Optimization with SIMULIA Tosca Structure

DTU

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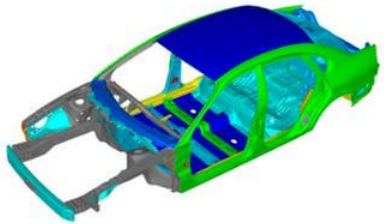
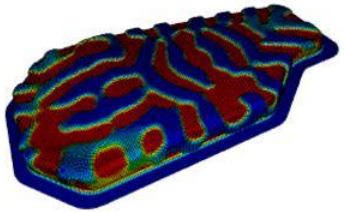
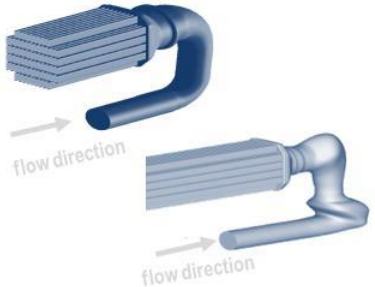
SIMULIA Technical Sales
Optimization

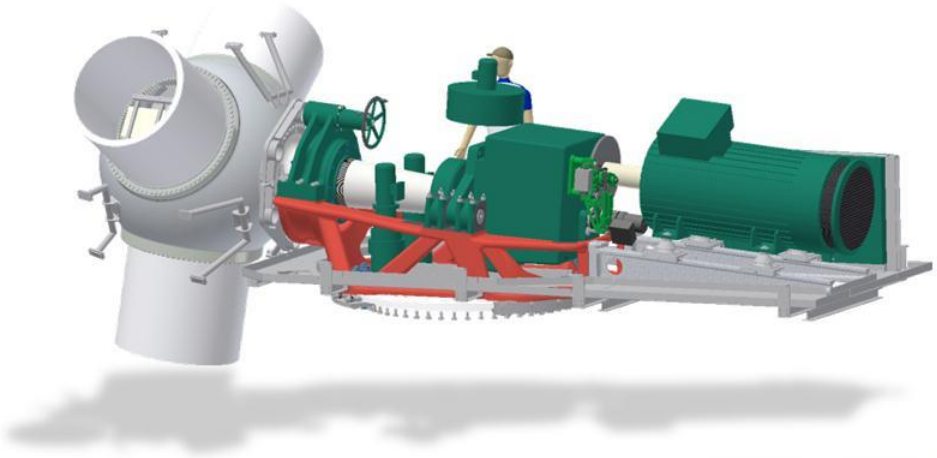
SIMULIA Tosca Optimization Modules

Tocsa Structure.topology	Tosca Structure.sizing	Tosca Structure.shape	Tosca Structure.bead	Tosca Fluid.topology
				
• Find the design with maximum stiffness or minimum weight	• Reduce mass through optimized sheet thicknesses	• Reduce local stresses and increase durability	• Increase stiffness or eigenfrequency of sheet metal structures	• Topology optimization of channel flow to reduce pressure drop

