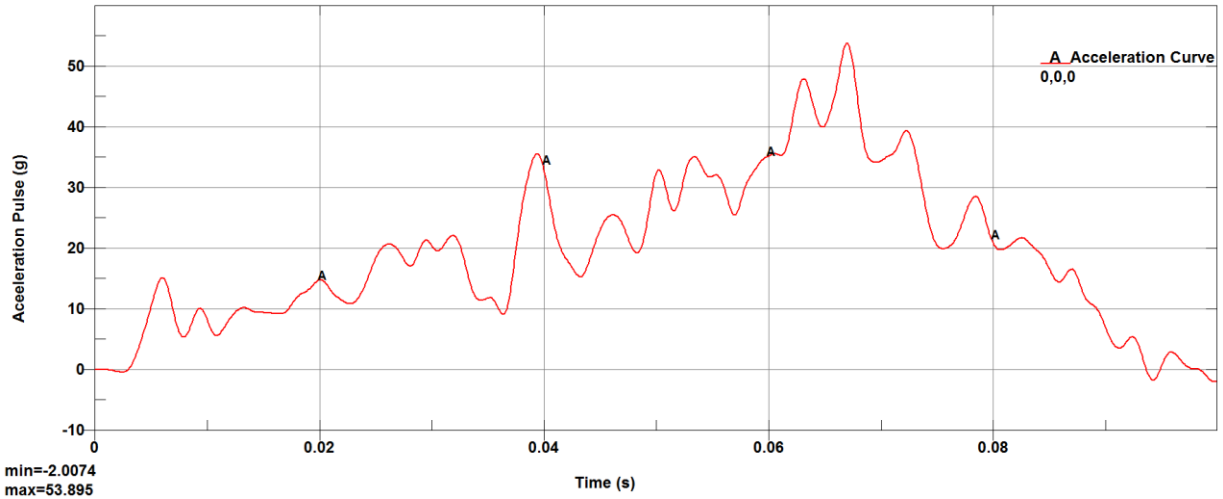
- REAR (FMVSS 301) IMPACT
  - Fuel tank zone intrusion
  - Fuel tank plastic strain



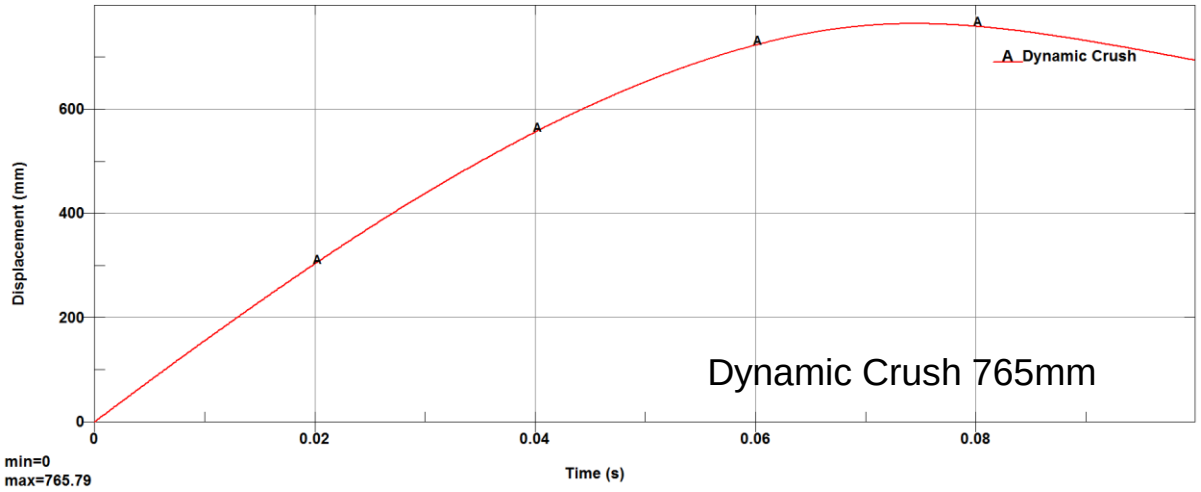
Baseline Vehicle Performance

Baseline model summary	
Dynamic Crush (mm)	765.79
Time to Zero velocity (ms)	74.6
Acceleration Pulse (g)	53.90
Dash Intrusion (mm)	661.41

