National Science Foundation Industry/University Cooperative Research Center (I/UCRC)

WindSTAR

Wind-Energy Science, Technology, and Research
Industry/University Cooperative Research Center

SOUTHERN MAINE COMMUNITY COLLEGE
envision a future

UT DALLAS
The University of Texas at Dallas

UMASS University of Massachusetts Lowell

IOWA STATE UNIVERSITY

KidWind PROJECT

1. What is an I/UCRC?

National Science Foundation
WHERE DISCOVERIES BEGIN

The Industry/University Cooperative Research Centers (I/UCRC) Program

Mission:

- To contribute to the nation's research infrastructure base by **developing long-term partnerships among industry, academe and government**
- To leverage NSF funds with industry to **support graduate students performing industrially relevant research**

Vision:

- To **expand the innovation capacity of our nation's competitive workforce** through partnerships between industries and universities

40 years of fostering and growing long-term partnerships among industry and academe based on shared value

National Science Foundation
WHERE DISCOVERIES BEGIN

I/UCRC Fast Facts – FY14 Snapshot

52 ENG Funded Centers 25 CISE Funded Centers

6 International Sites:
Belgium, China, Finland, Germany, India, Russia

Program Funding

- $20M in Program Funding (ENG, CISE)
- **6:1 Leveraging of NSF funds**

Students

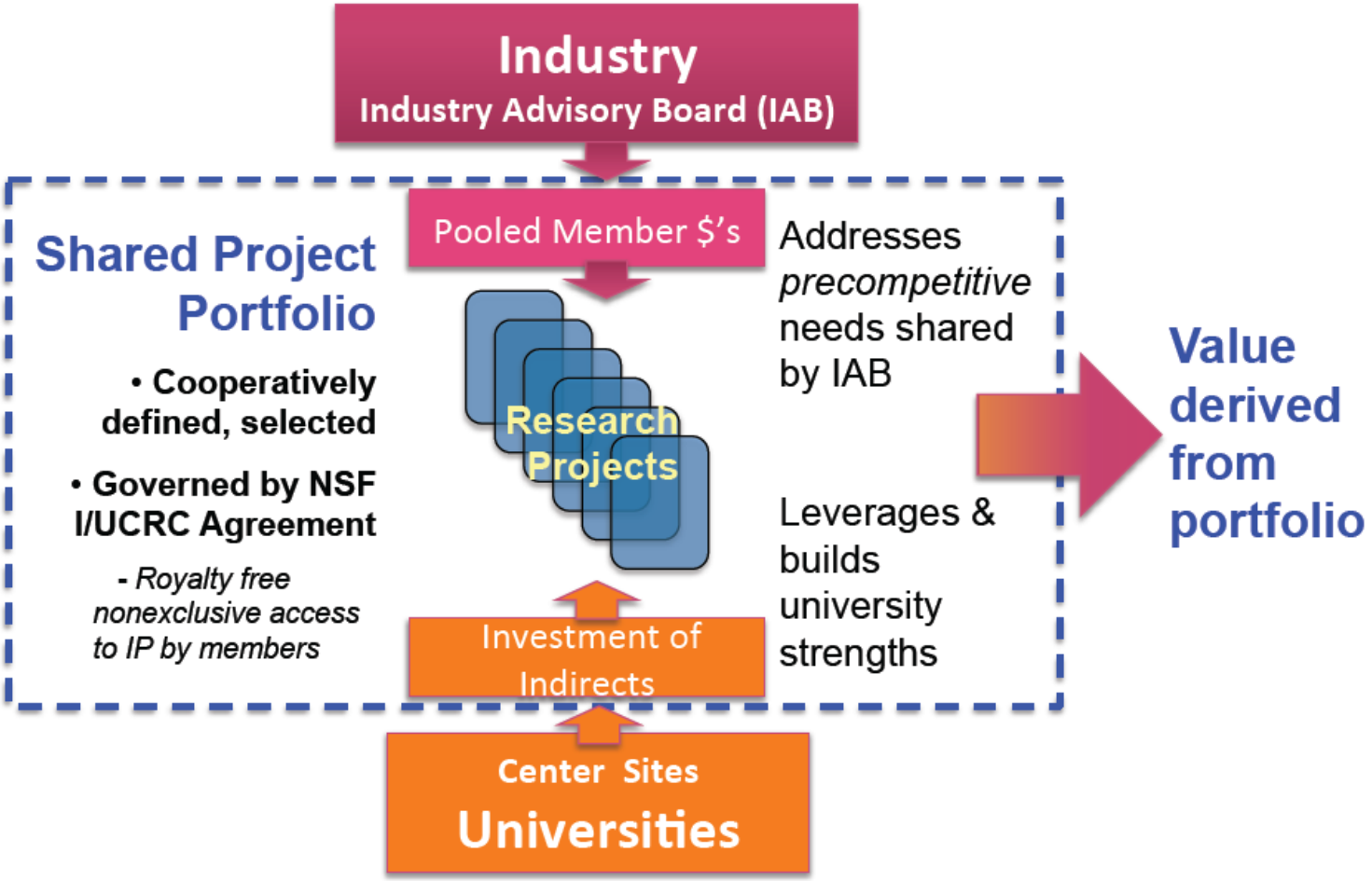
- **Over 2000 students engaged**
- **649 graduated in 2014, nearly 30% hired by members**