Images courtesy of AUDI AG

Images courtesy of Ford Werke AG

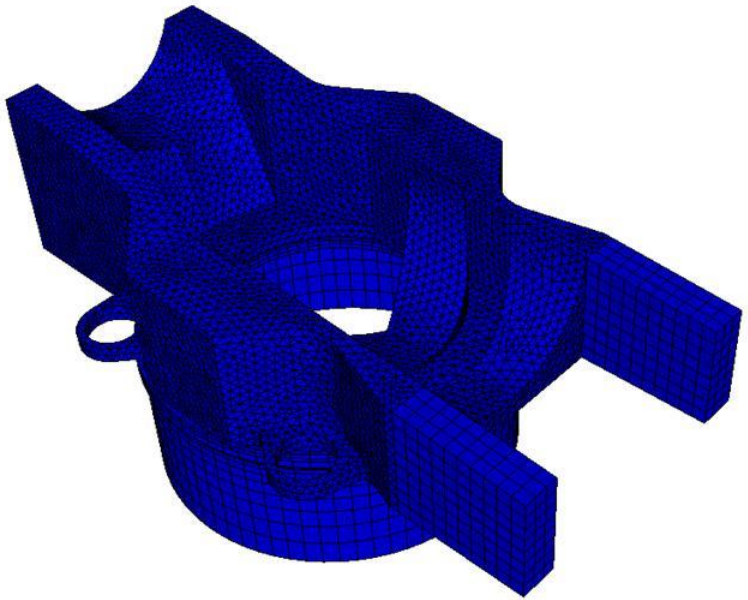
Main Frame Development



Courtesy of SUZLON POWERING A GREENER TOMORROW

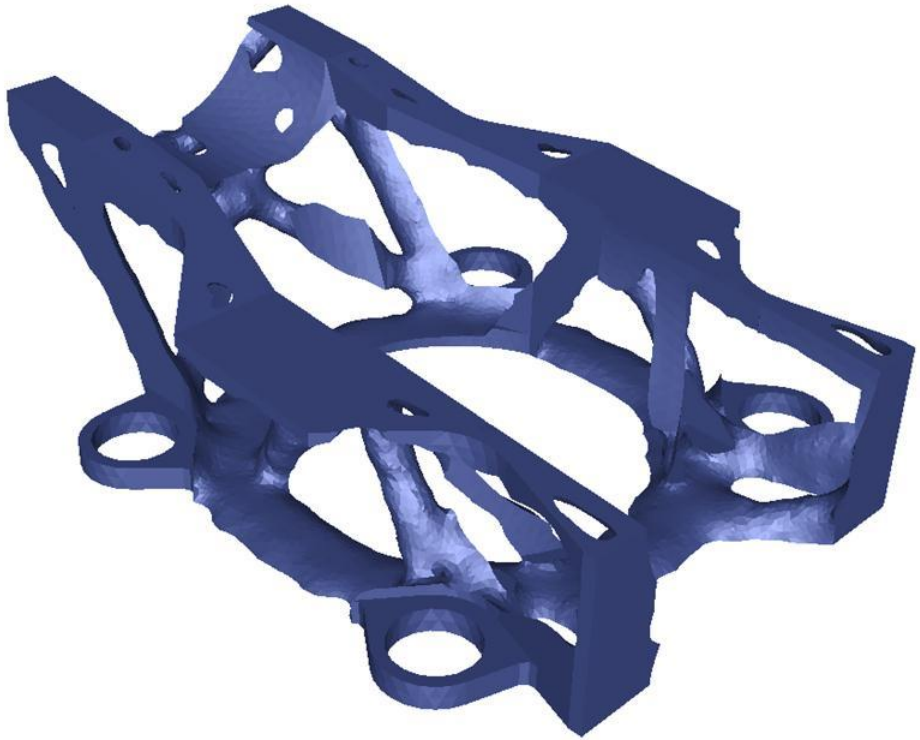
Topology optimization

Main frame optimization progress



Smoothed optimization results

Main frame



Topology optimization of a main frame

Series production

Conventional design

Design space for topology optimization

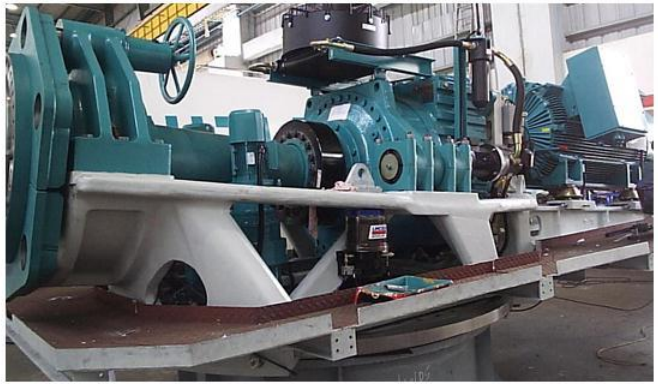
Assembly

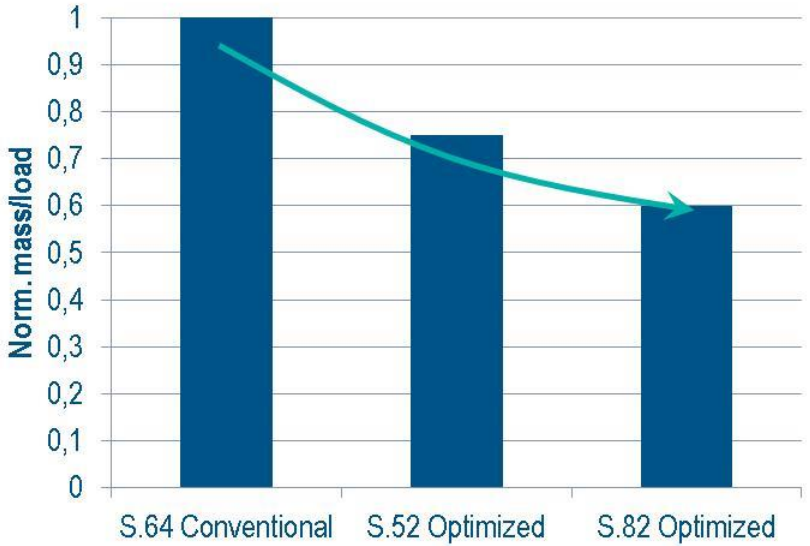
Optimization result

Courtesy of SUZLON POWERING A GREENER TOMORROW

Main frame - comparison

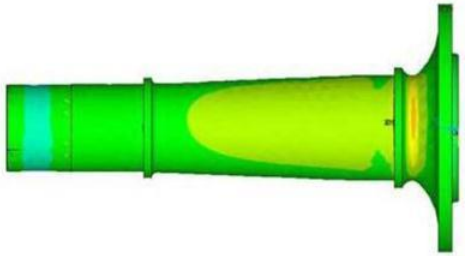
Saving >1,0 Mio EUR in one year with optimization

