

2nd US Wind Turbine Supply Chain Conference

Wind Energy Update Detroit, Michigan April 5-6, 2011

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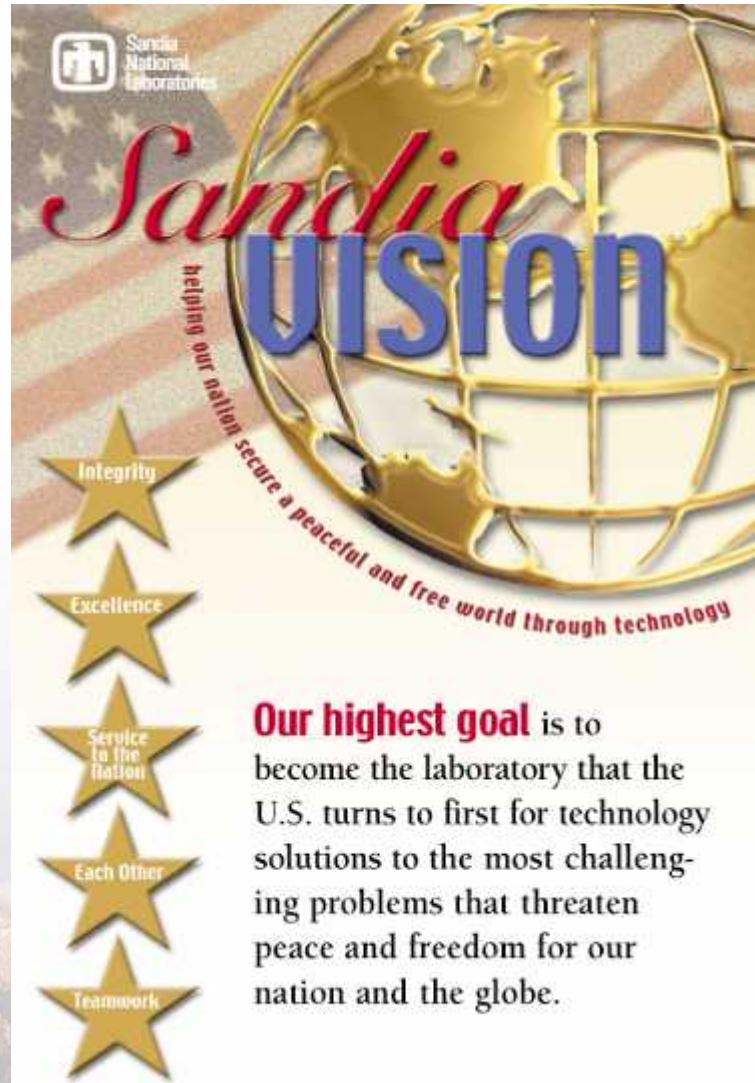


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Sandia National Laboratories

“Exceptional Service in the National Interest”

- National Security Laboratory
- Safety, security and reliability of our nation's nuclear weapon stockpile
- Broad mission in developing science and technology applications to meet our rapidly changing, complex national security challenges



Our highest goal is to become the laboratory that the U.S. turns to first for technology solutions to the most challenging problems that threaten peace and freedom for our nation and the globe.

