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Composite Wind Turbine Blade Manufacturers Face a Choice: Automate or Perish

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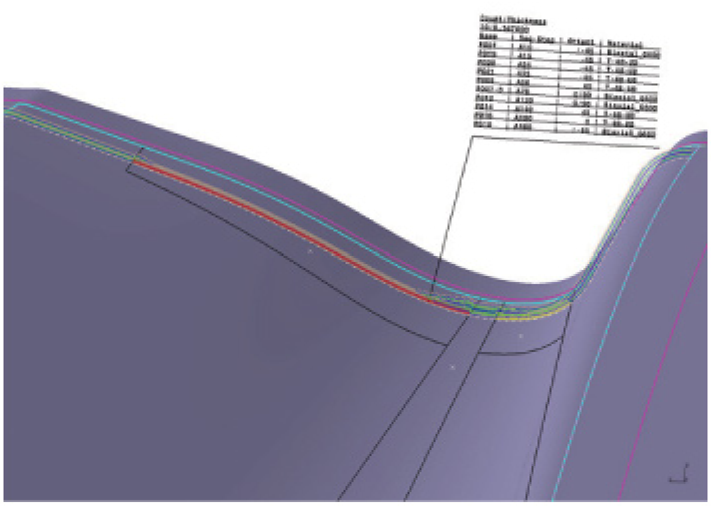
As the wind energy industry picks up speed, manufacturing organizations are understandably eager to go to market as quickly as possible to capitalize on the exploding demand for turbines. As a result, there is a new emphasis within the industry on finding ways to save time engineering and producing composite blades. Companies are searching for ways to reduce development and prototyping of new blades by several months and slashing the number of prototypes by a factor of two or more. Ultimately, the goal is to produce more blades per day as cost effectively as possible on a single production line.

Similar to the experience of aerospace companies over the last decade, a wind energy firm can expect dramatic reductions in labor and other manufacturing costs as well as cycle times by automating the composites manufacturing process. These cost reductions are now essential to making wind energy a sustainable and profitable energy source. Reduced cycle times enable manufacturers to go to market more quickly and capture maximum market share. More automated processes result in a greater level of consistency and quality, alleviating premature blade failure issues and leading to repeat orders from satisfied customers.



This figure shows the cross section of a wind blade shell laminate. FiberSIM software's documentation capabilities enable the user to sample the laminate at discrete points with an annotation that includes laminate thickness, ply names, sequences, orientations and materials. The cross section shows an exploded view of the plies as draped on the manufacturing tool surface. Colors indicate different orientations and materials. Such data is parametric and will automatically update any design change to the FiberSIM model, thereby providing a high level of robustness and flexibility to the development process.

No substitute for going digital

Transitioning from manual to automated manufacturing is critical for reducing labor, tooling and material costs and ultimately maximizing profits. Labor costs are obviously higher in well-developed economies so less established countries where expenses are lower offer a good alternative. However, the quality of the product may suffer due to high turnover and lack of sufficiently sophisticated skills and proper training of a low-cost workforce. Having access to proper skill sets is especially important in the area of composites, which uses highly complex technology and requires specialized training and knowledge. Unfortunately, accruing these skills comes at a price. And given the size of the wind turbine blades—which can easily run from 40 to 60 meters in length—remote manufacturing actually increases transportation costs, offsetting much, if not all, of any cost reductions achieved from using a low-cost workforce.

Additionally, aiding, augmenting or replacing human labor with automated systems will improve material utilization due to the accuracy of manufacturing planning systems and the operational precision of the equipment. This has the potential to significantly reduce material costs. It is clear that there is no substitute for going digital. But what are the key ingredients of a digital process?

Master model drives process

A prerequisite to an efficient automated manufacturing process is the use of a product development system that creates a complete and detailed digital master definition of a composite product within a commercial 3D CAD system, such as CATIA, Pro/ENGINEER or NX. It is vital that the digital composite model of a blade contains all the information required for properly manufacturing the part—including definition of all laminates and plies, associated flat patterns, manufacturing sequences and steps, accurate definition of the cored panels and interface definition for all mating parts. This enables seamless collaboration between engineering and manufacturing.

