



3DEXPERIENCE

# SIMULIA TOSCA STRUCTURE

*THE STRUCTURAL OPTIMIZATION SYSTEM*



# TOSCA STRUCTURE

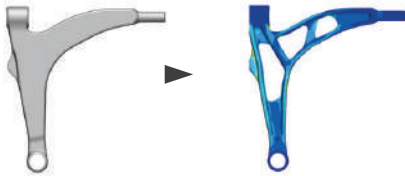
SIMULIA Tosca Structure is a flexible, modular software system for non-parametric structural optimization that provides topology, sizing, shape and bead optimization optimization using industry standard finite element solvers (ANSYS, Abaqus, MSC Nastran). The setup is simple – model parameterization is not necessary. Existing solver input files are used for the optimization. Tosca Structure is based on market-leading technology and provides advanced capabilities for optimization with nonlinear analysis and fatigue as well as a specific non-parametric morphing approach.

## TOSCA STRUCTURE FEATURES

### Innovative, lightweight design concepts

#### Topology optimization

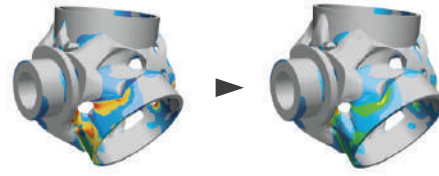
Conceptual design for lighter and stiffer structures. Create lightweight, ready-to-manufacture product designs and reduce time-to-market, physical tests, and prototype builds.



### Improved designs for more durability and strength

#### Shape optimization

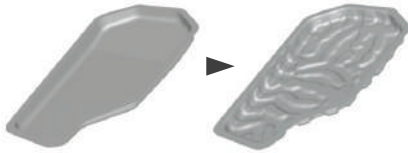
Improve existing designs for more reliable and durable components. Minimize stress, strain, and damage – or any combination of these – by automatic modification of the surface geometry.



### Efficient bead patterns for increased stiffness and reduced noise

#### Bead optimization

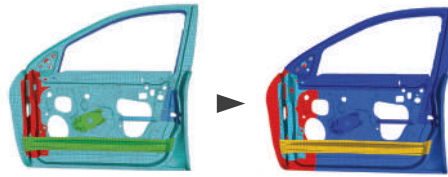
Improve the static and dynamic properties of shell structures. Generate optimal bead layouts while accounting for manufacturing constraints, complex geometries, and realistic loads.



### Best static and dynamic behavior through optimized sheet thicknesses

#### Sizing optimization

Obtain an optimal relation between weight, stiffness, and dynamic behavior, to gain material savings and take advantage of increased comfort.



## TOSCA STRUCTURE ADVANCED CAPABILITIES

### Full optimization potential with realistic simulation models

**Nonlinear analysis**—exploit the benefits of topology, sizing, shape and bead optimization in combination with contact, material nonlinearity and large deformation. Avoid error-prone and time consuming model simplification.

### Reduced weight and ensured reliability

**Durability**—augmenting shape optimization using fatigue simulation results, with standard or in-house fatigue solvers. Save weight and ensure highest result quality for reliable components.

### Faster design decisions by quickly changing mesh geometry

**Morph**—extending shape optimization to enable fast and easy creation of design variants. Make geometry changes directly applied to the existing finite element mesh and avoid intermediate CAD modifications.



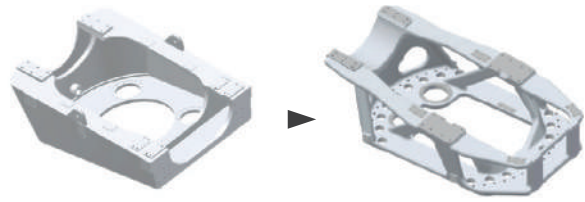
## EXAMPLES OF INDUSTRIAL USE OF TOSCA STRUCTURE

### Wind turbine mainframe

#### Optimization with Tosca Structure.topology

For larger wind turbines stiffness and strength requirements are more difficult to meet. The redesign of the mainframe should result in an economic design with optimal vibration behavior.

Topology optimization of the mainframe led to a lightweight structure which met static and dynamic criteria. Manufacturing constraints were considered during the optimization to generate a producible design, e.g. to avoid under-cuts. Mass reduction approaching 40%, a feasible final design, and a faster development process were achieved.



