Weight-optimized Design of a Commercial Truck Front Suspension Component

Dana Corporation

Automotive

United States of America

www. dana.com

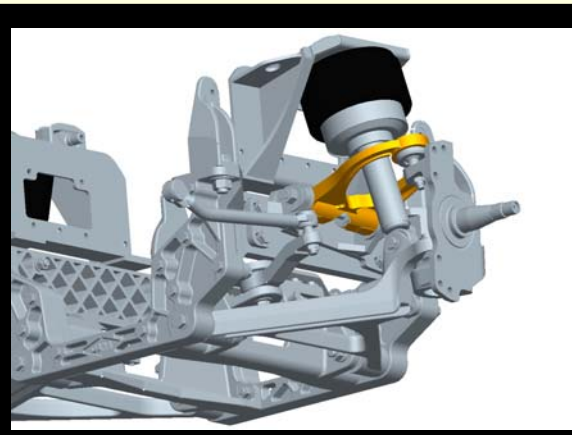
Overview

Headquartered in Toledo, Ohio, Dana Corporation is a leading supplier of parts and assemblies to the automotive industry. The company designs and manufactures a wide range of products for every major vehicle producer in the world and has twice received the Malcolm Baldridge National Quality Award. Dana is focused on being an essential partner to automotive, commercial and off-highway vehicle companies, which collectively produce more than 60 million vehicles annually. Dana's Commercial Vehicle Systems Group specializes in development of front-steer, rear-drive, trailer and auxiliary axles; driveshafts; steering shafts; suspensions; and related systems, modules and services for the world's commercial vehicle market. Dating back to the company's beginnings in 1904, Dana products have helped drive history's greatest vehicles, from the Model T and World War II era army vehicles to London taxicabs, 18-wheel rigs, giant earth-moving machines and every car on the NASCAR racing circuit. Building on this foundation of experience, Dana continues its commitment to quality and innovation in advancing the science of mobility for the benefit of its broad global customer base.

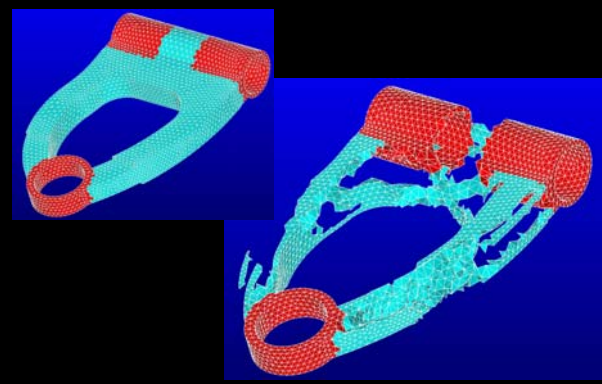
Testimonial

"The topological optimization capabilities of ANSYS Mechanical represent a key part of our work in developing well-designed, lightweight suspensions and other assemblies that meet the stringent requirements of the commercial truck industry. The optimization approach implemented at Dana enables our engineers to take advantage of this technology in reducing component weight much more quickly and cost effectively than trying to accomplish the same goals with physical prototypes. Such techniques save considerable time and expense in developing refined designs, give us tremendous insight into component behavior and are a business requirement for effectively designing tomorrow's innovative products in the competitive automotive industry."

Caner Demirdogen
Senior Principal Engineer
Dana Corporation
Heavy Vehicle Technologies and Systems



Designed by Dana Corporation for commercial vehicles, the upper control arm (highlighted) is a critical component in the front suspension system (Dana patents pending).



Starting with an initial mesh (left), the ANSYS topology optimization routine automatically eliminates elements with stiffness below a specified threshold (right). The result is an analysis model consisting only of the elements needed to maintain the required stiffness with minimal material (patent pending design).

Challenge

Design of suspension systems and other assemblies for heavy trucks is a formidable task due to heavy loads, harsh environments and long life requirements. Historically, components tended to be over-designed, heavier structures to meet these reliability requirements. But in today's economy, the weight of commercial trucks and its impact on vehicle cost, ride and fuel economy are of significant concern for both truck manufacturers and end users. Lighter, well-designed suspensions provide better ride quality, lower initial cost, increased fuel economy and greater truck payloads. The challenge is to design these parts with minimal material yet still maintain adequate strength and stiffness — all while meeting tight budgets and product launch schedules that rule out building and testing numerous hardware prototypes.

Solution

Dana Commercial Vehicle engineers use topology optimization features of ANSYS Mechanical software to optimize component weight as part of the product design process. The method begins by determining loads from multibody simulation. Then an initial rough solid model is constructed to fill the maximum available space envelope allowed for the component. Next, a finite-element mesh is developed and the ANSYS topology optimization routine automatically eliminates elements with stiffness below a specified threshold. The result is an analysis model consisting only of elements needed to maintain the required stiffness of the component with minimal material. This topology-optimized model is then overlaid on the solid model to guide engineers in completing the detailed design of the weight-optimized part.

Benefits

Because weight reduction is a critical issue, this optimization approach is used extensively with considerable success at Dana. In the development of an upper control arm for the front suspension of a commercial truck, for example, engineers reduced part weight by 25% while maintaining required stiffness and strength. The process was completed in less than a day, compared to weeks otherwise needed for trial-and-error iterations on expensive physical prototypes. Moreover, the optimization guided the design in a direction that was not intuitively obvious and provided engineers with greater understanding of component behavior and stiffness transfer paths. The approach has been standardized as a best practice in the group and is now applied readily to optimize the weight of most of Dana's commercial truck components.

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