Sustainability

- Over 40 Graduated I/UCRCs remain in operation true to model

National Science Foundation
WHERE DISCOVERIES BEGIN

WindSTAR's I/UCRC Nucleus: A Cooperatively Defined & Funded Shared Research Portfolio



Requires trust be built in the model, and between all partners in the center.

WindSTAR
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2. What is WindSTAR?

WindSTAR Vision Statement

Our vision is to become the premier research Center in the area of wind energy in the USA.

- Bring together **university and industry** researchers to conduct basic and applied research on wind energy
- Combine **state-of-the-art capabilities and knowledge** to advance projects relevant and of mutual interest to industry partners
- **Train students** in the advanced technologies that are important to industry partners and to have a pipeline of state-of-the-art talent flowing from academia to industry
- Foster a **community for networking, interactions,** and **collaboration**
- Conduct research that **benefits our industry members**

I/UCRC Partners and Members

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edp renewables
NSF
GE Energy
infigen
Pattern
tpi
bachmann.
NATIONAL INSTRUMENTS
HUNTSMAN
Enriching lives through innovation
nrg Renew
The Maine Composite Alliance
MASSACHUSETTS CLEAN ENERGY CENTER
UT DALLAS
The University of Texas at Dallas
UMASS University of Massachusetts Lowell
IOWA STATE UNIVERSITY
MAINE WIND INDUSTRY INITIATIVE
SOUTHERN MAINE COMMUNITY COLLEGE
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Kid Wind PROJECT

Thrust Areas

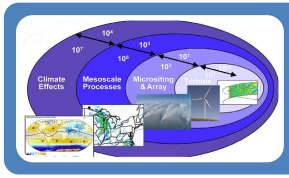
Composites and Blade Manufacturing

- Design and methods
- Next generation materials

Structural Health Monitoring and NDI

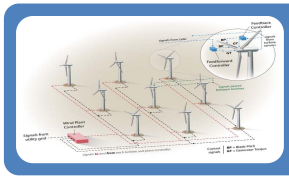
- Damage detection and prognosis
- Life cycle management

3 Projects
7 faculty members
4 graduate students



Wind Plant Modeling and Measurements

- Simulation of power production, power fluctuations and loads
- LiDAR for performance diagnostic and model validation



Control Systems Wind Turbines and Wind Plants

- Optimization of energy capture and load mitigation
- Wake management

2 Projects
5 faculty
4 graduate students

Energy Storage and Grid Integration

- Solutions for more reliable, dispatchable and grid-friendly wind energy systems

