

## Success Story

### About Altair

Altair empowers client innovation and decision-making through technology that optimizes the analysis, management and visualization of business and engineering information. Privately held with more than 2,000 employees, Altair has offices throughout North America, South America, Europe and Asia/Pacific. With a 29-year-plus track record for high-end software and consulting services for engineering, computing and enterprise analytics, Altair consistently delivers a competitive advantage to customers in a broad range of industries. Altair has more than 5,000 corporate clients representing the automotive, aerospace, government and defense, and consumer products verticals. Altair also has a growing client presence in the electronics, architecture engineering and construction, and energy markets.

### About HyperWorks®

Performance Simulation Technology

HyperWorks is an enterprise simulation solution for rapid design exploration and decision-making. As one of the most comprehensive, open-architecture CAE solutions in the industry, HyperWorks includes best-in-class modeling, analysis, visualization and data management solutions for linear, nonlinear, structural optimization, fluid-structure interaction, and multi-body dynamics applications.

[www.altairhyperworks.com](http://www.altairhyperworks.com)



**Altair Engineering, Inc., World Headquarters:** 1820 E. Big Beaver Rd., Troy, MI 48083-2031 USA  
 Phone: +1.248.614.2400 • Fax: +1.248.614.2411 • [www.altair.com](http://www.altair.com) • [info@altair.com](mailto:info@altair.com)

Altair®, HyperWorks®, RADIOSS™, HyperMesh®, BatchMesher™, HyperView®, HyperCrash™, HyperGraph®, HyperGraph®3D, HyperView Player®, OptiStruct®, HyperStudy®, HyperStudy®DSS, MotionView®, MotionSolve™, Altair Data Manager™, HyperWorks Process Manager™, HyperForm®, HyperXtrude®, GridWorks™, PBS Professional®, and e-Compute™ are trademarks of Altair Engineering, Inc. All other trademarks or servicemarks are the property of their respective owners.

## Developing Commercial Vehicles Inspired by Nature



#### Key Highlights

**Industry**  
Automotive

**Challenge**  
Design, optimization, and manufacturing of reliable and safe lightweight components for the automotive industry, in particular for commercial vehicles

**Solution**  
Topology optimization with OptiStruct, additive manufacturing methods

**Benefits**

- lighter products
- easier manufacturing processes
- lead time reduction

As Germany's largest independent engineering partner to the worldwide automotive industry, EDAG is continuously seeking for new technology and for innovative processes to streamline vehicle development. The company has a widespread expertise in integrated development and in the production of vehicles, production facilities, derivatives, and modules. Especially in the area of lightweight design, there is still a major demand for passenger cars as well as for commercial vehicles. EDAG is leveraging its engineering knowledge to combine state-of-the-art computer aided engineering tools with new production technologies such as additive manufacturing to deliver lighter and yet fully functional and validated components in a shorter time. In a current project, EDAG used the best practice optimization tool OptiStruct to develop a lightweight

biomimicry structure of a truck cabin and chassis in conjunction to the subsequent manufacturing of the component with additive manufacturing methods. The ingenious symbiosis of topology optimization and additive manufacturing allowed to fully benefit from the advantages and the design freedom of additive manufacturing. Also, the engineers conducted multi-physical optimizations and they combined strength and crash demands of the vehicle to find the optimal solution for the final design. To handle the involved development tasks, the EDAG engineers used HyperWorks and especially OptiStruct.

#### Challenges

The entire automotive industry, from passenger up to commercial vehicles, is facing major challenges: they have to

HyperWorks is a division of Altair

Keywords: Automotive, Optimization, OptiStruct, Lightweight Design, Additive Manufacturing

# EDAG Success Story

"At the beginning of our truck cabin and chassis project we used OptiStruct and based our design on bone structures. Like this OptiStruct helped us to reach a light, yet stable cab design, including a suitable chassis. The optimized frame structure integrates a large number of functions and provides a significant weight advantage compared to a non-optimized structure, manufactured with conventional construction methods."

