



Utah Aeronautics Conference 2022

Advanced Materials for AAM Aircraft

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Utah Advanced Materials and Manufacturing Initiative (UAMMI)

- **MISSION**: Expansion of Utah's Advanced Materials & Advanced Manufacturing Industry
- **Materials**: Carbon Fiber, Advanced Alloys, Ceramics, Polymers, Graphine
- **Manufacturing**: High precision manufacturing using robotics, digital engineering, and 3D printing
- **Markets**: aerospace, defense, medical, outdoor recreation
- **Organization**: Non-profit, Public-Private-Partnership



Utah leads in Advanced Manufacturing

- *1 of 13 communities* selected by **DoE** as Coal Innovation Community (2021)
- *Targeted Industry* (Economic Cluster) designation by **GOED** (now Go Utah) in 2020
- *1 of 6 communities* selected for **DoD** Defense Manufacturing Support Community Designation in 2020
- *1 of 7 communities* selected by **SBA** for Regional Innovation Cluster program in 2018
- *1 of 24 communities* selected as part American Manufacturers Community Collaborative designated by **U.S. Department of Commerce** in 2016

Utah's Companies in Composites & Aerospace

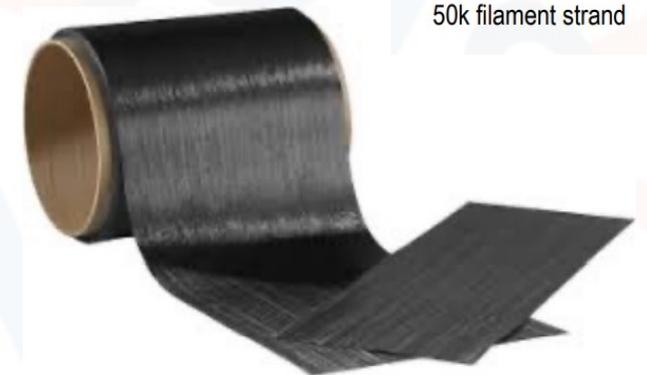
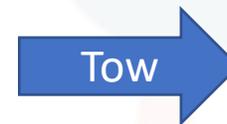


What are Composites and Carbon Fiber?

- A composite is a product that results by combining two dissimilar materials, typically a fiber and a resin
 - The result is greater than the sum of its parts
 - New product has superior structural properties not found in the original materials separately
 - Utah pioneered composites in the 1950s with the Hercules missile program
 - Utah is the epicenter for composites in the United States
- Carbon fiber is a reinforcing fiber made from a precursor
 - These include polyacrylonitrile (PAN) or pitch, which usually is petroleum based
- Fiber can be spun into different tow sizes
 - Smaller sizes are used in weaving fabrics
 - Heavier sizes are used for sheet materials that have reinforcements and uncured resin combined, called prepreg



50k filament strand



Benefits of Composites and Carbon Fiber

- Can "tailor" the properties to fit the application easier than metals
- On many levels, carbon fiber outperforms or equals metals
 - **Stronger** than steel
 - **Lighter** than aluminum
 - **As stiff as** titanium
- High strength combined with high strain
 - Can go through many operational cycles without failing
- Easily bondable to other materials



Image: Hexcel Corporation

Advanced Manufacturing

- Additive manufacturing is the *addition* of materials to produce a part
 - As opposed to traditional subtractive manufacturing where excess is cut away
- 3D printing is the primary additive process
 - Materials are typically in powder form
- ElectraFly used UAMMI's Carbon-Based Additive Manufacturing (CBAM) 3D printer from Impossible Objects to print parts
 - Using composites instead of aluminum enabled ElectraFly to keep aircraft weight under 55 pounds
 - Allowing flight testing under Part 107



Advanced Manufacturing is Important to Advanced Air Mobility

- Advanced Air Mobility (AAM) is the use of new flight concepts for:
 - Urban Air Mobility (UAM)
 - Select inter-city transportation
 - Cargo and package delivery
 - Public services (first responders, road & utility inspection, etc.)
- Comprises new light-weight aircraft with new energy solutions such as eVTOL
- AAM aircraft include those with on-board pilots and remotely piloted models
- It helps address America's transportation network needs
 - Reduces congestion
 - Addresss environmental concerns
 - Increases productivity
- Provides new tools for the warfighter
 - Attritable aircraft for surveillance and deliveries
 - Troop and materials transport



