

Design of Automotive Structures using Multi-Model Optimization

NAFEMS

Engineering Analysis & Simulation in the Automotive Industry:
Electrification & Advanced Lightweighting Techniques
April 27, 2017

Warren Dias

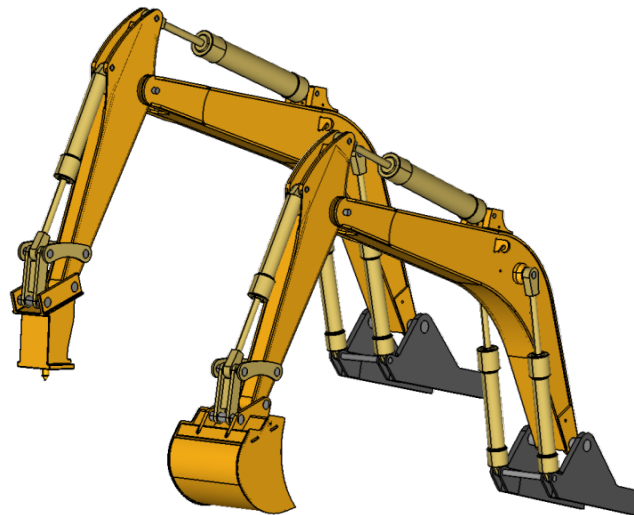
Business Development Manager – OptiStruct