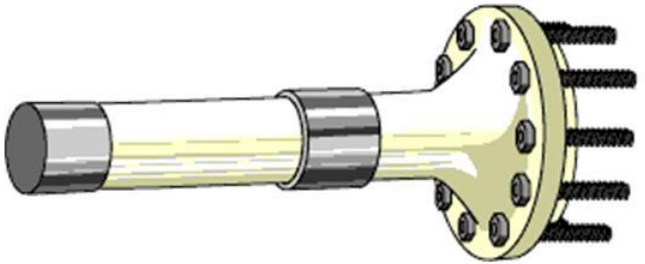




Courtesy of SUZLON
POWERING A GREENER TOMORROW

Wind turbine – main shaft

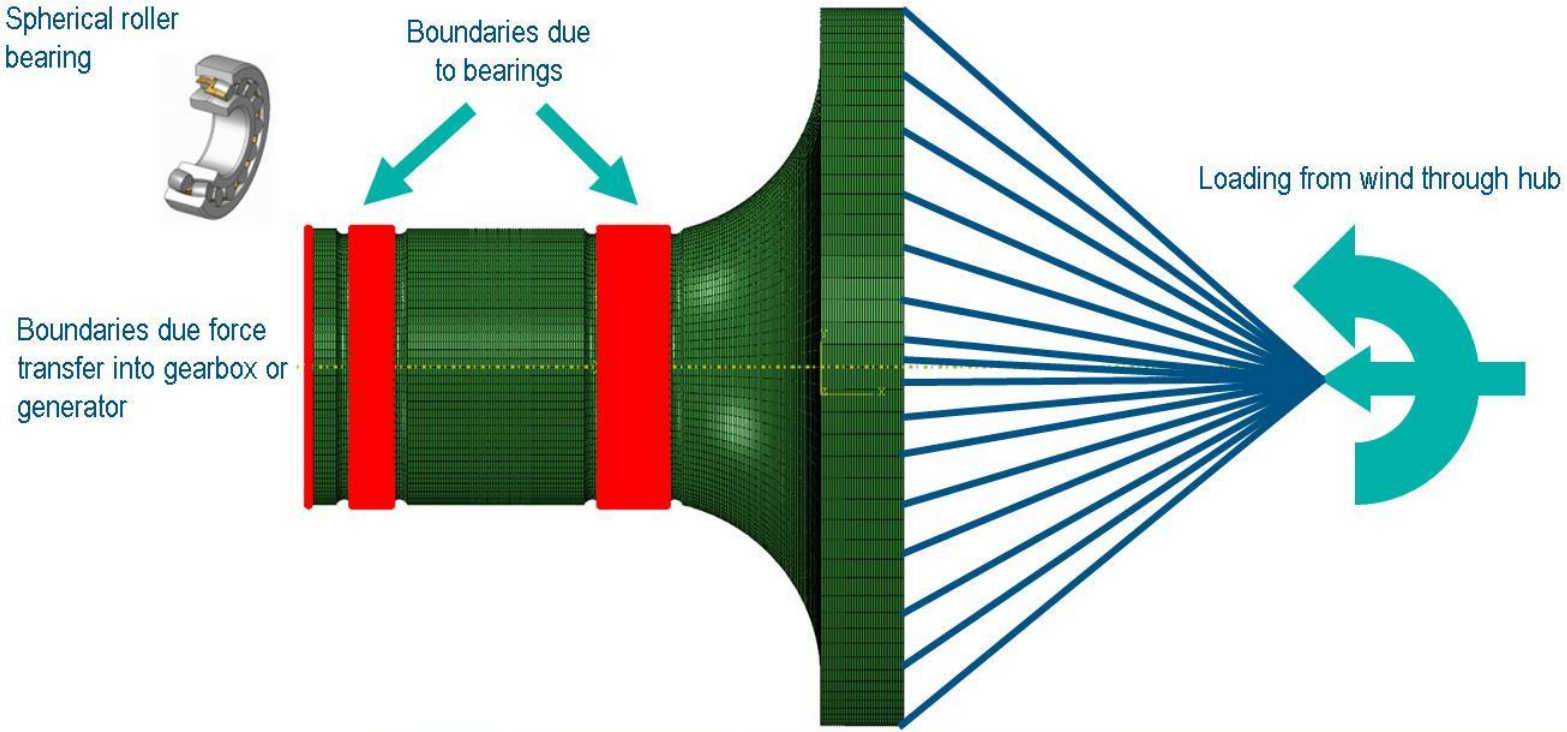




- High quality steel
- Normally forged, can be casted
- Usually hollow
- Diameter about 1% of rotor-diameter

