There's No Compromising on Quality for Composite Wind Turbine Blade Manufacturers

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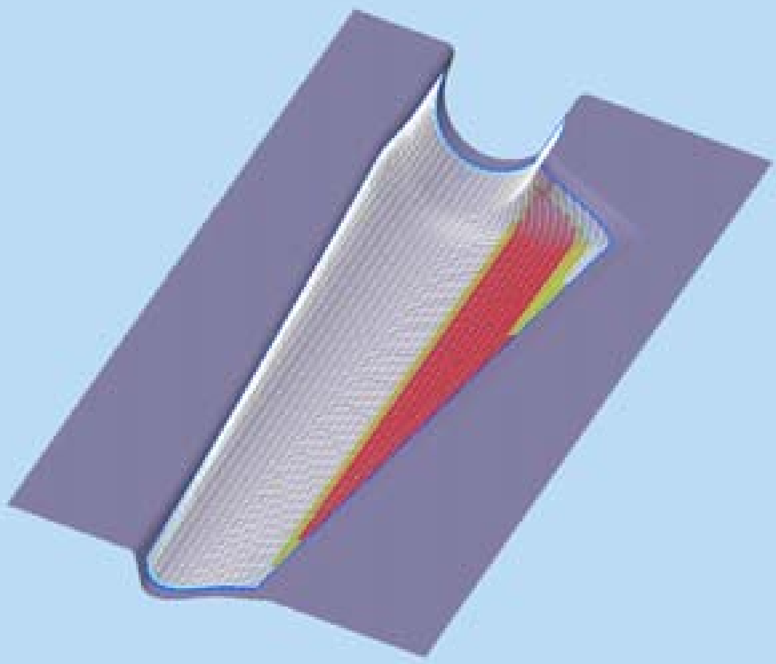
The idea that "quality sells" has been around for a pretty long time. Well, now that tried and true phrase can be applied to the relatively new wind turbine industry, which is finding that one of the keys to maintaining competitiveness is the ability to continually improve the quality of wind blade design and manufacturing processes.

It is a high stakes challenge because premature blade failures have the potential to generate a lot of negative attention with a resultant loss of credibility and business, not to mention high litigation costs.

It is also the test at the center of the wind blade business, as quality issues invariably increase costs and reduce margins by leading to higher maintenance and lifecycle costs due to part replacements, more repairs, and longer down time.



This FiberSIM® simulation highlights fiber orientations that deviate from specification when draped over complex curvature. Excessive deviation is highlighted in red (yellow for moderate deviation), alerting engineers to potential performance problems. FiberSIM offers multiple process simulation options for both manual and automated ply deposition.

Dealing With Multiple Concerns

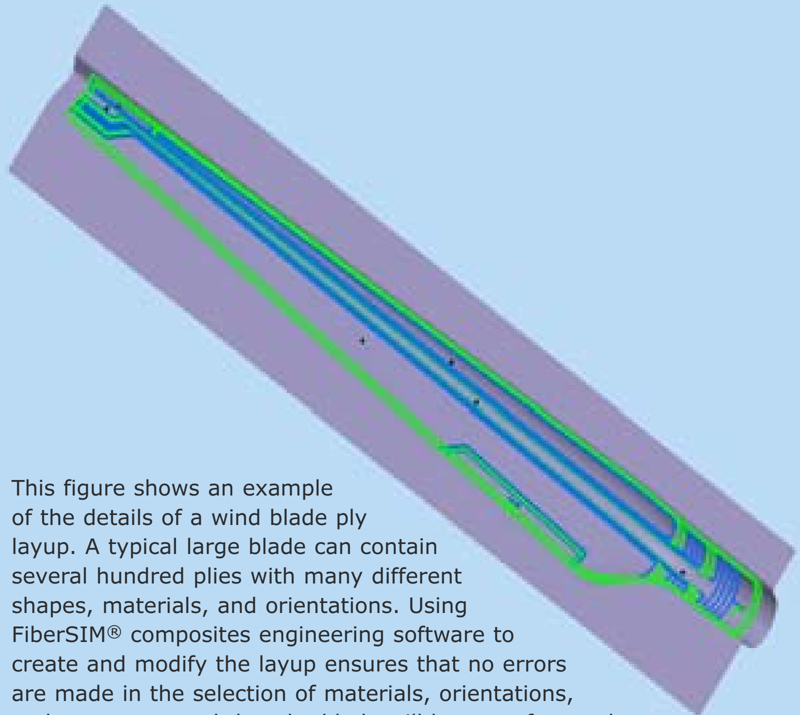
The quality challenge in the wind blade industry is compounded by two market trends.

