



IACMI – THE COMPOSITES INSTITUTE

STATE OF THE INSTITUTE

John Hopkins, IACMI CEO

IACMI Serves Today and Tomorrow



Reflection on why IACMI is important



Review of operational successes



Where do we go from here?

IACMI Provides Production-relevant Environments for Innovation



IACMI facilities service the composites supply chain

Modeling & simulation

Establishing business viability

Prototyping & testing

Full-scale production implementation

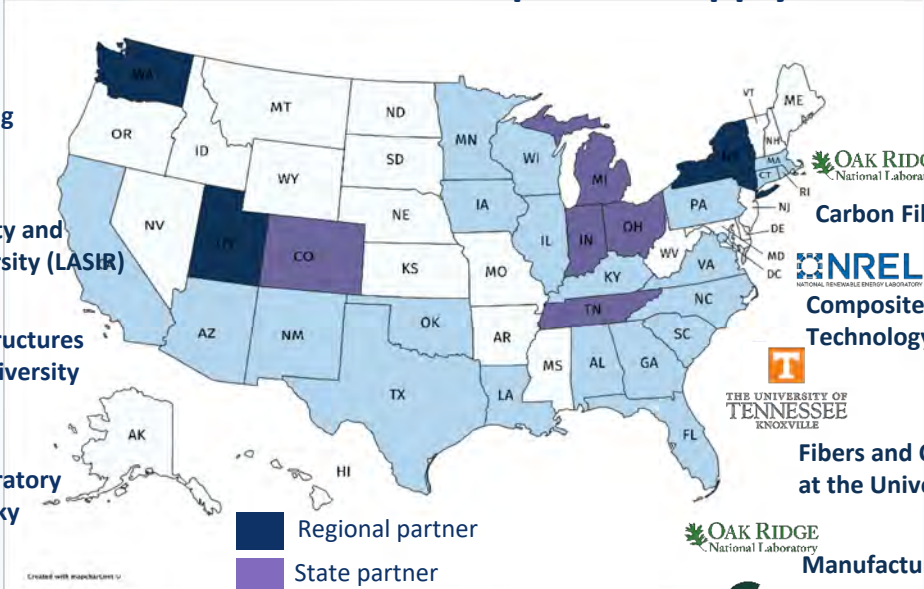
PURDUE Indiana Manufacturing Institute
UNIVERSITY

V Laboratory for Systems Integrity and Reliability at Vanderbilt University (LASIR)
VANDERBILT UNIVERSITY

M Composite Materials and Structures Center at Michigan State University
MICHIGAN STATE UNIVERSITY

UK Carbon Fiber Spinline Laboratory at the University of Kentucky

UDRI Composites Laboratory at UDRI
UNIVERSITY of DAYTON RESEARCH INSTITUTE



OAK RIDGE National Laboratory
Carbon Fiber Technology Facility at ORNL

NREL National Renewable Energy Laboratory
Composites Manufacturing and Education Technology Facility (CoMET) at NREL

THE UNIVERSITY OF TENNESSEE KNOXVILLE
Fibers and Composites Manufacturing Facility at the University of Tennessee, Knoxville

OAK RIDGE National Laboratory
Manufacturing Demonstration Facility

MICHIGAN STATE UNIVERSITY
Scale-Up Research Facility (SURF)

Composites Recycling Technology Center

Utah Advanced Materials and Manufacturing Initiative

Composites Prototyping Center

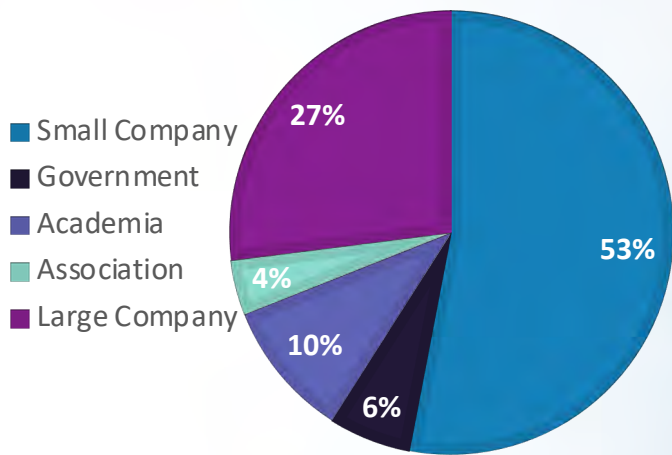


IACMI Creates a Community for Composites Innovation

IACMI improves U.S. security and manufacturing competitiveness by

1. providing production-relevant environments for innovation
2. establishing a supply chain-based framework for decision making
3. training the workforce in support of the needs of the advanced polymer composites industry