Courtesy of Suzlon GmbH

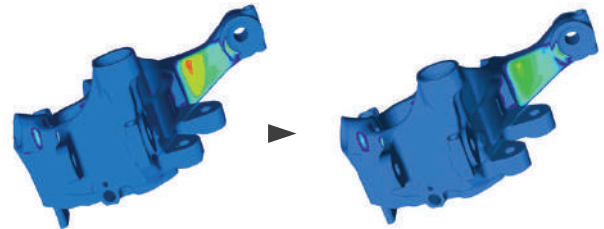
The integration of Tosca Structure into the product development process resulted in a shorter time-to-market for the mainframe, and a lightweight cast structure with 40% mass reduction.

### Rear wheel carrier

#### Optimization with Tosca Structure.shape

For the weight optimization of the chassis component multiple criteria such as strength, fatigue, plasticity and stiffness had to be considered.

Violated stiffness demands required a modified design for the rear wheel carrier considering damage requirements for multiple loads and maximum allowed strain for breaking loads. With Tosca Structure a shape optimization was performed directly on the existing model without error-prone model simplification or time consuming parameterization. After 20 automated analysis steps a redesign was derived with better performance and even a reduced mass compared to the initial design.



Courtesy of BMW Group

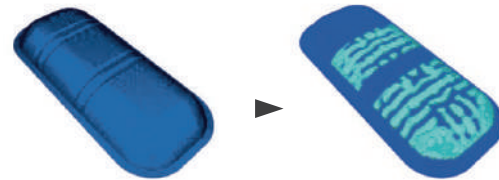
Damage was reduced by 60% from the initial value. At the same time formerly violated stiffness constraints were met.

### Automotive muffler

#### Optimization with Tosca Structure.bead

Noise issues motivate engineers to find the optimal dynamic behavior of the muffler. Key quality factors such as structural stiffness and vibration behavior should be met.

In order to reduce noise and improve structural stiffness, bead patterns are formed in sheet metal structures. In an automatic loop with Tosca Structure.bead the optimal bead layout was achieved after only three finite element analyses. Manufacturing requirements were directly applied to achieve a faster turnaround from analysis to the production process.



Courtesy of Tenneco

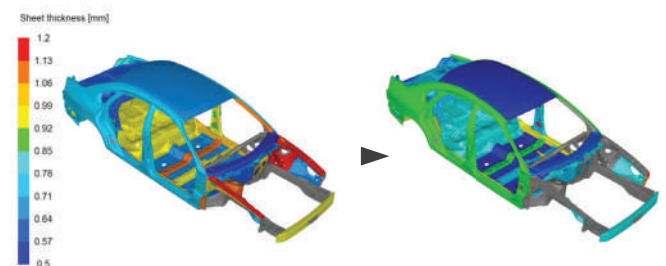
After only three FE analyses, a bead layout was created using Tosca Structure. The 1st and 2nd eigenfrequencies were increased significantly—from 280 to 520 Hz, and from 340 to 570 Hz, respectively. A corresponding reduction of noise was achieved.

### Body-in-White

#### Optimization with Tosca Structure.sizing

A higher eco-efficiency is one of the main targets in the automotive industry. To realize a significant weight reduction of a body-in-white, the optimum balance between weight, stiffness, and dynamic behavior is required.

Targeting weight reductions, Tosca Structure.sizing optimizes sheet thicknesses clustered together in groups or individually, up to element level. This way the best static and dynamic behavior for a body-in-white can be found. Through consideration of multiple complex load scenarios, stiffness, and manufacturing requirements, Tosca Structure.sizing helps to meet performance and production goals for an overall increase in eco-efficiency.



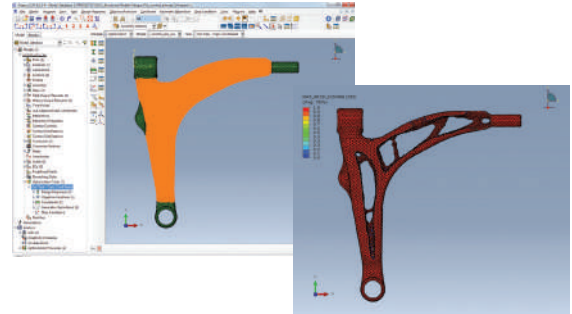
The optimal combination of weight, stiffness, and dynamic behavior using Tosca Structure.sizing resulted in a weight reduction of 15%—from initial 329 kg to 280 kg. While high stiffness requirements contribute to an increase in comfort, all other performance goals are met within a reduced development time.

