

SAND2018-12197C

Blade Reliability: Design, Test, Field

Special Reliability Workshop, October 23rd, 2018

Albuquerque, NM



PRESENTED BY

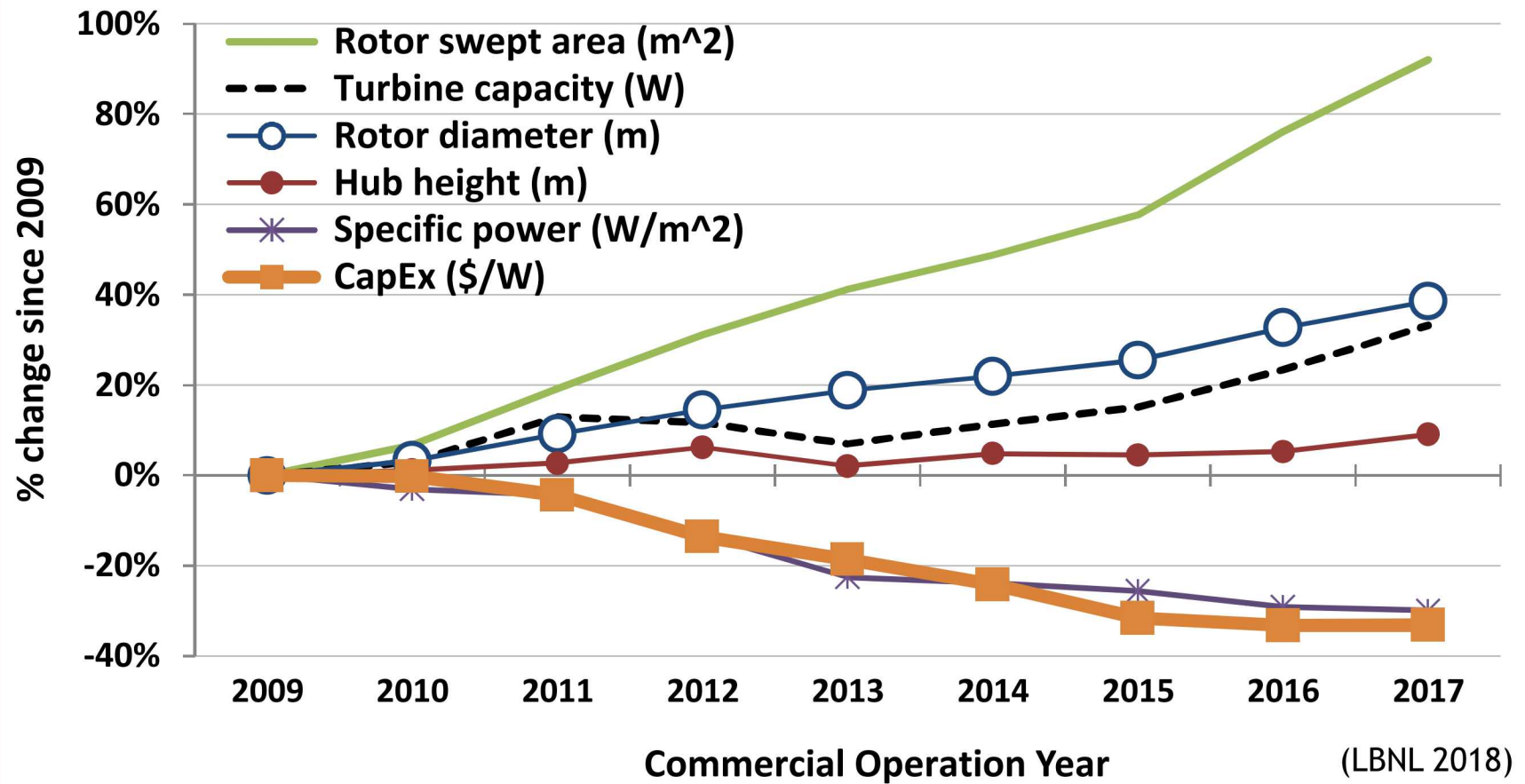
Josh Paquette

Principal Member of the Technical Staff

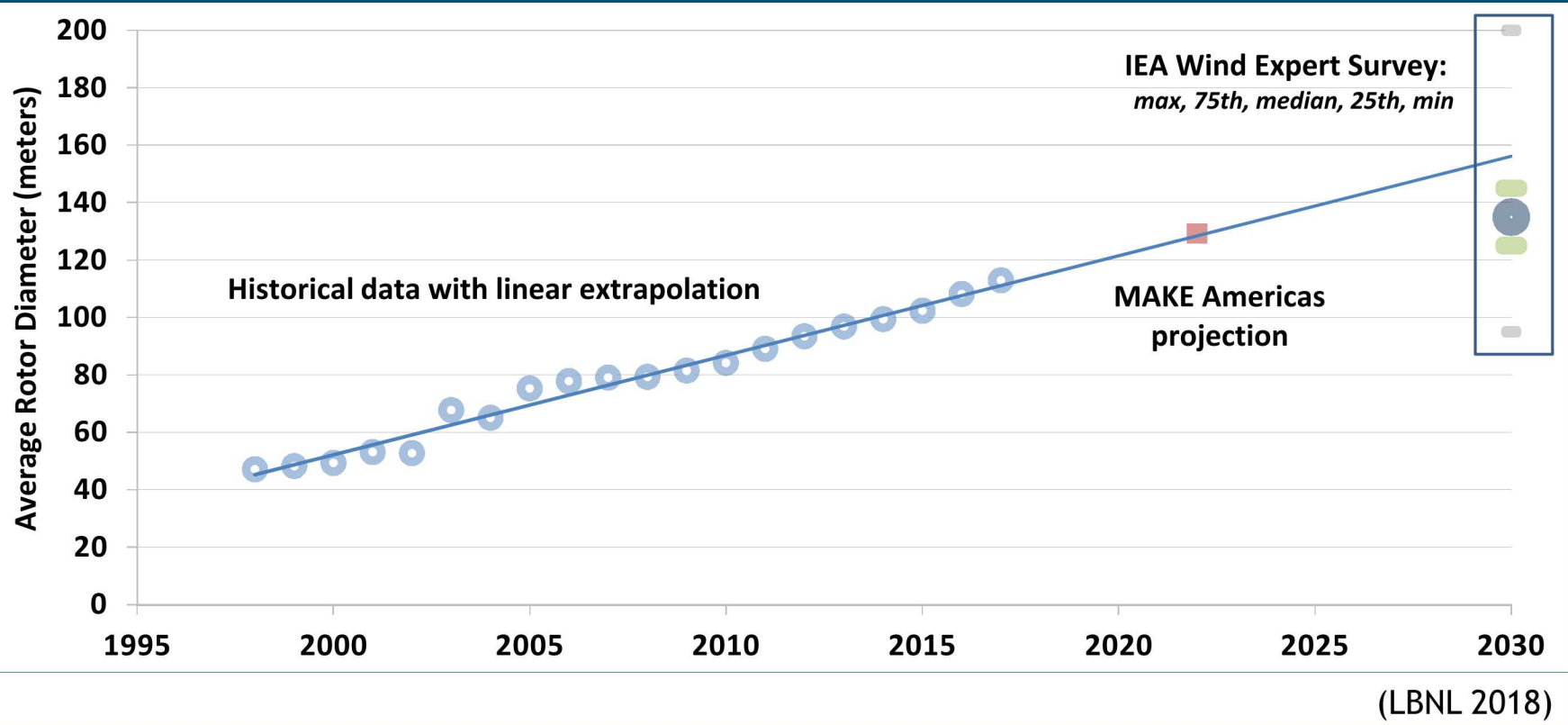
Sandia National Laboratories

SAND2018-9430 PE

The Problem:



The Problem (cont.):



Solutions: Design