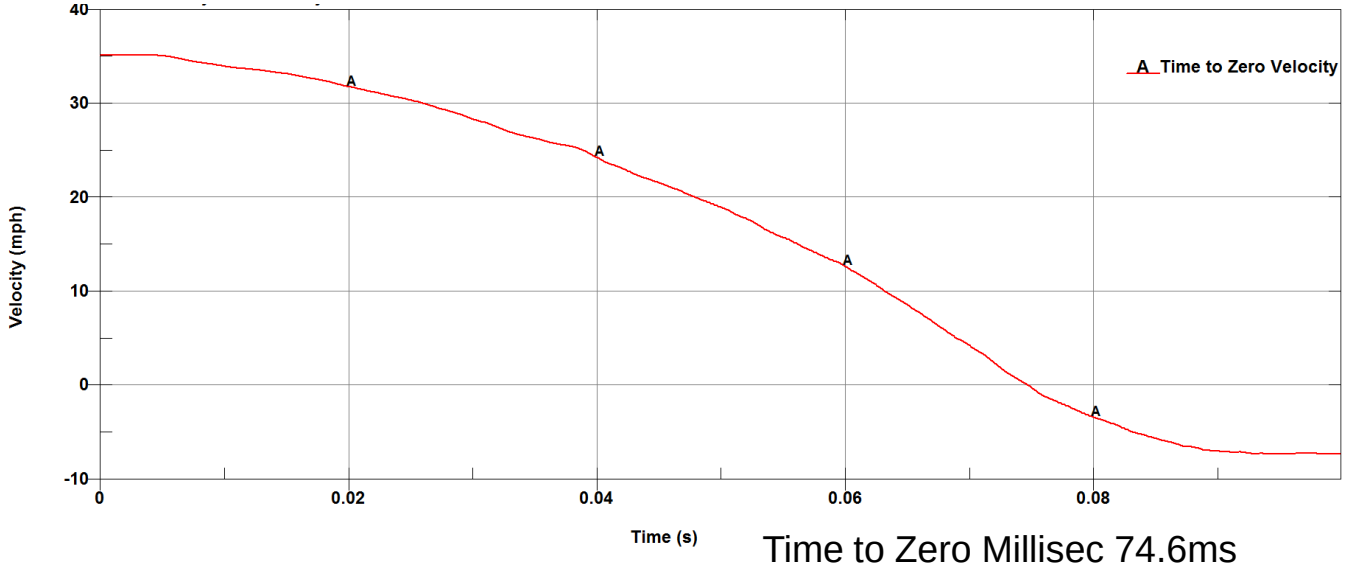




Baseline Vehicle Performance

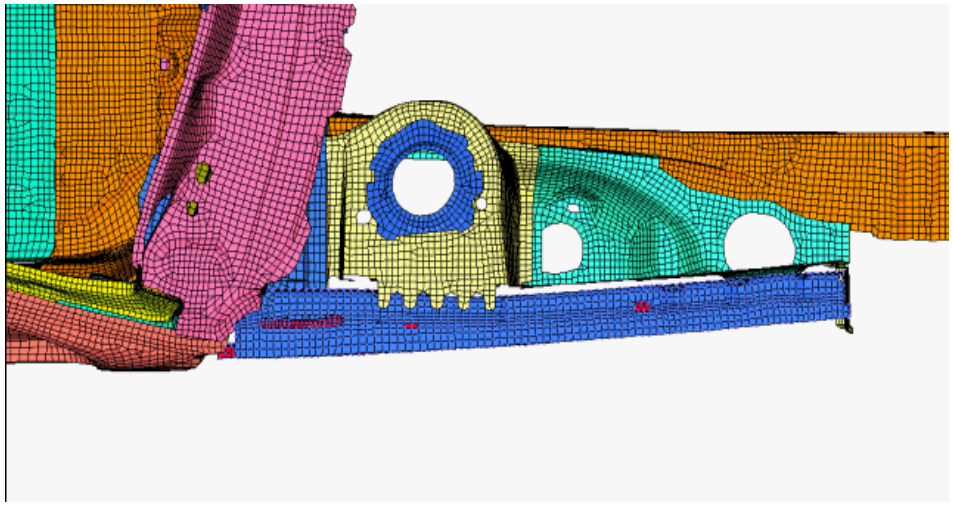


Dynamic Crush 765mm

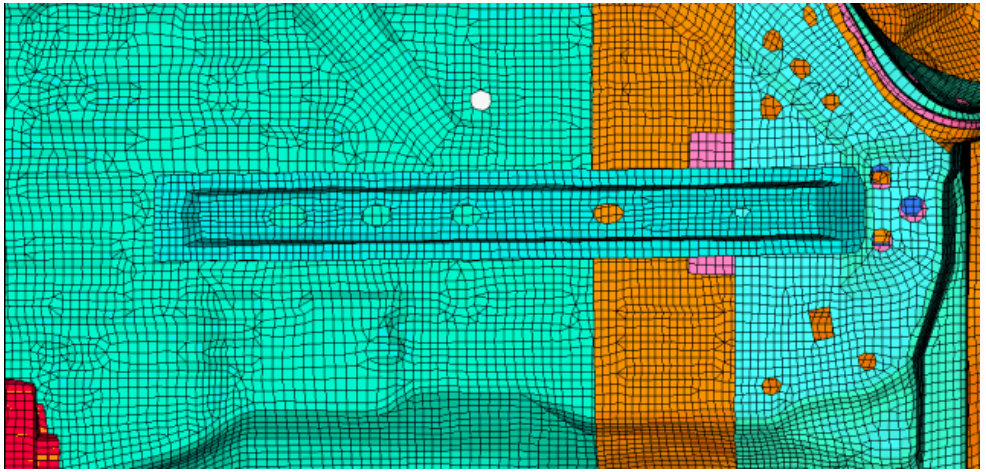


Time to Zero Millisec 74.6ms