Foundation and Towers

- Modeling and costing for higher towers
- Improved ground/soil assessment

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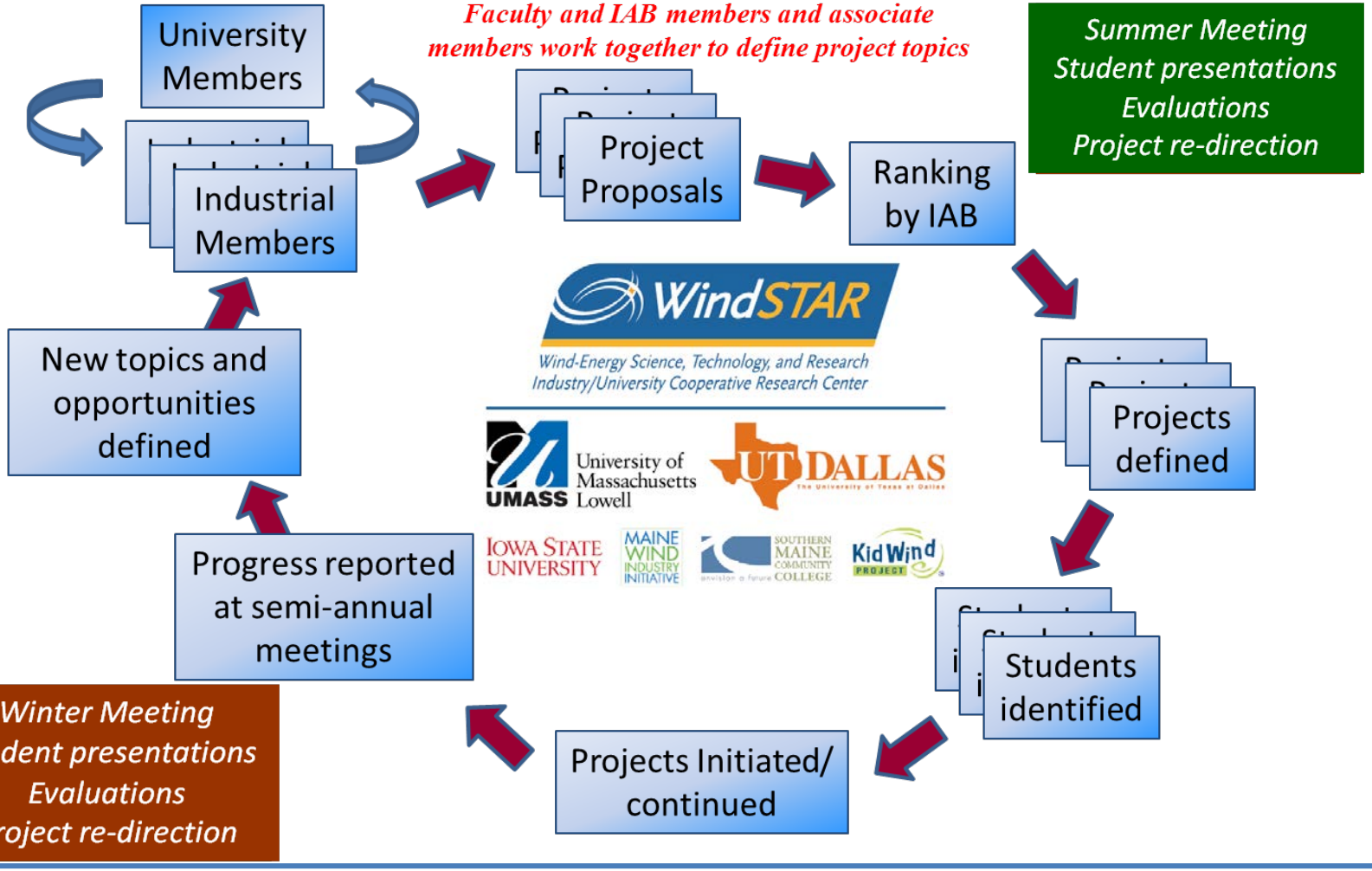
3. How does it work?

WindSTAR I/UCRC - Annual Schedule



WindSTAR - Membership

- Company joins as *WindStar Member* - $40,000/year membership fee, or a *Small Business Member* - $15,000/year (NSF supplements may decrease SB fee to $5,000)
  - **Financial Benefits:**
    1. Enjoy 10% overhead rates on project funds
    2. Pooling money improves return on investment in new technology with a 15:1 leveraging of membership fee (~$670k invested in the first year)
    3. Enables IAB members to team on other research projects supported by NSF and DOE
  - **Members Benefits:**
    1. Invited to attend semi-annual center meeting, guide project execution, and provide input and guidance to faculty and students (Cast 8 votes as an Industrial Member, 3 votes as an SB member)
    2. Work with faculty to identify topics of interest and propose new research topics
    3. Receive copies of semi-annual project reports
    4. Receive non-exclusive rights to all IP generated across the center
    5. Can also provide additional funds for special projects with exclusive rights to IP that is generated
    6. Receive copies of manuscripts generated by faculty and students prior to publication
    7. Receive annual resume book of participating students
    8. Receive access to network with other members and affiliates

Funds for the Center for Year 1

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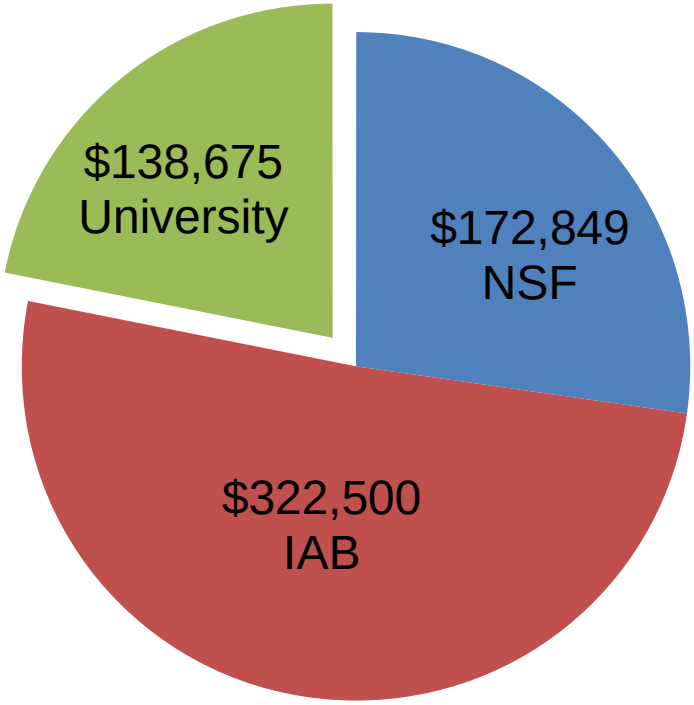

