Inaugural UMaine-ORNL Hub and Spoke REU Program Highlights

Doug Gardner, Professor of Sustainable Materials and Technology (UMaine)

Amber Hubbard, R&D Associate Staff Member (ORNL)

September 7, 2023

US Department of Energy (DOE), Office of Energy Efficiency and Renewable Energy, Advanced Materials and Manufacturing Office under CPS Agreement 35863

Inspired by the U.S. National Science Foundation REU program

Objective

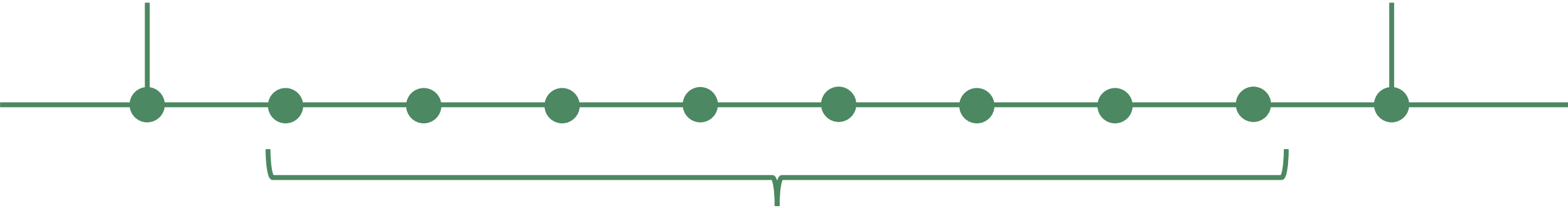
The objective of the Hub and Spoke REU Program between UMaine and ORNL is to provide active research participation among a diverse group of highly qualified undergraduate students to develop and utilize knowledge in an ethical manner to address the development of sustainable composite materials.

Program Overview

- Through DOE support, the program comprises a cadre of 12 students for 10 weeks.
  - Additional students increase the size of the cadre and are supported by other mechanisms including USDA and NSF funds.
- ORNL Organizers: Amber Hubbard and Cait Clarkson
- UMaine Organizers: Doug Gardner and Dave Neivandt

Week 1:
May 28th
Location: ORNL

Week 10:
July 31st
Location: UMaine

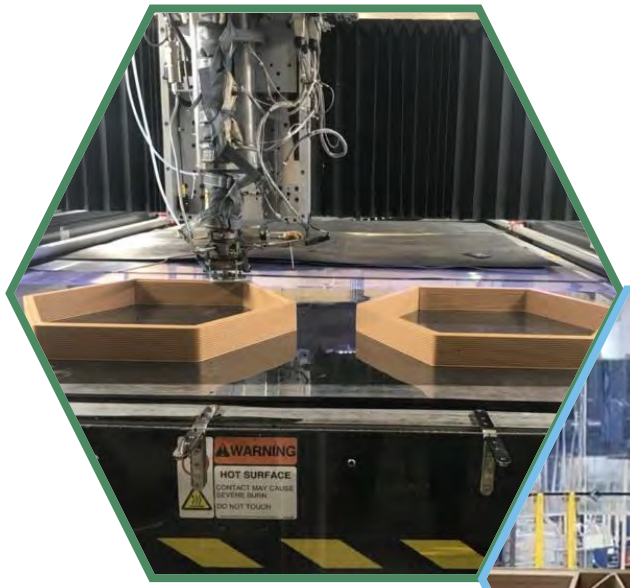


Weeks 2 – 9:
June 5th – July 28th
Research Locations:
6 students at ORNL &
6 students at UMaine

