Welcome!

Industry Technology and Innovation Summit

February 28, 2024

Agenda

Industry Technology and Innovation Summit

February 28, 2024

9 a.m.

Welcome, Overview

- Impact Arizona
- STC Updates
- New STC: Sustainable Innovation

9:35 a.m.

Guest Speakers

Air Force Research Lab

- **Andrew Hamilton**

10:00 a.m.

STC Project Showcases

- AMPED - Jerry Lin
- MADE - Michael Kozicki

10:30 a.m.

break

10:45 a.m.

STC Breakout sessions

- 3 STCs, 9 Thrust options

11:55 a.m.

Highlights and Next Steps

12:00 p.m.

Poster session and optional networking lunch

STC introductions

Kyle Squires

Senior Vice Provost, Dean and Professor at
Ira A. Fulton Schools of Engineering at Arizona State University

Arizona State University

Impact Arizona

Transformational opportunities

Focusing on areas of growth at the intersections of *unique capabilities* and *impacts*

Transformational opportunities require partnerships across an ecosystem

Experience to date – NEI - Impact Arizona, Chips Act, DOE EPIXC Institute, Water Innovation Initiative, NSF Regional Innovation Engine: "NSF Southwest Sustainability Innovation Engine", others – demonstrates that **major impact opportunities requires coordination** of federal, state, philanthropic and corporate partnerships

Focused connections on impact characterized by the following:

Building unique capabilities

Leveraging expertise

- Faculty
- Centers and facilities
- Industry partnerships

Corporate partnership

- Seed projects (STC's)
- Comprehensive connections (workforce, research, translation)

Coordinated Federal and State investment

Creating Impact for Arizona’s new economy

Creation of high-value jobs

- Technology startups with AZ founders and innovators
- Applied learning opportunities for students, internships and a pathway to high wage jobs
- Partnerships with established AZ technology companies

Workforce training

- Hands-on research experience produces thought leaders
- Entrepreneurial training paves way from lab to captured value
- Reskilling and upskilling opportunities to enhance and adapt current workforce to cutting edge technologies and innovations

Attraction and retention of leading corporations

- People, facilities, intellectual leadership
- Partnerships and acquisition oppotrunities for established companies
- Access to the largest diverse technical talent pool in the nation
- Multiplier opportunities for joint projects and next stage technological development

Talent … Research … Translation … Partnership

Building Arizona's Impact on the new economy

ASU's Assignment

What does it do?

Accelerates talent and skills development

Advances innovation that drives industrial growth by leveraging Arizona's public universities

Strengthens Arizona as a economic leader

How does it do it?

Workforce development
New graduates, re-training and upskilling for existing workforce

Science and Technology Centers
Catalyze industry-relevant research, development and manufacturing

Support for new economy enterprises
Multiple ASU units partnering with enterprise and supporting entrepreneurship

Investing in Science and Technology

Summary of an STC

Vision:

Engine driving AZ innovation, value creation, a skilled workforce and job growth

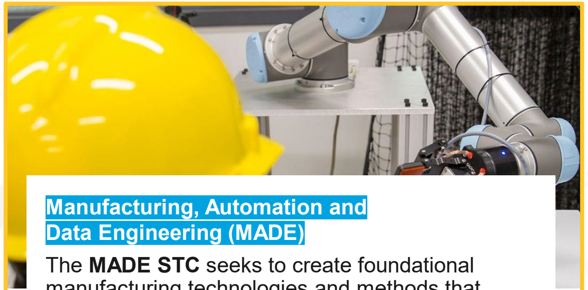
Key elements:

- State-of-the-art facilities provide research, development and prototyping capabilities.
- Student and employee training, upskilling and workforce development.
- Entrepreneur programs, tech-transfer focus.
- Industry-academia consortium defines needs and opportunities.
- Matching for industry-funded projects.

