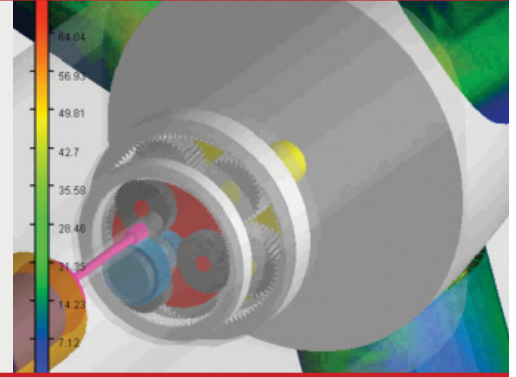


# Accelerating Development and Optimizing Designs of Wind Turbines

## Meeting the Efficiency Challenge Through Systematic Use of Simulations



### Wind Turbine Development Challenges

Wind turbines and other renewable energy have to be cost competitive compared to energy created from coal or other non-renewable sources. System performance and especially its reliability over a 20-year or longer life time have major impact on an operator's return of investment. Other requirements, like limiting noise emissions or off-shore installations, add to the already tough design challenges. If that's not enough, the ever growing dimensions of modern wind turbines make physical tests increasingly difficult.

By relying more and more on simulation, wind turbine manufacturers and their component suppliers can accelerate the development of new systems through rapid verification using virtual models, which reduce reliance on the slow, costly process of physical testing. MSC Software provides simulation solutions for accelerating engineering processes covering concept design, performance validation and fatigue as well as manufacturing analysis for a broad range of applications from single parts to complete systems. Our proven, powerful tools for simulation experts are easily customizable also allowing non-analysts like CAD designers reliable and efficient use of simulations to optimize their products.

### Why Simulation Is Important for the Design of Wind Turbines

Engineers and designers in the wind energy industry are leveraging computer-aided engineering (CAE) methods to understand performance attributes and make informed product development decisions.

By evaluating multiple variations of virtual prototypes, wind turbine designers gain more high-quality data faster and less expensive than through physical tests. Virtual tests help them to increase the robustness and reliability of their products while optimizing system performance. Designs can routinely be verified against required customer specifications using automated test processes. This enables shortest development cycles resulting in optimized products – a strong advantage when competing for business.

### Key Success Factors for Simulation

Wind turbine manufacturers typically may not have large simulation departments and often perform simulations by outsourcing or by purchasing unsophisticated point analysis tools to use on an ad-hoc basis.

To gain maximum value from simulation practices, progressive wind turbine manufacturers are implementing virtual methods that allow them to produce accurate results consistently. When the available expert resources are not sufficient to perform all necessary simulation tasks on time, companies can automate their virtual test processes offering a simulation environment that allows all engineers and designers involved in product development to perform reliable simulations generating the desired information for decision making.

Key success factors needed to ensure the effective simulation of wind turbine systems or components consist of:

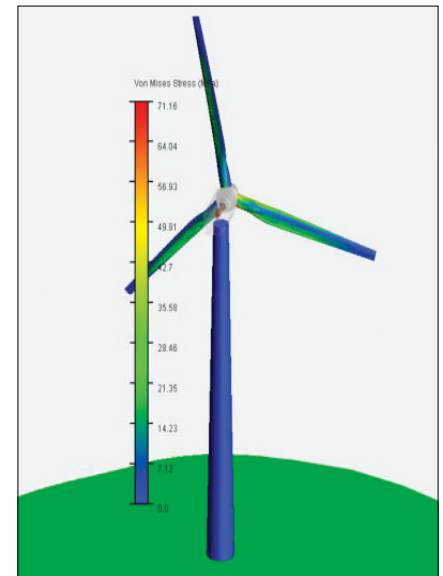
- Ability to perform not only single but multiple disciplines simultaneously, e.g. simulate the full wind turbine system including wind force load on the rotor blades, resulting power train motion and stresses as well as controls impact.
- Capturing expert knowledge for repeatability of best practices
- Correlate simulation with physical tests
- Control, manage, and trace simulation methods and processes
- Reuse simulation data across engineering teams

### MSC Software Solutions Add Value to Wind Turbine Development

MSC Software provides a suite of solutions that help companies address these key success factors for effective engineering simulation. These solutions enable manufacturers to complete more virtual testing repeatedly throughout the design process, reuse experts' best practices, create customized simulation environments and share resulting simulation data across engineering teams.