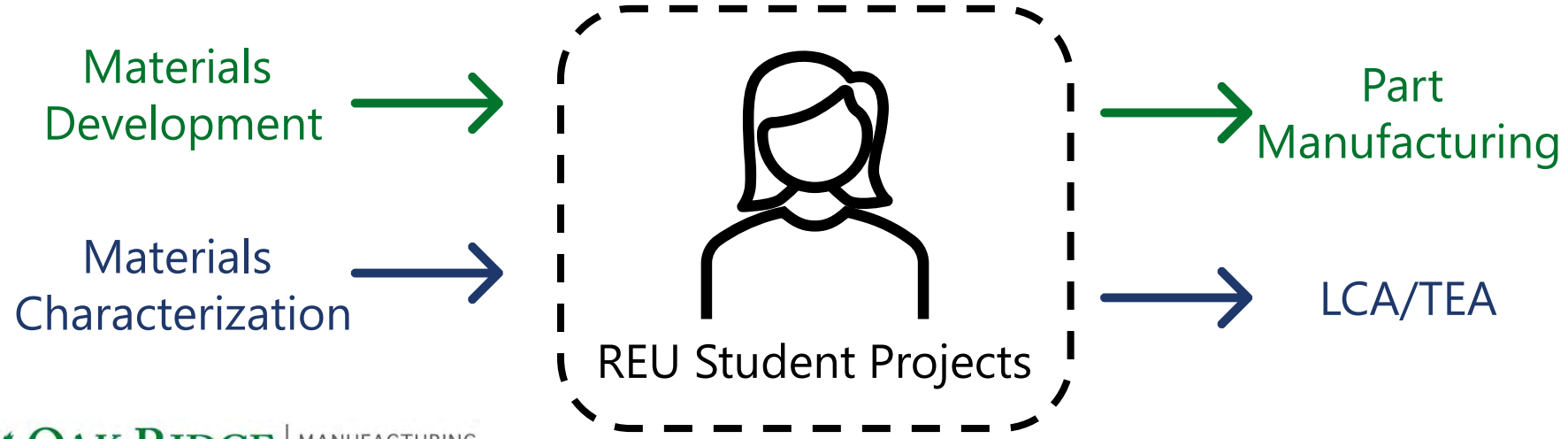
Why UMaine and ORNL?

- Research thrusts combine ASCC's extensive forest-derived bio-based composites expertise with ORNL's advanced manufacturing capabilities
- Unique feature of research cross-pollination between the two institutions
  - Strong history of teaching & student engagement

Cincinnati BAAM (ORNL)



Ingersoll Masterprint (UMaine)



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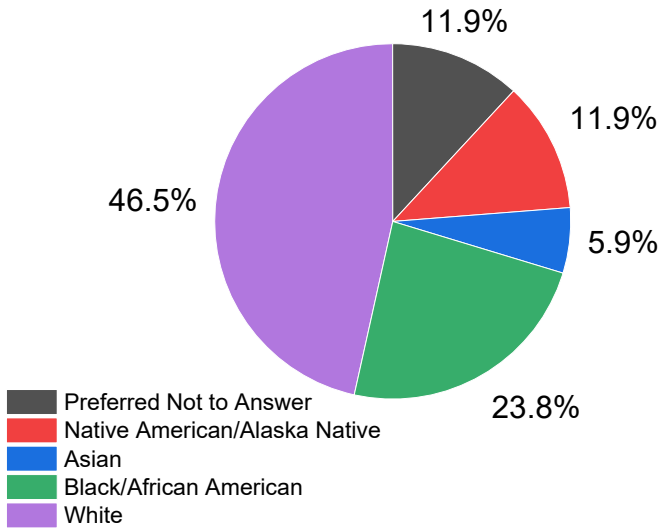
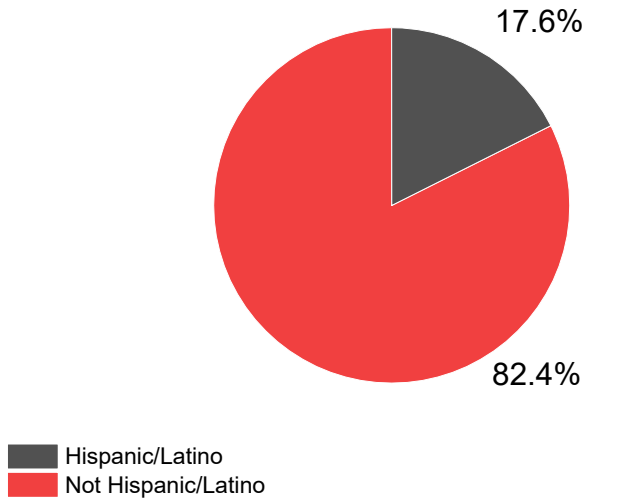
Mara Alonso
University of California Berkeley