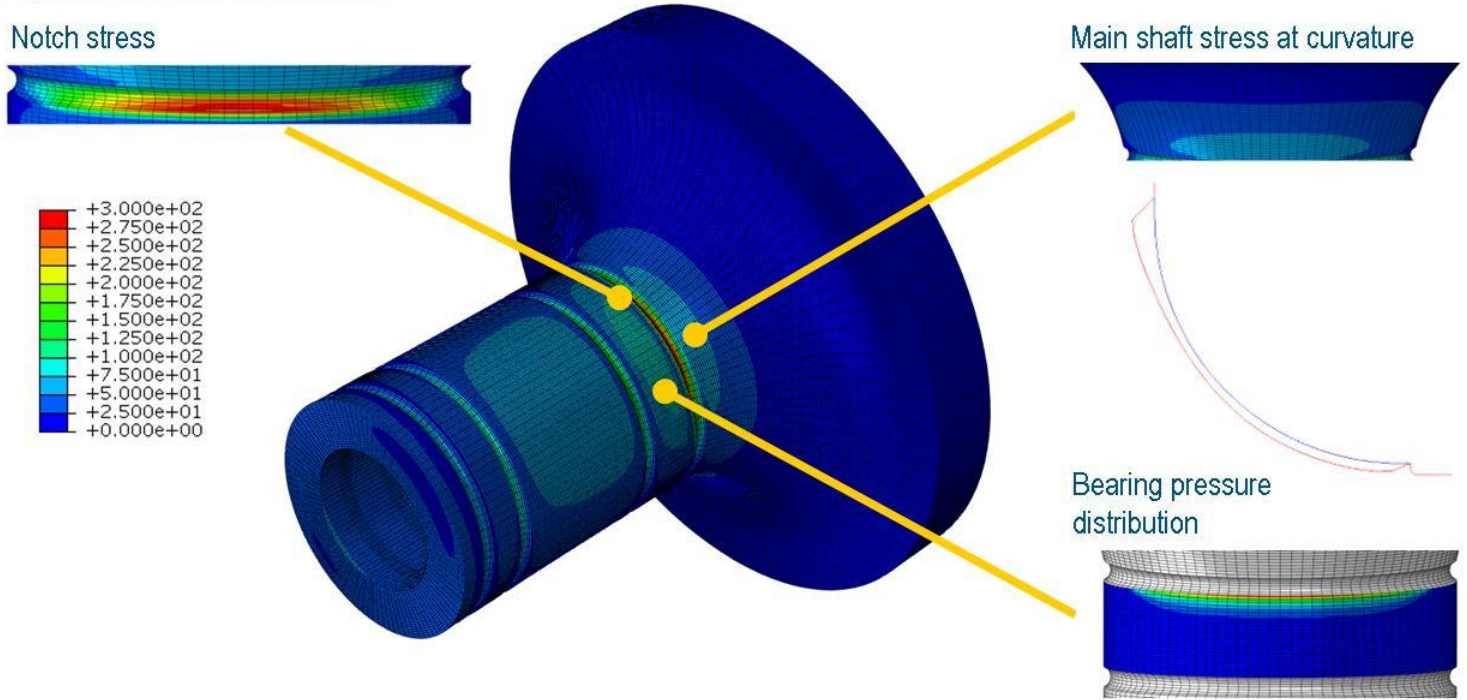
- Bigger dimensions means
  - Increasing power P
  - Decreasing velocity ω
  - Torque T = P/ω increases heavily by size

Main loadings



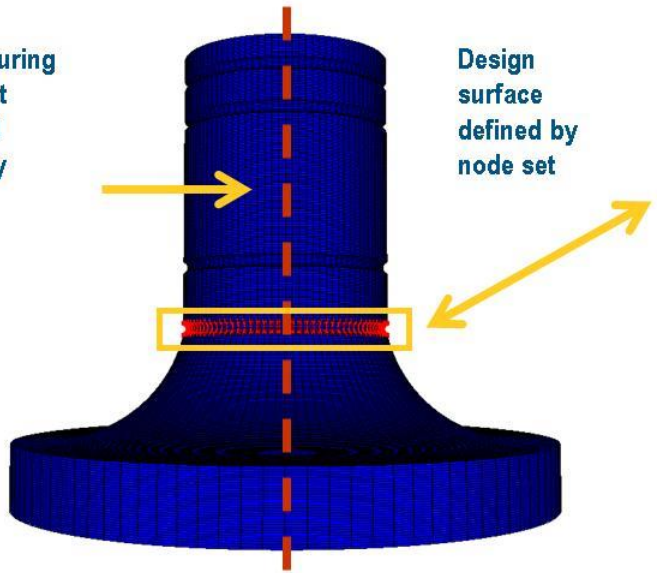
Examples of critical spots on the main shaft