First, the increased pressure from a fast growing market is driving higher production rates. But quality should not be sacrificed in the search for shorter cycle times and faster manufacturing because a bad blade, no matter how swiftly produced, never does anyone any favors.

Secondly, the average wind turbine size is regularly increasing in hopes of achieving better efficiency. Longer and lighter blades are being designed, pushing the limits of materials, design, and manufacturing capabilities. This trend makes it even more imperative that quality be a major consideration in the development of the wind blades.

There are several aspects of the blade development process that can work against better quality.

For instance, taking a conservative design approach with inflated safety factors can result in an over-designed blade with excessive material, which can then lead to a weight penalty and reduced wind turbine efficiency. Over-design will most likely not compensate for a manufacturing defect. In fact, it may trigger unsuspected modes of failure.



This figure shows an example of the details of a wind blade ply layup. A typical large blade can contain several hundred plies with many different shapes, materials, and orientations. Using FiberSIM® composites engineering software to create and modify the layup ensures that no errors are made in the selection of materials, orientations, and sequences and that the blade will be manufactured as designed and analyzed.

A weak link between design and manufacturing is another aspect of this issue. An incomplete engineering release leaves much room for interpretation and necessitates on-the-fly decision making later in manufacturing, leading to errors and rework that are costly, time-consuming, and result in suboptimal and inconsistent manufacturing.

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Finally, the manual and verbal transfer of information between design and stress or design and manufacturing often means that design and manufacturing changes are pushed back or left undone due to lack of time and production pressure.

Staying True to the Design

Robust quality improvement rests on a twofold approach: implementing a better design methodology and achieving a more consistent manufacturing process. These two efforts are joined at the hip by the overarching need for a more controlled and seamless development process for composite blades.

Several aspects of the design can be improved by the use of advanced composites design software, such as VISTAGY's FiberSIM® composites engineering software.

Better design entails using a more accurate and detailed representation of the composite blade earlier in the process. With 3D CAD-based composite design software, a detailed zone or ply definition is available earlier and can be used for more efficient sizing and optimization. A more accurate mass and stiffness distribution for the blade that is closer to the as-manufactured blade can also be obtained. More time can be spent on optimizing the blade further.

Developing a digital master model of the blade with composite design software will ensure that all information about the part — for detailed design, analysis, and manufacturing — will be easily generated electronically from one single source. In this way, consistency is maintained between disciplines. What is manufactured is what has been designed and analyzed.

Producibility simulation for ply layups can be performed with composite software before any prototype is even built. Fabric wrinkling during layup and other fiber deformations detrimental to the blade integrity can be assessed. In this way, manufacturability is ensured ahead of time, while design is still ongoing, which alleviates the need for a costly trial-and-error approach. Reducing engineering time and using fewer prototypes are critical to the competitiveness of blade manufacturers.

Furthermore, composite design software supports easy and reliable treatment of numerous design details that are part of the final composite layup definition, such as ply stagger and drop off, ply corner treatment, cored panel definition, multi-laminate assembly, and ply sequencing. The true quality of the final blade builds off of all these small design details that make or break a good design.

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Avoiding Late Changes

Ultimately, there needs to be a digital thread from preliminary design, to detailed design, to manufacturing and quality assurance that ensures a single-source representation of the blade, including the numerous changes as they occur.

This thread provides the ability to quickly assess the impact of design changes throughout the development process. It enables users to understand the ramifications of adding layers of fabric material in order to stiffen parts of the blade, redesigning a drop-off area to extend a few plies, or simplifying a mating area to alleviate the presence of a ramp under a shear web.

By establishing this thread, composites engineering software allows the designer and manufacturing engineer to assess the possible consequences of a design change and avoid late conflicts on the shop floor.

Updates to the design should be automatically captured so that engineers will have access to the current version of the manufacturing documentation at all times.

In addition to the digital thread, technical documentation produced in electronic format should always reference the latest design and be complete enough to efficiently support manufacturing, including all instructions on ply preparation, cutting, layup, infusion, trimming, and finishing. Updates to the design should be automatically captured so that engineers will have access to the current version of the manufacturing documentation at all times.

The digital thread should also extend to the supply chain where it is critical to have the ability for two-way communication. In these cases, a common composite engineering environment running across CAD systems will enable rapid and reliable data flow for engineering and manufacturing requirements, specifications, and certification documents between partners, suppliers, and customers.

At the end of the day, this thread is the tie that binds the entire process and guarantees a firm's ability to deliver high-quality wind blades.