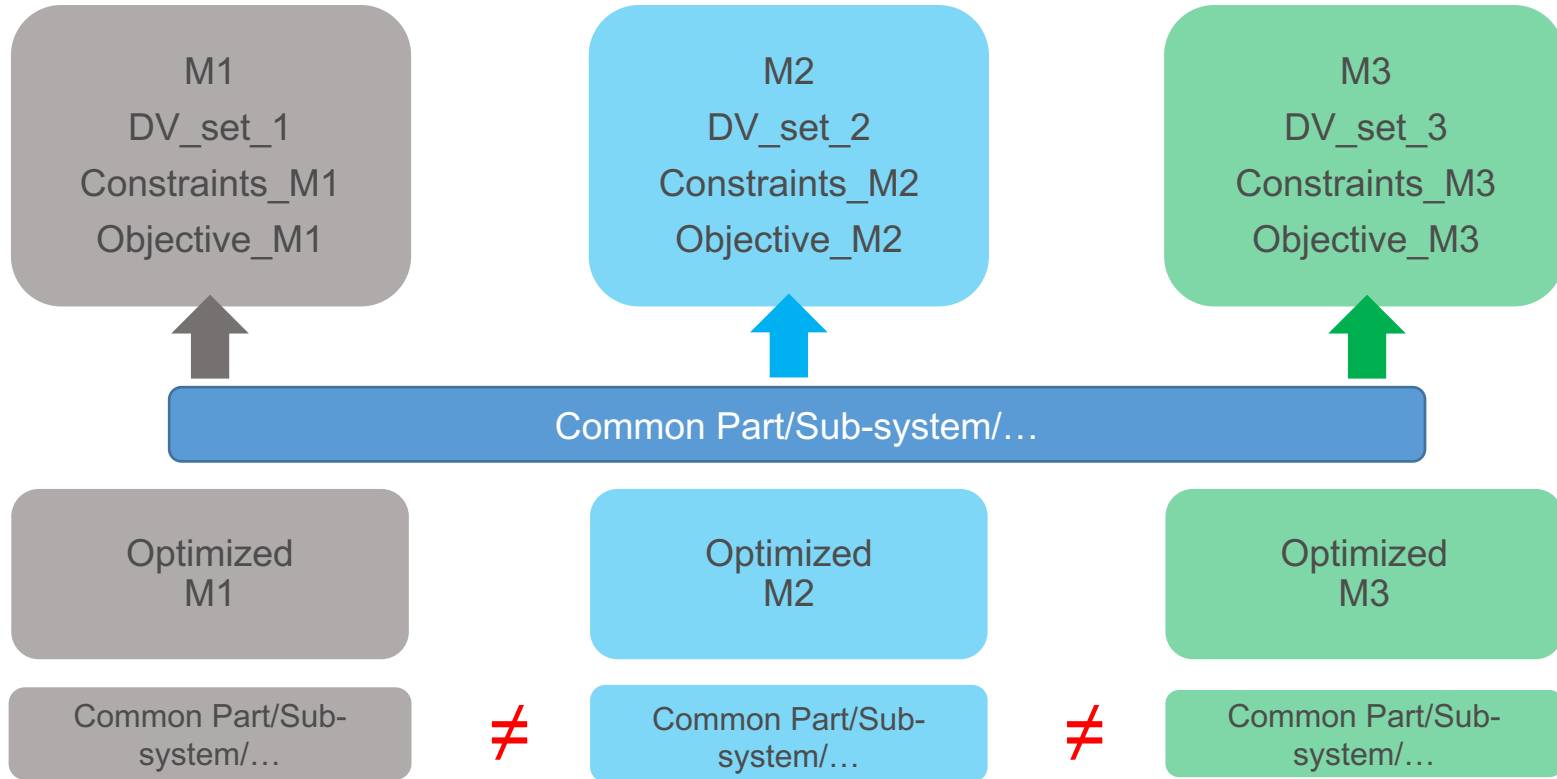
Altair | HyperWorks®

Agenda

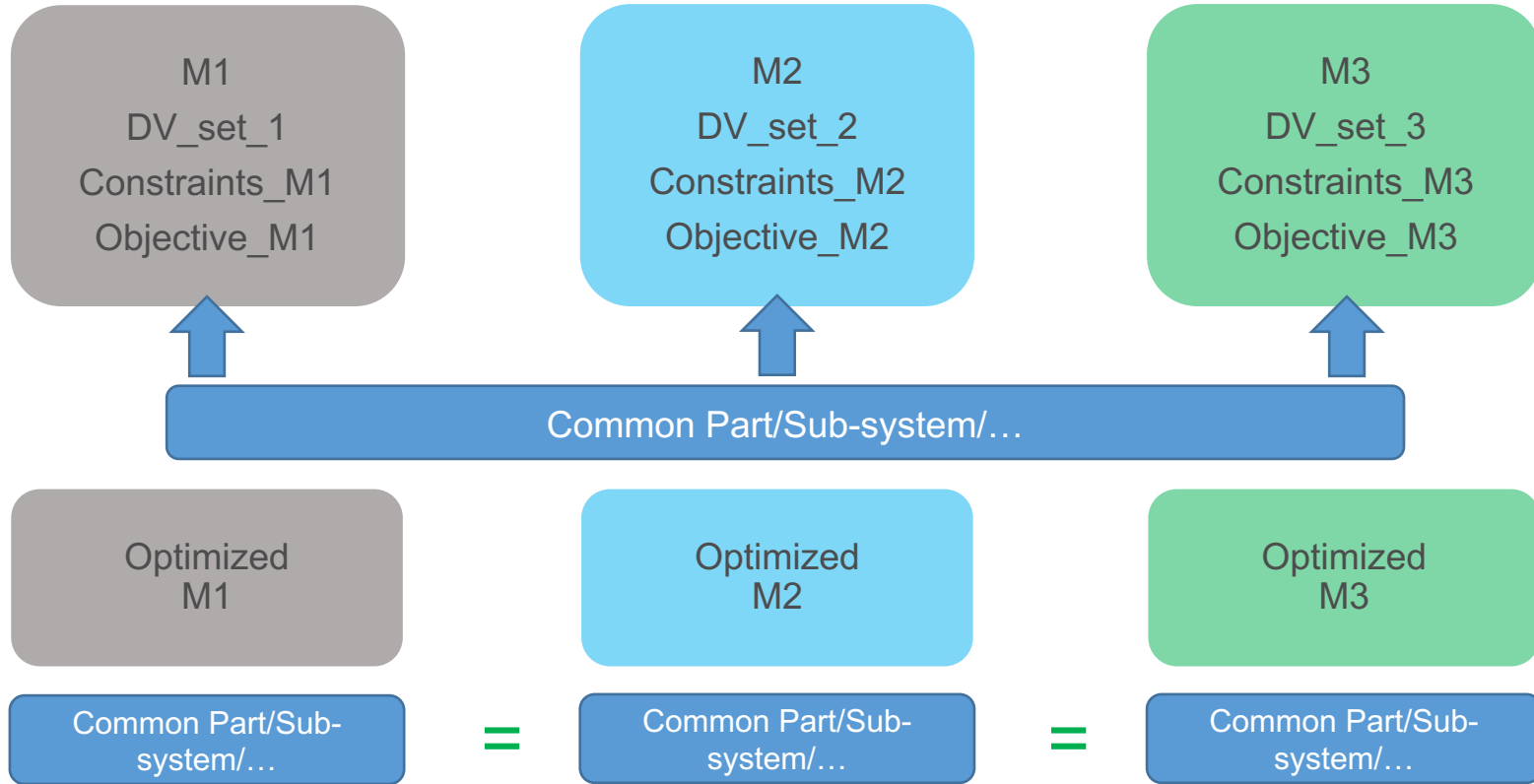
- Introduction to Multi-Model Optimization (MMO)
- Implementation of MMO
- Application Examples