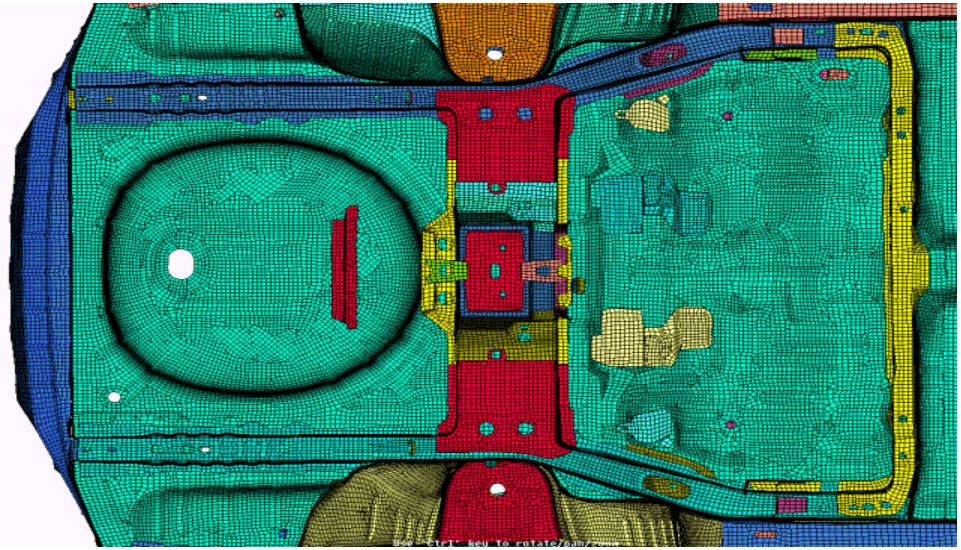
Frontal Impact Strategy

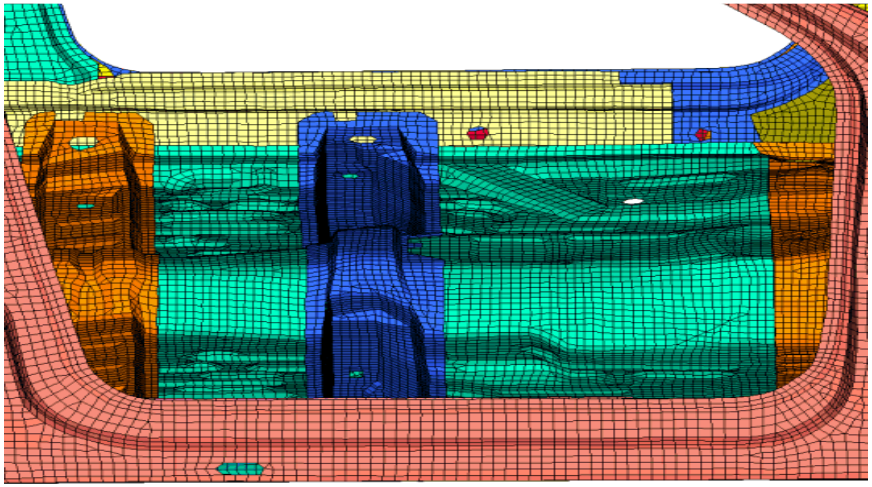


Front Rails Sections
Rocker Sections
Cradle sections
Underbody Rails

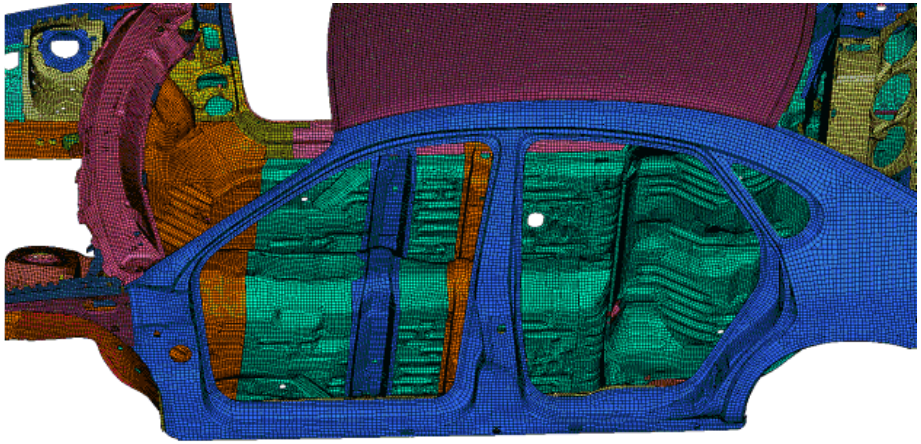