STCs shape Arizona new economy industries

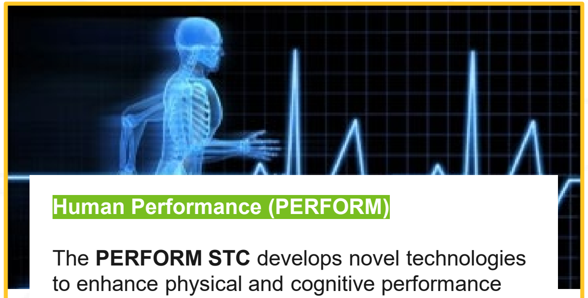
Advanced Materials, Processes, and Energy Devices (AMPED)

The **AMPED STC** seeks to create the materials and devices needed for broad electrification of the energy sector, with three thrust areas: **photovoltaics**, **batteries**, and **power-electronic devices**.



Manufacturing, Automation and Data Engineering (MADE)

The **MADE STC** seeks to create foundational manufacturing technologies and methods that enable new products and enhancing competitiveness, with three thrust areas: **process science and engineering**, **robotics and automation**, and **data analytics, cyber, and AI**.

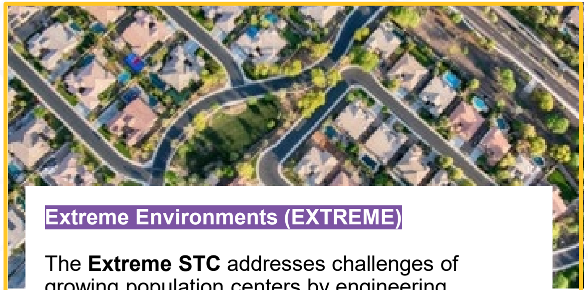


Human Performance (PERFORM)

The **PERFORM STC** develops novel technologies to enhance physical and cognitive performance and improve medical prevention and interventions with three thrust areas: **devices**, **assessment** and **performance multipliers**.

Advanced Communications Technologies (ACT)

The **ACT STC** drives innovation and reduce barriers to progress in emerging wireless communications and sensing systems with four thrust areas: **future RF systems**, **communication for augmented reality**, **flexible modem SoCs** and **awareness for autonomous vehicles**.



Extreme Environments (EXTREME)

The **Extreme STC** addresses challenges of growing population centers by engineering resiliency into airborne emissions, water systems and urban heat-island impacts through innovations in monitoring, processes and materials with three thrust areas: **air**, **water** and **heat**

Sustainability Innovation (SI STC)

The **SI STC** facilitates collaborative development and deployment of innovative sustainability, circularity and net zero solutions for public and private stakeholders with three thrust areas: **insight**, **foresight**, and **action.**

What an STC is

- **Consortium** of researchers, entrepreneurs, subject matter experts and technologists in industry
- **Advanced training and development tools** and methodologies that are developed at scale
- Research, development, and prototyping facilities with **state-of-the-art equipment**
- **Embodied expertise** focused on engineering, technology, and commercialization
- Convergence of stakeholders to develop a **growing and highly skilled workforce** to support research & innovation, economic development and state competitiveness

What an STC does

- **Engages industry** to develop a technology roadmap and identify opportunities
- **Solicits and co-funds** (with industry) **proposals** in response to identified opportunities
- Invests in and conducts **research and development** to understand and solve problems
- **Builds capacity by training** the present and future workforce with relevant curricula at scale
- **Transfers learning** to practice through entrepreneurship and industry partnerships
- **Translates projects to industry** to make products and systems that employ areas of strength for the region and ASU