Advanced Analysis Methods

- Non-linear models that account for sectional deformation
- Models with flaws/damage: If flaws are not detectable or proven to not exist in manufacturing process, analysis should include them
- Progressive damage growth and probabilistic models

Design for operational damage

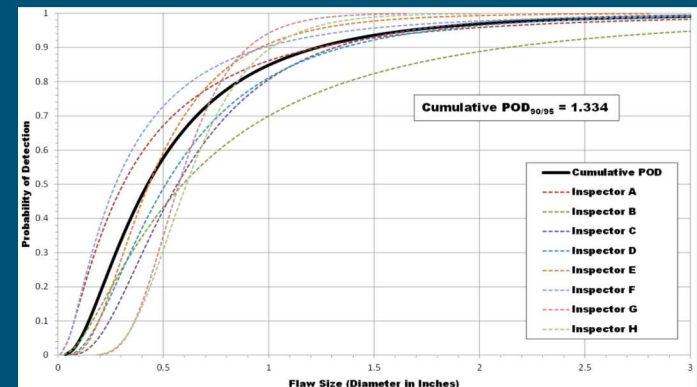
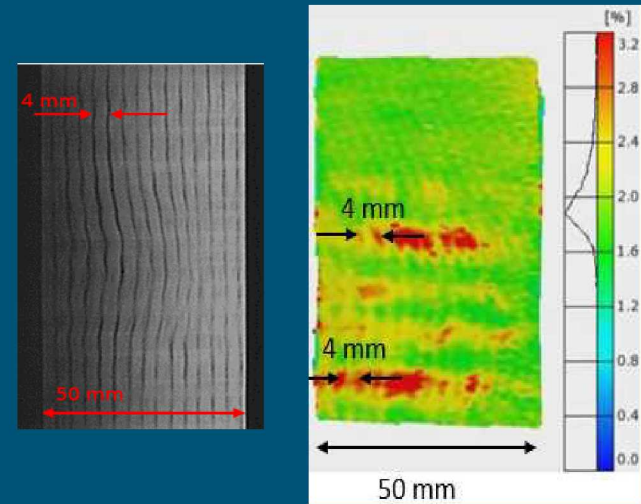
- Leading edge erosion