The Motivation (Single Model Optimization Approach)

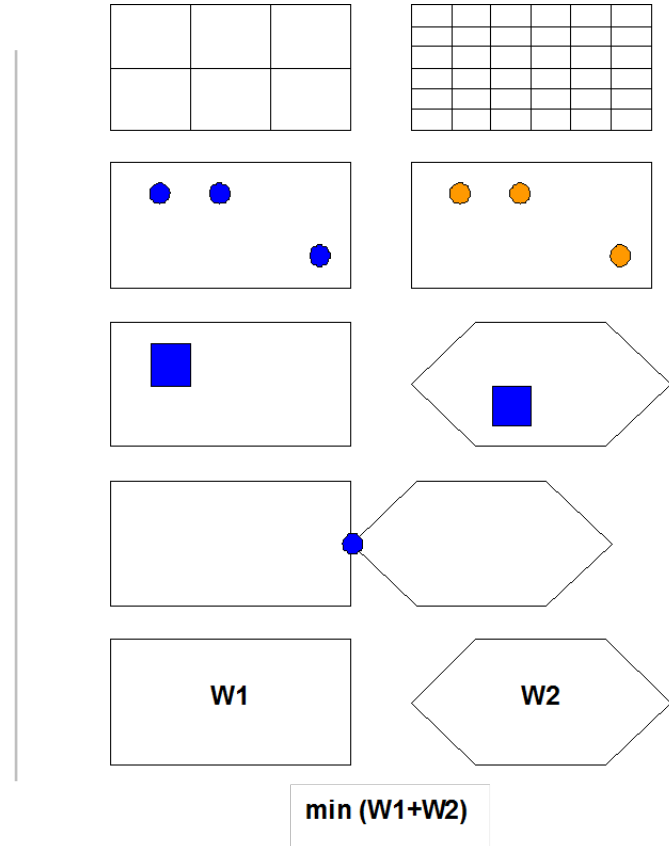


Multi-Model Optimization Approach

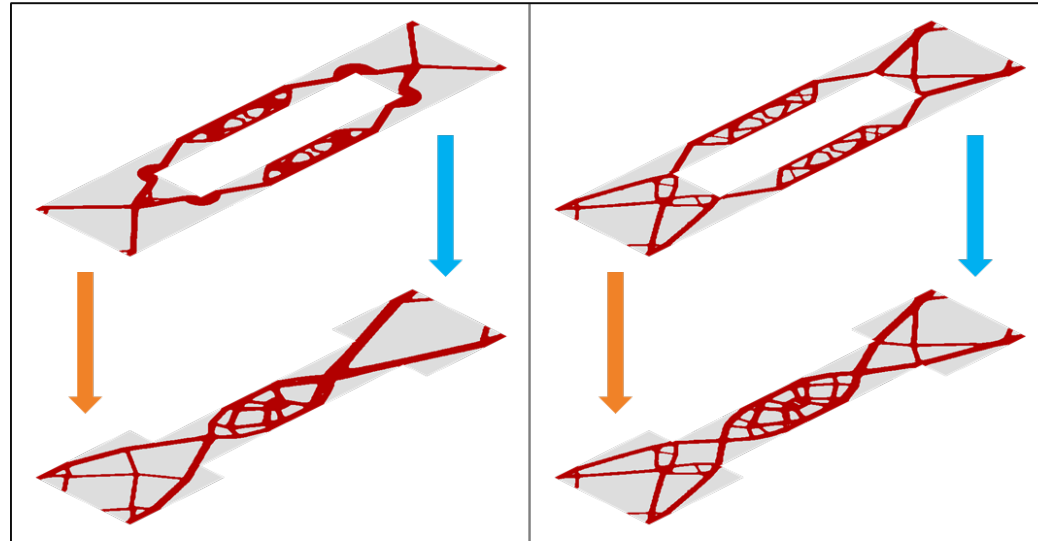
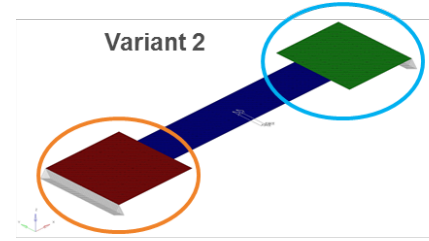
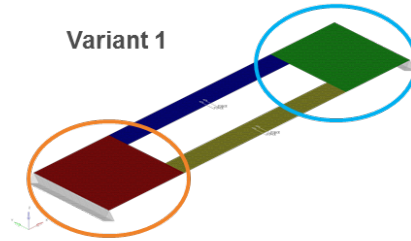


Multi-Model Optimization

- Simultaneously optimize multiple parts or configurations with common design variables
- Multiple optimization models in a single run
- Greater flexibility to optimize common components across structures
- Simplify iterative design process especially when conflicting requirements exist
- Existing models can be used without modification



For Example...

