OAK RIDGE National Laboratory | MANUFACTURING DEMONSTRATION FACILITY

MANUFACTURING RENEW3D

Manufacturing Renew3D Report Out

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Manufacturing RENEW3D

Knoxville, TN 2023

ORNL is managed by UT-Battelle, LLC for the US Department of Energy

U.S. DEPARTMENT OF ENERGY

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How can we prioritize the sustainable manufacturing and advanced manufacturing technology research that will build a net-zero future?

- Gather the community together
  - Academia
  - Aerospace
  - Material Suppliers
  - Wind Energy
  - Large Scale Additive Manufacturing
  - Buildings & Infrastructure
  - And more!

Big Picture

- **NET ZERO by 2050**
- **50% Reduction in green house gases**

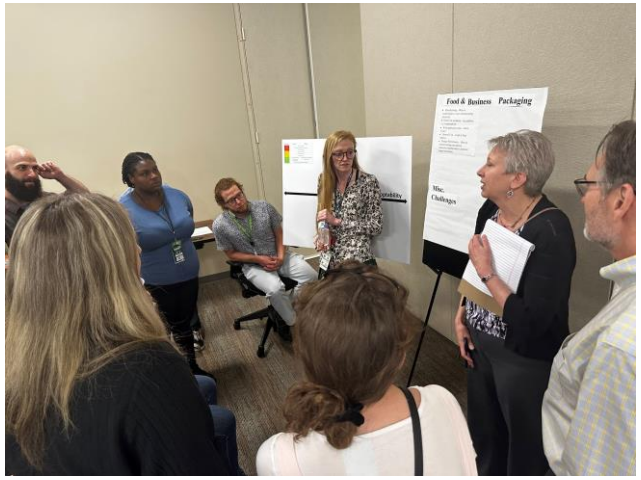
How can we prioritize the sustainable manufacturing and advanced manufacturing technology research that will build a net-zero future?

- Gather the community together- Industry, academia, government
- Identify which technologies to support and develop from the people that want them most
- Understand the technologies available
  - What needs de-risking?
  - What isn't working out?
  - What is up and coming?
- Collaborate to make it happen

Big Picture

- **NET ZERO by 2050**
- **50% Reduction in green house gases**

Snapshots from the Workshop



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Industry Keynote: Sustainability Policy Implications

Kelly Visconti, Department of Energy Office of Manufacturing and Energy Supply Chain

National Priorities

Develop and secure US manufacturing to increase competitiveness, create jobs and decarbonize our economy

Challenge (2050 net zero GHG emissions)

MESC is focused on “at scale” deployment

IRA/BIL opportunities

Estimated impact of IRA is 40% reduction in emissions by 2030

MESC is managing $16 billion in BIL and IRA funds

1. BIL 40209 Manufacturer and Recycling Grants in Energy Communities

Second round ($350 million) TBD

2. 48C Tax Credits
   a. Expanded with $10B in funding, sister program to 40209
   b. First round is $4B in funding
   c. Notice released May 1st, info webinar on June 27th, concept papers due July 31st

Innovation Pathways

Clean fuels and Products shot- decarbonize the fuels and chemicals industry

Goal- rebalance the carbon cycle for fuels and products, develop cost effective fuels and products from sustainable carbon sources that achieve >85% lower net GHG emissions by 2035

Critical research areas

1. Mobilize biomass and waste feedstock (scale up)
2. Efficiently capture and covert CO2
3. Develop carbon efficient conversion processes
4. Demonstrate integrated processes
5. Understand sustainability implications (LCA/TEA)

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Panel Discussion: Material Solutions to Sustainability

Moderator: Dr. Matthew Korey
R&D Associate Staff
Oak Ridge National Laboratory

John Korsgaard
Executive Senior Director
LM Wind Power

Russell Gentry
Professor of Architecture
and Civil Engineering
Georgia Tech

Dan Sawyer
Director of Sales,
Americas
NatureWorks

Tony (Wan Chung) Lee
Sr. Manager for Sustainability
& Commercial Processes
SABIC Specialties Business

Dr. Merlin Theodore
National Science Board,
Oak Ridge National
Laboratory

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Industry Panel: Material Solutions to Sustainability

What is sustainability?
Fulfilling the needs of current generations without compromising the needs of future generations, while ensuring a balance between economic growth, environmental care and social well-being.