## POWERFUL OPTIMIZATION AUTHORIZING INTERFACES

Tosca Structure, as an open optimization solution, offers a wide range of graphical user interfaces. Choose from a selection of fully featured user interfaces to seamlessly fit into your individual CAE environment. Use an intuitive graphical user interface for easy setup and execution of optimization tasks and workflows.

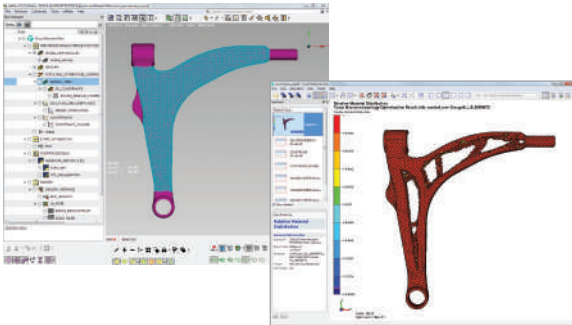
### Optimization module in Abaqus/CAE

- Define optimization tasks interactively on 3D Abaqus Standard models
- Author, run and post-process directly in familiar Abaqus/CAE environment
- Automatic consistency checks
- Integrated graphical user interface for optimization and FEA jobs



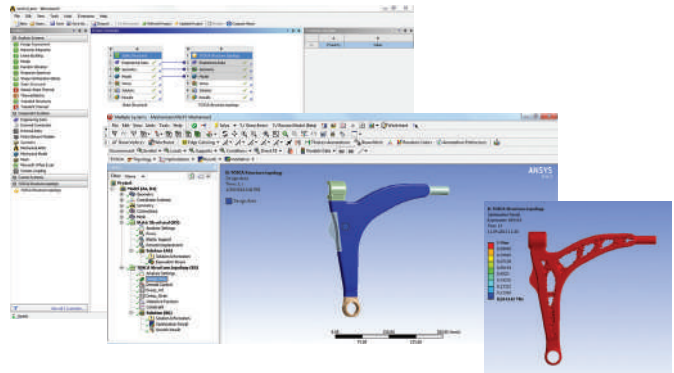
### Tosca ANSA environment (TAE)

- Define optimization tasks interactively on predefined 3D models supporting Abaqus, ANSYS, MSC Nastran
- Author (based on ANSA preprocessing technology), run and post-process – no FE model modifications
- Automatic consistency checks
- Fully automated validation runs
- Tosca Structure.view integrated to visualize results



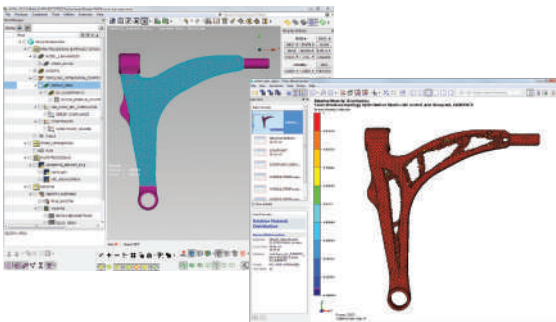
### Tosca Extension for ANSYS Workbench

- Define topology optimization tasks interactively on 3D ANSYS Workbench models
- Author, run and post-process your optimization task within familiar ANSYS Workbench environment
- Automatic consistency checks
- Semi-automated validation runs



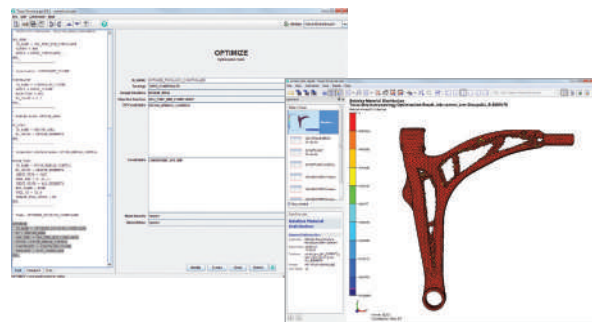
### ANSA

- Define optimization tasks interactively on 3D models supporting Abaqus, ANSYS, MSC Nastran
- Author (as integrated part of ANSA), run and post-process—additional to FE preprocessing
- Automatic consistency checks
- Fully automated validation runs
- Tosca Structure.view integrated to visualize results



### Tosca Structure.gui

- Define optimization tasks using existing properties and group definitions of FE models
- Form-based optimization authoring
- Author and run optimization tasks
- Easy and fast wizards for standard tasks
- Tosca Structure.view to visualize results
- Supports Abaqus, ANSYS, MSC Nastran FE models



## KEY BENEFITS FOR OPTIMIZATION SOLUTIONS WITH TOSCA STRUCTURE

Tosca Structure features best-in-class optimization technology for high quality simulation results. Take full advantage of your optimization potential while leveraging advanced simulation capabilities such as material and geometrical nonlinearity (large deformation and contact).

