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Howaldtswerke-Deutsche Werft

Submarine builder reduces manufacturing time and enhances quality of composite parts

Product

Fibersim

Business challenges

Decrease the weight and improve the hydrodynamic characteristics of the submarine

Cut manufacturing time by consolidating the number of parts

Reduce sonar and sound signature for better stealth characteristics

Increase the quality and strength of composite parts

Keys to success

Dependable simulation decreased the risk of using composite materials on a greater range of parts, thus reducing the overall weight of the vessel

Predictive design process enabled engineers to find and correct problems prior to manufacturing

Providing consistent data to the supply chain enhanced part fidelity and quality

Howaldtswerke-Deutsche Werft's (HDW) goal in adopting composites was to reduce weight and enhance vessel stability, streamline the shape to diminish the likelihood of being detected, improve sonar transmission and cut manufacturing costs by consolidating parts.

Siemens and Fibersim support submarines to be "faster, quieter, deeper" for 17 navies globally

Modern composite materials have been used in submarines since the 1950s, but until recently they were only used for select parts. However, that has started to change and tools, such as the Fibersim™ portfolio of software for composites engineering from Siemens PLM Software, are playing a major role in that change.

Proof of that is provided by the experience of Howaldtswerke-Deutsche Werft GmbH (HDW), a company of ThyssenKrupp Marine Systems. Since purchasing Fibersim software in 2008, HDW has used it to increase the amount of composites on its new submarines by 10 percent a year. And the company expects that rate of adoption to climb.

Currently, over 800 square meters of the new class of submarines (which are up to 65 meters in length) are made of composites, including the largest composite part,

"When a Class 212A or a class 214 submarine are surfaced, everything that you see is made of composites," says Marc Tillmanns, lead composites engineer at HDW. The use of composite materials results in a sleeker silhouette and reduced wake.

Results

Cut manufacturing labor time by 20 to 30 percent

Reduced development time

Increased the quality of composite parts

"Fibersim enables us to do a faster conversion from metal to composites, and minimizes the risk by verifying information before it ever gets to the manufacturing floor."

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HDW's lead composites engineer

which is a doubly curved panel of about 100 square meters (side lengths: 10m x 6m). All of HDW's new composite parts are being designed with Fibersim.

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Just as significantly, Fibersim has helped HDW to reduce development time and increase the quality of composite parts. And it has cut manufacturing labor time by 20 to 30 percent.

"Faster, quieter, deeper"
HDW has been setting milestones in submarine building for over a century. The first test submarine was built in 1897.

Howaldtswerke delivered the submarine docking ship Vulkan to the Imperial German Navy in 1908. It represented advanced technology at that time, and was intended to support the newly emerging submarine fleet of the Imperial German Navy. A number of ships were subsequently designed along the same lines.

HDW began to develop its reputation as the leading manufacturer of conventional submarines in the modern era with the construction of the submarine fleet for the German Navy starting in 1960. Today, HDW is the world leader in the construction of non-nuclear submarines. The company has built 61 Class 209 submarines, making it the most frequently built diesel electric submarine since World War II.

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This shows the dividing line between where composites (top) and metal (the hull) have been used on this class 214 submarine. HDW is using Fibersim to design and manufacture the complete upper deck, keel covers, tower sail fairings, propeller blades and rudders.

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HDW's reputation as a technology leader is reinforced by its Class 212A and 214 submarines, which are equipped with an air-independent propulsion system that is based on fuel cells. This system allows the boat to cruise submerged for weeks. HDW is the only company in the world currently able to offer a fuel cell propulsion system for series production. HDW submarines are serving in 17 navies around the world under the motto "faster, quieter, deeper."

Composites emerge

Composite materials are seaworthy and offer many benefits. First, they stand up well to the harsh and salty marine environment, resisting any corrosion while possessing much better aging capabilities than metals. Composites also provide the ability to "design the material" by combining fibers and resins in different ways and by placing the fibers along preferred orientations following loading and stress paths, thus reducing the weight-to-strength and weight-to-stiffness ratios.