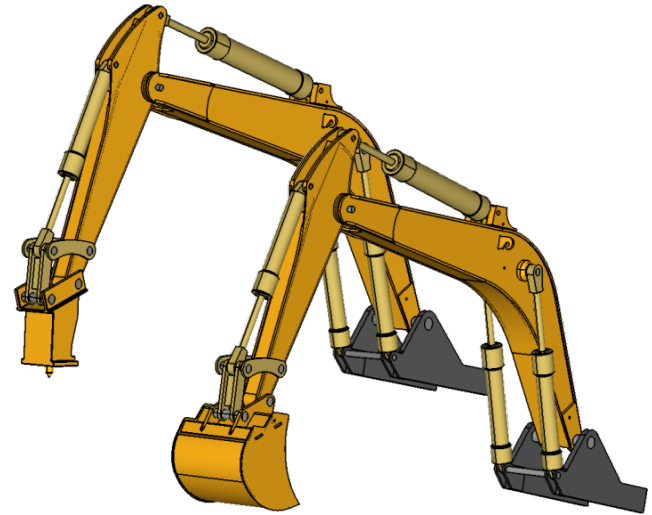


Single Model Optimization

Multi-Model Optimization

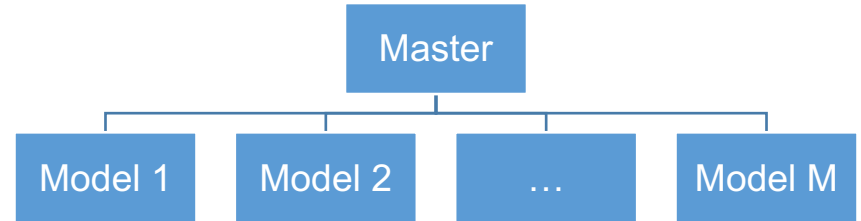
Agenda

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- Application Examples



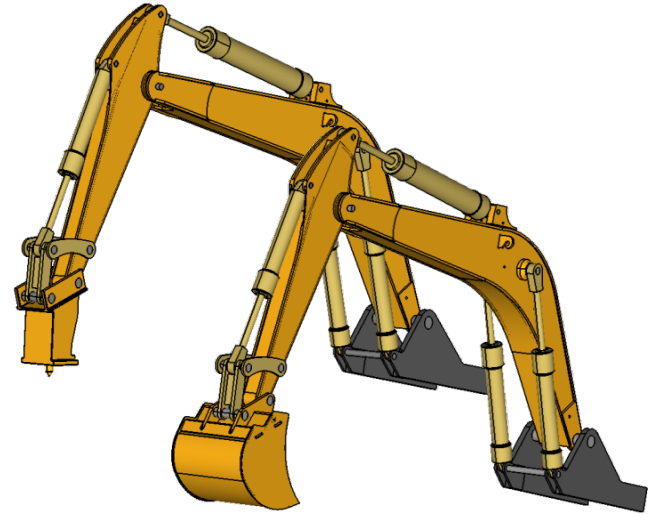
MMO Implementation in OptiStruct

- Implemented within an MPI-based framework
- Design variable handling
 - DVs with identical IDs are linked
 - Manufacturing constraints, dependent DVs, discrete DVs, etc. are supported
- Responses
 - All existing response types are supported
 - Global responses may be defined in the master file
- Constraints and Objective functions
 - Global constraints and objectives may be defined in the master file
 - Single objectives are combined into a MIMAX formulation



Agenda

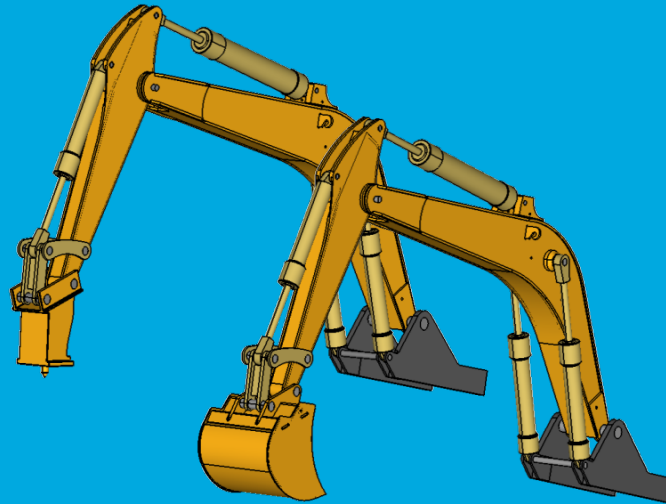
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Excavator Arm with Different Attachments