MEMBER ORGANIZATION TYPES



\$25.2 BILLION: Composites' annual contribution to the U.S. economy

Source: ACMA 2019 Industry Report

160+ IACMI MEMBERS
50%+ Small & Medium Organizations



Call to Action for the Community



Continue supporting IACMI through consortium engagement and project activities



Respond to upcoming surveys and provide input on future direction



Advocate for IACMI to stakeholders and decision-makers



Help prepare for transition to new models for operation

IACMI Establishes a Supply-based Framework for Decision Making



Driving Productivity & Growth Through Innovation

IACMI hosts bi-annual members meetings in its partner states to showcase technical advancements in IACMI projects, facility tours and updates, workforce initiatives, and member successes. **On average, each meeting brings in over 320 attendees from IACMI member organizations representing more than 30 states.**

96% of survey respondents from the Winter 2018 Members Meeting reported the meeting resulted in a new business opportunity

40+ Technical research and development projects underway, in contracting, or completed

90 IACMI members participating on R&D projects

\$60 Million IACMI industry led R&D projects grow advance manufacturing and position the US for global competitiveness.

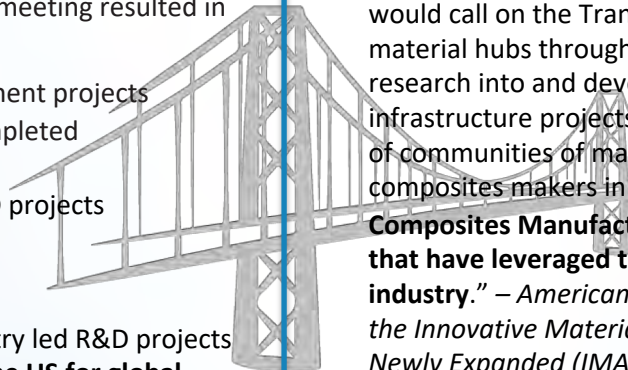
Addressing Critical National Needs

America's infrastructure scores a **D+**

American Society for Civil Engineers 2017 Report Card for America's Infrastructure



“One provision of the **[IMAGINE Act]** would call on the Transportation Secretary to form innovative material hubs throughout the country to continue to drive research into and development of innovative materials for use in infrastructure projects. The provision was inspired by the success of communities of materials manufacturers – like advanced composites makers in Rhode Island and the **Institute for Advanced Composites Manufacturing Innovation in Knoxville, Tennessee** – that have leveraged their innovations and expertise to grow their industry.” – *American Coatings Association discussing support for the Innovative Materials for America's Growth and Infrastructure Newly Expanded (IMAGINE) Act*