- Total Fund: $634,024 ($495,349 real dollars)
- Leveraging of $40k Membership = 14.9:1 (11.4:1 real dollars)
- In-kind Contribution (UML + UTD): $229,592

Funds Required to Support a Student

	STUDENT ONLY		TYPICAL PROJECT	
Indirect Costs	10%	53%	10%	53%
Faculty Salary	0	0	5,000	5,000
TOTAL SENIOR PERSONNEL	0	0	5,000	5,000
Number of Graduate Students	1	1	1	1
Graduate Students (academic)	17,005	17,005	17,005	17,005
Graduate Students (summer)	12,996	12,996	12,996	12,996
Total Salaries & Wages	30,002	30,002	35,002	35,002
Fringe Benefits	2,411	2,411	2,482	2,482
Total Salaries, Wages & Fringe	32,413	32,413	37,484	37,484
Equipment	0	0	500	500
Travel - Domestic	0	0	1,500	1,500
Materials & Supplies	0	0	3,000	3,000
25% Tuition - RA Fees ($5,000/RA)	5,000	5,000	5,000	5,000
Total Other Direct Costs	5,000	5,000	8,000	8,000
Total Direct Costs	37,413	37,413	47,484	47,484
MTDC	32,413	32,413	41,984	41,984
Indirect Costs	3,241	17,179	4,198	22,252
Total Direct & Indirect Costs	**$40,654**	**$54,592**	**$51,683**	**$69,736**
I/UCRC BENEFIT (University Contribution)		**$13,938**		**$18,053**

- Center Savings in Year 1: **$138,675**

Projects in Year 1 and New Projects

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- E2-14: Extremun Seeking Control for Wind Turbine Power Maximization
- D1-14: Large Area Turbine Blade Inspection
- A3-14: Failure Prevention via Self-healing Materials
- A1-14: Design for Composite Wind Turbine Blade Manufacturing
- E3-14: Two-layer Optimization for Maximizing Wind Farm Power Output
- A1-15 Enhancing Epoxy Infusion in Carbon Fiber Composites
- A2-15 Evaluation of Leading Edge Erosion Protection Systems and Their Effects on Wind Turbine Power Production
- B1-15 Low-Cost Wind Turbine Blade Structural Health Monitoring

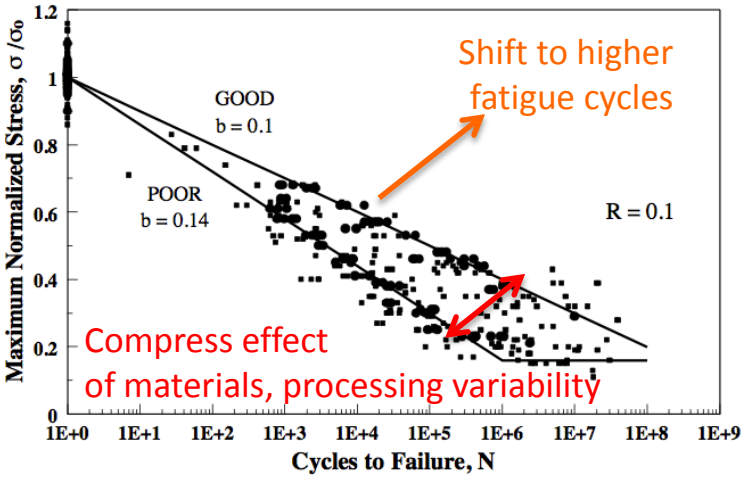
Failure Prevention via Self-healing Materials

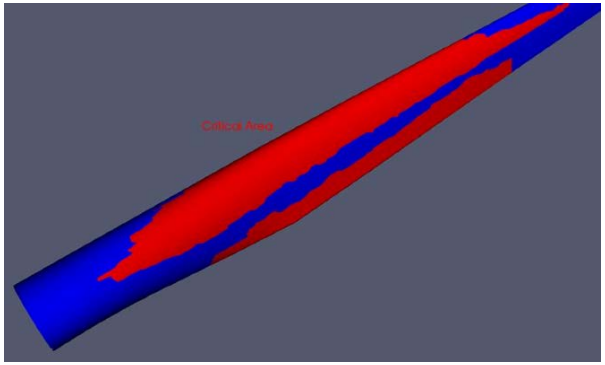
Scope:

- Embed self-healing capsules for improved fatigue life in fiber-reinforced materials
- Increase turbine blade reliability and extend service life while minimizing manual inspection and intervention