4 linear static load cases (dig,
scrape, side, top)

Minimize weighted compliance,
s.t. volume fraction constraint



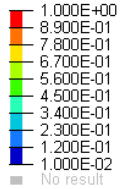
3 linear static load cases (load
down, load side, load front)

Minimize weighted compliance,
s.t. volume fraction constraint

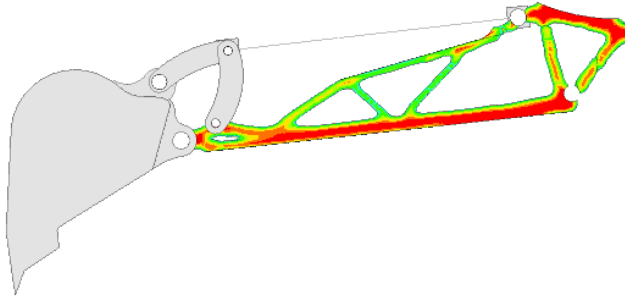
Excavator Arm Design Studies

SMO

Contour Plot
Element Densities(Density)
Simple Average

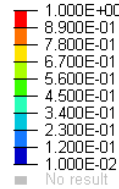


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Grids,182475
Min = 1.000E-02
Grids 182726

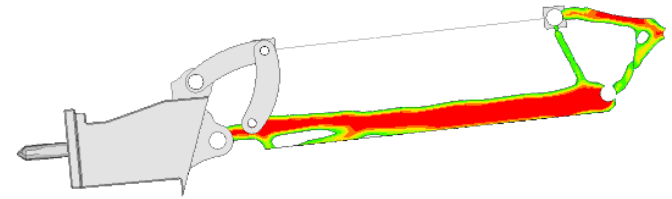


1: Model
Design : Iteration 31 : Frame 25

Contour Plot
Element Densities(Density)
Simple Average



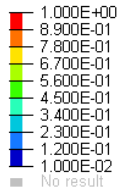
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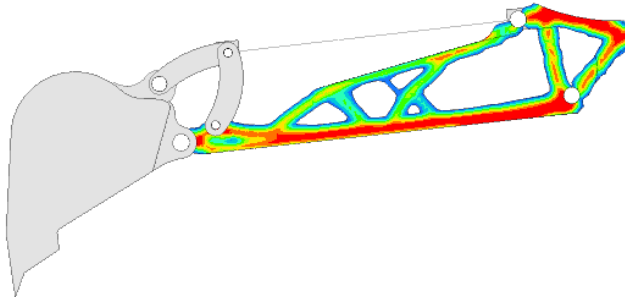
1: Model
Design : Iteration 28 : Frame 25

MMO

Contour Plot
Element Densities(Density)
Simple Average

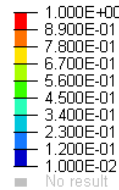


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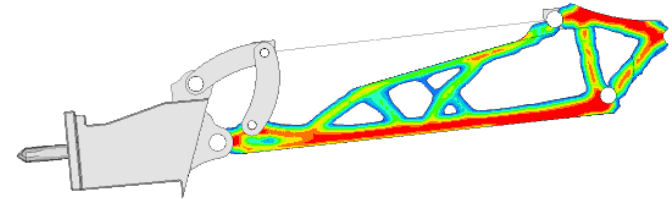


