Fraunhofer IWES NEWSLETTER
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Pressing the start button (from left to right): Dr. Maik Wefer (IWES), Timo Haase (Fed. Ministry for Economic Affairs and Energy), Thomas Kloppenburg (Project Management Jülich) and Christian Dörsch (IWES)

Center for industrialized rotor blade manufacturing kicks-off operation

The chips really did fly at this launch! As part of the official opening of the "BladeMaker Demonstration Center", 150 representatives from the industry got the chance to watch the milling of a tool mold for a 40-meter blade. The goal is to achieve savings of up to 10% through more efficient production processes, the use of innovative materials and carefully selected automation approaches. A verified cost model that has been developed in close collaboration with a large number of blade manufacturers has confirmed the feasibility of this aim. The center has been set up as an open platform to the industry for the joint development and testing of innovations together with Fraunhofer IWES and 15 partners.

Blade sections measuring up to 25 meters (scale 1:1) for blades in the 50-meter class can be used in the workshop. The L-shaped design of both gantry systems offers two advantages: First, loading and unloading from the side is possible. Secondly, the robot combines the precision of a milling machine with a load bearing capacity of up to 400 kg. Contrary to the general trend in composite manufacturing, linear drives with additional rotational degrees of freedom are preferred to a robot solution. This concept offers advantages with regard to precision and flexibility in setting up new processes. The next milestone will be the production of a model blade which will pass through the various production steps.

Inauguration: April 27th 2016, Bremerhaven/Germany

Integrated machinery concept

The opening of the "BladeMaker Demonstration Center" marks a major milestone for the publicly funded "BladeMaker" research project. In addition to investing in infrastructure, innovations along the complete process chain of blade manufacturing are also to be developed. The requirements of an integral solution for the industrialization of the entire rotor blade manufacturing process are in part contradictory.

The key processes involved in the manufacturing of the rotor blade structure made of fiber composites require high loading of the machine for the semi-finished products to be processed, after all a rotor blade in the 50 m class can weigh up to 12 tons. Yet, on the other hand, the requirements in terms of accuracy are not as demanding as for subsequent machining; here tolerances of just a few fractions of a millimeter are necessary at times. The integrated machine concept with its high speed and low tolerances is able to satisfy the demands of both production and further processing.

Vertical integration of design and production

The two gantry robots made of fiber composite serve to frame the working area for blade sections. They move along the lines at a maximum speed of 2.5 m/s. A heavy-load platform for transporting the semi-finished products and materials is towed along the floor to facilitate the setting up of the gantry.

The machine is programmed and operated via a CNC control, which, in this form, represents a new approach: The advantages of simple handling and vertical integration of design and production in order to simulate the process steps in advance can now be exploited for the very first time.

"Our EEW-Protec HSM-Modal portal milling machine is made largely of CFRP. Through consistent lightweight construction and Fraunhofer IWES' innovative machine concept the HSM-MODAL meets the requirements for the tasks in the rotor blade production and offers flexibility for a variety of processes."