Specific Objectives:

- Develop encapsulated self-healing solvent or epoxy-amine chemistries applicable to blade material systems
- Apply self-healing microcapsule based technology to composite specimens manufactured using VARTM
- Examine mechanical properties of manufactured samples using quasi-static fracture and fatigue tests and characterize healing efficiency
- Compute the scope for materials reduction based on material fatigue models

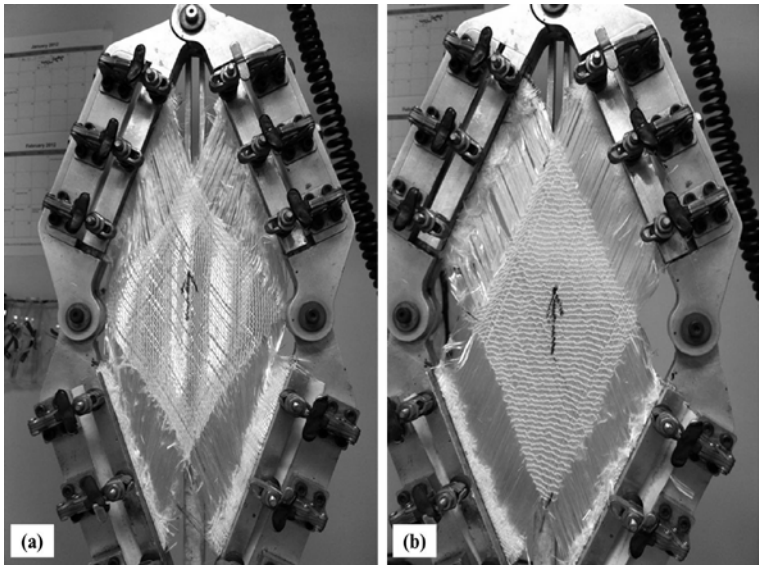


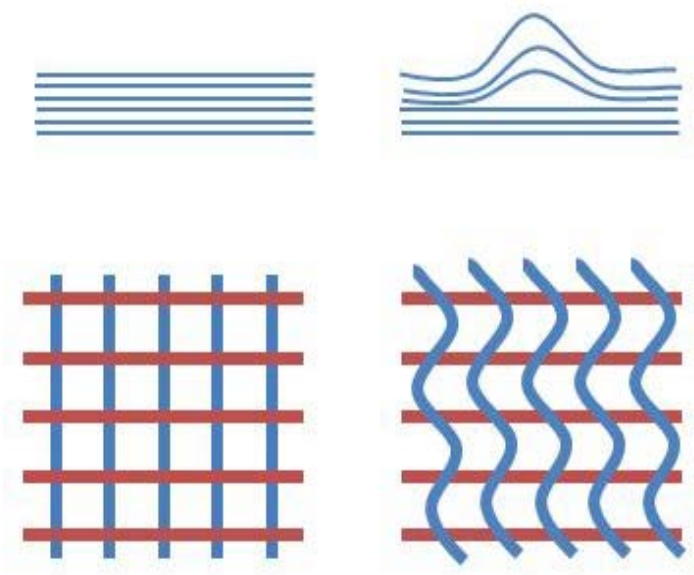


Could target self-healing to critical fatigue locations to further minimize cost

Problem Statement (2/5):

- Depending on the mechanical behavior of the fabric, i.e. in-plane shear stiffness and bending stiffness, localized defects in the form of in-plane waviness and out-of-plane wrinkling can occur.