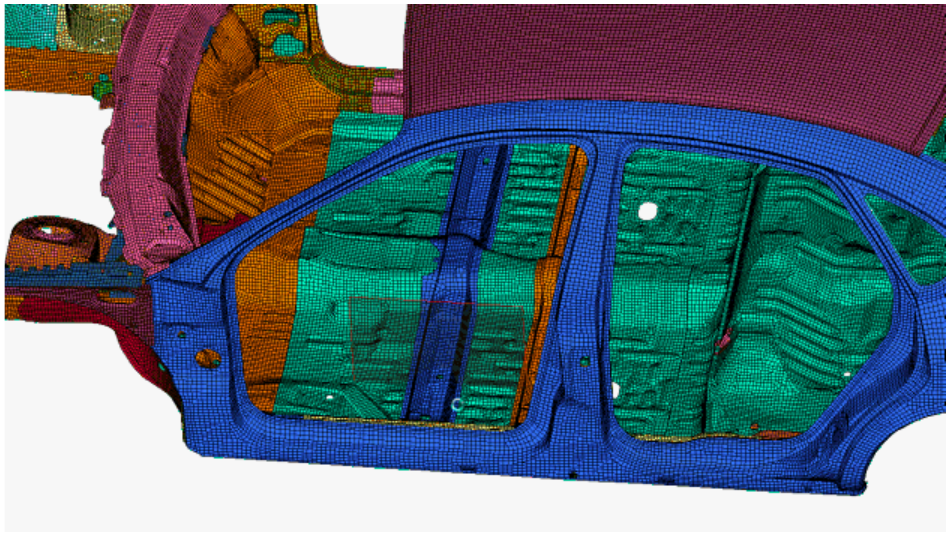
Side/Rear Impact Strategy



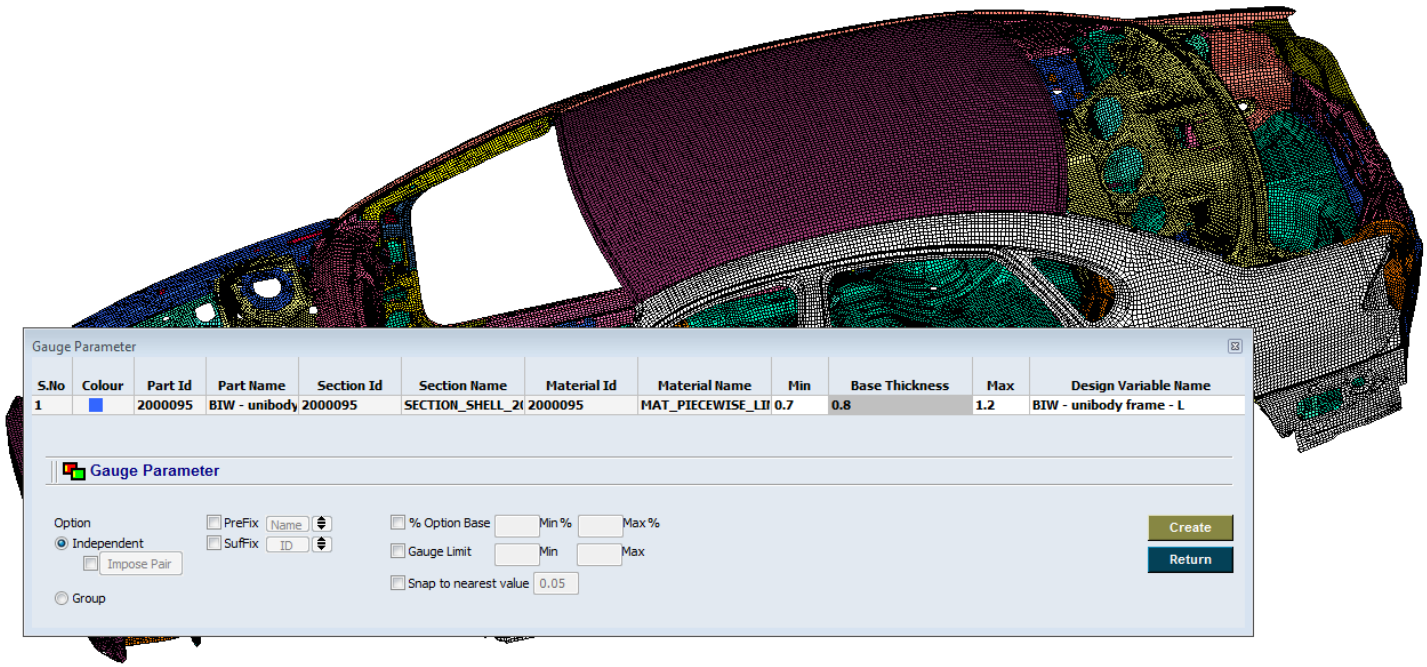


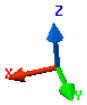
Design Enablers Strategy