Goals: 50% reduction in GHG by 2035
Net zero manufacturing by 2050

1. Recycled vs recyclable vs biobased material inputs- which are most important?
    - Accessibility is most important factor- as long as the desired circularity output is achieved then material source is less important
    - “Delay the grave” approach
    - Upcycle vs Downcycle is most desirable

2. End of life science is not well developed (worn out vs obsolescence)
- Need to develop materials with end of life in mind (design for sustainability)
- European model- you make it, you take it back and dispose of it
- Producers can impact supply chain by refusing to purchase inputs that are not designed for sustainability
  - Create partnerships within the supply chain to drive circularity
  - Need for 3rd party validation, certify materials to prevent "greenwashing"
  - Problem is this can drive innovative materials to commodities
  - Answer- make up in sales volumes?
- LCA/LCI analysis, need a system within composites that we can all use, a common platform to analyze different material options

Industry needs to coordinate efforts, demand specific materials and end of life scenarios and set standards, this will then drive to specific outcomes and create economies of scale for solution providers to make money while driving down costs

ORNL/UMaine "Hub and Spoke": Sustainable Materials and Manufacturing

- **Goal:** ***Bring sustainable, functional bio-based materials and smart manufacturing to the market***
- **Connects a $2 Billion national laboratory to local ecosystems**
- **Combines MDF-ORNL expertise in advanced manufacturing with UMaine innovation in forest derived biocomposites**
- **Aligns with National Strategy for Advanced Manufacturing (Whitehouse.gov Oct 2022)**

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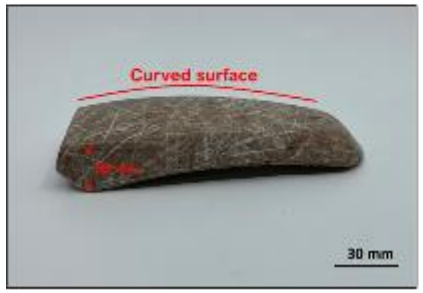
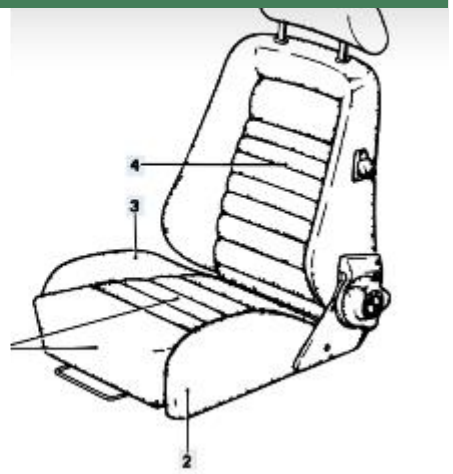
Core Development Areas for the Hub & Spoke

Building Technologies

Food & Business Packaging



Automotive & Vehicles



Marine & Offshore Wind

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Identifying Technologies, We Can De-risk Now to Enable Adoption

Brainstorm → **Moderator Opens Floor for Discussion** → **Place technologies on ranking chart**