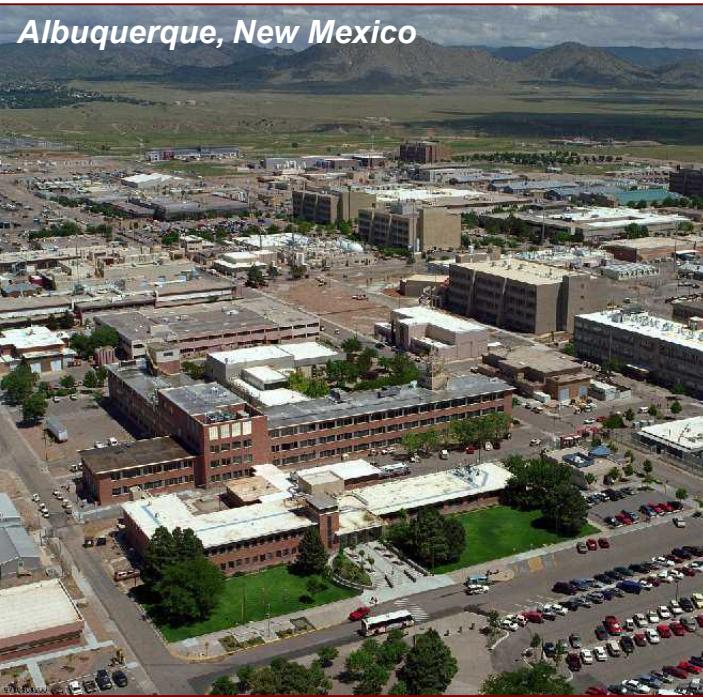


Sandia National Laboratories is Geographically Distributed

Tonopah, Nevada



Albuquerque, New Mexico



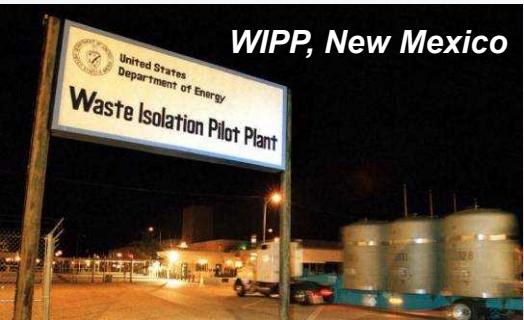
Kodiak, Alaska



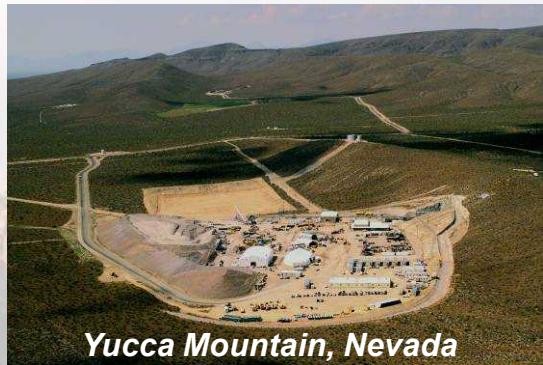
Pantex, Texas



WIPP, New Mexico



Yucca Mountain, Nevada



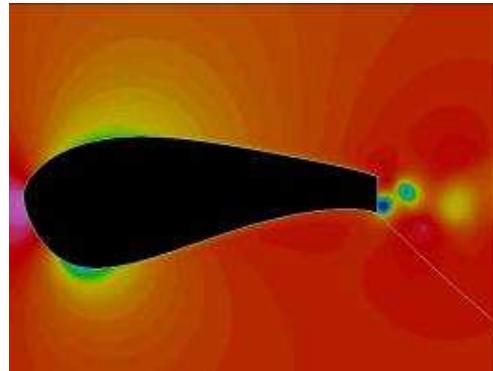
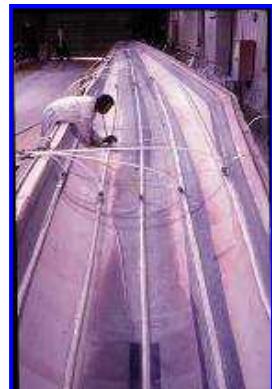
Livermore, California



Sandia Wind Energy Technology

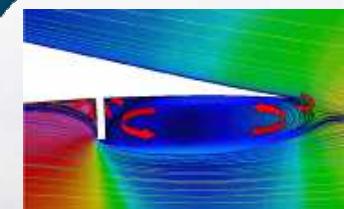
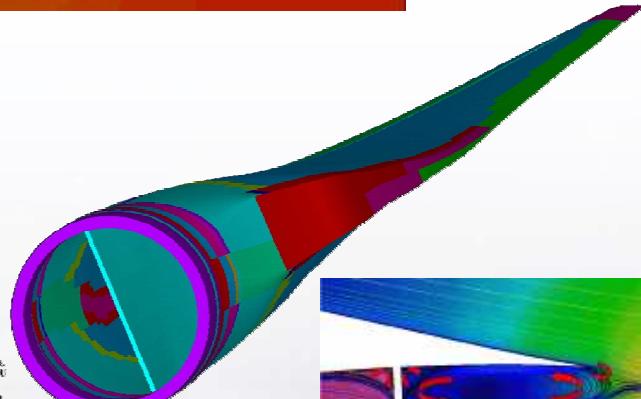
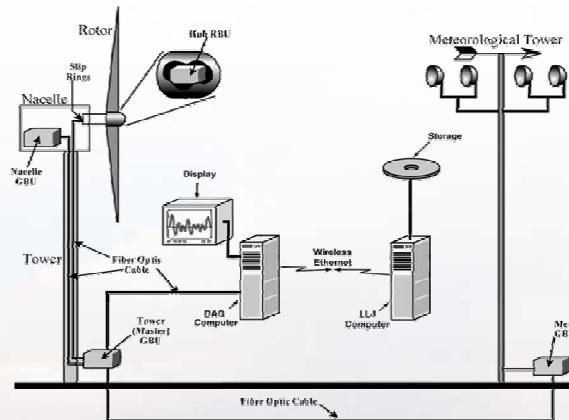
■ Blade Technology

- Materials and Manufacturing
- Structural, Aerodynamic, and Full System Modeling
- Sensors and Structural Health Monitoring
- Advanced Blade Concepts
- Lab - Field Testing and Data Acquisition

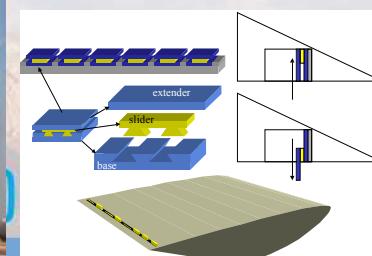


■ System Reliability

- Industry Data Collection
- Improve reliability of the existing technology and future designs