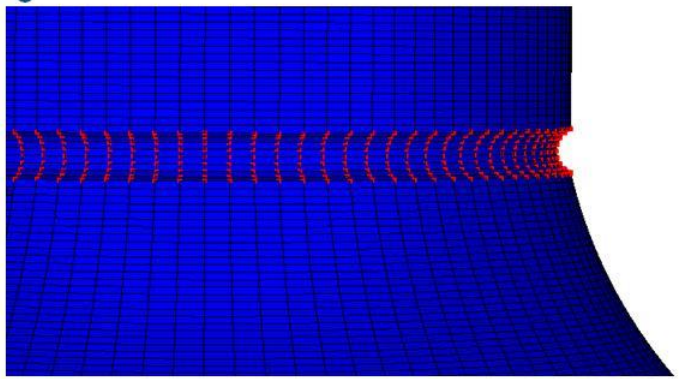
for stress minimization



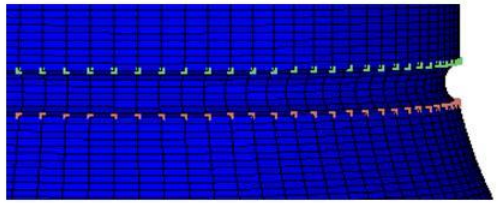
Stress reduction in notch

Shape optimization including manufacturing



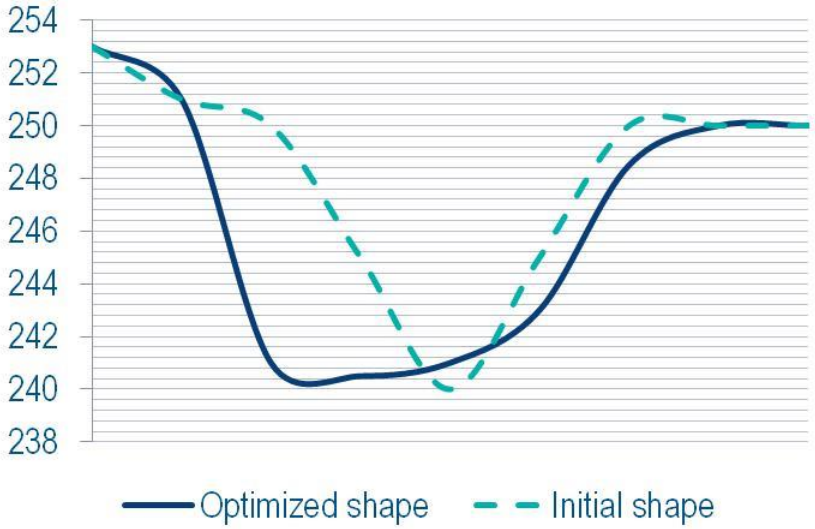


Lock side nodes

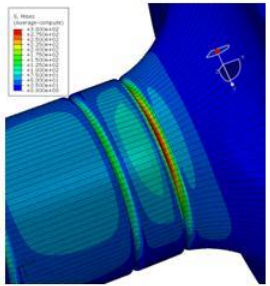


Initial von Mises stress = 300 MPa → target von Mises stress = 200 MPa

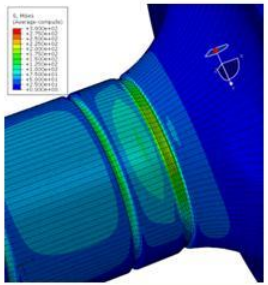
Optimized shape of notch



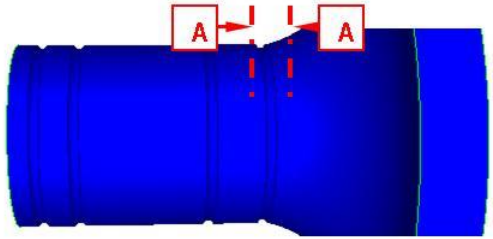
Stress for original shape (~300 MPa)

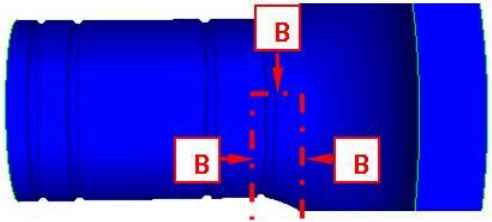


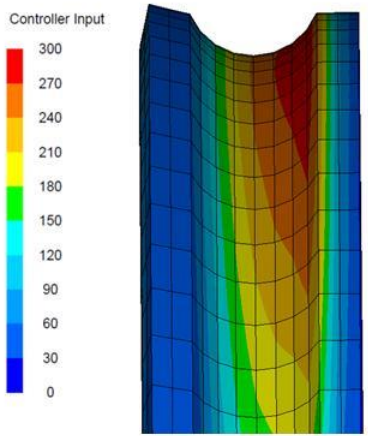
Stress for optimized shape (~200 Mpa)