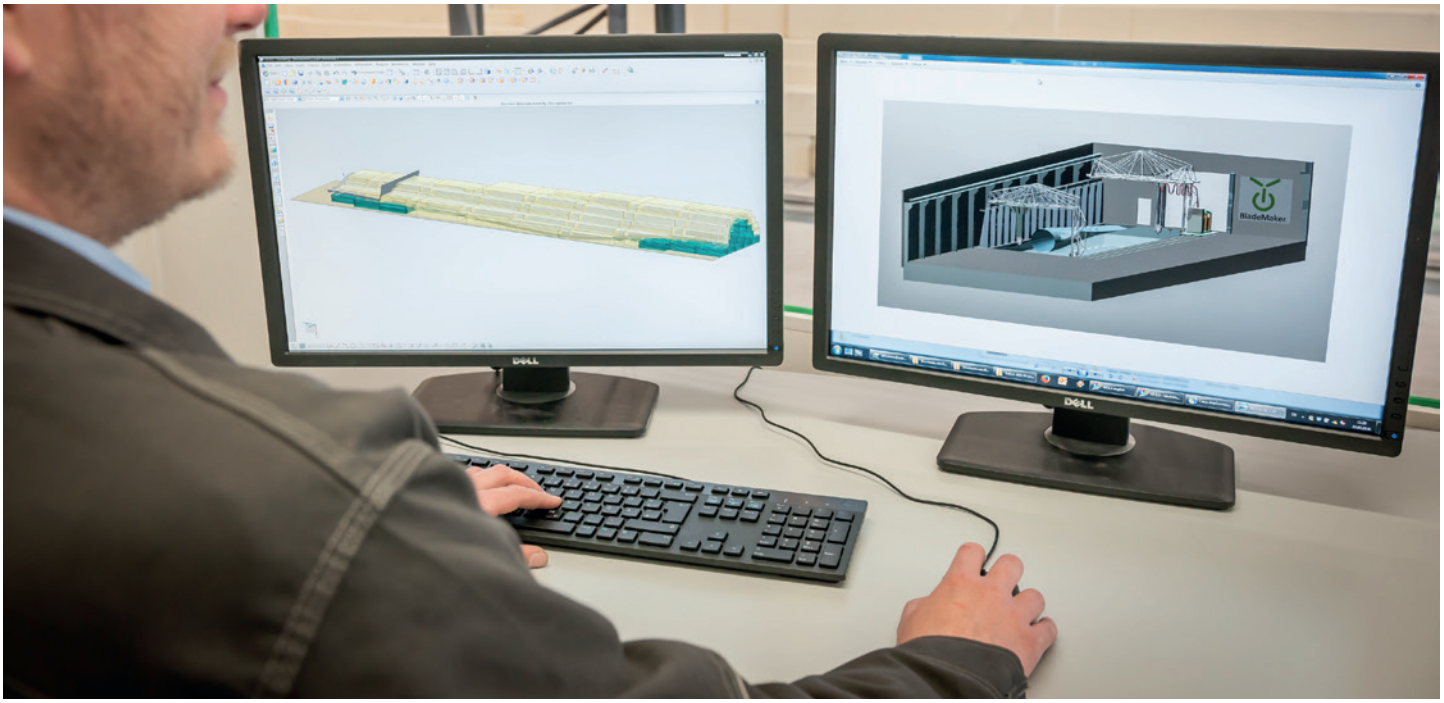
Joachim Knapp,
Managing Director,
EEW-PROTEC GmbH

Working space
- 25 m (L), 4.35 m (W) and 2.3 m (H)
- Fits the root half of a 50 m blade

Gantry robot
- 2 independent working gantry robots, moveable in 6 DOF
- Load-bearing capacity: 400 kg
- Speed: max. 2.5 m/s by accelerating with 4.5 m/s²

Heavy load platform
- 3,500 kg capacity for additional material and equipment
- Follows gantry system in longitudinal direction

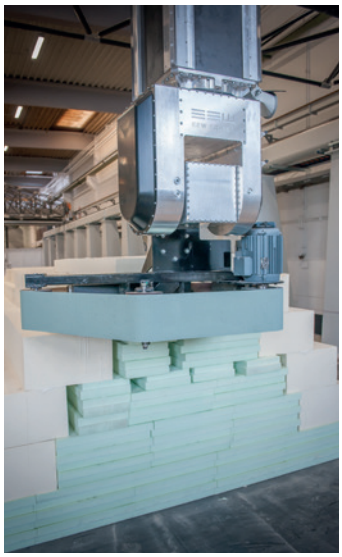
Integration
- In preparation for the integration of 8 main process steps
- Fully Siemens NX CAD-CAM integration for offline programming and process simulation



One gantry robot fits eight production steps

In contrast to a purely automated approach, "BladeMaker" is focused on the industrialization of the entire process. In this context, new materials or the consistency of the semi-finished products have to be improved in order to open up further opportunities for reducing costs and manufacturing time. In addition to the direct tooling approach, Fraunhofer IWES has set up an innovative process chain together with specialized partners for the manufacturing of the rotor blade molds. Thanks to the special fiber composite gantry robots, various production steps, which would normally be conducted at different machines, can be performed at the same workstation by simply changing the process head.

The manufacturing of rotor blades still demands a high degree of manual labor. This is due to the low number of pieces in each production lot compared to the automotive industry for example: Whilst in the latter sector, models roll off the line hundreds of thousands of times, the tool mold for a rotor blade is only used as a template a few hundred times. Comparing the weight of components from blade and automotive production, the former are much heavier. Yet, for manufacturers, the ability to produce parts more quickly and with a constantly higher level of precision can result in significant cost advantages. Given the structural design of the former building, integration of the portal system presented no problems at all.