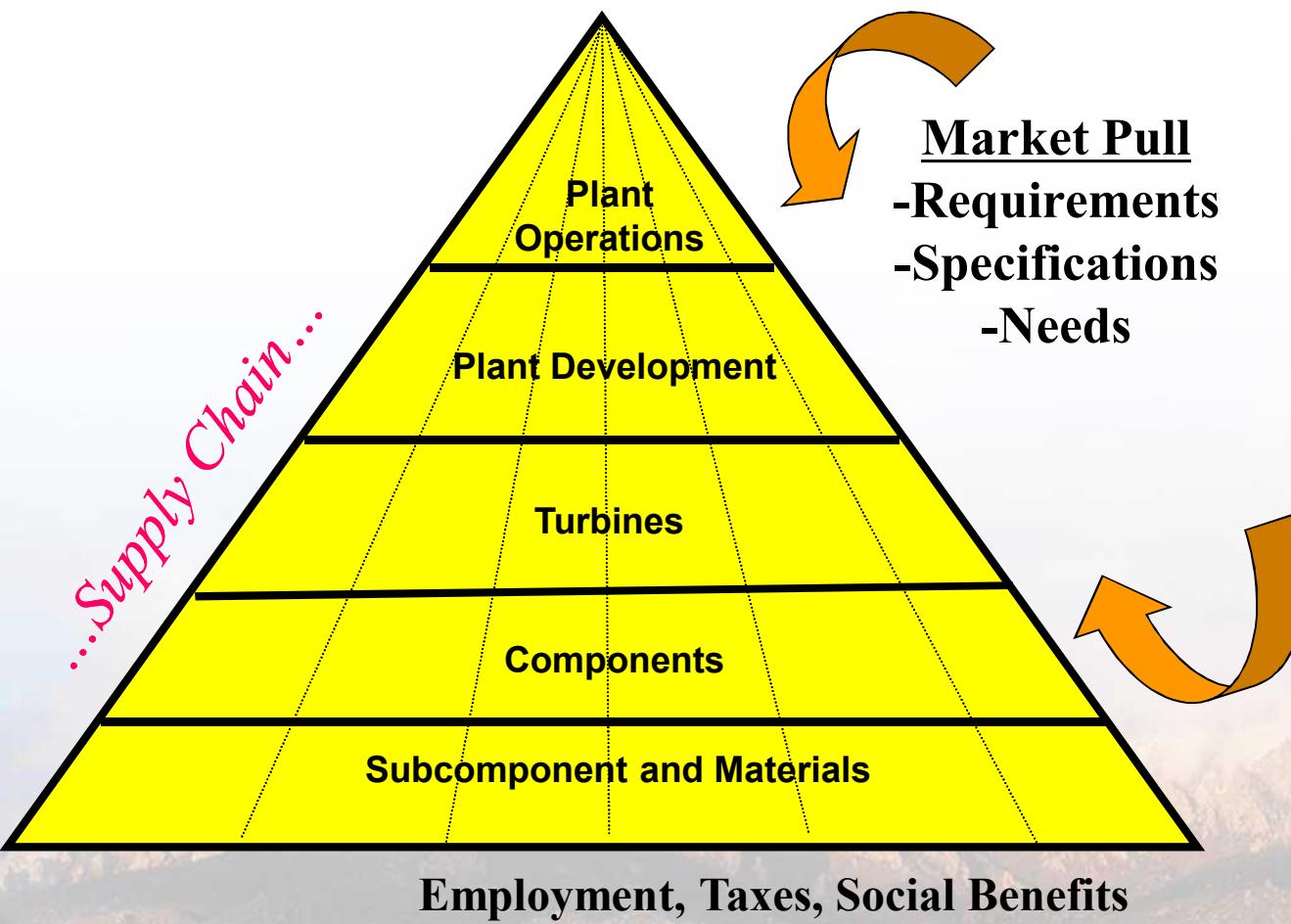


■ System Integration & Outreach



Wind Turbine Supply Chain Model

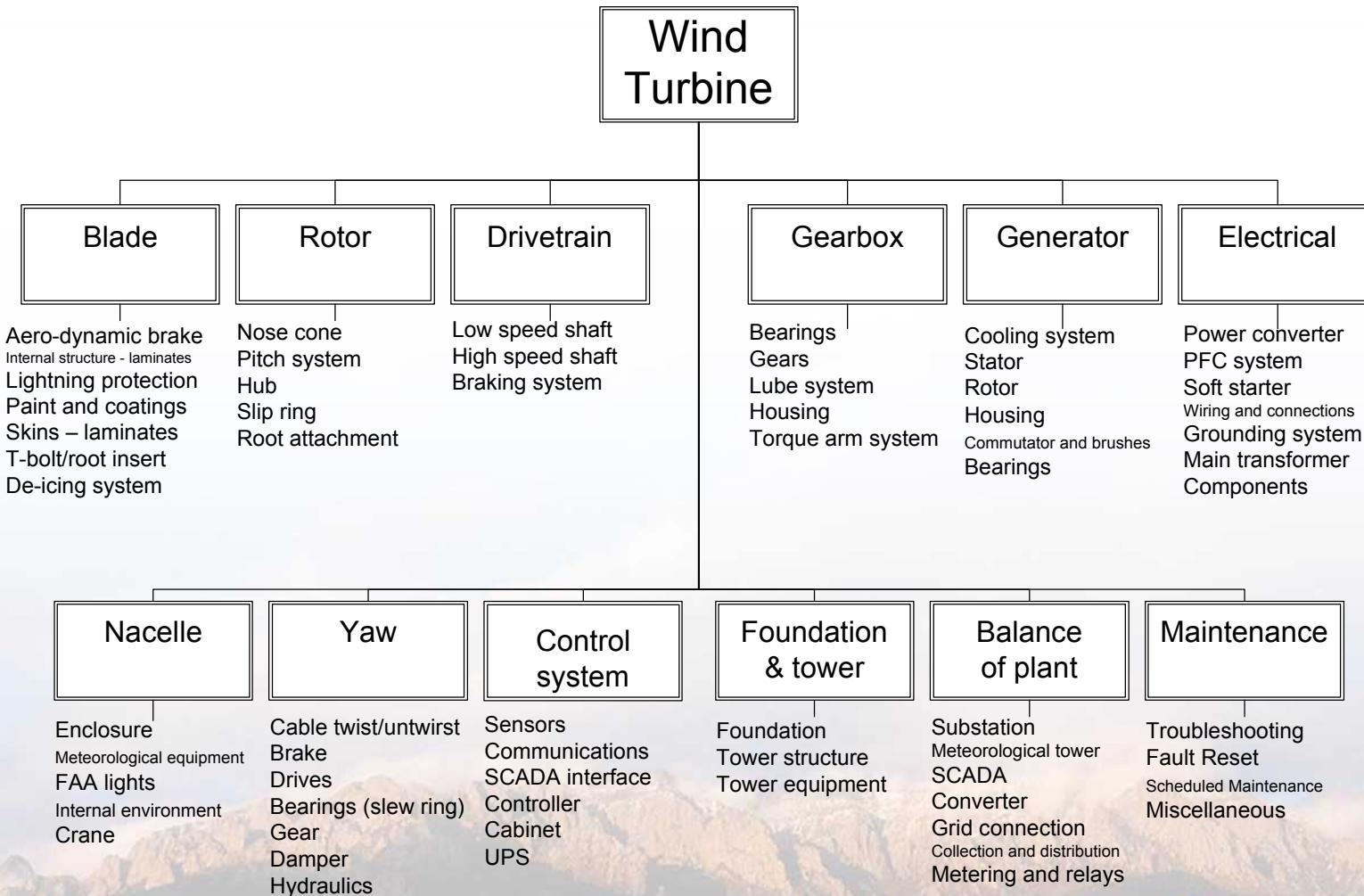
Utilities, Ratepayers,
Taxpayers, Social Benefits