AAM is a *dual-use* technology that can meet 21st century defense objectives

- The U.S. Air Force has identified the need for ***attritable*** aircraft
 - Low-cost
 - Limited use
 - Not slated for long-range maintenance plans like conventional aircraft
 - Can be produced at high rates
- Such aircraft would allow the U.S. to counter the technological capabilities of near-peer competitors such as China
- Range of use cases for AAM in a military environment would provide enhanced tools and safety for the warfighter



UAMMI is Advocating for Innovation in Advance Materials Qualification for Aircraft

- Regulatory environment does not support qualifying new materials and advanced manufacturing
- In 2021, UAMMI released an important whitepaper developed with NEXA Advisors
- Provides foundational research to support qualification of advanced materials
- Proposes a new center of excellence:

The Aerospace Advanced Manufacturing Center (AAMC)



AAMC Will Help Address a Significant Commercial Market

- Within a few years, Advanced Air Mobility (AAM) will radically transform transportation for both the commercial and military sectors
 - AAM will help alleviate traffic congestion, reduce emissions and provide military flexibility
- The market potential is enormous, at more than \$1.5 trillion
- However, UAMMI's research identified a growing gap in U.S. manufacturing capabilities and the urgent need for innovation in advanced materials qualification
 - In addition to the military challenge posed by China, the country threatens to grab the commercial market

AAM Requires High Production, Speed and Quality in Materials Certification

- In aerospace, new material qualification takes up to a decade
- AAM demand, and thus production rates, are a hybrid of aerospace and automotive

				
<i>Units Produced:</i>	3,500	10,000	60,000,000	proj. 10,000s
<i>Product Size:</i>	100 x 200+ ft	5 - 10 ft (dia)	5 x 15 ft	30 x 45 ft
<i>Part Count:</i>	2,500,000	25,000	30,000	est. 10 - 15,000
<i>Quality Drivers:</i>	Product integrity	Product integrity	Production integrity	Product integrity
<i>Key Challenge:</i>	Size	Tolerance	Production rate	Production rate
<i>Supplier Base:</i>	Duopoly	Oligopoly	Globally competitive	Globally competitive

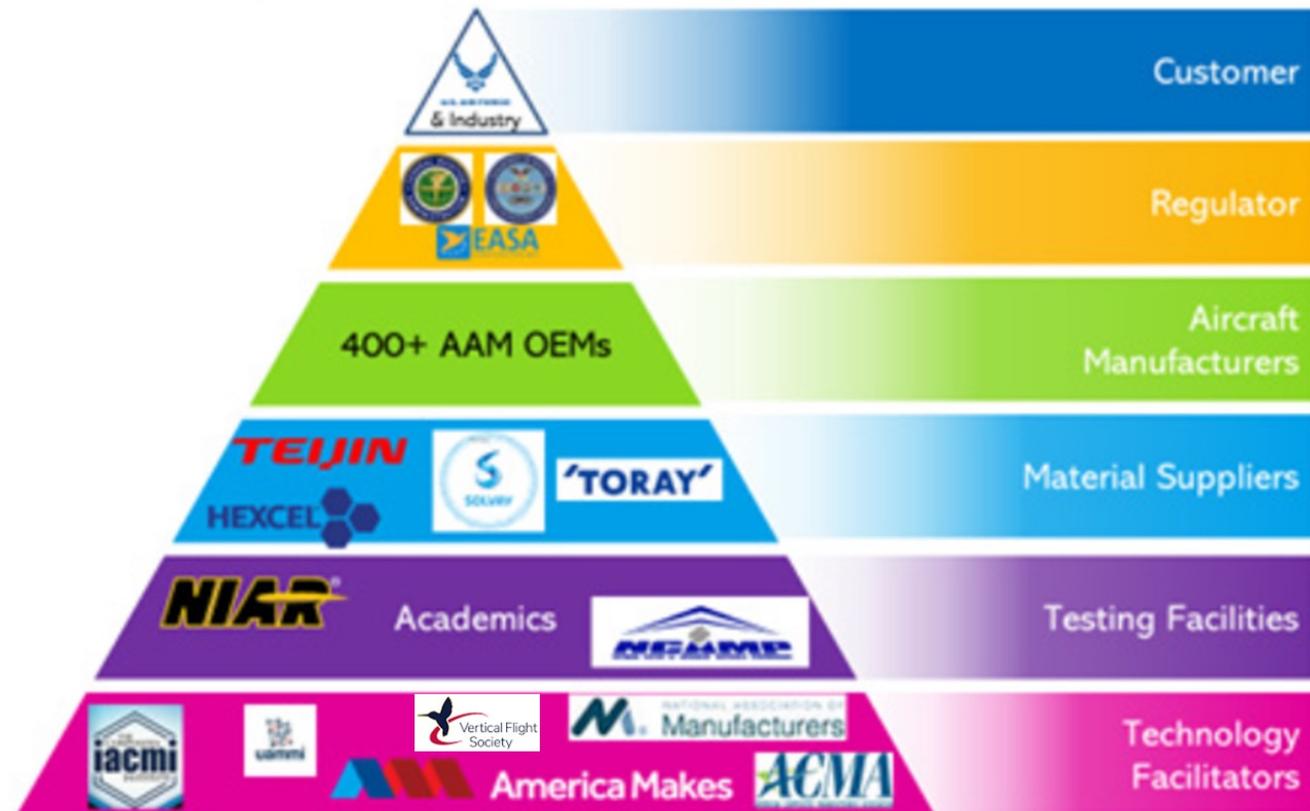
Major Differences Between Materials Certification for Automotive and Aerospace