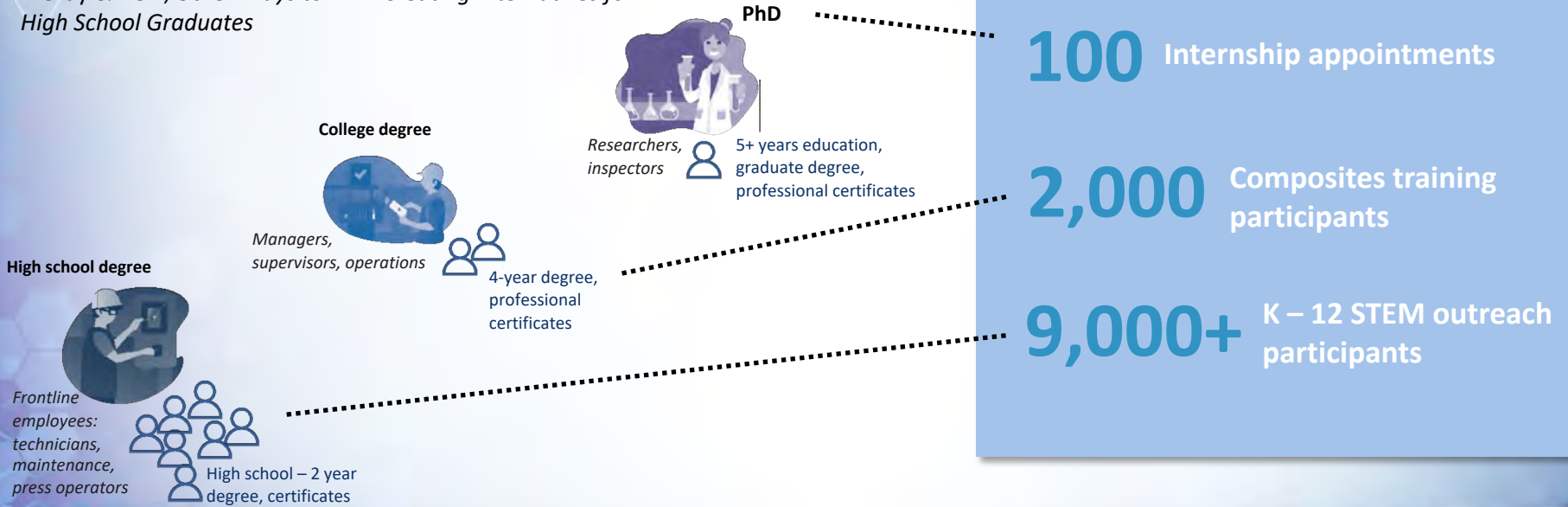


IACMI Trains the Workforce to Meet the Critical Need Skills Gap



“For every occupation that requires a master’s degree or more, **two professional jobs** require a university degree, and there are over **half-a-dozen jobs requiring a one-year certificate or two-year degree**; and each of these technicians are in **very high-skilled areas** that are in great demand. This ratio is **fundamental to all industries.**”

- Gray & Herr, *Other Ways to Win: Creating Alternatives for High School Graduates*



IACMI Supports Recovery, Reuse, Recycle for LCA



Demonstration of Multi/Mixed Stream Fiber Recovery

(CHZ, Ashland, A Schulma, cefic, CSP, John Deere, GE, Boeing, Toray, Owens Corning, Polynt, Scott Bader, Creative Pultrusions, ISRI, LM Wind Power, PRC Composites, ACMA)



CHZ Technologies Wins 2018 R&D 100 Award!

Recycling of Pre-preg Scrap



Progress towards goals

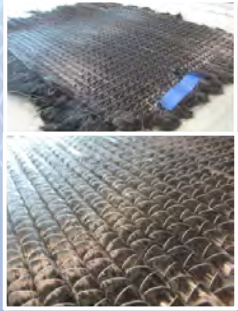
- Developed hybrid guillotine/rotary chopping to utilize tape/roll/edge trim scrap
- Ran at 0.54 kg/min (260 tpy)
- Implementing machine vision for defect repair
- Developed methods of “rigidizing” pre-pregs so cutting of mixed scrap is possible
- Working with supply partners on in-plant optimized collection and transfer systems



IACMI Creates a Path to Adoption – Textile-based CF (TCF)



TCF Stitch-Bonding and VARTM



Large Tow Fiber Placement Stitching/Bonding

(Top) Successful stitching of the second layer (90 degrees) on top of the first layer (90 degrees), thereby creating a bi-axial fabric.

(Bottom) Magnified picture showing consistent high quality fiber placement and stitch bonding on second layer.

Type of thread, stitch type, spacing, etc., could be changed depending on desired efficiency and application. Further structural Z-stitching is possible.

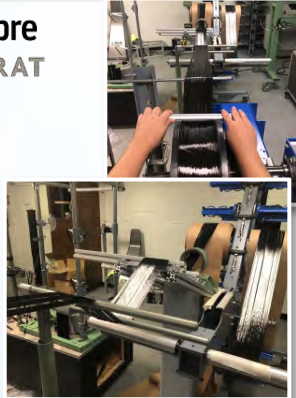


TCF Packaging



Lab Setup

- 1,200-1,300 grams of unrolling tension
- Standard composite creel with 76mm cardboard tube supply package
- DIN bobbin – 4”W x 12” Dia x 6” barrel
- Spreader bars – anodized aluminum & stainless steel, and adjustable
- 457K single tow
- No paper infull on take-up



First Large-scale Molding of TCF – 75 sec cycle time

Compounding Made Simple



- Resin Pellets + TCF (chopped and sized) + secret sauce
- Feeders (downstream for CF)
- Twin screw extruder
- Strands
- Cooling belt
- Pelletize