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Taxonomy of a Wind Plant

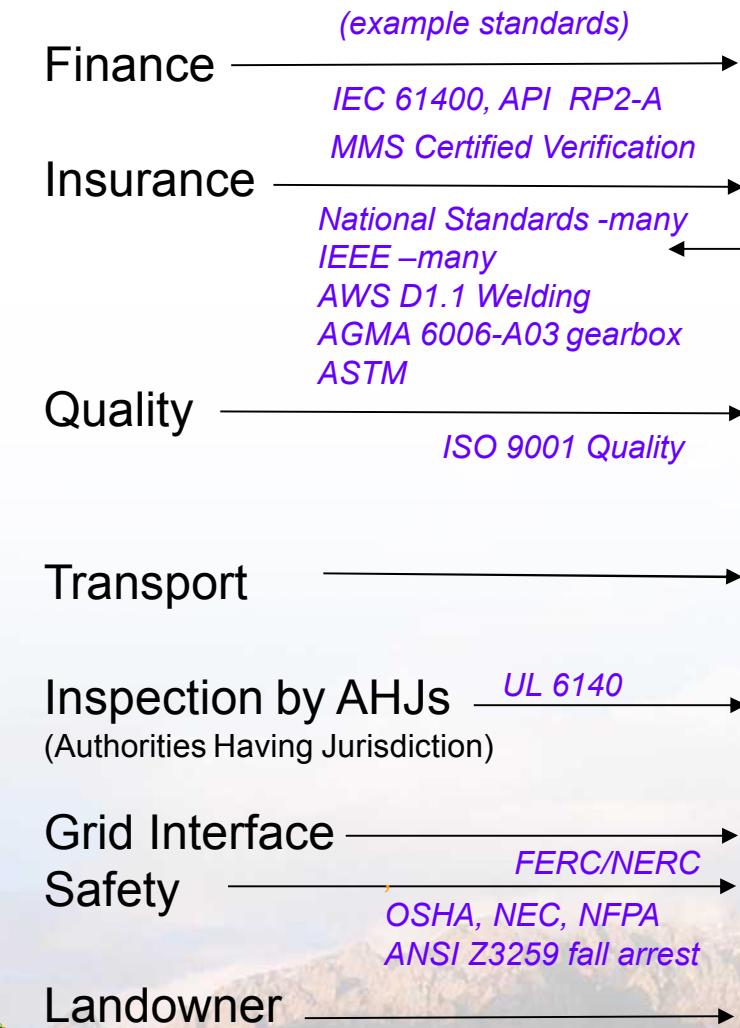
Over 8,000 individual components in a single wind turbine



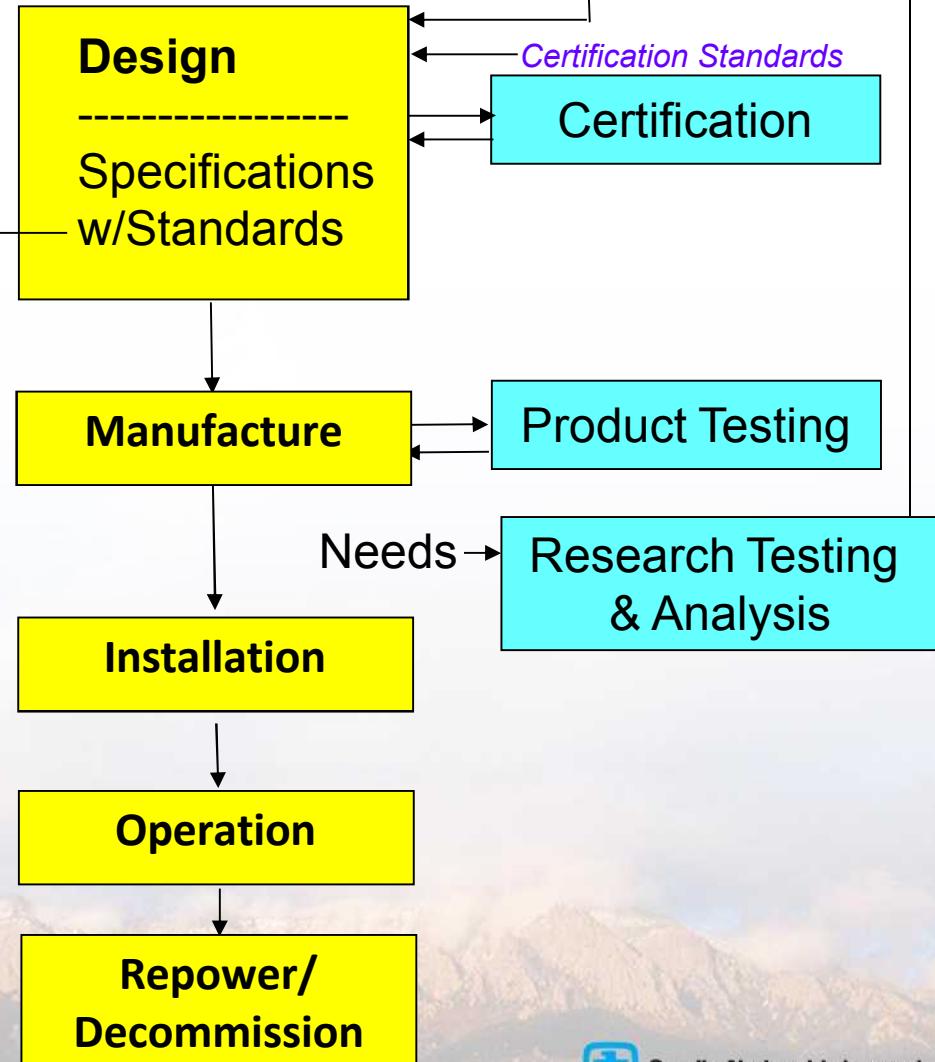
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Another Perspective with Adjacent R&D Space