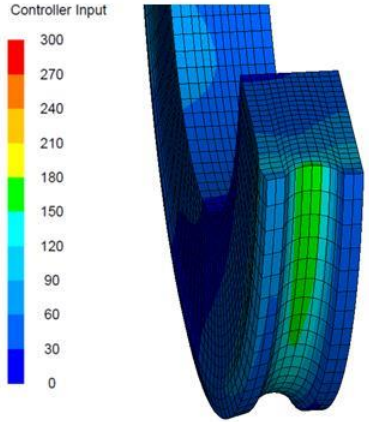


Shape optimized iteration history of notch

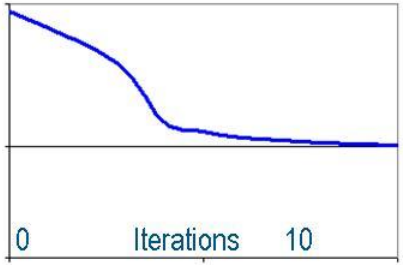








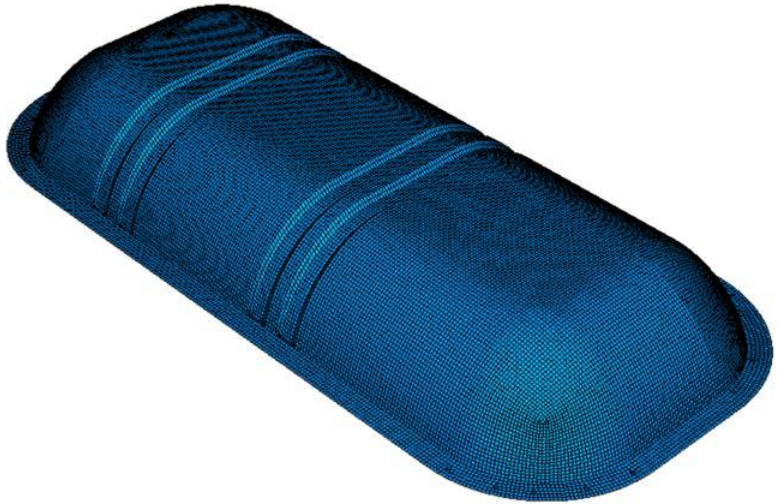
Optimization iteration history



Stress target 200 MPa

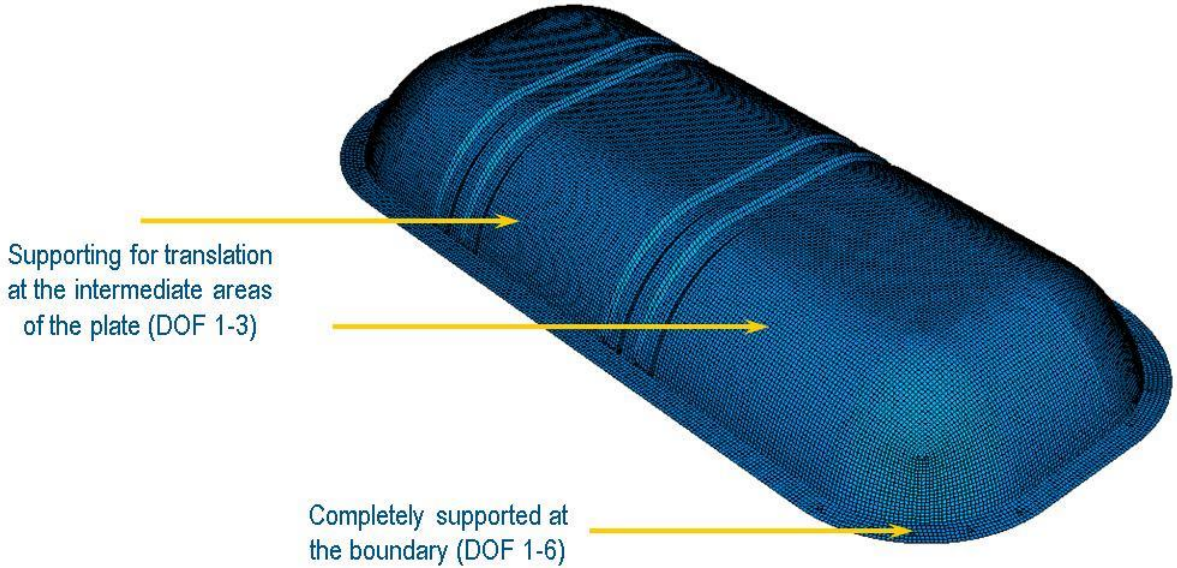
Initial stress 300 MPa

Bead Optimization of Sound Absorber



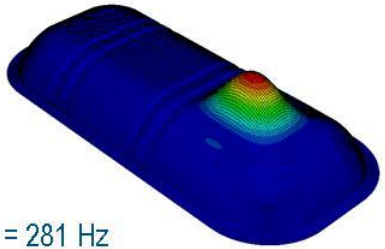
Increasing the 1st and 2nd eigenfrequency

Meshing using S4 and S3 elements for precise stress results

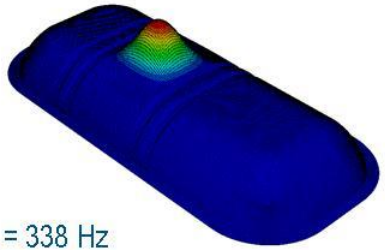


Model by courtesy and kind approval of TENNECO Automotive

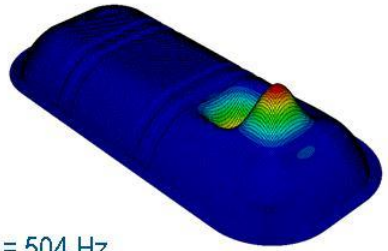
Natural eigenfrequencies and eigenmodes of the initial sound absorber



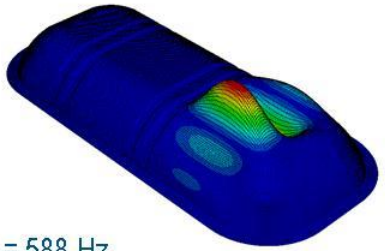
ω_1 = 281 Hz



ω_2 = 338 Hz



ω_3 = 504 Hz



ω_4 = 588 Hz

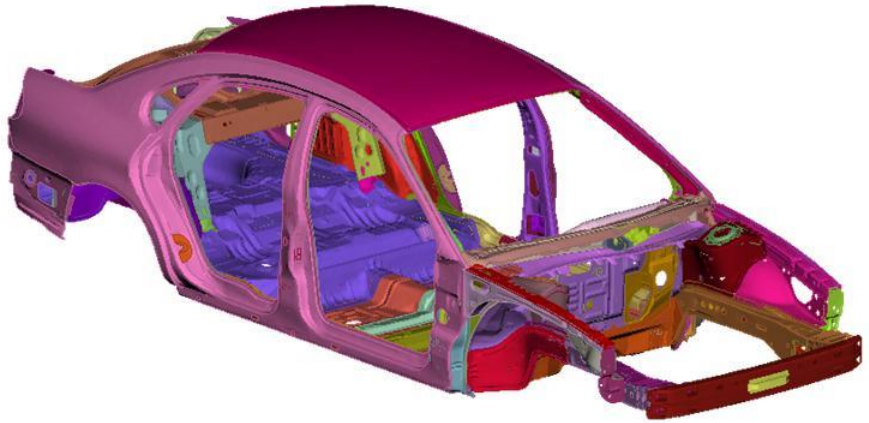
SIMULIA Tosca Structure.sizing

Application example: car body

Model description

- Initial weight ~329 kg
- ~350,000 shell elements
- 198 shell sections used as clustered design variables
- Optimization task
  - Minimize mass
  - Stiffness constraints