### Virtual Tests that are crucial for studying Wind Turbine performance include:

- Structural analysis of gear box and other power train components
- Structure and airborne noise
- Structural analysis of rotor blades
- Structural analysis of tower, nacelle, etc.
- System level test including controls
- Rotor blade composite modeling
- Impact analysis (bird strike)



System level simulation

MSC Software solutions which improve the efficiency of wind turbine development processes include:

- Multidiscipline Engineering to Simulate Complex Interactions
- Best Practices for Simulation
- Auditable Simulation Process

Multidiscipline Engineering to Simulate Complex Interactions

**Simulating Real World Problems**

Wind turbine systems are typically subject to a wide range of complex environmental loading conditions. The variability of these conditions makes the physical testing of all possible scenarios both difficult and extremely time-consuming.

By using MSC Software's leading simulation technology, engineers can study a greater number of real-world interactions with higher accuracy. MSC provides a methodology for the analysis of complex engineering systems and subsystems, exploiting the synergism of mutually interacting phenomena such as wind forces, motion and structural loading. MSC also enables the chaining of analysis sequences so that the output state of one sequence can be used as the input state for the next.

Best Practices for Simulation

**User-Friendly Desktop Simulation**

MSC Software delivers powerful, easy-to-use simulation workspace environments that capture and automate comprehensive virtual testing processes. Templates are the enabling technology to cost effectively build customized virtual test solutions which allow the user to focus on evaluating product design alternatives instead of specifics on how to run a simulation.

**Rapid Virtual Testing with Integrated Workspaces**

Fully integrated simulation workspaces provide a range of built-in multidisciplinary capabilities for linear and nonlinear structures, motion, thermal conditions, impact, and more. By using common data models across workspaces within a customizable user interface, wind turbine developers can perform tightly coupled simulations with total flexibility for faster results.

Auditable Simulation Processes

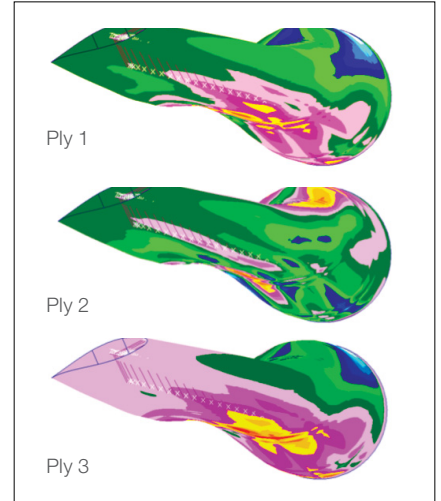
**Ensuring Design and Simulation Traceability**

Managing and tracking the simulation process is just as important as the simulation process itself.

Wind turbine manufacturers benefit from managing and tracking product development data including all simulation content. Quick access to simulations done in the past, with all resulting data, saves time and reduces redundancy in development. SimManager controls the following simulation content:

- Records of all simulation data
- Revision management and control
- Correlation with physical test results
- Proven repeatable methods
- Software version tracking

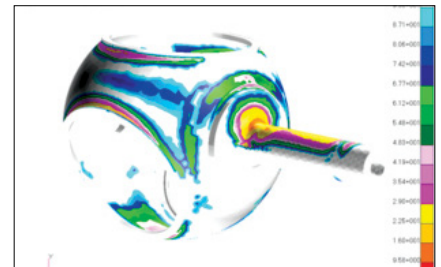
SimManager captures the entire simulation process to provide an audit trail for Type Certification and future reference. Turbine engineers can locate models and results instantly, tracing and proving the methods which were used to create those results.



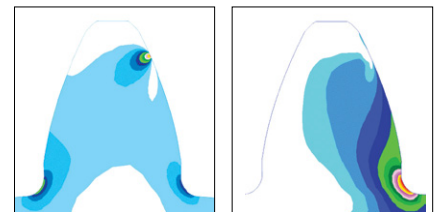
Composites Blade Modeling



Drive train performance & durability



Component tests



Detail analysis

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