Functional Requirements



IEC Design Standards



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Sandia Manufacturing Efforts

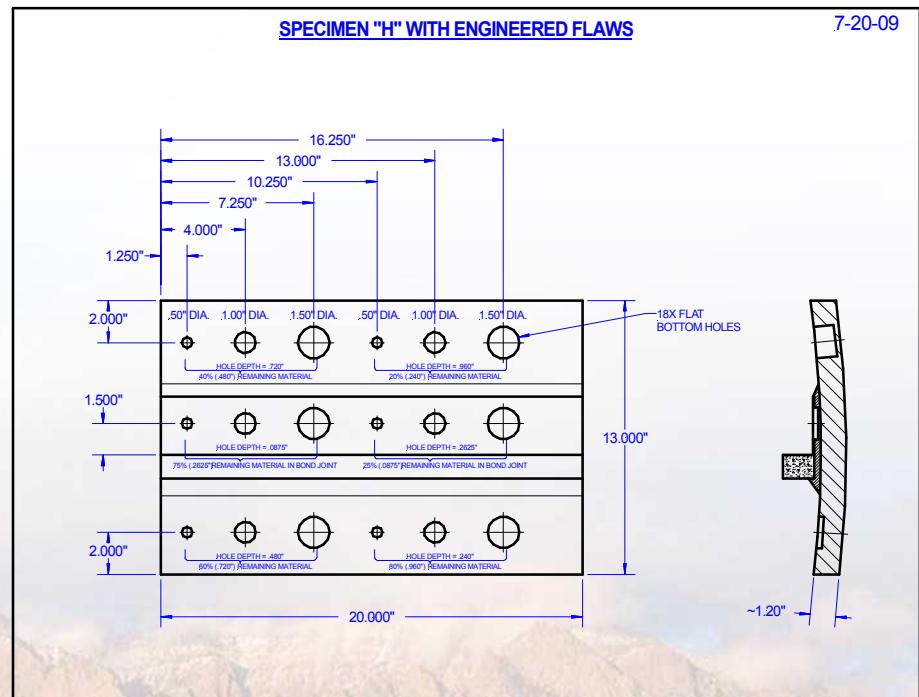
- Manufacturing R&D
- Advanced Manufacturing Initiative, AMI-Blades
- Component Demonstration Platform
- Blade Reliability Cooperative
 - survey of issues and problems
 - various size blades
 - various manufacturing approaches/processes
 - identification of underlying causes of defects
- Sensor Blades,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



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Core Manufacturing R&D

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



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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



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Advanced Manufacturing Initiative (AMI)



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Statement of Problem

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

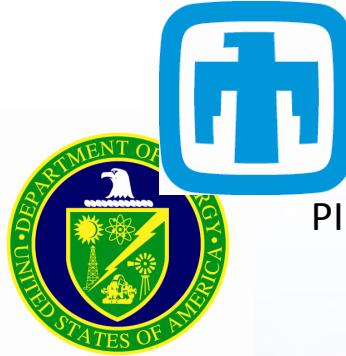


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Approach

Three-way Manufacturing Research Collaboration

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



PI – Daniel Laird



PI – Steve Nolet



PI – Frank Peters



Challenges:

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



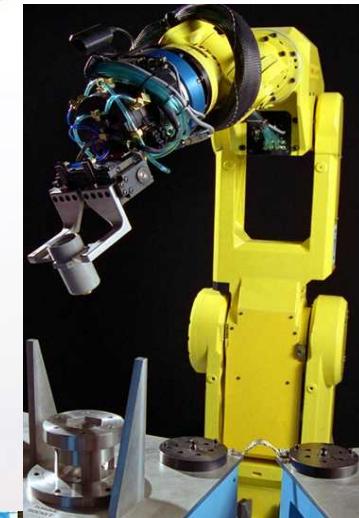
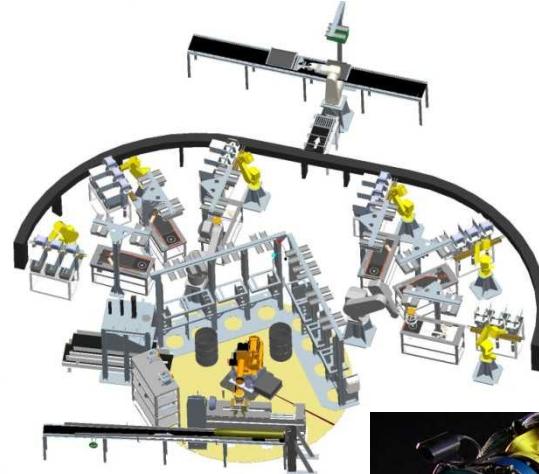
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Approach

