



*A lighter steering knuckle, redesigned by Georg Fischer Automotive using Tosca™ Structure software for optimized structure and weight, is in large-series production in the Audi A3 and other vehicles.*

## Designing for a Lighter Future

Georg Fischer Automotive uses Tosca Structure optimization software to design lightweight components for improved fuel efficiency

As the auto industry worldwide works hard to improve fuel efficiency and meet increasingly stricter CO<sub>2</sub> emission standards, almost every conceivable way to make vehicles lighter in weight is on the digital drawing board of automotive engineers.

Such is certainly the case at Georg Fischer Automotive AG, the Swiss-based manufacturer and developer of high-performance casting components for the industry. As a key supplier that casts more than 600,000 metric tons of iron, aluminum, and magnesium into 100 million components yearly, the company is addressing weight through advances in designs, materials, and processes.

The benefits of such lightweighting strategies are clear and align with the company's "sustainable mobility" mission. A U.S. Department of Energy report says that reducing vehicle weight by 10 percent can increase fuel economy between six to eight percent.

### Designing the weight out

For GF Automotive, an essential part of the development of chassis components is the use of modern simulation and optimization software methods. Engineers at the firm have employed these computer-aided engineering (CAE) tools for years, achieving significant savings in product development time and upgrades in quality. The company

currently relies on Tosca Structure, with its topology and shape optimization modules, for reducing component weight while ensuring the product conforms to all required stress loads.

Reducing component weight requires a holistic approach to product development that combines engineering expertise with computer-based methods. Tosca Structure from FE-DESIGN (which has been part of Dassault Systèmes SIMULIA since May, 2013) is a flexible, modular software system for non-parametric structural optimization. Its methods include topology, shape, and bead optimization that couple with industry standard finite element analysis solvers. GF Automotive uses the software on a wide variety of vehicle design projects in an effort to save weight.

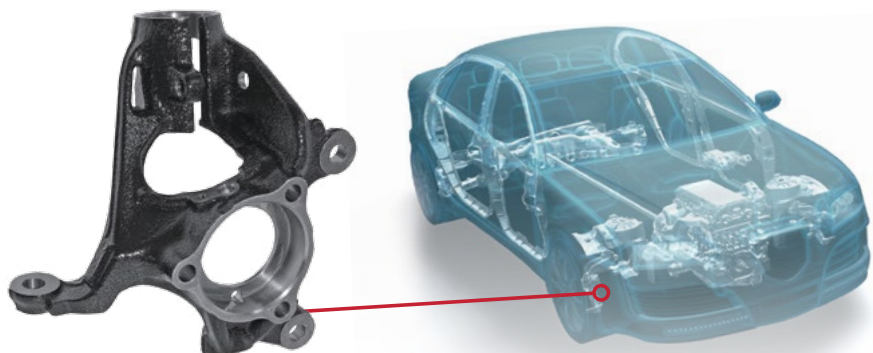


Figure 1. GF Automotive optimized steering knuckle (left) and location in wheel suspension system (right).

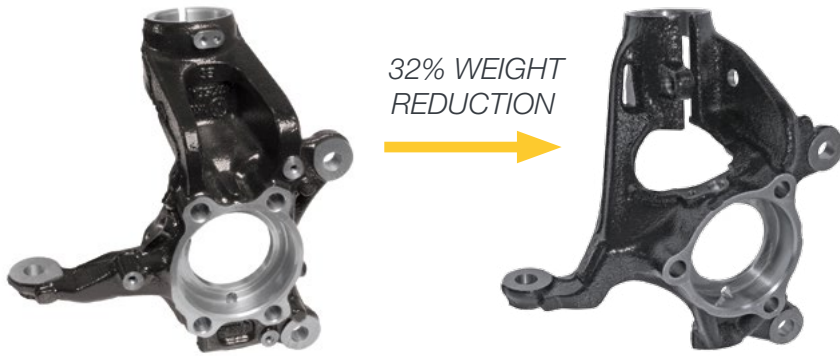
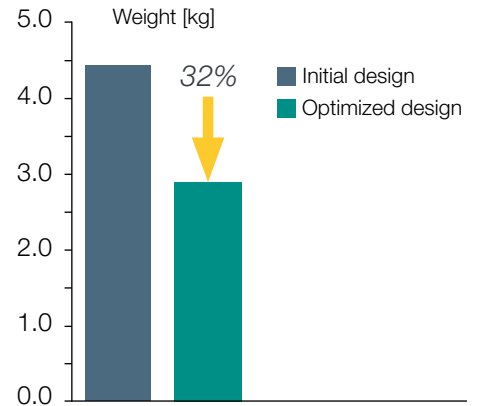


Figure 2. Tosca™ optimization of a steering knuckle. Optimized design with 32% weight reduction.