1: Model
Design : Iteration 29 : Frame 25

Contour Plot
Element Densities(Density)
Simple Average

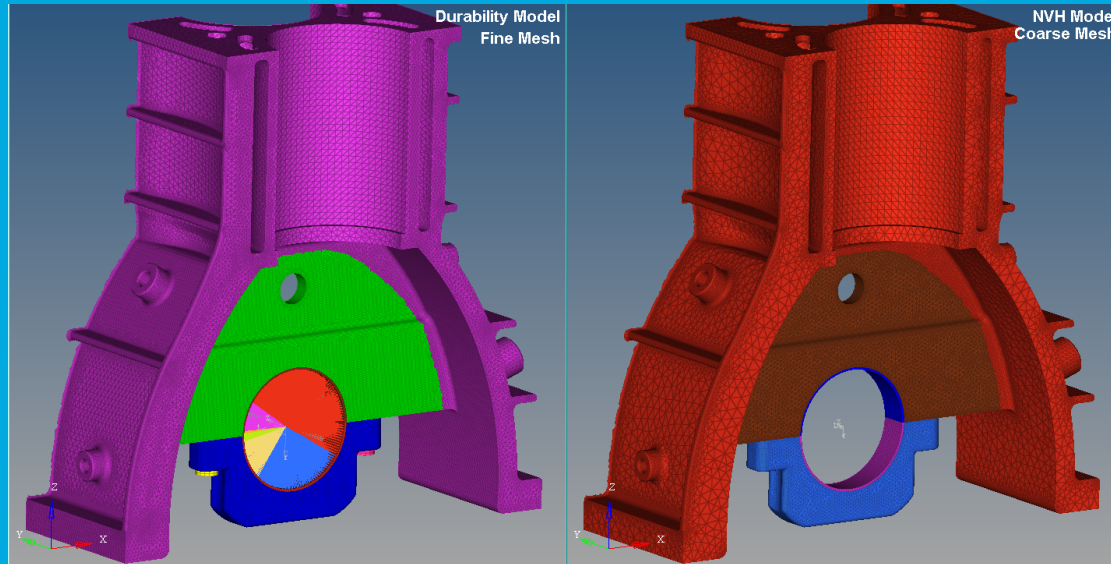


Max = 1.000E+00
Grids,182475
Min = 1.000E-02
Grids 182726



1: Model
Design : Iteration 29 : Frame 25

Engine Block Bulkhead for NVH and Durability



Bolt pretension +
bearing pressfit +
6 preloaded NL
subcases

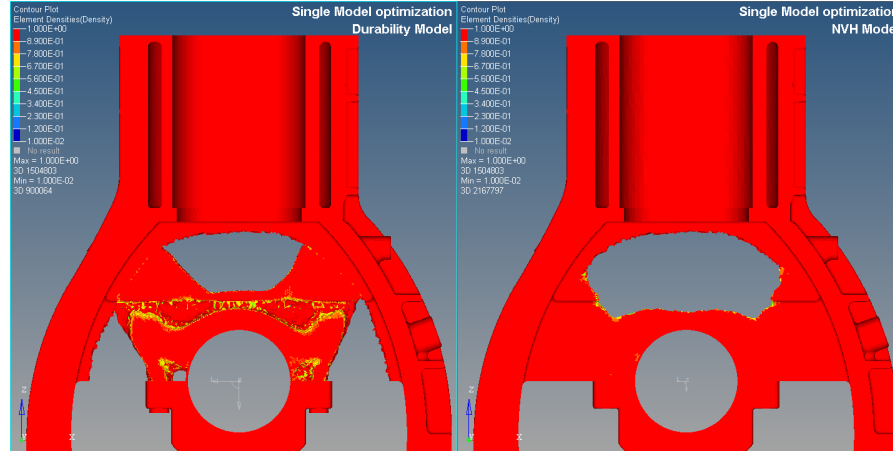
Minimize
compliance, s.t.
volume fraction
constraint

Modal analysis
subcase

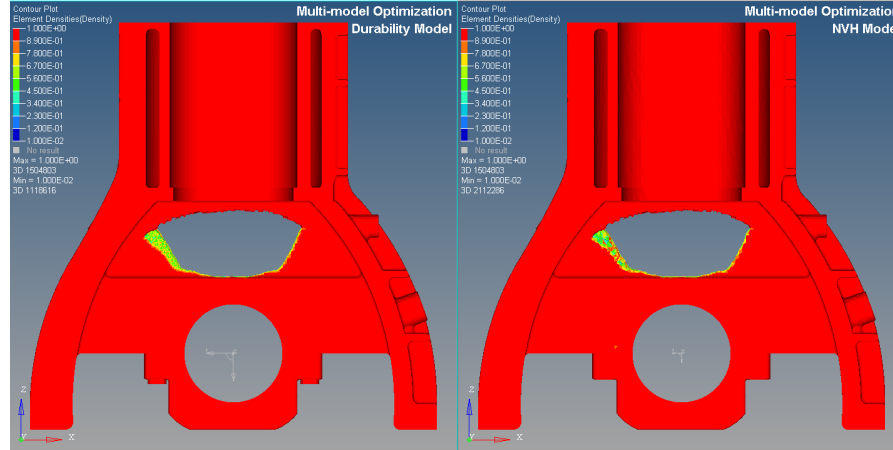
Minimize mass,
s.t. constraint on
bending mode