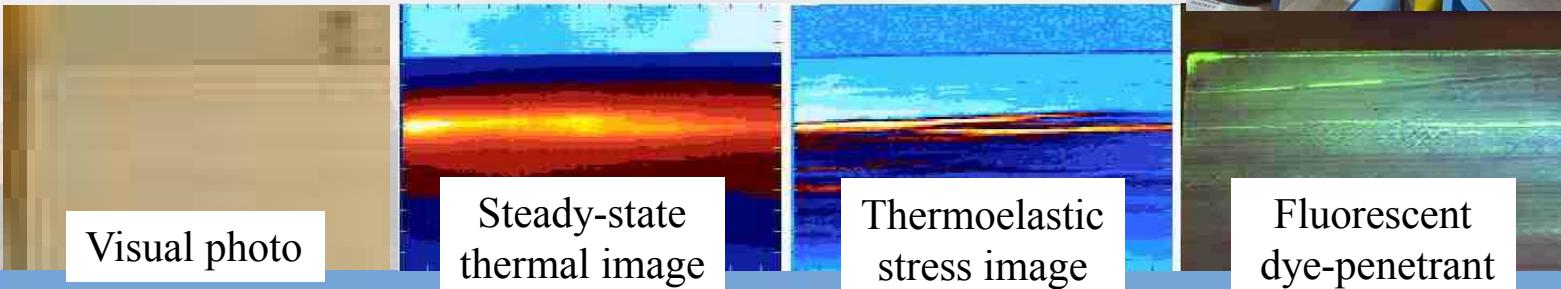
AMI - Blades

■ 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



Non-Destructive Inspection Methods



AMI-Blades Current Efforts

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



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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

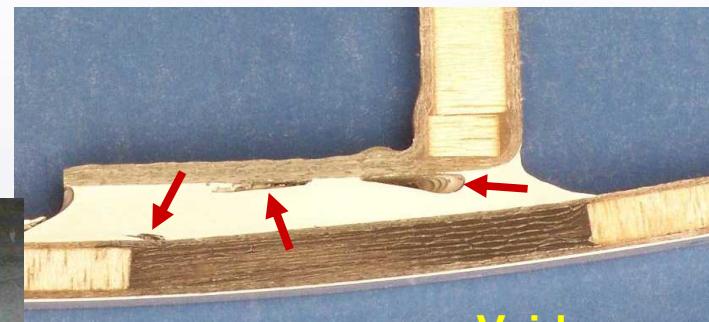
Interested? dllaird@sandia.gov



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Objectives of Sandia Wind NDI* Programs

- Develop, evaluate and validate the array of potential nondestructive inspection methods for the detection of flaws in composite wind turbine blades
- Plan and implement a national capability – including a physical presence and methodology - to comprehensively evaluate blade inspection techniques
- Produce optimum deployment of automated or semi-automated NDI to detect undesirable flaws in blades (time, cost, sensitivity)



Voids

*Courtesy of Dennis Roach



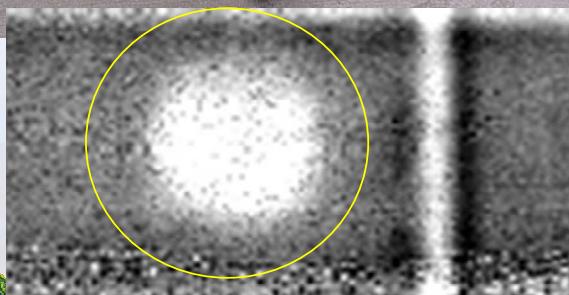
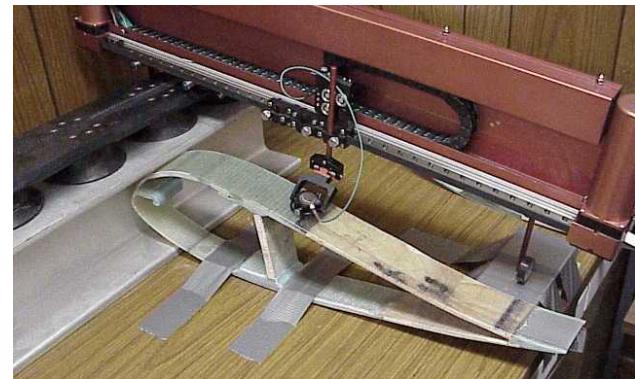
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Inspection of Wind Turbine Blades

Depth of penetration in thick, attenuative laminates is key issue

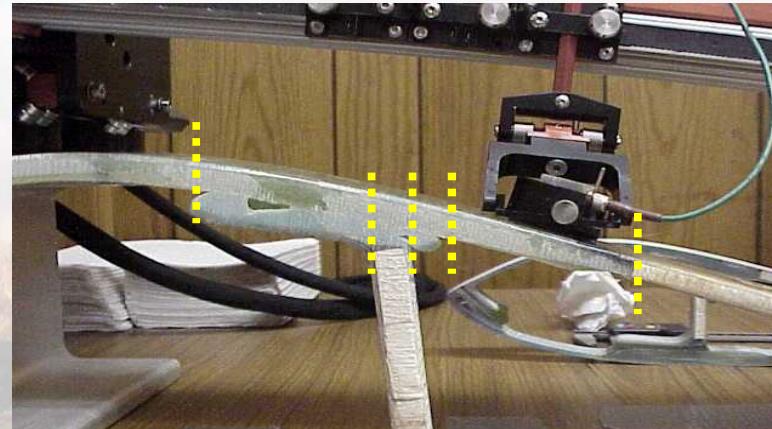
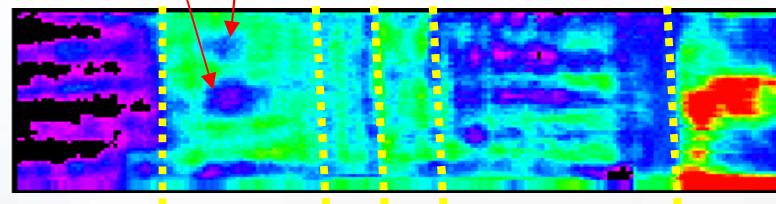