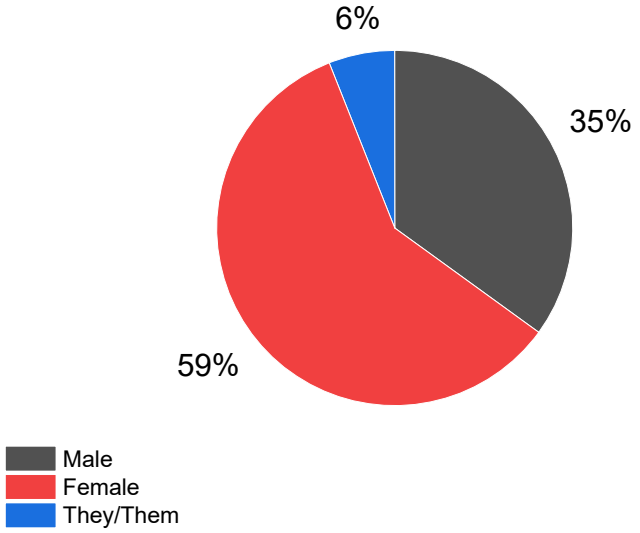
Hub and Spoke Themes Reflected in the REU

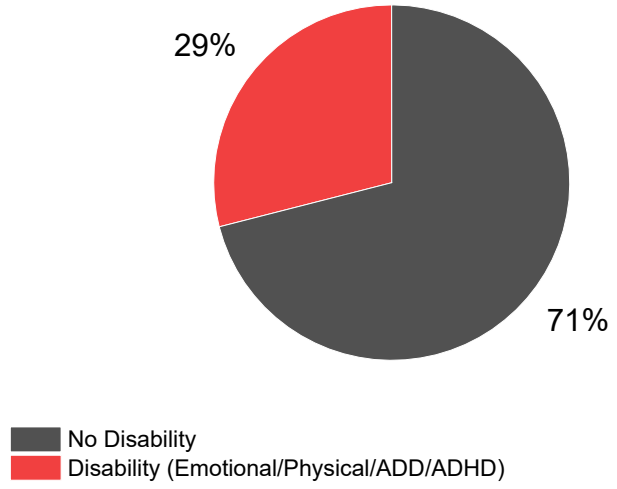
- Feedstock Production & Modification
- Life Cycle Analysis (LCA) & Technoeconomic Assessment (TEA)
- Sustainable Materials Development & Characterization
- Large-scale Additive Manufacturing
- New Product Development

2023 Student Demographics



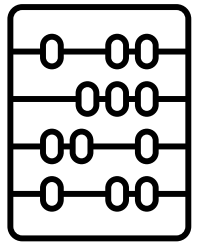




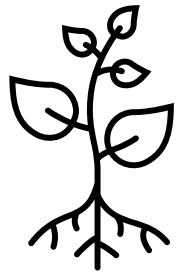


2023 Student "Home Institutions"

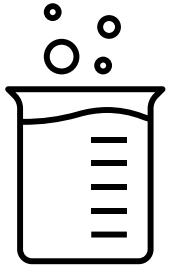
Select Student Majors



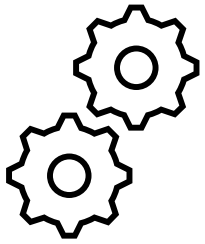
Mathematics



Botany



Chemistry



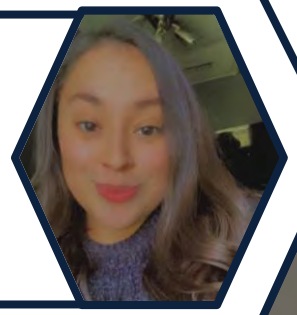
Engineering (Materials, Chemical, & Mechanical)

