SIEMENS
Ingenuity for life

Automotive and transportation

Roding Automotive

Fiber-reinforced plastics hold enormous potential

Product

Fibersim

Business challenges

Efficient development of products using fiber-reinforced plastics

Develop lightweight components to meet government emission and fuel economy regulations

Keys to success

Adoption of Fibersim software

High-level expertise in fiber-reinforced plastics processing

System-level assessment of costs

Results

Developed a world leading lightweight street-legal sports car

Expanded the range of light-weighting design services beyond the automotive industry

Reduced overall costs with lightweighting strategies and the use of composites

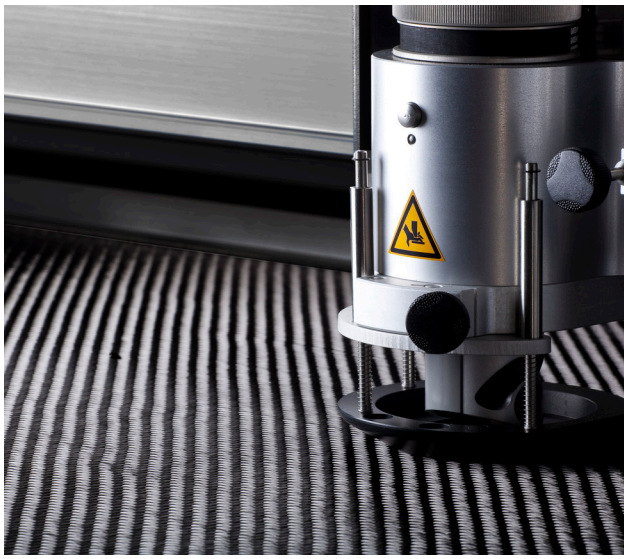
Fibersim helps Roding Automobile advance lightweight design

The potential of alternative materials

Up until a few years ago steel was the material of choice across most manufacturing industries, especially in the automobile industry. Designers had this material firmly fixed in their materials databases. The need for increased energy efficiency has led to an increased demand for lighter-weight vehicles and alternative materials used to manufacture them. Aluminum and magnesium, as well as a range of innovative plastics including fiber-reinforced plastics, are becoming more and more common in the repertoire of many designers. The advanced functionality of state-of-the-art 3D computer-aided design (CAD) systems makes precise calculations and detailed design of these materials possible. As a result, fiber-reinforced plastics (FRP) such as carbon-reinforced plastics (CFRP) and glass-reinforced plastics (GFRP) are gaining ground as a high-performance, lightweight alternative to metallic materials.

The FRP processing challenge

Roding Automobile (Roding) ranks among the trailblazers in the processing of fiber- reinforced plastics. As a leading German-based manufacturer of lightweight, high-performance vehicles, Roding has high-level expertise in the development and manufacture of FRP products. Georg Käsmeier is the CEO and founding



member of Roding Automobile GmbH. For him, the early definition of part designs and material selection in the 3D computer-aided design (CAD) system is key. “In mass production, basically only the kinds of materials that are defined in the designers’ 3D CAD systems can be used cost-efficiently,” Käsmeier says. “Fiber-reinforced plastics pose a particular challenge here. The flat textile-like mats must be draped and preformed correctly, and only then, while taking account of the fiber architecture, is a usable part feasible. Now, a calculation of the material properties based on the designed fiber architecture to determine strain and deformation is interesting. These complex processes can only be mastered with know-how and the right software tools.”