Thermography



Voids

Resonance Scan 152 kHz



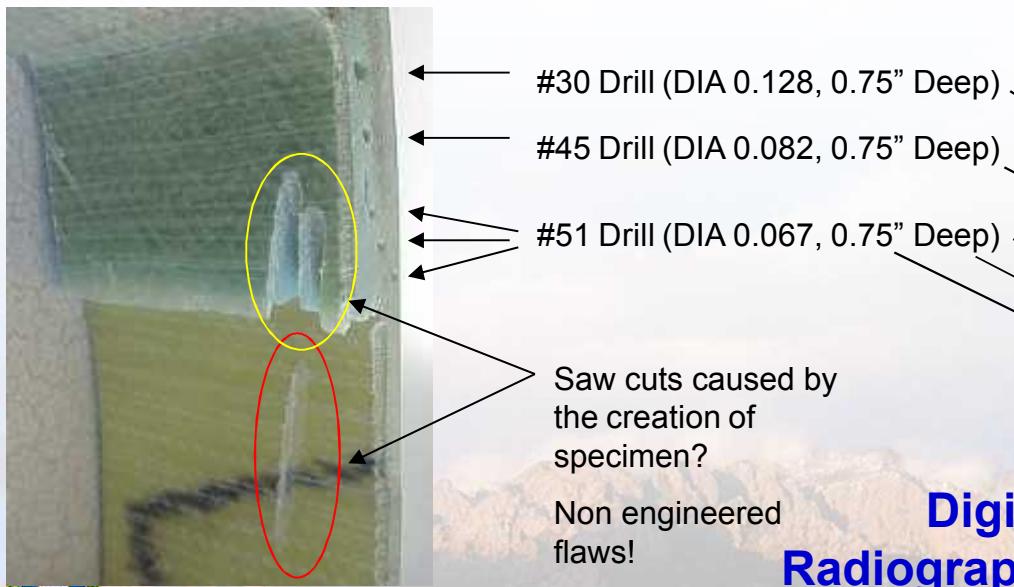
Quality Assurance for Turbine Blades

Areas of interest for inspection

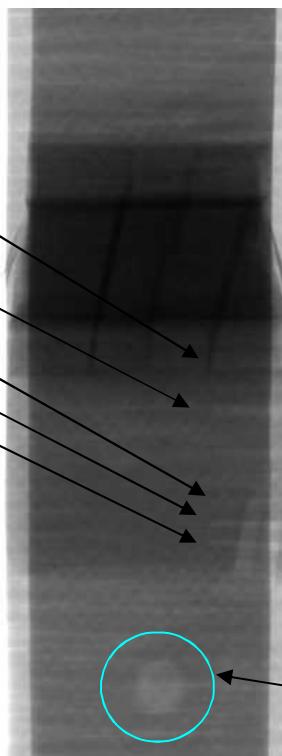


NDI Technique	Inspection Issue
Ultrasound	Attenuation
Pulsed Thermography	Depth of Penetration
X-Ray	Radiation Hazards
Microwave	Maturity of technology
Eddy Current	Fiberglass is nonconductive
Shearography	Thickness/Stiffness