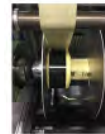
PA66 + TCF
Car Fender



TCF NCF via C-PLY



457K Input



Winding



Assembling

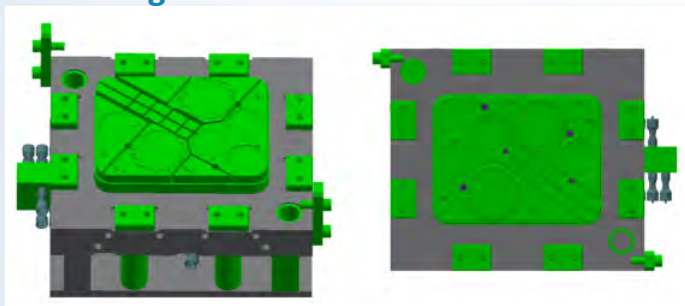
CHOMARAT



Stitching

IACMI Optimizes Processes and Life Cycle Costs

Multi-process Tooling



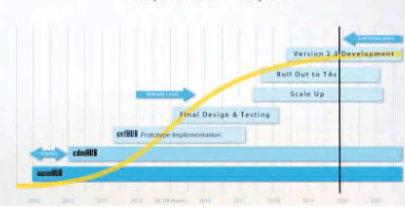
cvfHUB Cloud-based End-to-End Simulation



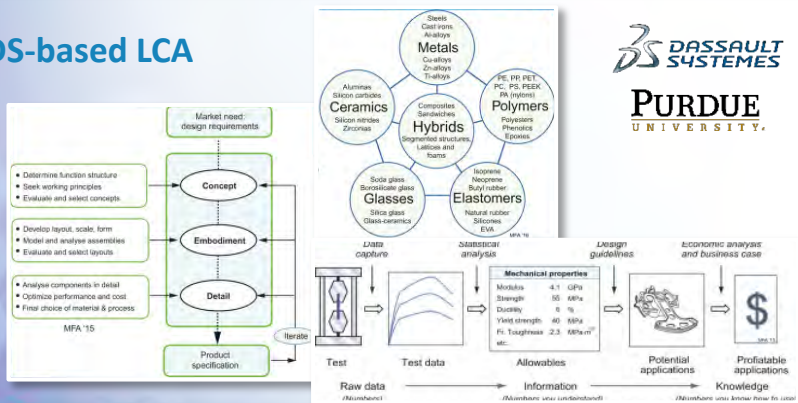
Roll out of cvfHUB

- 11 IACMI projects
- Industry users from:
 - Ford
 - VW
 - DuPont
 - Local Motors
 - Resource Fiber
 - TPI

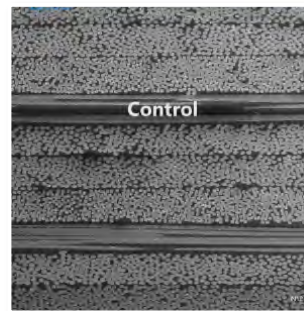
cvfHUB: Development Timeline
Composites Virtual Factory HUB



3DS-based LCA



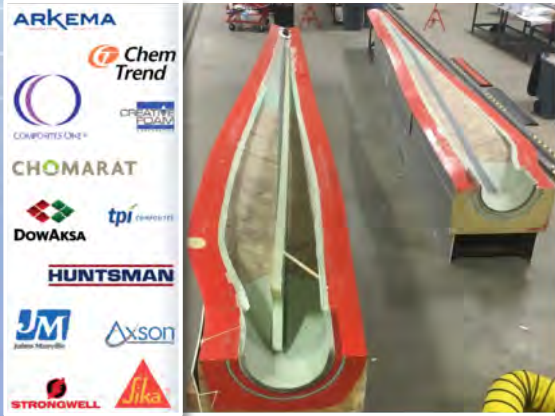
NanoStitch Decreases CFRP Delamination



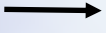
IACMI Demonstrates New Materials and Processes at Application Scale



9 M Blade Technology Demonstrator



Thermoset Resins



Thermoplastic Resins

Standard Carbon Fiber



Low Cost Carbon Fiber

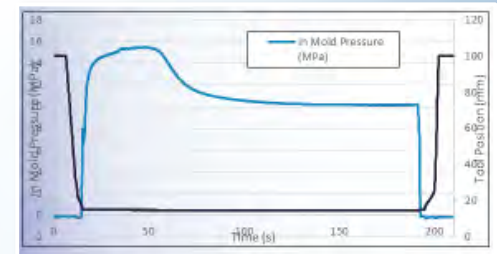
CGS Tank via laser-assisted AFP Vessel After Process Steps