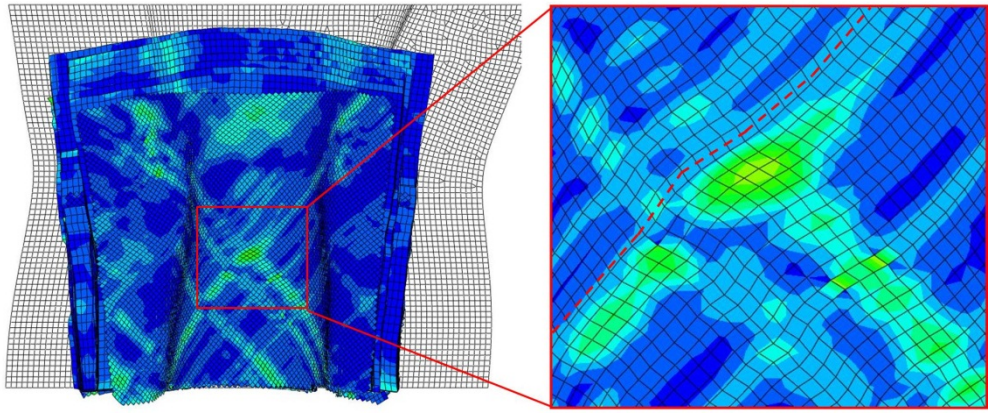




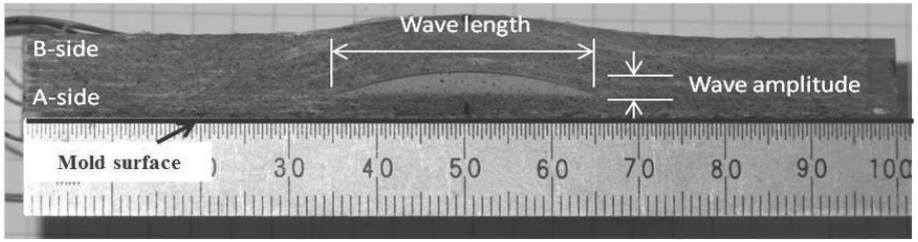
Problem Statement

Problem Statement (3/5):

- Both types of defects can compromise the load path through the structure and lead to reduced stiffness and reduced strength.

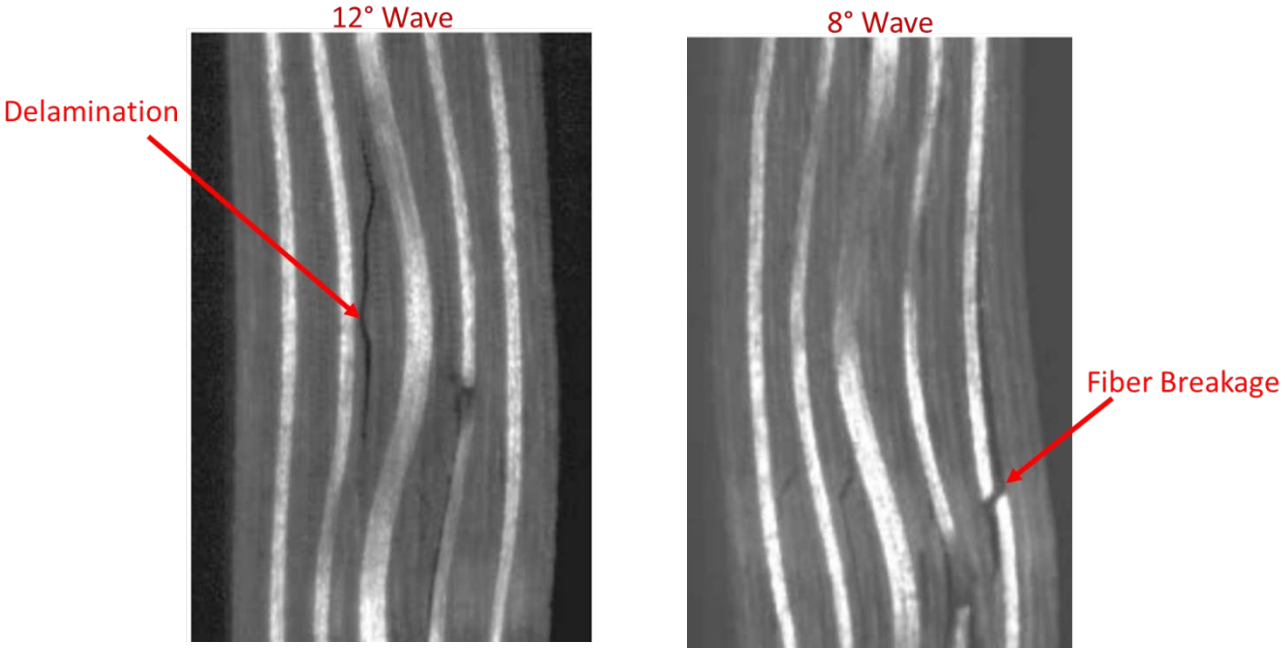


Zoomed-in view of double-bias fabric showing slight in-plane waviness of yarns



Problem Statement (4/5):