Tosca Structure creates optimized design concepts with significant potential for savings of material and weight. Optimization in an early phase speeds up the product development and hence results in a shorter time-to-market. Gain and maintain a better competitive position in the marketplace with innovative, state-of-the-art designs.

### TECHNICAL HIGHLIGHTS

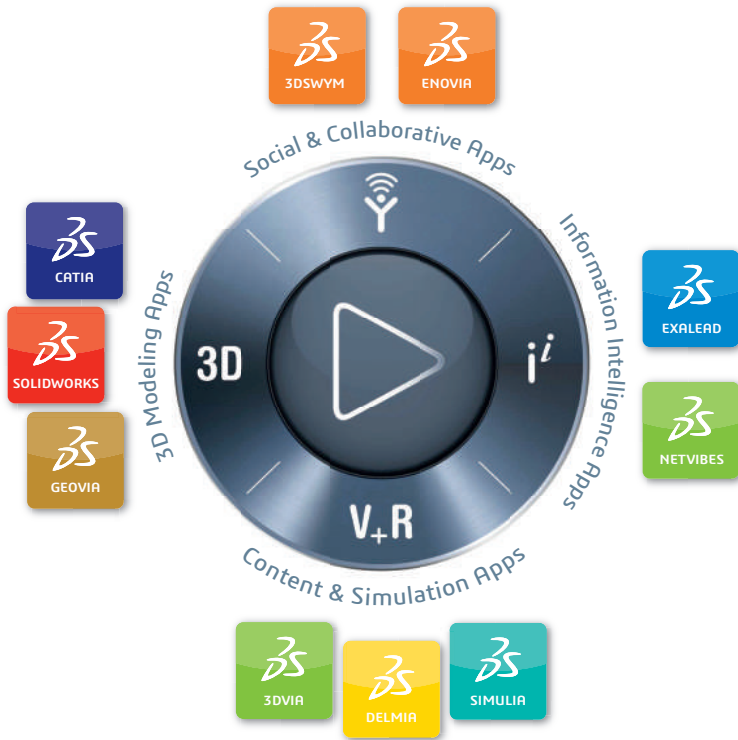
- Seamless integration with leading FEA & durability solvers
- Direct use of existing knowledge and models
- Full design flexibility without time-consuming parameterization
- Fast and easy creation of design variants avoiding intermediate CAD modifications using shape morphing capabilities
- High fidelity optimization for nonlinear analysis and durability
- Simultaneous optimization to meet static, dynamic, and thermo-mechanical requirements
- Handling of complex manufacturing conditions
- Automatic validation analysis runs and direct data transfer to CAD systems

### ECONOMIC ADVANTAGES

- Economic use of existing IT investments
- Faster turnaround from analysis to design or manufacturing
- More durable and lightweight designs
- Optimized products drive innovations in your market

## INDUSTRIAL APPLICATION EXAMPLES OF SIMULIA TOSCA STRUCTURE

<p><b>TRANSPORTATION &amp; MOBILITY</b></p> <p>Brake, Wheel Carrier, Wishbone, Exhaust Muffler, Turbocharger Housing</p> 	<p><b>MARINE &amp; OFFSHORE</b></p> <p>Drive-Shaft, Crankshaft, Crankcase</p> 	<p><b>AEROSPACE &amp; DEFENSE</b></p> <p>Engine and Gearing Components</p> 
<p><b>ENERGY, PROCESS &amp; UTILITIES</b></p> <p>Drive-Shaft, Hub, Machine Slide, Rotary Blades</p> 		<p><b>LIFE SCIENCE</b></p> <p>Medical Devices, Measuring Technique, Hearing Aids</p> 
<p><b>INDUSTRIAL EQUIPMENT</b></p> <p>Telehandler Axle, Tractor Lever, Machine Slide, Machine Housing Cylinder Head, Oil Pan, Turbocharger Housing</p> 	<p><b>CONSUMER GOODS &amp; CONSUMER PACKAGED GOODS</b></p> <p>Beverage Bottles, Packaging, Household Appliance</p> 	<p><b>FIND MORE APPLICATIONS ON OUR WEBSITE</b></p> <p><a href="http://www.3ds.com/tosca">www.3ds.com/tosca</a></p>



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