**Andreas Pfeiffer**  
CAE Engineer and specialist for optimization and NVH topics at EDAG

increase the fuel efficiency of vehicles and fulfill legal requirements on emissions. At the same time, they have to make sure that the vehicles meet or even exceed the demands for safety and can be offered at a competitive price. While the industry is always looking for new materials and innovative production methods to create lighter products, lightweight design and a simulation driven design process are essential to meet these goals – as a result these methods gain more traction in industry.

EDAG was founded by Horst Eckard in Groß-Zimmern near Darmstadt on February 1<sup>st</sup>, 1969, at which time the company was known as "Konstruktionsbüro Horst Eckard".

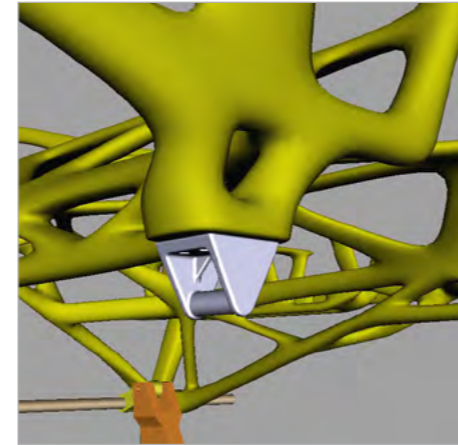
With more than 7900 employees worldwide and a total turnover in 2013 of € 632 Million, today EDAG is the world's largest independent engineering partner to the international automotive industry. EDAG offers its services to all of the automotive industry – from OEMs to suppliers. The company works with some of the most exiting automotive brands in the world.

In a recent project, the engineers at EDAG were looking for a new approach to develop and manufacture affordable lightweight constructions of a commercial vehicle for tomorrow. New ways for flexible and customized manufacturing should be part of the process to meet the individual customer

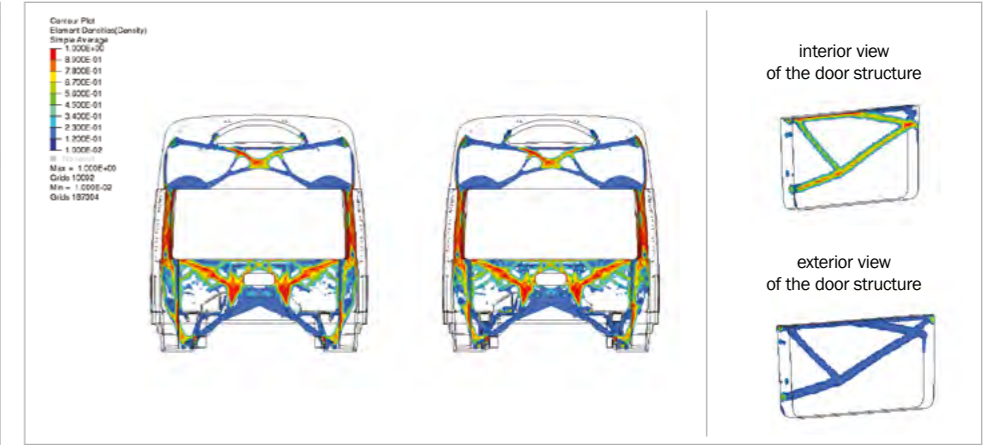
specifications without major changes in the production facilities. To achieve this, an overall process had to be set up which offers not only the best design approach but also includes the requirements of the selected manufacturing method.

## The revolutionary solution: a symbiosis of topology optimization and additive manufacturing

Structures inspired by nature often feature an optimal structural efficiency. Optimization tools such as OptiStruct from Altair create structures based on occurring forces and load paths just like nature is doing it in its evolutionary processes. Material is only



Supports are added as boundary conditions when setting up the optimization process.



Left side: Comparison of cabin structure with and without design space of steering column. Right side: Element density of door structures

placed where it is required to meet the loading conditions and is removed where it is not required. As a result, optimization is not only giving inspiration on how an ideal structure could look like, it also gives the engineers a clear design proposal which is structurally efficient by using material only where it is really needed and in an optimal distribution.