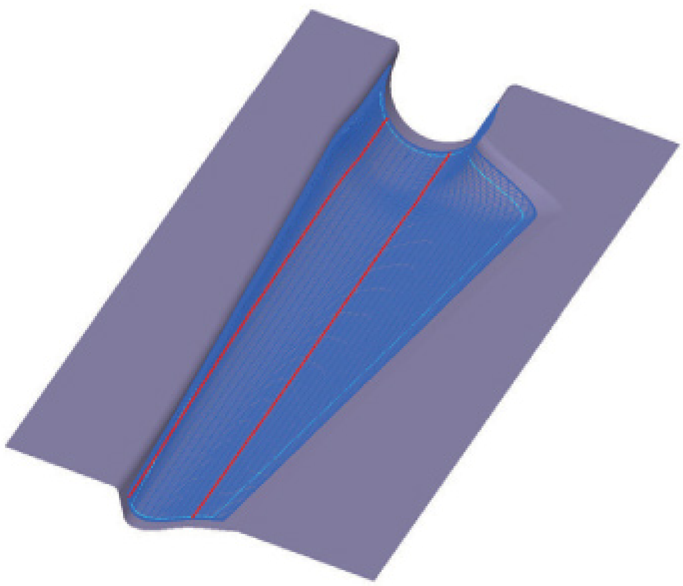
Such a master model must also enable so-called producibility simulations, or simulations of the manufacturing process, be it curing of prepreg layup, dry layup for resin infusion, or some other manufacturing method. Producibility simulations enable the design or manufacturing engineer to predict manufacturing issues, such as composite fabric wrinkling or bridging, that may appear during layup operations due to the deformation imparted to the material when laid up in the blade molds. By accurately predicting such issues, simulation software enables early resolution of the manufacturing issues without the need for making many costly prototypes that lengthen the development process.

The data from the master model drives all downstream manufacturing processes. Once the engineering master model is created and released to manufacturing, all data sets necessary for production can be readily exported to the shop floor for manufacturing the parts. For example, all ply shapes will be exported to a nesting or cutting system for automated cutting. This can save a significant amount of time compared to manual cutting as well as provide better repeatability and quality of the ply shape.

Another valuable function of a master model is the ability to export laser projection data (in essence the 3D ply contour) so it can be projected onto the mold surface with a laser projection head. This will help the operators select the appropriate plies and position them inside the mold in the proper sequences, locations and orientations. Consequently, human errors that can lead to costly time spent reworking some of the laminate to add missing plies or replace wrongly positioned plies are avoided.

Achieving manufacturing flexibility

In the not-so-distant future, automated systems based on robotic or gantry machine deposition of entire rolls of materials will be used to manufacture composite blades. Such systems will be fed the data obtained from the master model in order to generate the layup trajectories, spray the gelcoat, add the adhesive beads and finish the blades.



Pictured is the automated splicing of plies on a blade surface based on a FiberSIM® composites engineering software simulation. The red curves indicate desirable ply edges based on the simulation results and the bolt width of materials. Such manufacturing engineering capabilities enable composite design engineers to rapidly study various layup options and come up with an optimized layup definition. This definition can in turn be transferred quickly to the factory for actual cutting and positioning of all the plies in the mold. FiberSIM includes an extensive materials database which includes characteristics for material thickness and width, producibility, cost and weight and other mechanical properties.

These systems will also have to have the flexibility to handle hard-to-manufacture part areas, which will only work if the digital master model has been completed and prepared. Where a human can interpret and correct on the fly on the shop floor, a machine has to be fed accurate and appropriate information.

VISTAGY's FiberSIM® composites engineering software provides a complete, detailed and accurate digital master model that is indispensable to successfully implementing automated manufacturing. The FiberSIM suite of software supports all of the unique and complex design and manufacturing methodologies necessary to engineer innovative, durable and lightweight composite wind turbine blades. It's also the only comprehensive software suite that addresses the entire composites engineering process, from conception, laminate definition and ply creation through simulation, documentation and manufacturing.

By automating many tasks, FiberSIM helps manufacturers achieve consistent and high quality wind turbines blades. FiberSIM automates a variety of tasks, including:

• Flat pattern generation
• Nesting data export based on flat pattern generation
• Cutting machine data export based on flat pattern generation
• Laser projection data export
• Automated material placement, fiber placement and tape laying data export
• Generation of drawings and work instructions directly from the digital master model
• Parametric definition of all composite data leading to rapid assessment and propagation of any design and engineering changes even late in the development or production process

"Automate or perish"

As the market increasingly demands larger, lighter and better performing wind turbine blades, the need to automate the development process will only become greater. Companies that are able to master automation will thrive because they will enjoy dramatic reductions over manual methods in labor and manufacturing costs as well as cycle times. Those cost reductions will be essential to making wind energy a sustainable and profitable energy source. Reduced cycle times will enable manufacturers to go to market more quickly and capture maximum market share.

In academia, where publishing is critical to achieving tenure, the well-known advice is "publish or perish." When it comes to automating the development of wind turbine blades, the operative phrase for manufacturers may well be "automate or perish."

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For more information please visit http://www.vistagy.com