Select REU Student Projects

Cellulose nanofibril-reinforced surfactant-assisted lignocellulosic foam for **packaging and building applications**

The **3D printing** of spray-dried cellulose nanofibrils and reinforced polypropylene composites using the Juggerbot 3D

Aqueous **surface modification of cellulose nanofibrils** to create bio-based composites



Validating Multi-Scale Models of Material Process Property Relationships of 20% cellulosic wood flour reinforced PLA

Creating a user-friendly **LCA research tool** for CNF production

THE UNIVERSITY OF MAINE

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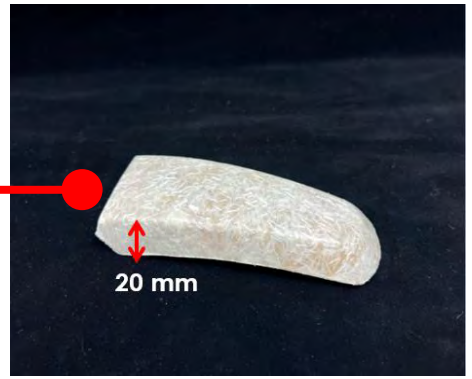
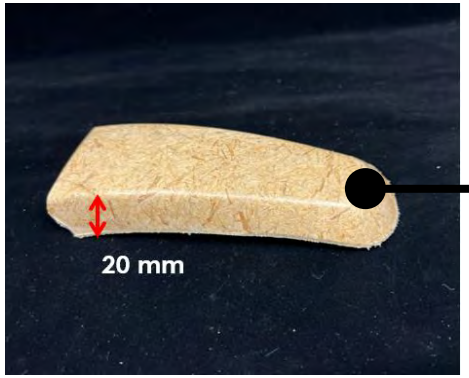
Brianna Greer
Berea College

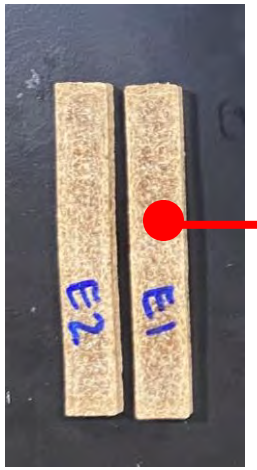
Hybrid Banana & Glass Fiber (40wt%) Polypropylene Composite





40wt% Banana Fiber Polypropylene Composite

Emma Drake
Auburn University



Untreated Banana Fiber PLA Composites:
Discoloration after Water Exposure and Limited Thermal Stability

Treated Banana Fiber PLA Composites:
Resistance to Water Exposure and Increased Thermal Stability by 45 °C

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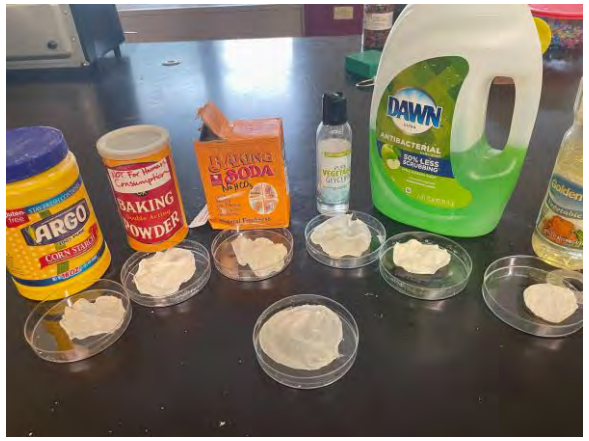
Tracy Vassiliev

Research Experience for Teachers

James F. Doughty Middle School

- RET distills REU research to appropriate engineering level to develop middle school research projects
- Lesson content is aligned with the Next Generation of Science Standards.



Example Middle School Project:

- 3wt% CNF Drying Challenge
- What can you add to disperse CNF as it dries ambiently?
- Students rate films: thickness, water permeability, uniformity, etc.

