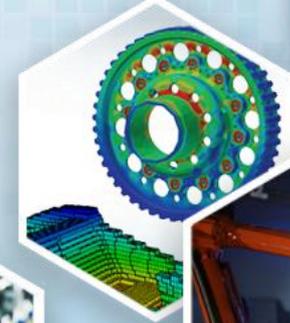


Welcome to the **Future Mobility** **/ Vehicle Technology Work Group**

Ray Boeman, Michigan State Univ.
Uday Vaidya, IACMI/UT-Knoxville
October 8, 2020



Working Group Meeting Rules/Guidelines



- ◆ **Format includes an introduction and opening presentation from the meeting leader(s)**
- ◆ **All participants will be muted once the presentation starts**
 - ◆ Remain on mute unless you wish to speak. You will need to unmute yourselves to speak. Please re-mute yourself after speaking.
 - ◆ If you are on the meeting via phone, use *6 to unmute and re-mute
- ◆ **The platform allows for live polls**
 - ◆ One poll will be for meeting frequency
 - ◆ Other polls may be created by the leaders or in live time based on input

Consortium Working Groups



- ◆ **Mission – Focus on addressing technoeconomic barriers to mass adoption of composites in partnership with similarly aligned organizations**
- ◆ **Formation**
 - ◆ Topic based, ideally formed organically from the membership
 - ◆ Members include industry, academic, national laboratory at all levels of consortium
 - ◆ Elect chair, meet at least 4x per year, more if desired by group
 - ◆ Opportunity to align with external entities (ACMA, ACC, other organizations)

◆ Principal Activities

- ◆ Identify key technical and cost challenges and possible solutions to those
- ◆ Conduct roadmapping as needed specific to topical market or technology focus
- ◆ Inform funding agencies (DOE, DOD, etc.) of priority R&D needs
- ◆ Propose projects for funding – using working group funds or IACMI pool funding
- ◆ Propose mini-conferences or other activities, possibly with outside entities
- ◆ Report activities and successes at IACMI member meetings and other forums, including trade press and conferences

Megatrends Shaping Future Mobility



AUTONOMY



Advanced driver-assist safety technologies and other technological breakthroughs are helping to gradually relieve human drivers from controlling passenger vehicles.

CONNECTIVITY



Future vehicles will offer greater levels of connectivity and communications, driven not only by in-vehicle comfort and convenience but also by safety considerations.

CIRCULARITY



Principles of a circular economy emphasize recovering materials at the end of their usable life, refurbishing and repairing materials to extend product lifecycles, and remanufacturing and reusing them in new products.

ELECTRIFICATION



Electric vehicle (EV) sales are accelerating and projected to represent between 30% and 50% of worldwide vehicle sales by 2040, up from just 1% of worldwide vehicle sales in 2016.¹¹

SHARED MOBILITY



Adoption of ridesharing has grown from 15% of U.S. consumers having used ridesharing in 2015 to as many as 43% of U.S. consumers in 2018, helping to reduce travel costs and environmental impact of passenger vehicles.¹⁴

SUSTAINABILITY



Automakers are working to achieve sustainable automotive design that reduces environmental impacts and improves the efficiency of products throughout their lifecycle.

Trends in the Transportation Market

GLOBALIZATION

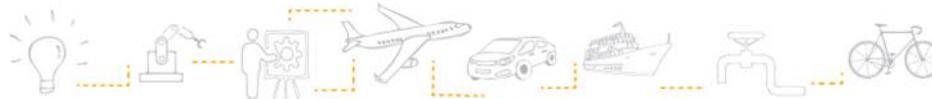
ELECTRIFICATION

LIGHTWEIGHTING

MIXED MATERIALS

ENVIRONMENTAL IMPACT

WE FORM THE FUTURE



CAMX

Anaheim Convention Center | Anaheim, CA, USA

Scope of the working group

- Application/market areas
 - Primary Focus historically on automotive applications
 - Ancillary application opportunities:
 - Commercial Vehicles
 - Shared Transportation
 - Defense?
- Technology focus – increase value
 - Increased performance
 - Increased throughput (e.g., automation, process, materials)
 - Reduce cost (e.g., scrap minimization, next bullet)
 - Optimization/hybridization
 - Feature Integration/Multi-functionality
 - Sustainability