Liftgates for Qualification Testing Prototype Liftgate Molding Process Parameters for Corktown Scale Up Facility



Liftgate inners from Corktown trial



IACMI Supports Complete Development Cycle

Simulation from Design Through Assembly

Simulation: the language of innovation across the automotive supply chain



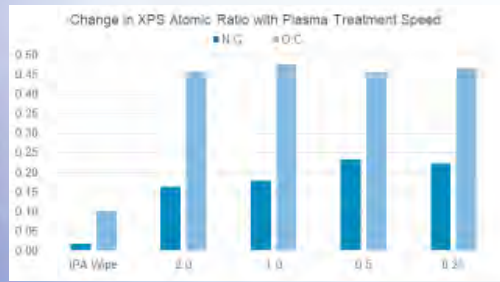
Large Scale Molding

CF-SMC Liftgate Trials at the Scale-Up Research Facility



Analysis

Adhesion to CF/Epoxy Composite Surface



Prepreg

Pre-preg processing Trials at Scale-Up Research Facility



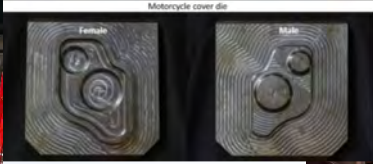
IACMI Continues to Demonstrate New Materials and Processes



Additive Metal Tooling

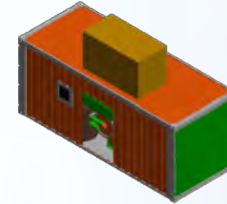


Demonstration of design to molded part at IMTS



Recycled Carbon Fiber

Mixed stream demonstration; Integration with prepreg systems

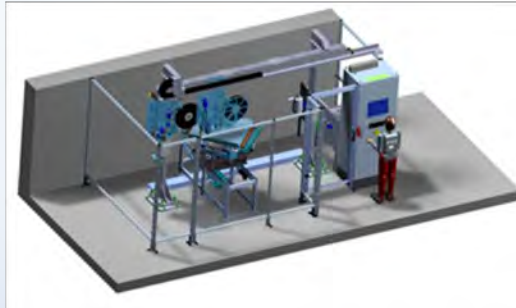


Automated Layup

AFP/ATP Systems

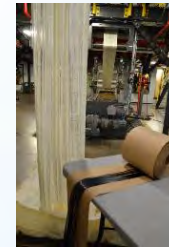
To support multiaxial thermoplastic blanks for molding/overmolding
Specifications

- 48 in x 48 in
- Multiaxial lay-up
- At least 6 layers in under 60 sec.



Textile Carbon Fiber

Characterization -> Sizing -> Handling -> Preforms -> Molding



IACMI Future Direction Builds on Momentum



Expand Scope of Application and
Market Focus



Diversify Funding



Refine Membership Model

Institute Direction - Application Focus



INFRASTRUCTURE

- ◆ Generalization of medium to large structures
- ◆ Staking ground via workshop April 18 at city of Miami Smart Cities event
- ◆ Continued engagement with ACMA and IMAGINE Act



TRANSPORTATION

- ◆ Extension into other modes and vehicle types
- ◆ Commercial – technoeconomic competitiveness
- ◆ Defense – rapid qualification of components

Institute Competitiveness

- Unique materials, scale of processes, and scope of capabilities
- Multi-institutional collaboration model
- Supply chain centric approach for consortium collaboration

Institute Direction - Funding



Federal

Department of Energy
AMO, VTO, WiTO, BTO, SBIR

Department of Defense
R&D, ManTech, SBIR

NSF, NIST, DOL, DOC

Industry

Consortium Membership

Direct funding
Privately Funded Projects
Co-location, Internships

State/Local

Innovation
Entrepreneurship
International

Education
Workforce Development

Fundamental Tenets



Distinguish IACMI from DOE Cooperative Agreement



Create and share value via consortium engagement



Position Institute and consortium for co-investment



Drive ROI via direct and shared benefit



Recover costs for sustainably maintaining consortium

Call to Action for the Community



Continue supporting IACMI through consortium engagement and project activities



Respond to upcoming surveys and provide input on future direction



Advocate for IACMI to stakeholders and decision-makers



Help prepare for transition to new models for operation