Top of Blade (Near) Shear web



Digital
Radiography
Image

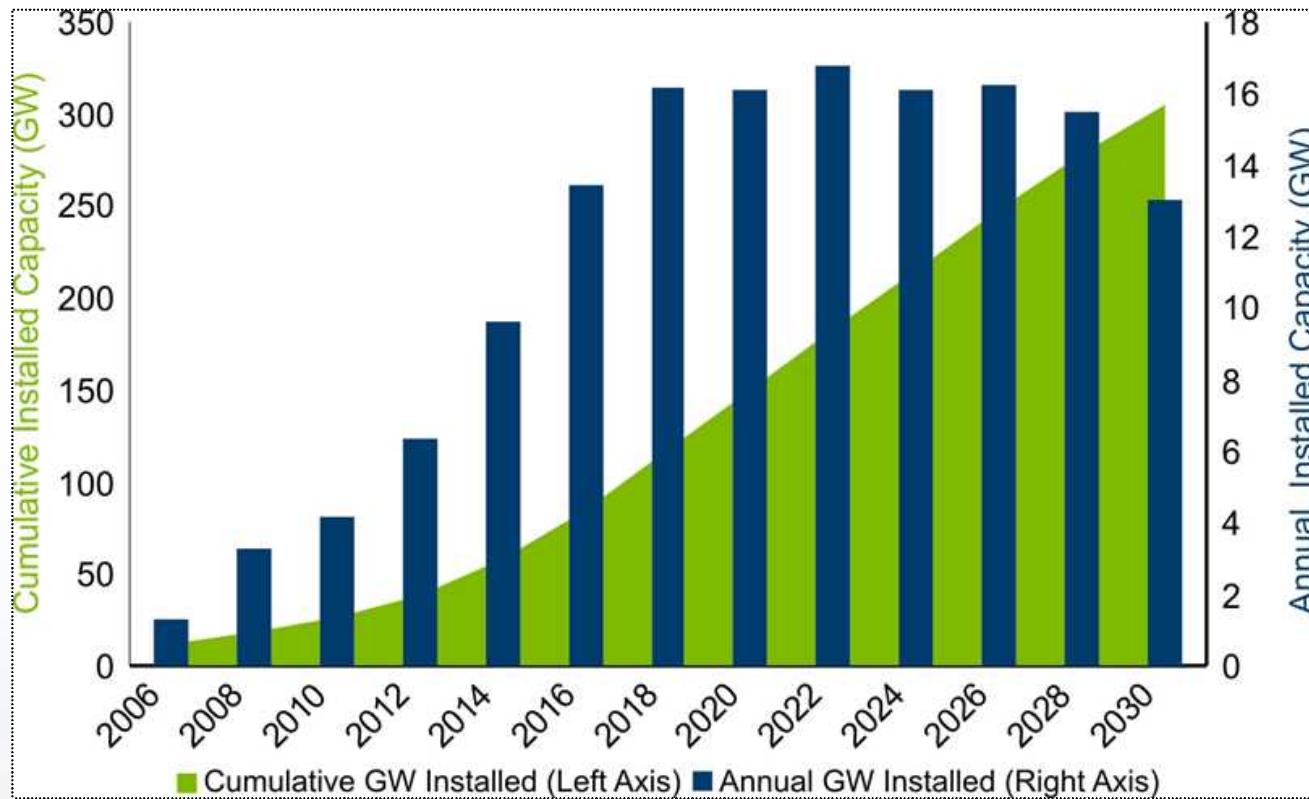


Bottom of Blade



Semi Flat Bottom Hole:
0.4375 DIA and 0.0615 Deep

Federal Support: DOE 20% by 2030 Report



20% Wind Energy by 2030

Increasing Wind Energy's Contribution to U.S. Electricity Supply, July 2008



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Technology Improvement Summary

20% by 2030 Report

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

20% Report, Table 2-1, page 41 (working from 2002 baseline)



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Federal Support for Wind Manufacturing

- Manufacturing Workshop
- ARRA Wind Manufacturing Projects (FOA)
- Massachusetts Wind Technology Testing Center
- Large Wind Turbine Drivetrain Testing Facility
- Advanced Manufacturing Initiative – Blades
- Manufacturing Tax Credit (48C)

Wind Funding Opportunity Announcements (FOAs)

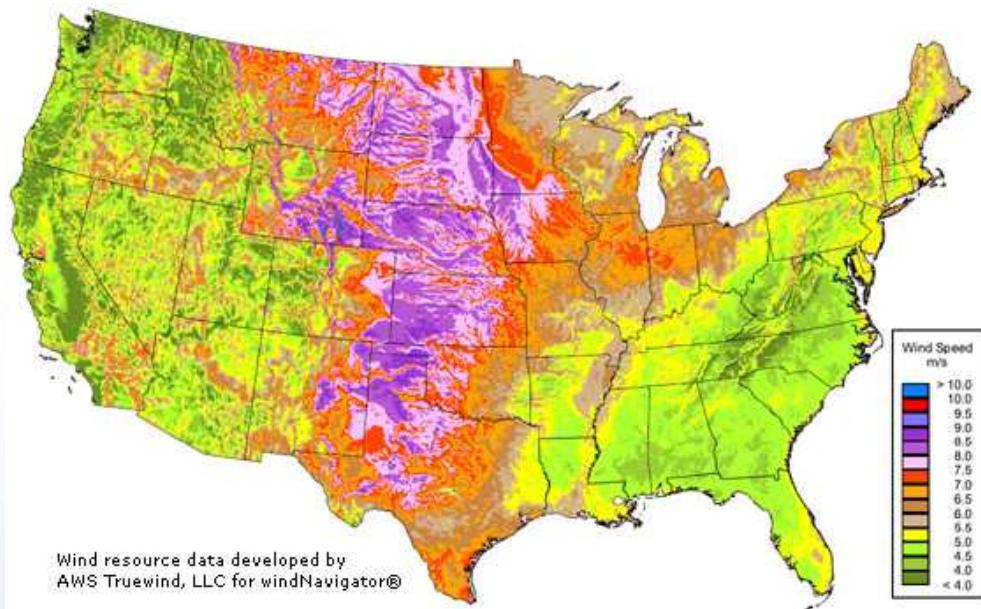
<http://www1.eere.energy.gov/windandhydro/>

(Hint: Google DOE wind power)
Click on financial opportunities



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A Final Word on Economic Clusters



- Natural resources drive development of industries
- Geographic concentrations may develop specialized suppliers, service providers and associated institutions
- Clusters arise because they increase the productivity with which companies can compete



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Publications@ sandia.gov/wind

Active Aero Control Design

Blades:

Adaptive

Aeroacoustics

Blade System Design

Study

Carbon Hybrid

Flutter

General

Testing

Computational Fluid Dynamics

Control System Design:

Nonlinear Control Theory

Wind Turbine Blade Controls

Data Acquisition and Field Measurements

Fatigue and Reliability:

General

LIFE2

Loads

Probability of Failure

Health Monitoring

Manufacturing

Materials:

Aluminum

Bonded Joints

Composites

Material Testing and Fatigue

Property Determination

Modal Testing and Analysis

Non-destructive Testing

NuMAD

Partnerships:

Low Wind Speed Technology:

Knight & Carver

WindPACT

Supervisory Control And Data Acquisition

Structural Dynamics

Turbine Systems

Turbulence Simulation

VAWT Archive

Wind Plant Reliability

Wind Powering America



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Thank You

The “Eye” of the dollar bill has two Latin phrases:
Annuit Coeptis
-Approves Our Endeavors
Novus Ordo Seclorum
-New Order of the Ages

Roger Hill

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