Note:

- These are thought starters.
- This is our working group.
- Collectively we will define/revise

◆ Specific Activities

- Provide platform for aggregating and sharing information among members
 - Trends & developments (mega, technology)
 - National & International collaborations and standards
- Compelling demonstrations to validate new technologies
- Identify and recruit members to fill gaps in stakeholder engagement
- Prepare and disseminate critical information to stakeholders

◆ High-level Objectives

- Form collaborations throughout value-chain to translate promise to reality
- Inform Industry, government, and educational stakeholders
- Assist in growing the robustness of the value chain to capitalize on commercial promise

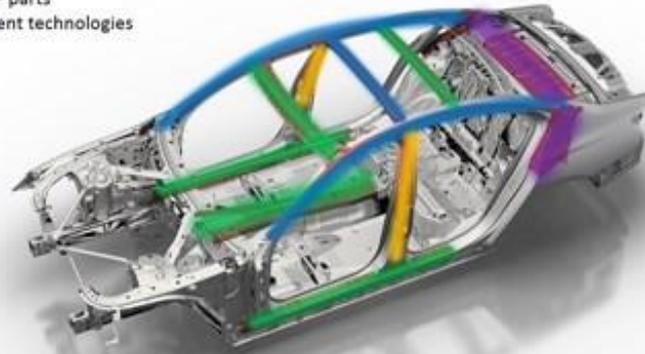
Past Decade Perspective – BMW Transition

