Sandia Manufacturing Efforts

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy’s National Nuclear Security Administration under contract DE-AC04-94AL85000.
Manufacturing Efforts

- Core Manufacturing R&D
- Advanced Manufacturing Initiative, AMI-Blades
- Component Demonstration Platform
- Blade Reliability Cooperative (Thur)
  - survey of issues and problems
  - various size blades
  - various manufacturing approaches/processes
  - identification of underlying causes of defects
- Sensor Blades, Smart Blades
## Technology Improvement Summary

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Description</th>
<th>Increased Energy</th>
<th>Capital Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Towers</td>
<td>Taller with new materials/self erecting</td>
<td>+11/+11/+11</td>
<td>+8/+12/+20</td>
</tr>
<tr>
<td>Rotors</td>
<td>Lighter &amp; larger with smart structures</td>
<td>+35/+25/+10</td>
<td>-6/-3/+3</td>
</tr>
<tr>
<td>Site Energy</td>
<td>Improved reliability – less losses</td>
<td>+7/+5/0</td>
<td>0/0/0</td>
</tr>
<tr>
<td>Drive Train</td>
<td>Innovative designs – high reliability</td>
<td>+8/+4/0</td>
<td>-11/-6/+1</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>Process evolution and automation</td>
<td>0/0/0</td>
<td>-27/-13/-3</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td></td>
<td>+61/+45/+21</td>
<td>-36/-10/+21</td>
</tr>
</tbody>
</table>

20% Report, Table 2-1, page 41 (working from 2002 baseline)
Core Manufacturing R&D

- Manufacturing Sensors
- Manufacturing Simulation
- NDI
  - Public database
  - creation of new NDI standard (engineered flaw panels)
- Composite Joints
Core Manufacturing R&D

- Manufacturing Sensors (Collaboration with MSU – Prof. Doug Cairns)
  - improve manufacturing throughput
  - minimize scrap rate
  - minimize rework
  - potential condition monitoring
  - Sensors cannot compromise blade
    - Static
    - Fatigue
  - Support Blade Reliability Collaborative
Core Manufacturing R&D

- Manufacturing Sensors
  - Environmental degradation to strain gage coatings
  - Environmental degradation to PVDF Piezoelectric Film

Blades Manufactured with Sensors and Flown for 1+ Year (Skystream 3.7)
Core Manufacturing R&D

- Manufacturing Simulation
  - Provide public domain manufacturing simulation technology
  - Enable new manufacturers
  - CFD process modeling
    - Large scale
    - Coupled field (flow, resin kinetics)
- Hybrid Manufacturing
  - Preforms
  - Pultrusion with infusion
  - Prepregs combined with dry preforms
Advanced Manufacturing Initiative (AMI)
Statement of Problem

Background: Current U.S. demand for wind turbines, and thus blades, is very high

Challenge: High cost of labor in U.S. makes it difficult to manufacture blades economically

Goal: Improve labor productivity (and leverage transportation advantage) to make U.S. manufacture for U.S. market economically viable
Objectives

- Improve Labor Productivity by 35%
- Reduce Cycle Time by 35%
- Improve Reliability and Maintain Cost
Approach

Three-way Manufacturing Research Collaboration

- 3-year duration (Aug 2009 start)
- Equal funding
  - DOE
  - Iowa OEI
  - TPI

Challenges:
- Collaborating at “industry speed”
- Intellectual Property
- Disseminating Results

First DOE Wind AMI project
- Develop Framework for Future AMI Projects

First year Iowa OEI Project

PI – Steve Nolet
PI – Frank Peters
PI – Daniel Laird
Sandia Wind for Research Broader SNL Capabilities

- Chemistry
- Non-Destructive Inspection & Acoustics
- Factory Simulation
- Robotics and Automation
- Composites Manufacturing
- Grid Operations Support

Projects Industry-oriented Applications

Advanced Manufacturing Initiative (AMI)
- SMART Rotor
- Wind / Radar
- Blade Reliability Collaborative
- Sensor Blade 2
- Reliability Database
- Advanced Rotor
- Blade Manufacturer Demonstration Platform
- Integration Studies & KAFB/SNL Wind Farm
- Certification & Standards

Tech Transfer

Facilities, Processes, Test Results, Analyses, Robots

Wind Industry
Research Areas Identified

- Mold Layup Productivity
  very labor intensive
- Non-destructive Evaluation
  initial interest in shear web bondline integrity
- Virtual Factory Simulation
  key to long-term optimization of manuf. processes
- Modular Automation
  implementation of results from other areas
Technical Steering Committee (TSC)

- Generate and Solicit Proposals for AMI-Blades
  - Cost
  - Timeline
- Monthly Telecons/Meetings to Consider Proposals
  - Cost/Time versus Impact on Objectives
- Approved Proposals Presented to Oversight Committee

Oversight Committee

- Project Status/Spending
- Consider Proposals from TSC
AMI-Blades Current Efforts

- True 3D Laser Projection
- Edge Operations Study
- Non-Destructive Inspection Capabilities Evaluation (2)
- Factory Logic/Process Flow Simulation (2)
- Engineering Data Software Platform
- Spar Cap Assembly Fiber Placement
- Ply Nesting Optimization
Workforce Development
University Students Involved

Iowa State University

- Fanqi Meng PhD Industrial Engineering
- Ben Wollner MS Industrial Engineering
- Sunil Chakrapani MS Aerospace Engineering
- Corey Magnussen MS Industrial Engineering
- Wade Johanns MS Industrial Engineering
- Travis Kieffer BS Industrial Engineering
- Andrew Gross BS Aerospace Engineering
Component Demonstration Platform

Goal: Facilitate the entry of new U.S.-based blade manufacturers into the wind industry

Challenges:
- High entry costs
- Unfamiliar with materials used in wind turbine blades
- Unfamiliar with wind blade manufacturing processes

Approach:
- Make molds and baseline blade design available to industry ("library card" for blade molds)

Industry Impact:
- Significantly reduce barriers for manufacturers considering an entry into the wind industry

Interested? dllaird@sandia.gov
Thank You