Changing from milling to grinding is possible with a simple change of the process head

Main Moulds (pressure and suction side)

- Length: 18 m (root section to transition area of a 40 m blade)
- Design-Features: flatback, slender geometry
- Heating: electrical heating by integrated carbon fiber heating mats
- 3 heating zones
- max. temp. 120° C

Shear web mould

- Length: 18 m (root section to transition area of a 40 m blade)
- Flat metal plate with convective heaters
- Heating capacity approximately up to 70° C
- Extendable with heating mats (except of the web feet)
- Flexible mould attachments for the web feet
  -> 2 webs out of 1 mould

2017: full-scale demonstration

The BladeMaker project will end in fall 2017 with a full-scale process demonstration using a blade design developed by Fraunhofer IWES. It will be available to interested parties. The results of the project will give quality-conscious manufacturers a competitive edge and, ultimately, also render the generation of wind energy more cost-efficient.

The equipment in the "BladeMaker Demonstration Center" is available to the blade industry as well as material suppliers and mechanical engineering companies. Based on the results of the generic cost model for rotor blade production, the main cost drivers have been identified. The production of the spar cap, positioning of the textile blanks for the root area in the mold through to alignment of the layers, innovative in-situ core concepts, direct infusion of the resin, application of the adhesive, and surface finishing to prepare for varnishing, all offer potential for cost savings.

Partner

• BASF • EMG • EEW Protec • Faserinstitut Bremen • Fibretech composites • Fraunhofer IFAM • Fraunhofer IWES • Henkel • Hexion • PD Group • Schmalz • Siemens AG und Siemens Industry Software • Sinoi • University of Bremen/BIK • 2KM

Funding

- Federal Ministry for Economic Affairs and Energy: € 8 mio.
- Industry contribution: € 6 mio.

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Structural design for testing and manufacturing

Structural design expertise and Fraunhofer IWES' system know-how are essential preconditions for managing blade manufacturing, contriving structural validation concepts and also material and process development. This knowledge of the particular needs of the rotor blade industry has now been made accessible for material development and the machine building industry. Fraunhofer IWES supports you with estimating the impact of adjusting material properties on structural blade behavior and cost structure, as well as changing blade details for a more economic process industrialization.

A profound structural understanding is also required for future full-scale blade test developments. On the one hand, a virtual set-up of the full-scale blade test supports the physical test set and helps to reduce the test duration. On the other hand, it enables Fraunhofer´s engineers to generate new test methods and simulate structural loads. Generally, only one rotor blade undergoes the complete blade testing procedure right through to certification. The calculative safety factors selected by the certification bodies are not necessarily those leading to optimum costs, but rather those which can certainly withstand the operational loads. A higher number of tests at reasonable costs allows the safety margins to be reduced, which, in turn, means a more economical blade design.

"Bringing together material know how, manufacturing technology insight and design competence, Fraunhofer IWES supports our thriving for efficient development. The experimental validation of new designs or methods generates pivotal value by assuring investments."

Kim Klausen,
Head of Covestro Global
Wind Competence Center

More detailed insight and 30% time savings

Separating a blade into segments for testing – e.g. root segment and rotor blade tip – has two advantages: tests become possible at higher frequencies and with a more accurate load profile. The tests are rendered even more precise when individual sections with a critically high load and greater material thickness or strong curvatures, for example, are investigated separately. This innovative approach not only provides a more detailed insight, but also reduces the testing times by up to 30 per cent.

A first upgrade of the facilities is scheduled for 2018 and this will enable Fraunhofer IWES to test blade components. This will include full-scale trailing edge tests, full-scale blade section tests of the outboard blade region and other large-scale component tests under multiaxial loading. Blade segment and blade component tests are currently numerically analyzed at Fraunhofer IWES and the results and structural understanding gained from this are helping to shape the "future concept rotor blades" project. Ten years of experience with mechanical test methods and a sound understanding of material properties and the behavior of fiber composites are a profound background for this concept. The project is funded by the Federal Ministry for Economic Affairs and Energy and the State of Bremen via the European Regional Development Fund fund with 10 mio. euros.

"The experimental full-scale blade test is a major milestone in the development process of wind turbine blades. The development of sectional blade tests as well as component test methods by the Fraunhofer IWES will lead to more efficient test procedures and supports the development of more reliable wind turbine blades."

Bart Veldkamp,
Senior System Integration Leader - Rotor
GE Renewable Energy Wind

"Future concept rotor blades"

EDITORIAL NOTE

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- determination of physical properties of fibre enhanced synthetic materials and fibre composite materials using mechanic-technological and thermal testing
- testing of mechanical loads on wind turbines

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