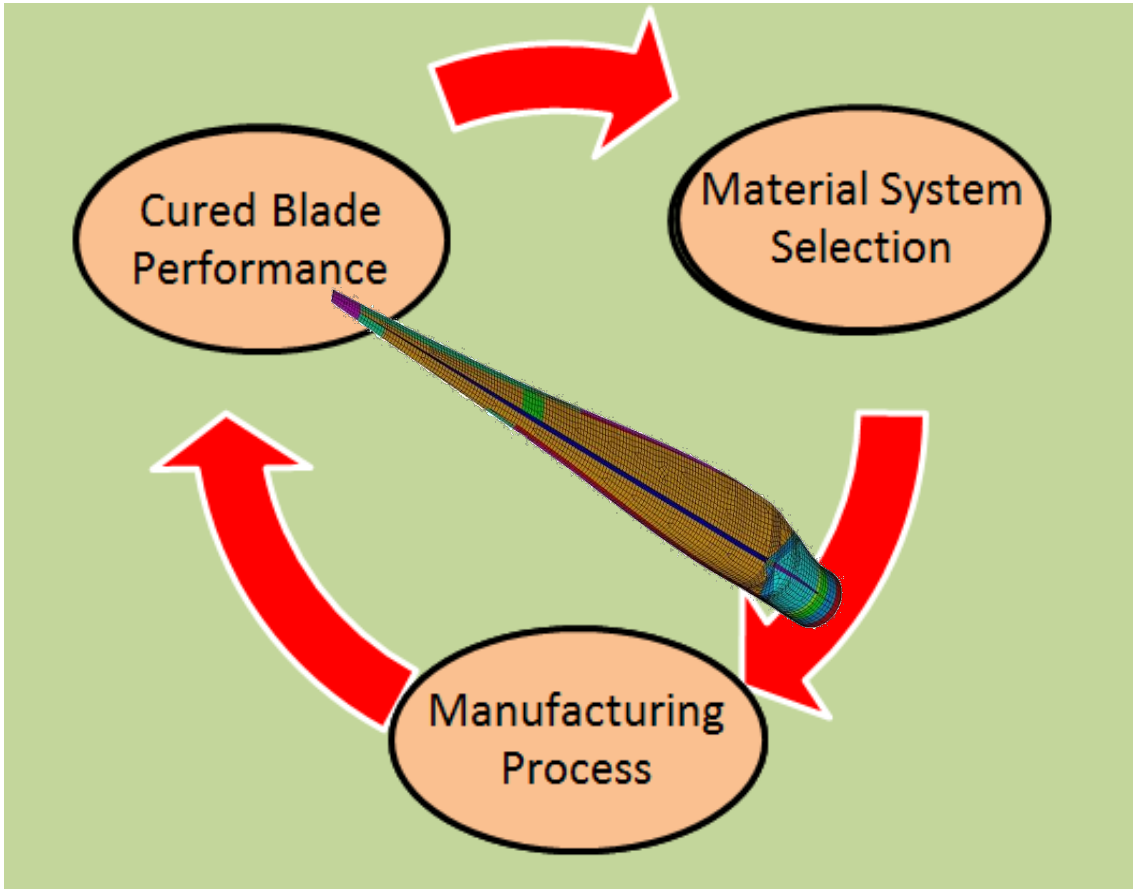
- Example failure mechanisms



Failure mechanism for (a) high and (b) low wave angle

Problem Statement (5/5):

- Need access to an easy-to-use virtual design tool
  - Considers the mechanical behavior of the fabric
  - Valuable tool to assist in the design of the blade manufacturing process
  - Reduce the potential for defects to develop during the manufacturing process
- If defects cannot be eliminated,
  - at least design the process to push the defects into an area of the blade that is of little importance to the structural health of the blade.



Top Reasons to Join WindSTAR

1. Pooling money improves return on investment in new technology with a ~15:1 leveraging of membership fee and only 10% overhead rate (50-100% is typical)
2. Industry members direct the selection and execution of research topics across a broad range of researchers and facilities at multiple universities
3. Sharing risk at an early stage in research is a good business strategy
4. Royalty-free licenses to technology generated through the Center and pre-publication access to research results
5. The Center allows us to pursue other sources of funding
6. Student engagement - resume book and access to graduates who are well trained in the field of wind energy
7. Strategic networking and synergistic cooperation opportunities with complementary *and* competitor companies

Timeline for Joining WindSTAR

1. Attend the next WindSTAR Center IAB Meeting to define research topics with all potential industry members.
   - January at University of Texas Dallas
   - June at UMass Lowell

2. Decide whether becoming a member makes sense for your company and provide a membership fee and sign the membership agreement.

3. WindSTAR I/UCRC will execute its next set of research projects starting September 2015.

www.uml.edu/WindSTAR

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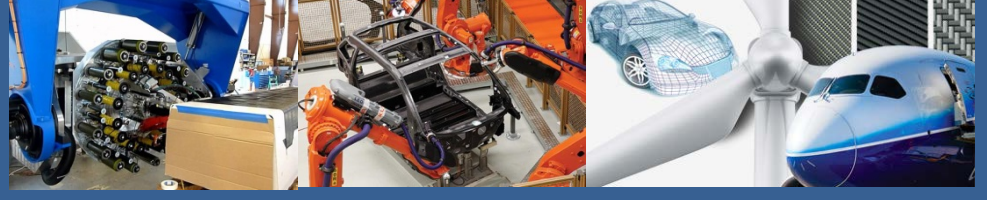
Phone: 401-247-4009

Facilitating **I**ndustry **b**y **E**ngineering, **R**oadmapping and **S**cience for the Composites Industry

FIBERS
Facilitating Industry by Engineering, Roadmapping and Science
Composites Industry Consortium