    Bending, torsional, and axial stiffness

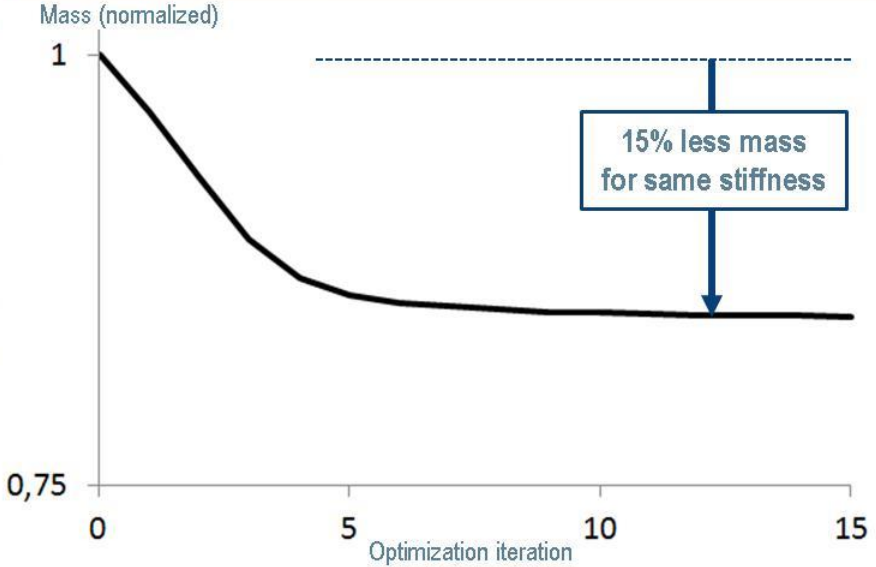


This model has been developed by The National Crash Analysis Center (NCAC) of The George Washington University under a contract with the FHWA and NHTSA of the US DOT

SIMULIA Tosca Structure.sizing

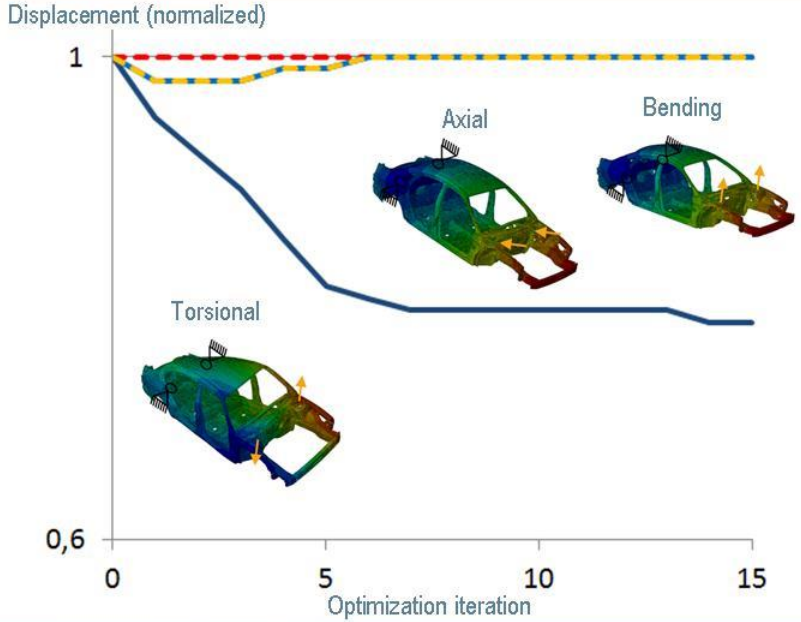
Application example: car body

Objective: Minimize mass



Here: 15 Abaqus design cycles needed

Constraints: Stiffness (through displacement constraints)

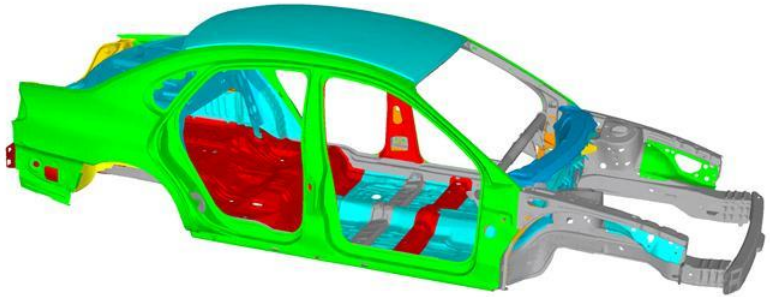


SIMULIA Tosca Structure.sizing

Application example: car body

Optimization result	
Initial weight	~329 kg
Weight reduction	~49 kg
Total weight	~280 kg

- Stiffness maintained!