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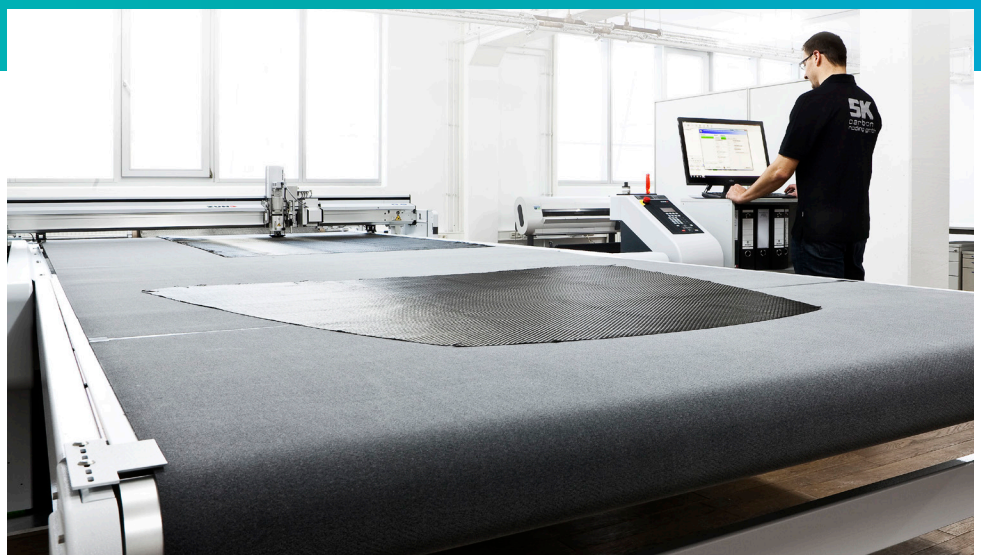

For mastering the complexity of designing, analyzing and manufacturing FRP products, Roding relies on the Fibersim™ portfolio of software for composites engineering, from product lifecycle management (PLM) specialist Siemens PLM Software. "We decided in favor of Fibersim as the key link between 3D CAD, performance calculation and production," says Käsmeier. "The software is seamlessly integrated in our existing design and production processes. What's more, it's easy to operate. As the software developer, Siemens PLM Software is a capable partner for ongoing development."

From niche to mainstream

In 2007, four young engineers from the Technical University of Munich teamed with the directors of the Stangl & Kulzer group, renowned for precision technology, and conceptualized an ultra-lightweight roadster sports car. The founding of Roding Automobile yielded the lightest-weight street-legal sports car anywhere in the world to date. Today the Roding Roadster R1 is made as a sports car designed in lightweight carbon in small production runs.

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With this success in the automobile industry, Käsmeier wants to give other industries an understanding of the usability of fiber-reinforced plastics as well. "For us, the Roding Roadster R1 is a prime example of how CFRP advances lightweight design," Käsmeier explains. "As a result, with Roding Technologies we've expanded our range of services and are providing other industries with our expertise. In addition to automotive, aeronautic and astronautic technology, we're a development partner for machine and plant manufacturing, medical technology and the consumer goods industry. It's a question of our knowing the material and assessing where it will most likely demonstrate its advantages. Replacing classic materials with CFRP, for example, often produces a domino effect that has a positive influence on weight reduction for the entire vehicle assembly."

The "lightweight design spiral" saves costs

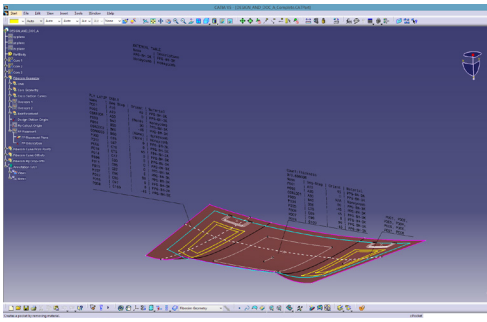
Experienced designers consequently refer to the emergent "lightweight design spiral." Weight reduction strategies should not independently target individual components, because optimal weight reduction can only be achieved with a systems approach to lightweighting. In addition, meeting weight reduction targets requires designing for lighter weight from the start.

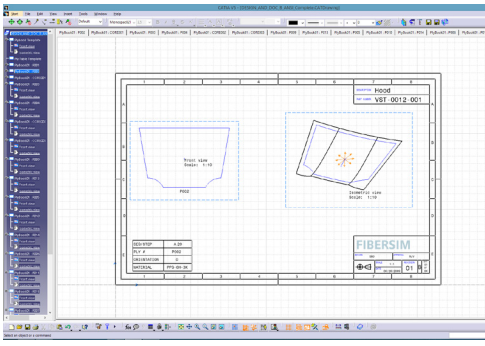
Weight reduction of the car body has a spiraling impact on overall vehicle weight reduction: a lighter body results in a lighter chassis, which requires a smaller engine, which requires less battery power or reduced fuel tank capacity, which requires less braking, resulting in additional body weight reductions. When viewed individually, reducing weight with a part made from CFRP is more expensive at first glance as compared to a metallic steel or aluminum part. But if the entire vehicle is considered, cost becomes more favorable for the use of CFRP.