Design for manufacture

- Materials/manufacturing are inherently linked, especially for composites
- Tolerances that are difficult to achieve will likely be difficult to achieve

Design for Lifetime Value

IEC 61400-5 is an important step towards improving blade design



Solutions: Test

Realistic Fatigue Loading Conditions

- Uniaxial tests are likely missing important loading conditions
- IEC 61400-23 is addressing this and other topics

Testing with flaws

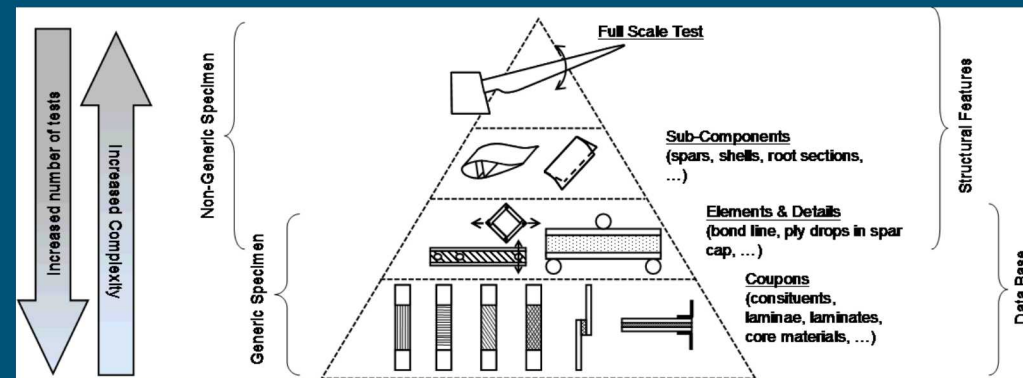
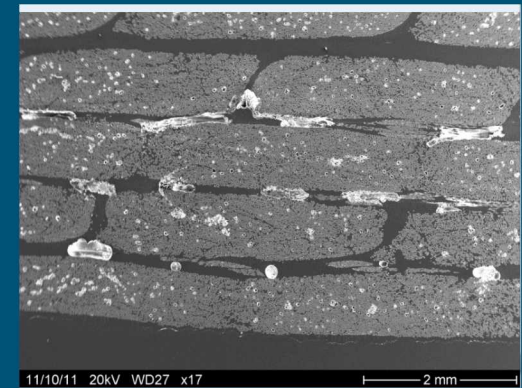
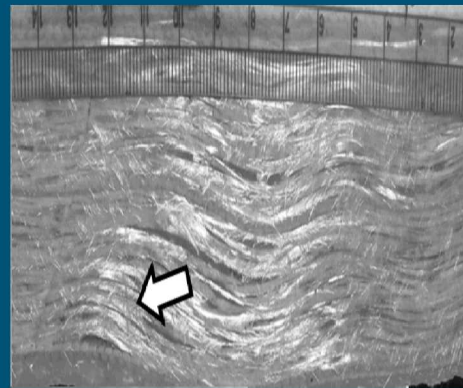
- Damage emanating from manufacturing flaws remains a leading cause of blade failures
- Quantification of effects of defects should feed back to the design/analysis

Sub-Component Testing

- Faster testing
- Multiple specimens
- Better control of loading conditions
- Much more difficult fixturing

Test Methods for Leading Edge Erosion

- Accelerated life testing of erosion with environmental conditions (UV, temperature, freeze-thaw, hail, etc.)



Solutions: Field

Better, More Informed Inspections

- Deployment of advanced inspection methods autonomously
- Use of structural health monitoring systems and digital twins to direct inspection schedules, types, and locations

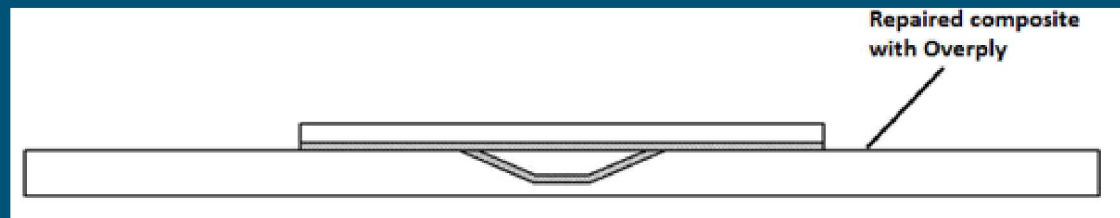


Standardized/Optimized Repair Methods

- Quantified and inspected repairs to ensure structural restoration
- Design for repairs
- Known trade-offs between repair cost and performance impact



Load Accumulation Monitoring



IEA Wind Technical Experts Meeting #91: *Durability and Damage Tolerant Design of Wind Blades*

Bring together wind and aerospace communities

Develop a vision for how durability and damage tolerant design can be implemented for wind blades

Topics:

Aerospace Experience and Wind Standards

Manufacturing & Inspection

Modeling & Testing

Operations

<https://community.ieawind.org/home>



IEA TEM #91 Participants, Bozeman, MT, June, 2018



Thank You!

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