Engine Block Bulkhead

SMO

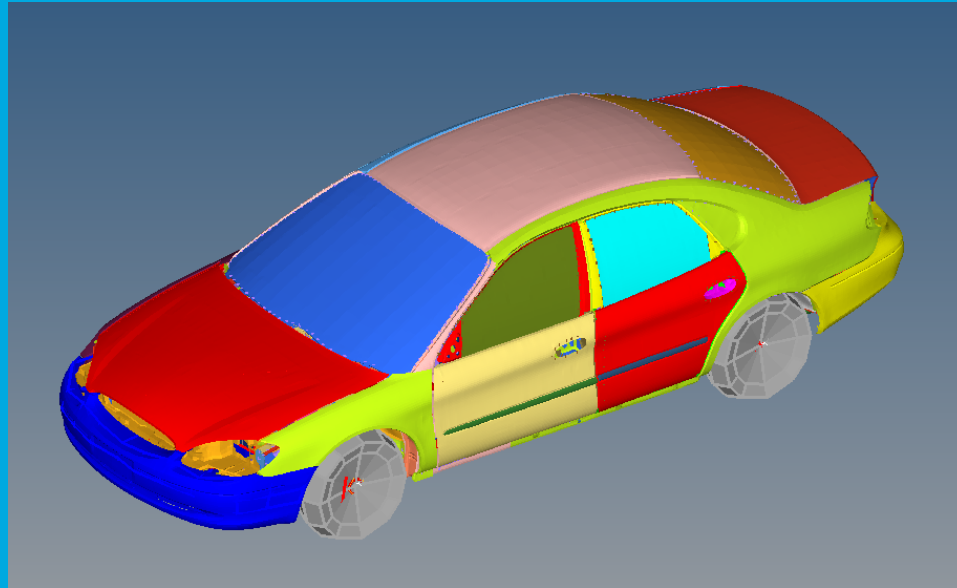


MMO



Subcase Dependent Model Properties

Idle shake, High speed shake and Rough road shake
Response: Steering wheel acceleration in vertical direction



Run Summary: SMO vs. MMO

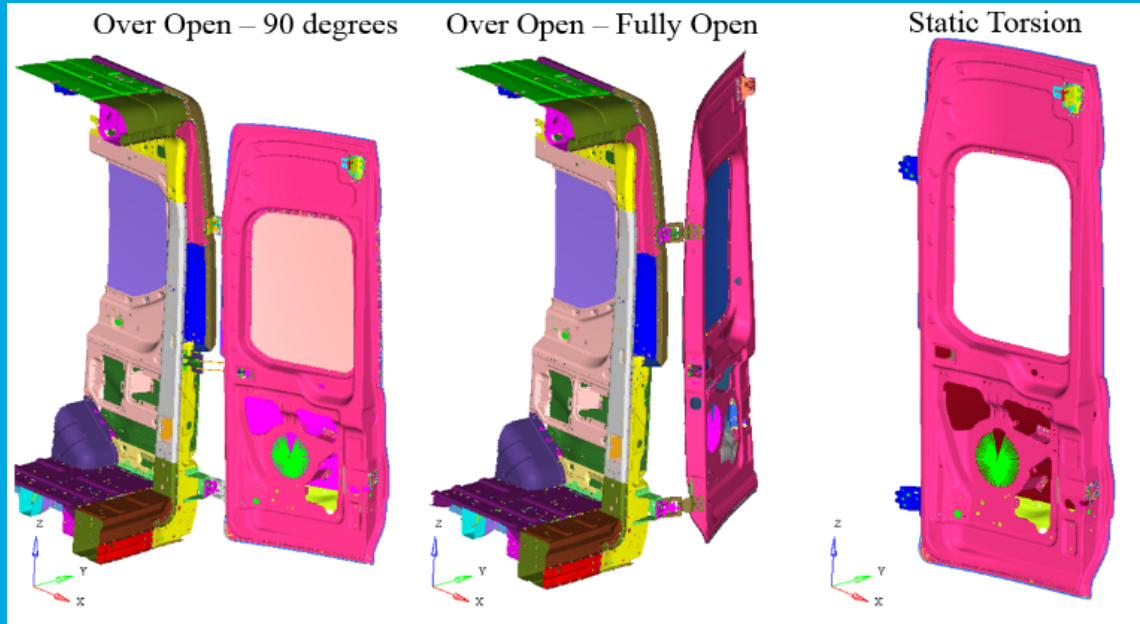
Approach	Load case	Design Validation		
		IS	HSS	RRS
SMO	IS	Green	Red	Red
	HSS	Red	Green	Red
	RRS	Red	Red	Green
MMO	IS, HSS, RRS	Green	Green	Green