### Optimizing a steering knuckle: As light as possible—yet safe

In an automotive suspension system, the steering knuckle serves to attach the wheel to other suspension components (Figure 1). GF Automotive engineers—looking to eliminate weight from this component, while keeping the structure strong and safe—performed an optimization exercise using Tosca Structure software.

“Through the use of Tosca we get designs best adapted to loading, for lightweight and notch stress-free components in iron and light metal castings,” said Roman Brauner, former project engineer in product development at GF Automotive.

The essential starting point for a successful high-volume (or series) design is to first define the appropriate design space. For the steering knuckle this included consideration of the axle, the wheel, and the kinematics of the suspension assembly. The component’s product specifications were then transformed into mechanical requirements for the analysis.

Optimization to reduce weight began with the Tosca Structure topology module. The analysis created a lightweight, stiff and strong design concept considering all relevant operating load and load-abuse cases simultaneously—which is especially important for a dynamically stressed component such as a steering knuckle. The software’s shape optimization module was next used to eliminate an additional 100 grams of weight through modifications to the part’s surface geometry.

### Considering manufacturability and material choices for mass production

For a supplier that relies heavily on casting such as GF Automotive, topology and shape optimization are perfectly suited to their manufacturing methods because of the inherent design freedom of the process.

*“Tosca Structure allows us to develop our products efficiently and thus fulfills the demands for consistent lightweight designs.”*

**Roman Brauner, former project engineer in product development at GF Automotive**

Casting’s flexibility allows sophisticated optimized lightweight designs to be mass-produced cost effectively and with high quality.

The benefits of the optimization process are many. For one, the new design concept can be easily transferred from Tosca Structure to a CAD model with little added interpretation effort.

Tosca Structure’s fully automated optimization process also provides results quickly. In the case of the steering knuckle, the software enabled engineers to easily arrive at a manufacturable design by considering critical manufacturing processes and steps—such as de-molding directions and clamping points for mechanical finishing—right in the optimization setup.

Value can be further added by selectively combining the improved design with the right material and a revised manufacturing process. GF Automotive engineered a new type of cast iron, Sibodur, developed in-house. This material is characterized by better properties at break, tensile strength\*, and fatigue strength\*\*. Given these properties, the lighter optimized design geometry complies with all safety requirements for the part.

“In addition to aluminum, innovative cast-iron materials are the trend,” said Brauner. “In each case, the aim is to use only the

minimum amount of material required for the safe function of the component.”

### 32% lighter component yields reduced CO<sub>2</sub> emissions and wins an award

Following optimization results (Figure 2), the steering knuckle, which initially weighed 4.39 kg (9.7 lbs), is now 2.98 kg (6.6 lbs)—a 32 percent savings. Since each chassis requires two components, the total reduction is 2.82 kg (6.2 lbs) per vehicle. When looking at projected installation in 1.6 million vehicles, weight savings from this component alone would cut an estimated 11,600 tonnes (12,787 tons) of CO<sub>2</sub> emissions over the life of the part.

The new lighter steering knuckle has been implemented in large-series production since 2012. It’s being used by VW in their MQB platform, e.g. in the Golf VII and in the Audi A3, among others. The design has also received the prestigious environmental ÖkoGlobe, awarding pioneering innovations for sustainable mobility, in the category of “raw materials, materials, and process optimization.”

“Tosca Structure allows us to develop our products efficiently and thus fulfills the steadily increasing demands of our customers for consistent lightweight designs,” said Brauner.

\*Tensile strength: The resistance of a material to a force tending to tear it apart, measured as the maximum tension the material can withstand without tearing.

\*\*Fatigue strength: The maximum stress a material can endure for a given number of stress cycles without breaking.

**For More Information**  
[www.georgfischer.com](http://www.georgfischer.com)  
[www.3ds.com/tosca](http://www.3ds.com/tosca)