Further, composites facilitate the manufacture of seamless, complex shapes for better hydrodynamic performance and stealth characteristics. Composites can be more easily draped over round surfaces while sheet metals cannot. They also enable part consolidation and part count reduction using resin transfer molding or co-curing of large assemblies at once, without the need for riveting or joining small parts together, thus reducing manufacturing cycle times and costs.

Composites also offer some valuable mechanical properties, including better fatigue resistance and less sensitivity to crack propagation than aluminum and other metals; enhanced acoustic transparency for improved sonar transmission (for instance, in the bow dome); and reduced lifetime and maintenance costs compared to metallic structures.

HDW is using Fibersim to design and manufacture a variety of glass fiber and carbon fiber outfitting parts, including the

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complete upper deck, keel covers, tower sail fairings, propeller blades and rudders. In the near future, HDW expects to extend the use of Fibersim to include the design of structural parts, starting with a new, lighter weight storage rack for torpedoes.

"Fibersim enables us to do a faster conversion from metal to composites, and minimizes the risk by verifying information before it ever gets to the manufacturing floor," says Tillmanns.

Fibersim surfaces

When HDW was seeking a composites software vendor, one of the factors that worked in Siemens PLM Software's favor was its vast experience with composites in the aerospace, automotive and wind energy industries. Siemens PLM Software was able to take the lessons learned in those industries and transfer that knowledge and technology to the marine product environment.

HDW's original goal in adopting composites was to reduce weight and enhance vessel stability. Other engineering challenges included reducing the likelihood of being detected, improving sonar transmission and cutting manufacturing costs by consolidating parts. Using Fibersim to transition from a manual to an automated solution has enabled HDW engineers to develop an initial design more quickly and understand the impact of design changes earlier in the process.

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Virtually no shipyard in the world has more experience in the design and construction of non-nuclear submarines than HDW. HDW partners with the German Navy and has also delivered submarines for coastal and blue water deployment to the navies of 17 countries.

Customer's primary business

A company of ThyssenKrupp Marine Systems, HDW has been building submarines for more than a century. About 2,000 employees are involved in the construction of non-nuclear submarines at its shipyard in Kiel. www.hdw.de/en/

Customer location

Kiel
Germany

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Using Fibersim best-in-class producibility simulation has enabled HDW to produce accurate flat patterns required for manufacturing. The placement of darts and splices is now performed using this virtual manufacturing simulation approach – a big improvement over the trial-and-error methods of the past, which resulted in a significant waste of time and material. HDW uses a number of different composites, so the extensible Fibersim database and the applicability of its simulation to a wide spectrum of materials, including advanced noncrimp fabrics (NCF), has proven valuable.

Improving the link

One of the major benefits HDW has realized by using Fibersim is the ability to deal with very thick laminates. The laminates may contain many plies under and over a thick layer of core materials. By keeping track of all the exact amounts of materials that come into the composite part, the software enables HDW engineers to precisely calculate material weight, center of gravity and other inertia properties that are critical to sound structural design of the submarine.

Using Siemens PLM Software's Fibersim, HDW has found that there is less likelihood of making mistakes since design is linked to manufacturing. This reduces the risk of

misinterpretation by the supply chain (HDW outsources the cutting of composite plies). In addition, Fibersim Laser Projection™ software enables HDW engineers to further reduce errors while shortening the layup time for composite parts by displaying ply outlines directly on the layup tool.

"Fibersim has enabled us to improve the link between engineering tools and enhance the flexibility for creating documentation drawings and ply books, so engineers can access essential data faster and more easily on the manufacturing floor," says Tillmanns. "This allows us to streamline and improve the overall quality of the design-to-manufacture process."

Further, the software is used to design parts for multiple manufacturing processes, including resin transfer molding, prepreg hand layup and wet layup.

"There's no question that composites will continue to grow in prominence for us going forward," says Tillmanns. "So our strategy to develop a best-in-class methodology around Fibersim to help us continuously improve our entire design-to-manufacturing process is critical to our sustained success."

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