- IS: idle shake
- HSS: high speed shake
- RRS: rough road shake

Cargo Van Rear Door Material Assessment Study

Open overload at
90 degrees

Drop off/door sag



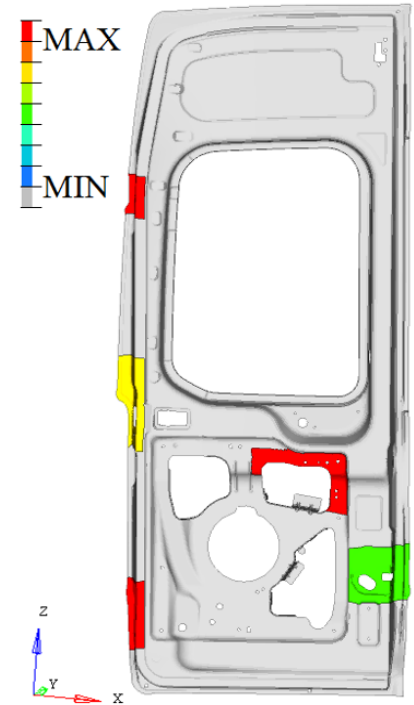
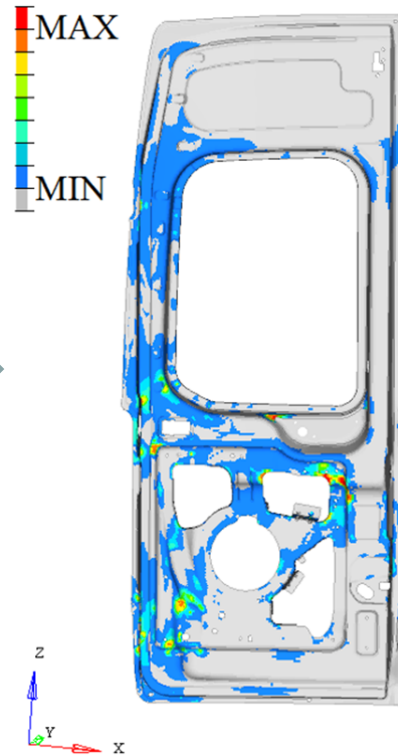
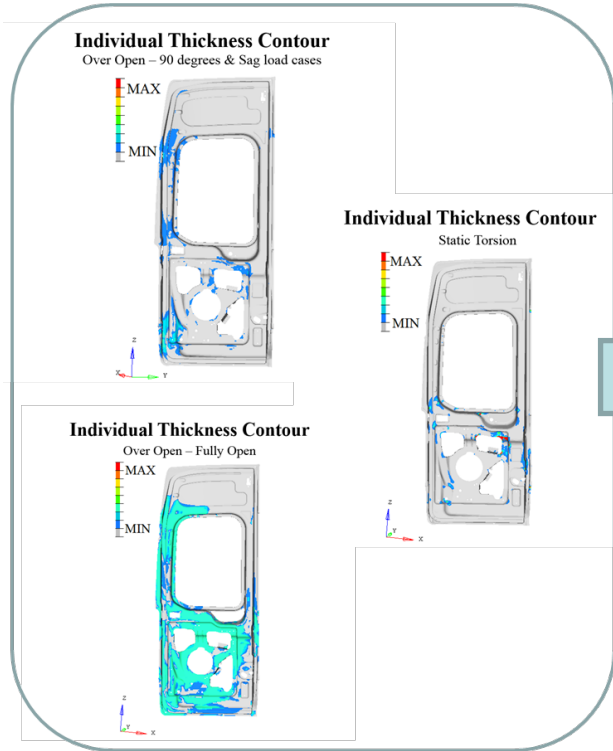
Open overload at
fully open position

Static torsion

Door Inner Panel MMO Study

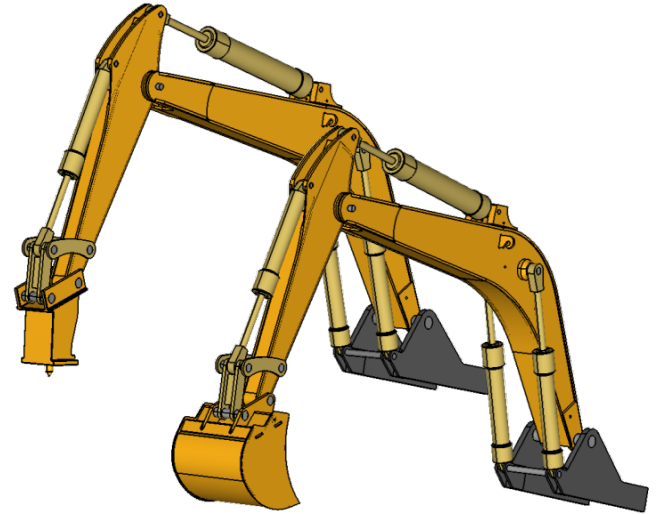
Thickness Contour MMO

Thickness Contour MMO – Size Optimization



Summary

- An MMO strategy can be used to simultaneously optimize multiple parts or configurations with common design variables
- Efficient way of managing conflicting design requirements
- MMO can include an MDO formulation
- Easy to use and deploy



Thank You!