Using traditional manufacturing methods, these design proposals often have to be adapted to manufacturing constraints. That leads to better and lighter designs but not to perfect ones that would provide the full lightweight potential of an optimized design. New production technologies, such as additive manufacturing (also known as "3D printing"), ensure an almost restriction free process, so that the final design of components is much closer to the ideal result of the optimization. In this way, optimization and additive manufacturing form a perfect symbiosis leading to a combined development and manufacturing process that wholly benefits from the potential this new production method offers.

To begin with, the engineers at EDAG started their research and development work by using OptiStruct for the project of the truck cabin and chassis and based their design on bone structures to design a light,

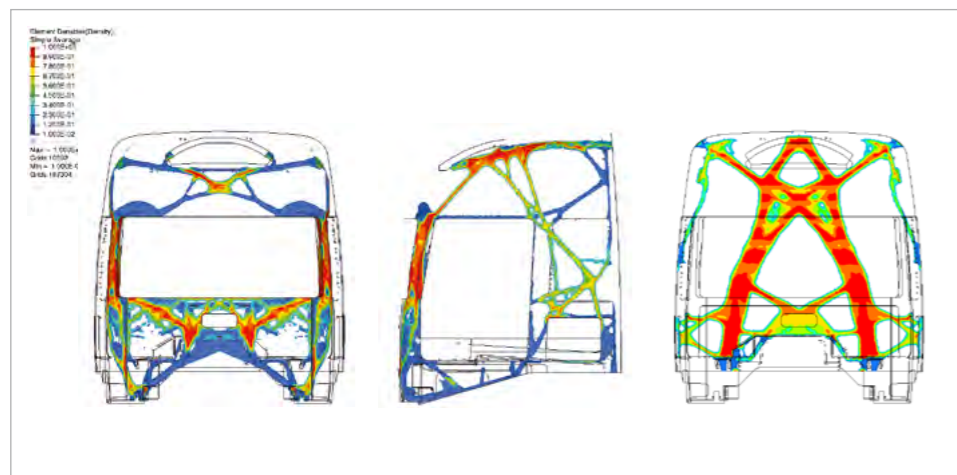
yet stable cab, including a suitable chassis. As a result, the EDAG engineers obtained an optimized frame structure that integrates a large number of functions and provides a significant weight advantage compared to a non-optimized structure, manufactured with conventional construction methods. Additionally, a specially designed safety cell inside the cab to protect occupants from typical injury risks in crash scenarios was designed and analyzed: Specialists validated the structure and then optimized it with OptiStruct topologically. To also meet the safety requirements, the engineers set up a multi-physical optimization including stiffness and crash specifications – and they achieved useful results. In addition to a high level of stiffness and torsional rigidity, the cab also fully meets the ECE R29-3 standard (EU regulation for passenger safety in vehicle cabins), which will come into force in 2017. Moreover, it also has been possible to optimize the interface between the chassis and cab – thanks to the degrees of design freedom gained by using additive manufacturing methods.

## Results/Benefits

In combination with optimization, additive manufacturing opens up revolutionary opportunities in the commercial vehicle sector. The flexibility of the manufacturing

method allows to directly to create designs inspired by nature that are customized to the individual requirements of the use case with an optimal material usage. The potential of additive manufacturing regarding manufacturing freedom and lightweight design is impressively large – especially when combined with topology optimization. The engineers realized that complex, topologically designed geometries could be manufactured from data sets in series and that in a wide range of models without limitations, without tools and in one production step. This paves the way to be able to technically and economically manufacture customized trucks for all operating requirements. Even though industrial use of additive manufacturing processes is still in its infancy, the advantages as to greater freedom in development, tool-free production and lightweight design make this technology a crucial subject for the future.

OptiStruct, and optimization in general, plays an important role to further extend the development capabilities and to include manufacturing requirements in the design process right from the start. Multi-physical optimizations considering different objectives such as target stiffness and crash safety enable the engineers to handle the manifold development requirements and to find the optimal solution.



Topology optimization results of the lightweight truck cabin, front view, side view and rear view



Visualization of tensile (red) and compressive (blue) stresses