- Automobiles have far fewer parts than aircraft
 - Reduce overall pool of materials used
- Process time to qualify an existing material for aerospace is four years
 - ***But can take up to a decade to qualify a NEW material***
- For the auto industry, qualification of metals takes just 18 to 20 months on average
 - Even lower for new plastics or composites: five to seven months
- Other key differences
 - Size of parts – consider that fasteners are more predominant in aviation, where automobile production will use spot welds
 - Magnitude of failure if something goes wrong in terms of lives lost and cost of asset

AAMC Consortium of Stakeholders

- AAMC will be organized such that its work for the both Air Force and the commercial industry benefits from the base support of technology facilitators
- The proposed Aerospace Advanced Manufacturing Center provides the needed solution to ensuring the U.S. competitiveness in this emerging market

Aerospace Advanced Manufacturing Center (AAMC)
Facilitation Pyramid

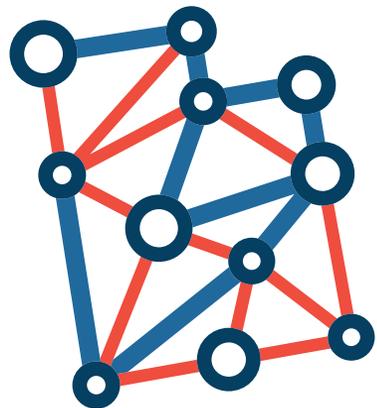


Sustainable Business Plan for AAMC

- AAMC business model incorporates license and royalty agreements that can be leveraged to repay investments in innovative projects.
- Up to \$1 billion in funding, almost all from the private sector, will be teamed with grants and funding from the Air Force Research Labs.
- AAMC will be self-sustaining over the long term: a public private partnership (P3) to ensure adequate funding.
- The result will **revolutionize** methods of materials qualification and manufacturing
- **Positive outcomes**
 - U.S. dominance in AAM and attritable remotely piloted and autonomous aircraft
 - Increased national security
 - Economic productivity, jobs, and tax revenues
 - Far-reaching industrial and social benefits

Conclusion

- New materials and advanced manufacturing are the future
- They meet 21st century challenges in both commercial and defense sectors
 - More efficient cities with reduced congestion
 - Better tools for the warfighter
- *But* we have work to do to get there
 - Enhanced qualification and certification efforts are key
- Focused entities, such as AAMC, and funding are a major part of the solution



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