Composite Monocoque - i3, i8
~2010



"Carbon Core" – Series 7
~2016

16 CFRP parts
4 different technologies



CFRP Wet Compression
Molding

CFRP Resin Transfer
Molding

CFRP-Steel Hybrid

CF Sheet Molding
Compound



Source: BMW, Composites World, BNEF

Radius Protrusion – GM, Shape, Thomas-Technik



2020 Chevrolet *Corvette* curved, pultruded rear bumper beam

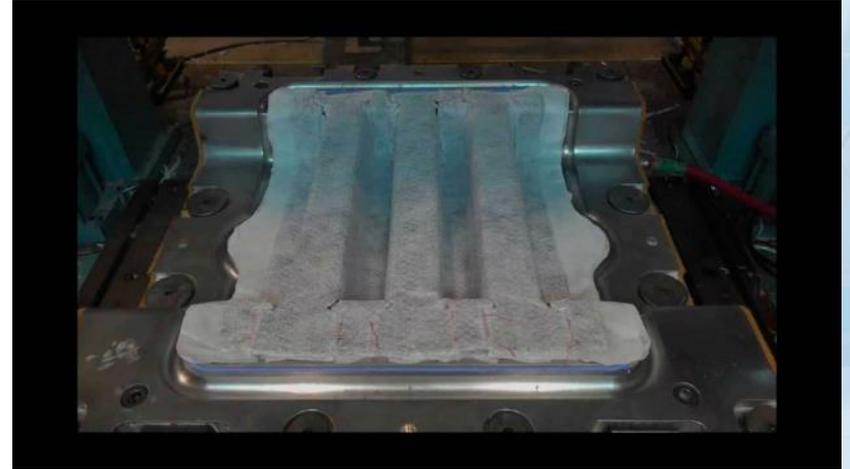


<https://www.compositesworld.com/articles/curved-profiles-radius-pultrusion>

Directed Fiber / Tailored Preforms

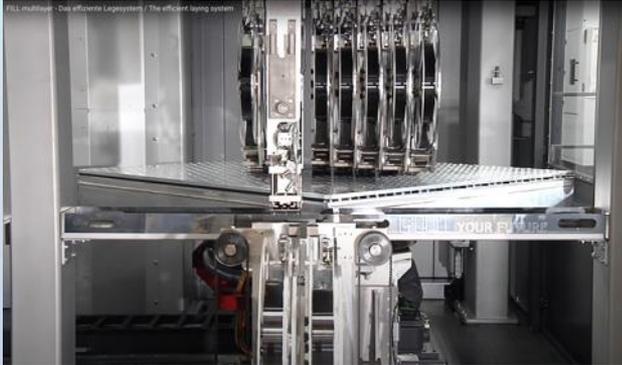


Source: Coats

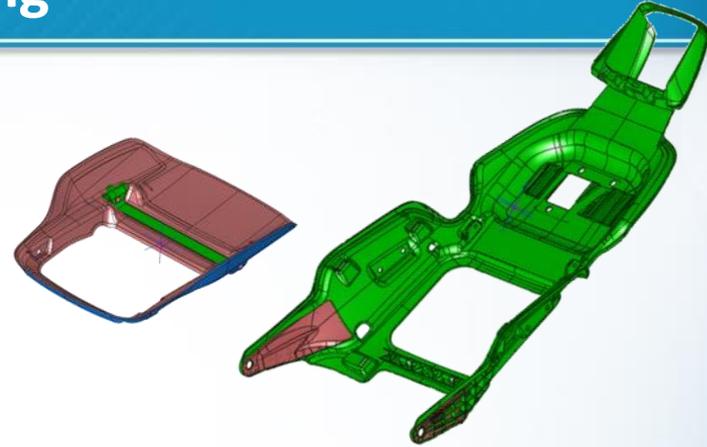


Source: General Motors, GALM

Automated Lay-up & Hybrid Molding



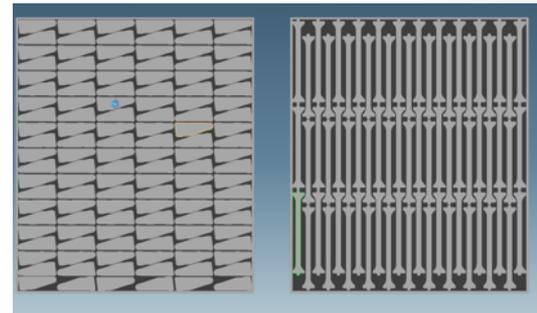
High Through-put Tape Lay-up



Hybrid Structure



Tailored Blanks



Nested Inserts

Recycled carbon fiber feedstock for injection molding compound (Vartega/Techmer/MSU)



	Baseline	Recycled fiber
Carbon fiber @10%	115 MJ/kg	5 MJ/kg
PA 6/6 @90%	52 MJ/kg	52 MJ/kg
Compounding	8 MJ/kg	8 MJ/kg
Injection Molding	<u>11 MJ/kg</u>	<u>11 MJ/kg</u>
Total energy	186 MJ/kg	76 MJ/kg

← 96% reduction

← 60% reduction

DOE Vehicle Technology Office Composites R&D Strategy



U.S. DEPARTMENT OF
ENERGY

Office of
ENERGY EFFICIENCY &
RENEWABLE ENERGY

VTO Composites R&D – Vision and Strategy

May 8, 2019

Felix Wu (presenter)

- Dave Howell
- Gurpreet Singh
- Sarah Kleinbaum
- Jerry Gibbs



Why Composites R&D?



- **Composites offer significant weight saving potential for vehicles**
 - High specific strength, High specific stiffness, Durable, Lightweight structures enable direct fuel economy improvement
 - Excellent chemical/corrosion resistance, high thermal conductivity
 - Design flexibility, consolidated parts and functions
 - Significant reduction of noise, vibration, and harshness (NVH)
 - High performance at high temperature up to 500 °C
- **So what's “Barrier” with composites?**
 - High cost carbon fiber
 - High-rate composite manufacturing
 - Composites require somewhat complex designs when using multiple materials
 - Effective joining of multi-material structures
 - High-rate composite manufacturing
 - High manufacturing cost for finished part
 - Computational tools and performance prediction
 - Converting theoretical values into component reality
 - Recycling

Materials Technology Roadmap (October 2017)