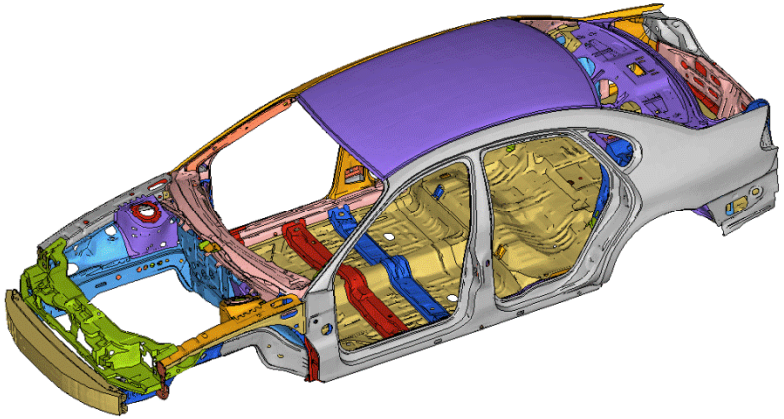
Gauge Strategy

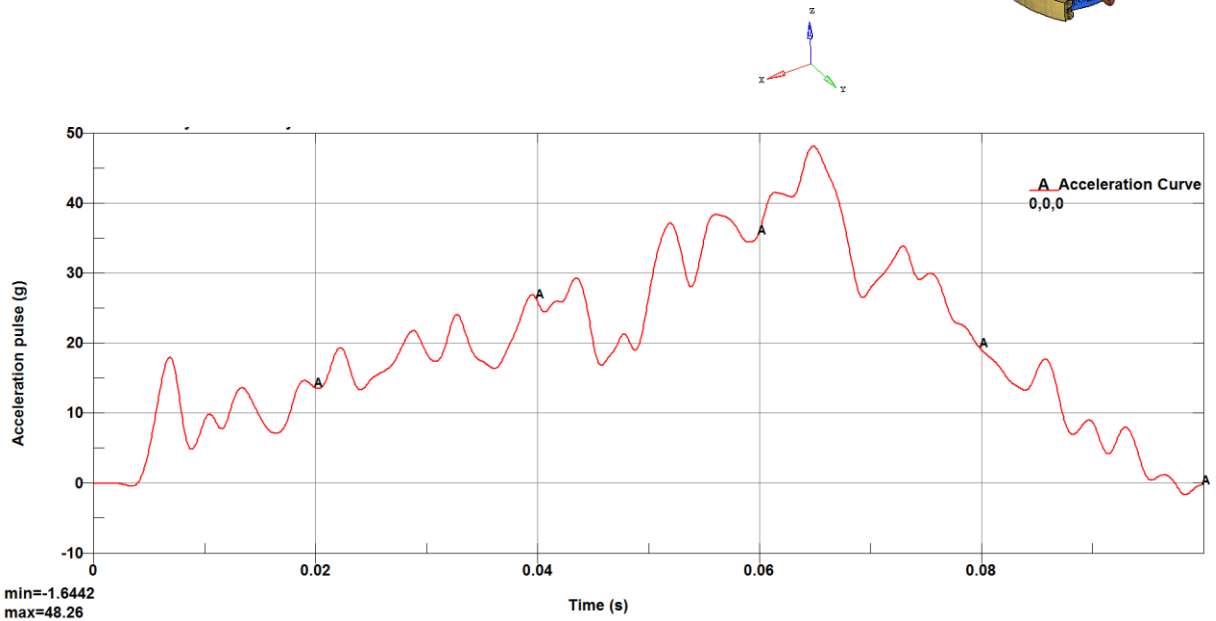




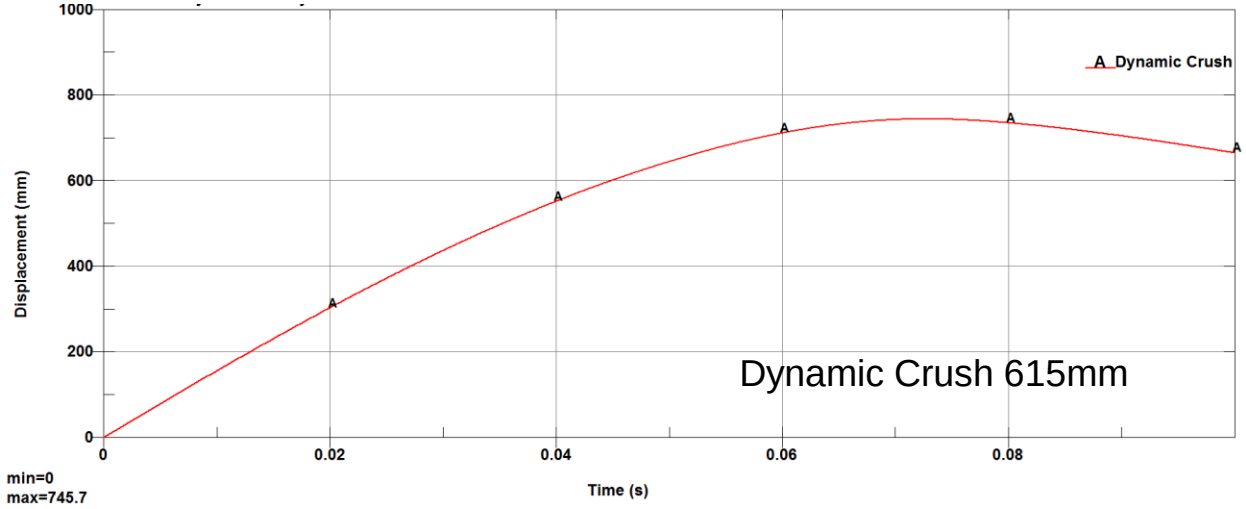
Parameterized Vehicle Performance

Baseline model summary	
Dynamic Crush (mm)	745.7