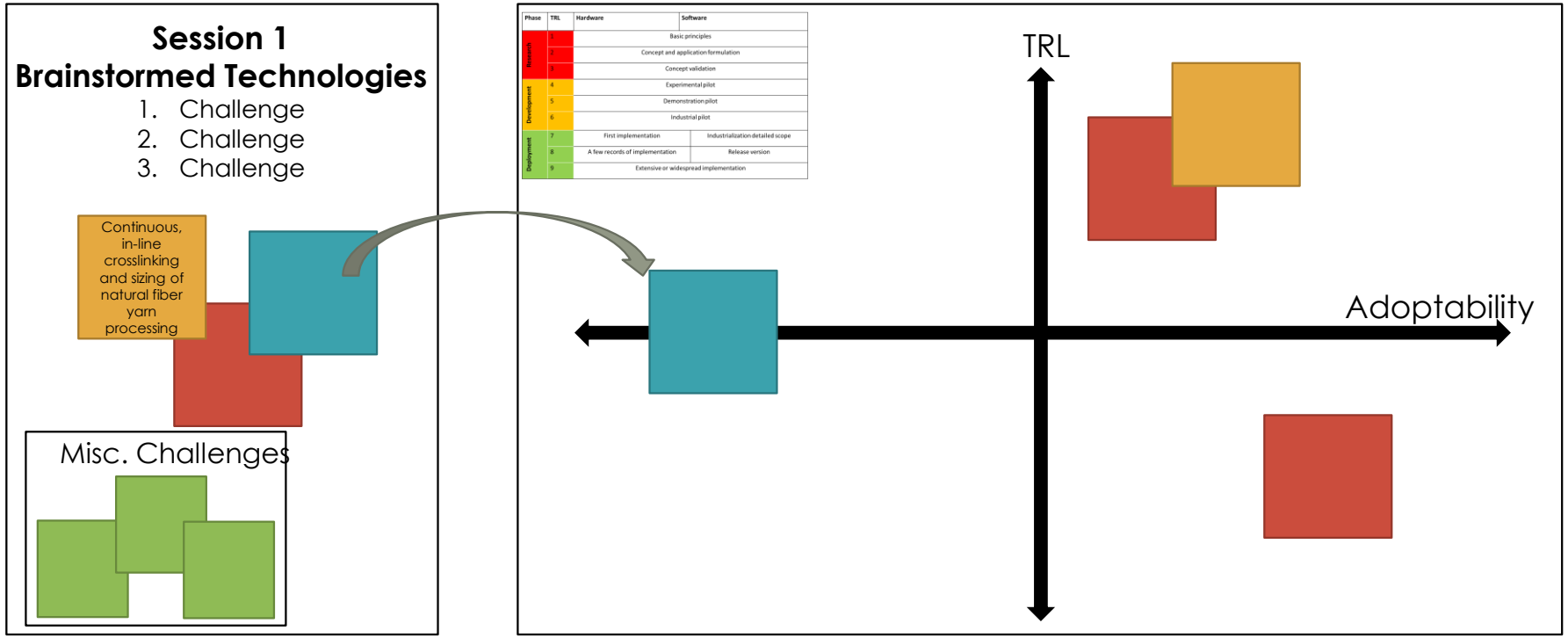
Board One

Session 1
Brainstormed Technologies

1. Challenge
2. Challenge
3. Challenge

Continuous, in-line crosslinking and sizing of natural fiber yarn processing

Misc. Challenges



Participants add their ideas

Relative ranking of technology solutions

Identifying Technologies: Building Technologies

Technical Areas or Challenges

- Materials - Supply of Bio-Resins
- Proficient Large-Scale Compounders
- How to meet flame / fire Performance
- Manufacturing - Scaling Printers and/or Facilities to meet potential demand. What does a regional print facility look like?
- Market - Updating Building Codes, Understanding Customer Demand

Common Themes and Highlights

Top TRL/High Adoptability

- High operating speed printability
- Flammability Coatings
- Workforce Development

Low TRL/High Adoptability

- High speed and large format printing
- Building codes

Identifying Technologies: Marine & Offshore Wind Energy

Technical Areas or Challenges

- Wide application area – where focus?
- Material Cost – tough to beat plastics
- Product Performance – Meet or exceed existing mechanical, structural, thermal and/or chemical barrier properties
- Manufacturing - Drop-in technologies vs. new manufacturing processes
- End of life scenarios – recyclability vs. compostability

Common Themes and Highlights

Top TRL/High Adoptability

- Bio-based thermoplastics and thermoplastics for wind blades
- Erosion control and storm surge mitigation for high-risk coastal environments

Low TRL/High Adoptability

- Light weighting for wind blade
- Repair of wind blades (onsite repair)

Identifying Technologies: Food & Business Packaging

Technical Areas or Challenges

- Marine Vessels – Passenger Ferry, Autonomous Drones, Cargo
- Sensor and Navigational Buoys – LiDAR Buoy
- Concrete Formworks – VolturnUS, Ports & Piers, Breakwalls
- Composite Tooling – Wind Blades, Marine Vessels
- Green Marine Initiatives – Marine biodegradable materials

Common Themes and Highlights

Top TRL/High Adoptability

- AI Controlled separation of waste streams
- PHA based materials
- Regenerated cellulose films & barrier coatings

Low TRL/High Adoptability

- Compatibilizers for mixed plastic reuse and recycling

Identifying Technologies: Automotive Applications

Technical Areas or Challenges

- How can large format additive and sustainable materials help address rising vehicle development and concept production challenges ?
- Building robust supply chains for new materials and/or technologies.
- Opportunities to support manufacturing challenges associated with lower volume production using sustainable materials, large format additive manufacturing, or circular economies
- What technologies can enable the use of renewable and recycled materials?

Common Themes and Highlights

Top TRL/High Adoptability

- Rapid prototyping (AM) for parts
- Foams for light weighting (3D printed, molded, extruded, etc.)

Low TRL/High Adoptability

- Rapid prototyping for molds for car parts (high throughput demands challenge production rates for AM)

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