NIST
National Institute of Standards and Technology
U.S. Department of Commerce

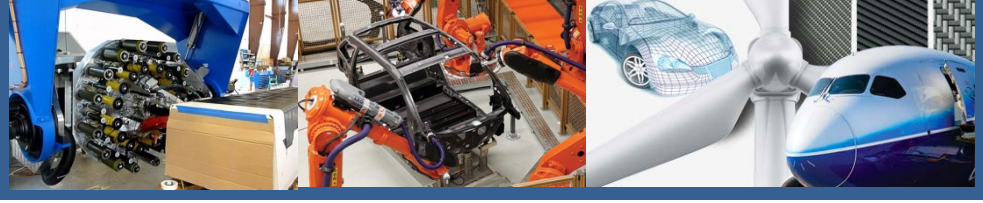


Industry Participation

Companies Providing Letters of Interest for Proposal

ARKEMA, ATK, Aurora Flight Sciences, Automated Dynamics, Bowman Scientific, Performance Quality Cost Composite Sourcing Solutions, CW CompositesWorld, Creative Composites, Ltd
Custom Composite Technologies, Cytec, Dixie Chemical Company, Inc., ecovative, fives, Ford, Front Street Shipyard, GE
Graco, Hodgdon, Honeywell, Kenway Corporation, Kubota Research Associates, Inc., Lockheed Martin, LM
The Maine Composites Alliance, Maine Marine Composites, Maine Wind Industry Initiative, Maine Composites, MSI Mentis Sciences, ORPC Ocean Renewable Power Company, Owens Corning, Plasan
Plastics Unlimited Forming the Future, Quatro Composites, Siemens, Spaulding, Textech Industries, Thermo Scientific, tpi, tsi
Turcotte Yacht Design, LLC, Vistex Composites, Warrior

FIBERS
Facilitating Industry by Engineering, Roadmapping and Science
Composites Industry Consortium



NIST
National Institute of Standards and Technology
U.S. Department of Commerce

University / Non-Profit / Government Participation

UMASS LOWELL

MassMEP
Manufacturing Extension Partnership
YOUR RESOURCE FOR MANUFACTURING GREATNESS

University of New Hampshire

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

ciras

OAK RIDGE National Laboratory

SOUTHERN MAINE COMMUNITY COLLEGE
envision a future

CEG
CENTER FOR ECONOMIC GROWTH
anything's possible™

DEMEP
DELAWARE MANUFACTURING EXTENSION PARTNERSHIP

Rensselaer

UNIVERSITY OF DELAWARE

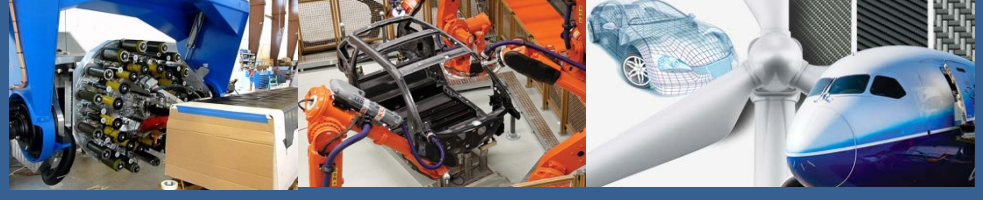
NYSTAR
Empire State Development
Division of Science, Technology & Innovation

BENÉT LABS

NEW HAMPSHIRE MEP
MANUFACTURING EXTENSION PARTNERSHIP

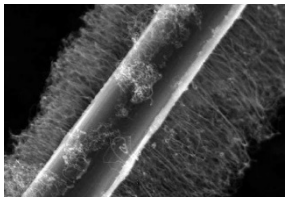
ACMA
AMERICAN | COMPOSITES | MANUFACTURERS | ASSOCIATION

Supply Chain and Life Cycle



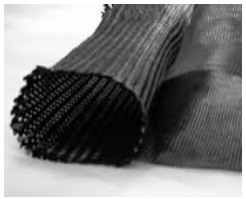
Raw Materials

- Core Materials
- Fiber Production
- Resin Production




Conversion

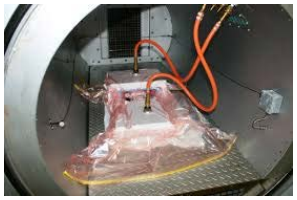
- Braiding
- Coating
- Compounding
- Prepreging
- Weaving
- Winding


Recycling

Manufacturing

- Autoclave
- Infusion
- Molding
- OoA
- Process Design
- Stamping
- Tooling

Applications

- Aerospace
- Automotive
- Energy
- Infrastructure
- Marine
- Military
- Sports

Industry Sectors

Aerospace

Military

Sports / Recreation

Energy

Rail

Automotive

Marine

Architectural

Infrastructure

Other
Piping / Rebar /
Pressure Vessels