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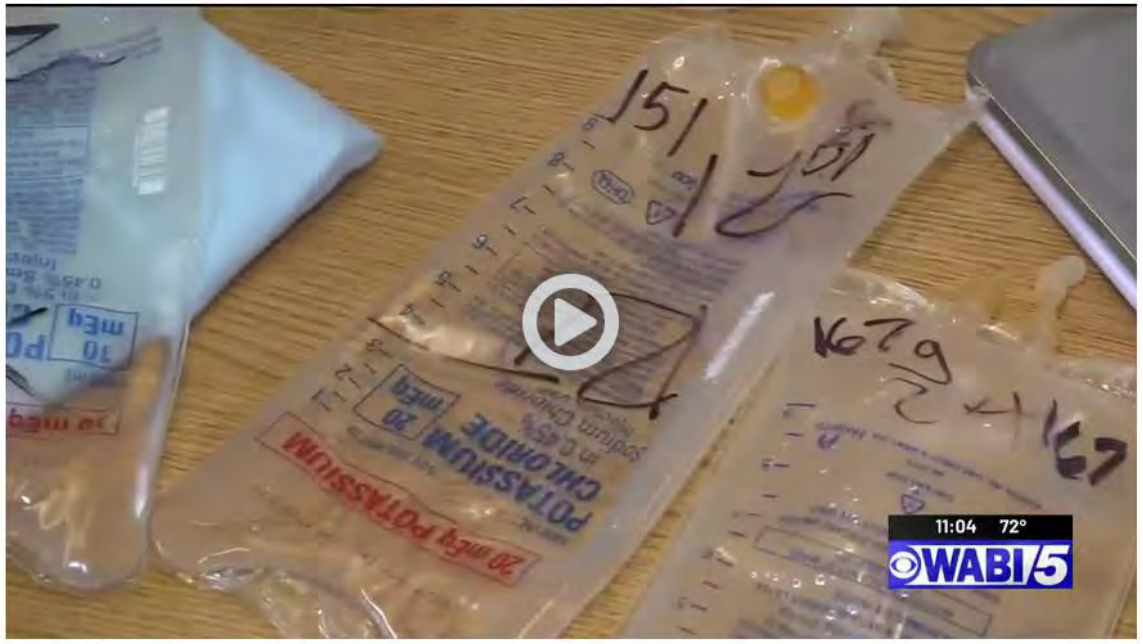
Tracy Vassiliev

Research Experience
for Teachers

James F. Doughty
Middle School

Bangor student's eighth grade science project gaining state, national attention

Updated: Sep. 5, 2023 at 4:11 PM EDT



WABI TV5 News at 11

Training Sessions (Week 1)

- Safety Training/Proposal Writing Workshop
- 5-minute Proposal “Pitches”
- Responsible Conduct of Research
- Diversity, Equity, Inclusiveness Workshop

Weekly Seminar Series

- What is Graduate School & Why Go?
- The Process to Publish
- Nanocellulose and its Role in Sustainable Manufacturing
- Luck or Persistence? An Personal Account of an Academic Journey

Industrial/Facility Tours:

- TimberHP
- Carbon Rivers
- Hancock Lumber
- Advanced Structures & Composites Center (UMaine)
- Process Development Center (UMaine)
- Frontier (ORNL)
- Spallation Neutron Source (ORNL)
- Building Technologies Research and Integration Center (ORNL)
- High Flux Isotope Reactor (ORNL)

Deliverables

- 10-15 page research report
- 20-minute technical presentation

Final Assessment

- 10/11 students recommend the program to others
- 4/11 students intend to pursue a master's
- 7/11 students intend to pursue a PhD

Increase Student Collaborations

Increase Research Outputs (publications, presentations, patents, etc.)

Increase Seminar & Training Diversity

Increase Recruitment

Outlook

Student Testimonials

"I made lifelong friendships."
–Yuniva Mendoza-Apodaca (NCSU)

"If you're looking to conduct sustainable materials research for widespread possible industrial applications, this program is for you!"
–Abigail Gibson (Johns Hopkins University)

"I got to learn what research would be like as a real job and meet some great people!"
–Ethan O'Banion (Purdue University)

"My biggest takeaway is that I know I have the capacity to do independent research."
–Mara Alonso (UC Berkeley)