Roding Automobile sees additional windows of opportunity. "We want to remove factors like these from the assessment of the overall system and provide reliable decision-relevant data," says Käsmeier. "The automobile industry is in a period of significant change that hasn't been experienced for more than 20 or 30 years. Lightweight design is the change lever for forward-looking conservation of natural resources, and every industry can profit from this."

Fiber knowledge in the design

In addition to the advantages of light weight, high rigidity and enormous strength, fiber-reinforced plastics provide an appearance that is perceived as higher value, and they offer outstanding design flexibility. When designers model FRP products, textile information is a part of





every piece of geometric information, and must be considered when calculating material behavior. That's where Käsmeier sees the outstanding advantage of Fibersim: "We're using Fibersim to get from the geometry to the fiber layers and from the design to manufacture. The software supports us during the entire workflow from the CAD model to the finished part."

Take for example, a surface patch generated from the geometry with precise definition of the fiber layer, the fiber type and the fiber angle. By way of a draping simulation of the textile, designers can use Fibersim to determine if it is possible to produce the desired draping situation. The use of Fibersim helps identify trouble spots with easy-to-interpret color scales. Red zones, for example, are wrinkles or other undesirable draping effects. These are remedied by changing the data for the part, applying notches or switching the material.

Fibersim includes a material database that can be modified and adjusted using specific material properties. For example, it contains data on the material thickness, the fiber's shear angles and mechanical properties. Structural simulations give the designer confidence about the properties of the finished part. Fibersim can be used to provide output data for structure simulation and finite element modeling (FEM) programs for calculation. Even the process of "marrying" fiber and matrix material in manufacturing can be illustrated by full simulation programs, thanks to data from Fibersim. "For us, this is where the particular advantage of Fibersim becomes apparent," Käsmeier says. "It's an extremely efficient tool that delivers a quick response. As a contract manufacturer we're reliant on quick results with exceptional reliability. Fibersim is an extremely elegant solution indeed."

Transfer to production

On the production side, Fibersim automatically generates ply book instruction for layup as well as ply flat patterns properly formatted for the cutting machine. "For us, Fibersim is the ideal interface between the CAD model and production," Käsmeier says. "Another important component that Fibersim provides us with is the positioning map, the so-called ply book. This operating procedure makes sure that the finished blanks are inserted in the correct position on the extruder die. Fibersim generates these positioning maps automatically and renders precisely the orientation and the order in which the composite fiber mats must be inserted. This way, additional advantages in

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Solutions/Services

Fibersim
www.siemens.com/plm/fibersim

Customer's primary business

Roding Automobile GmbH is a technology company and an elite manufacturer of the exclusive carbon lightweight sports car, Roding Roadster, launched in 2008. Since its inception, Roding Automobile has focused on the development and manufacturing of lightweight structures made of carbon fiber-reinforced plastic, serving clients in the automotive, industrial machinery, and aerospace industries.
www.roding-automobile.de

Customer location

Roding
Germany

processing composite materials become feasible for the first time, like combining different fiber and material types in a sandwich composite, for example."

For mass production the process is refined further by simplifying the ply shapes to optimize nesting efficiency and to reduce material waste and cost. Next, the cut reinforcing plies are preformed to the required 3D shape in a deep drawing process. The 3D preforms are then ready for resin infusion and are transferred to the high-pressure resin transfer molding (HD-RTM) machine where resin, injected under high pressure, spreads itself uniformly throughout the preform. The injected preform then quickly cures to provide the desired composite part.

Greatest lightweight design potential in composites

"From our perspective the greatest potential for lightweight design is in the utilization of composite materials," Käsmeier says. "Fibersim provides the key to this because it masters the ins and outs of the design and calculation of composite materials. Successful, future-oriented design demands an overview of every relevant type of material. Multi-material mixed construction definitely demonstrates this capability. The more alternatives available, the better the solution variations are. Those who can easily determine the place where carbon, aluminum, steel, magnesium or thermoplastics is best applied have a big advantage."

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