Current VTO Materials Portfolio

← Increasing Need for R&D

Increasing Impact on Reducing Vehicle Mass

Material	Critical Challenges				
Multi-Material Systems Enablers	High Volume Joining (Fusion, Mechanical, Adhesives)	Engineered Surfaces (Corrosion, Wear, Friction)	Predictive Modeling	NDE & Life Monitoring	Recycling
Carbon-Fiber Composites	Low-cost High-Volume Manufacturing	Low-Cost Fibers	Predictive Modeling	Joining, NDE, Life Monitoring & Repair	Recycling (OFFAL / Vehicle)
Aluminum	Low-cost Al Manufacturing Processes	Improved Alloys (Body/Powertrain) for Performance & Manufacturing	Joining Mixed Al Products	Recycling Vehicle	
Ultra High-Strength Steels	Improved Alloys for Room Temp Forming	Weldability for Dissimilar Steel Alloys	Predictive Modeling (Formability, Crash)		
Magnesium	Low Cost Feedstock, Low Carbon Footprint Production	Galvanic Corrosion Protection	Improved Alloys for Energy Absorption	Manufacturing (Sheet and Extrusions)	Recycling
Glazings	Low Cost Feedstock for Polymer Glazings	Low Temp Processed Chemically Toughened Glass	Durable, Scratch Resistant, UV Resistant Coatings		
Metal / Ceramic Composites	Feedstock Cost	Compositing Methods	Powder Handling	Compaction	Machining & Forming

Opportunity to Re-Align Vision to Focus on Two Thrust Areas



Thrust Area 1

Low Cost, High Volume Components

- Semi-structures
- Interior
- Inner panels

Application-inspired R&D focused on low-temperature and low to intermediate-strength vehicle components:

- Semi-structure, interiors
- Thermoplastic-based polymer composite systems
- Hybrid composite systems
 - ✓ Use of different reinforcements
 - ❖ Carbon fiber
 - ❖ Glass fiber
 - ❖ Kevlar fiber
 - ❖ Nano-cellulose fiber
 - ❖ Basalt fiber
 - ❖ Nano-fillers/particles (CNTs, graphene)
 - ❖ Etc.

Thrust Area 2

High Performance Components

- Primary structures
- Crash worthiness
- Under hood (engine)

Application-inspired R&D focused on high-temperature and intermediate to high-strength vehicle components:

- Primary structure, suspension, power transmission (shafts, tires, belts), propulsion
- Thermoset-based and hybrid polymer (a mix of thermoset and thermoplastic systems) composite systems
- Hybrid composite systems
 - ✓ Use of different reinforcements
 - ❖ Carbon fiber
 - ❖ Glass fiber
 - ❖ Kevlar fiber
 - ❖ PBO fiber
 - ❖ UHMWPE fiber
 - ❖ Nano-fillers/particles (CNTs, graphene)
 - ❖ Etc.

Begin Polling



Polling Instructions

- Open the meeting chat for a SurveyMonkey link.
- Click on the link to be taken to a survey and respond accordingly.
- We'll share the results soon and discuss.

Poll – Most Important factors impacting growth



Pick top 3

- ◆ Lightweighting
- ◆ Electrification
- ◆ Integration of sensors, actuators
- ◆ Multi-functionality
- ◆ Design flexibility
- ◆ Circular economy, sustainability, LCA

Poll – Technologies Opportunities and Challenges



Pick top 3

- A) Development of new materials (improved cost, performance)
- B) Reduction of offal (waste from making individual parts)
- C) Reduction of scrap (percentage of bad parts)
- D) Automation
- E) Process throughput (non-automation)
- F) Hybridization (similar or dissimilar materials)
- G) Multifunctionality/integration (e.g., sensors, actuators, etc.)
- H) Multi-material joining
- I) Education and workforce development
- J) R&D resources (e.g., financial, infrastructure)

Poll – Primary Stakeholder Role



Pick one

- A) Automotive OEM
- B) Tier 1
- C) Tier 2
- D) Materials suppliers
- E) Engineering and services supplier (including M&S)
- F) Research Institution (University, Government, Non-Profit)
- G) Federal or State Agency
- H) Trade & Professional Associations, Communication, Advocacy, etc.

Poll - How often should this working group meet?



- ◆ Quarterly (4x per year)
 - ◆ IACMI virtual member meeting - week of February 15, 2021
 - ◆ SAMPE Long Beach – May 24-27, 2021
 - ◆ IACMI summer meeting Detroit – week of July 19, 2021
 - ◆ CAMX Dallas – October 18-21, 2021

- ◆ Bi-monthly (6x per year)
 - ◆ Four meetings above plus two additional meetings

- ◆ Monthly (12x per year, or 11x if December skipped)
 - ◆ Four meetings above plus virtual in other months

- ◆ What innovative materials/processes that are on the horizon?
- ◆ What are the opportunities for multifunctionality or integration?
- ◆ What are the most significant high-level challenges for the value chain?
- ◆ What is the relevant scope beyond Automotive?



**Thank you for
attending!!**