This model has been developed by The National Crash Analysis Center (NCAC) of The George Washington University under a contract with the FHWA and NHTSA of the US DOT

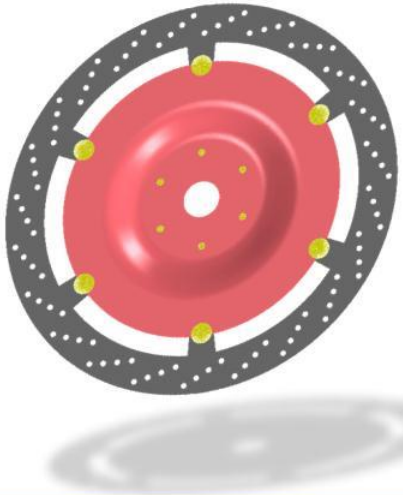
3DEXPERIENCE®

Live Demonstration

Topology Optimization of Motorcycle Disc Brake Carrier

SIMULIA Tosca Structure
Optimization Module within Abaqus/CAE

Motivation



Conceptual Design

- **Lightweigt**
- **Stiff**
- **Manufacturable**

SIMULIA Tosca Structure.topolgy Optimization Module within Abaqus/CAE

Model and Optimization Task

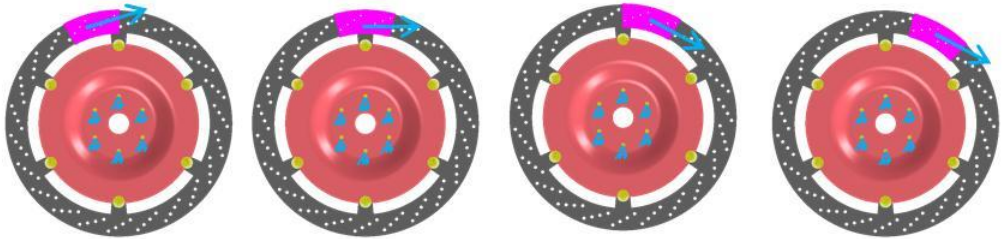
- Steel Disc & Aluminum Carrier
- Disc and carrier - connected through couplings (buttons)
- Full fixation at screw position
- Braking force on different patches - multiple static loadcases

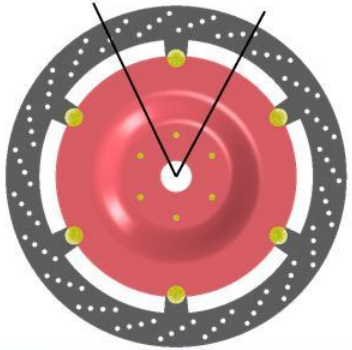
Objective: Maximum stiff design

- Volume/Weight constraint: 40% from the available design space

Geometric Restriction:

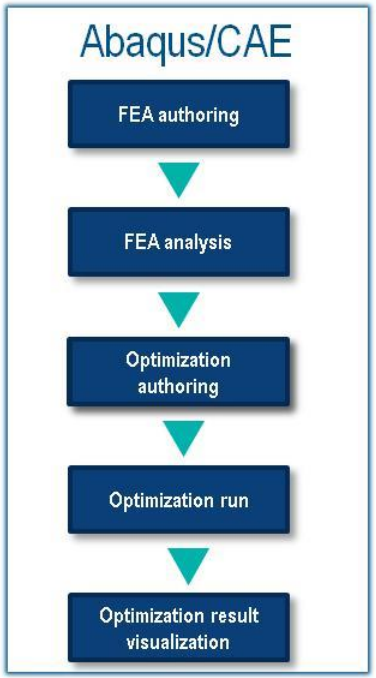
- Maintain functional areas – interfaces to buttons and screws
- Rotational symmetry – 6 pie sections, 60°
- Stamping – maintaining thickness of the carrier
- Insuring certain minimum thickness of the spikes

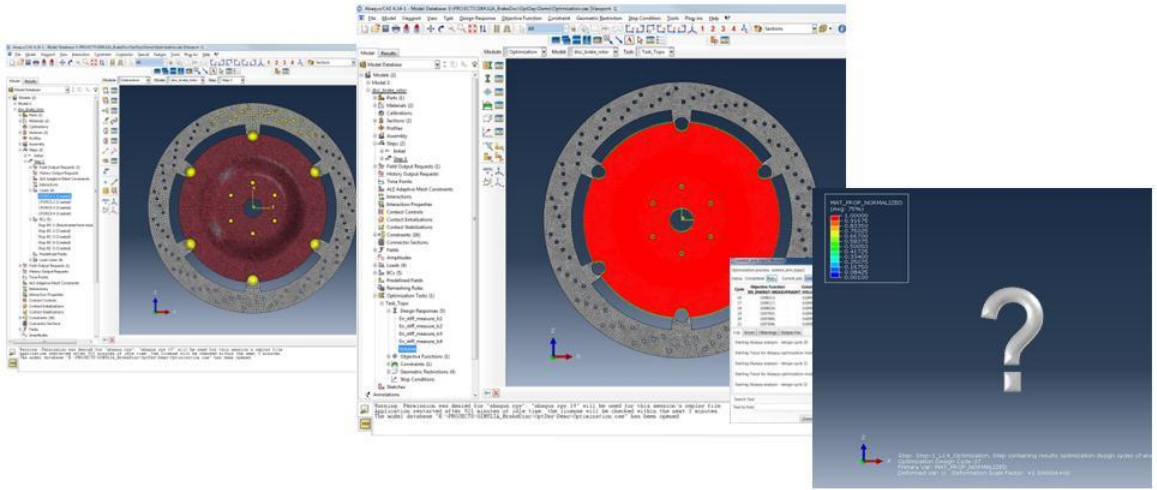




Optimization Module within Abaqus/CAE

Integrated graphical user interface for Tosca Structure optimization and FEA





Author, run and postprocess FEA as well as optimization jobs