Time to Zero velocity (ms)	73.6
Acceleration Pulse (g)	48.26
Dash Intrusion (mm)	615.12

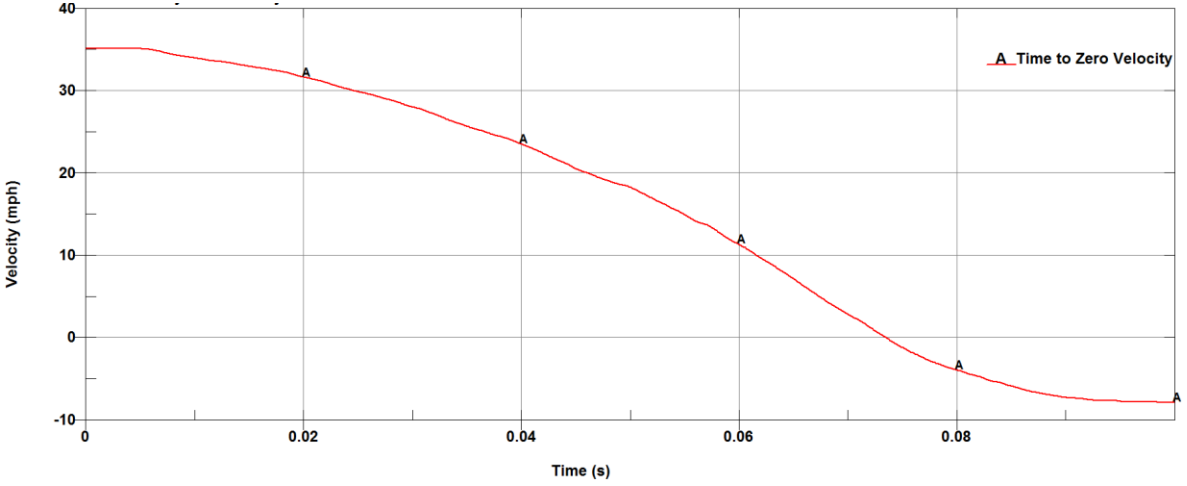




Baseline Vehicle Performance



Dynamic Crush 615mm



Time to Zero Millisec 73.6ms

Next Steps

- Parameterization on the vehicle load path and considering them for the Shape optimization
- Applying the High strength steels optimally
- Run the optimization considering Front and Side load cases