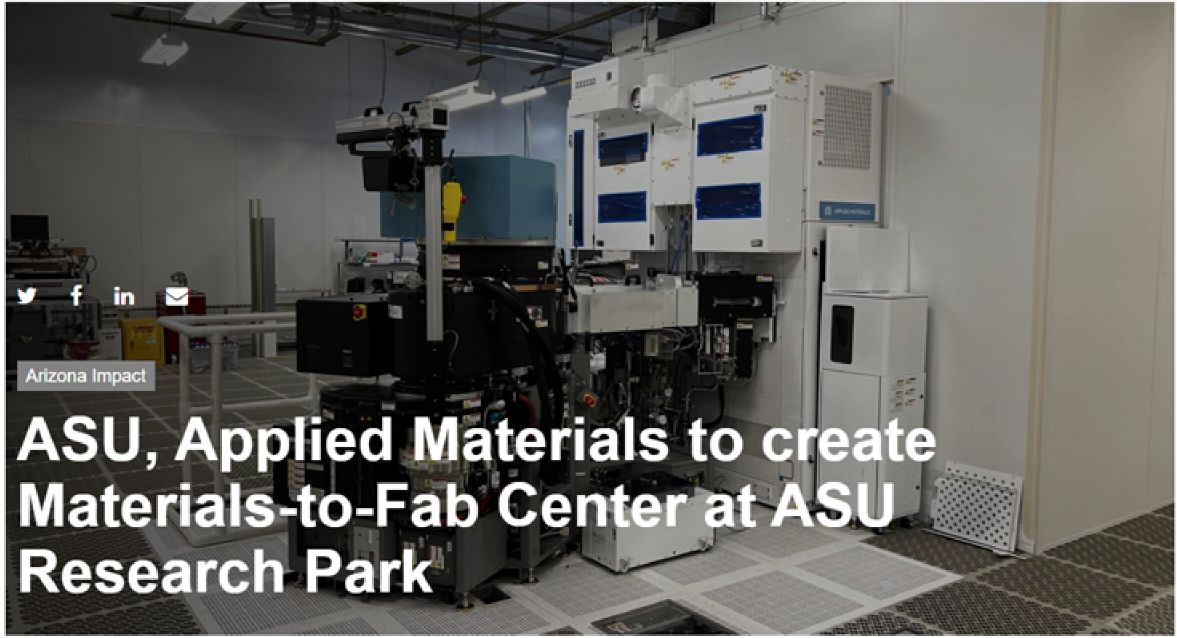
Seeding Comprehensive Partnerships

ASU - Applied Materials Center

$270M partnership, supported by Applied Materials, ASU, and ACA

Brings a suite a 300 mm deposition, etch, and metrology tools to ASU's MTW facility

Capabilities (tools + expertise) are available to *all innovators* on a pay-per-use basis

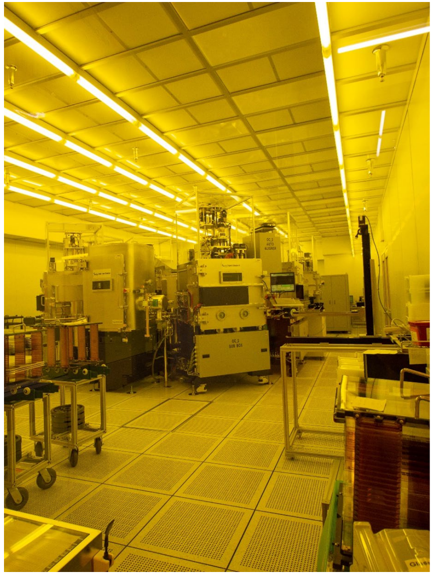


July 11, 2023

More than $270M in corporate, state investment will help advance Arizona's semiconductor industry

Example of strategic differentiation

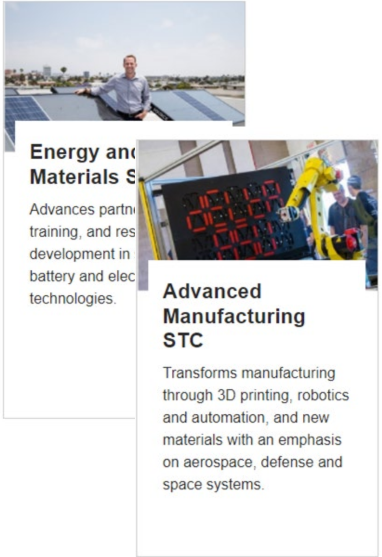
MTW: A fab an order of magnitude larger than other schools'; the scale for prototyping at the 200- and 300-mm scales



Corporate partners: The semiconductor boom in the Valley means we are the go-to university for companies of all sizes

Our size: The largest engineering school in the country for producing the talent and innovation needed by our industry partners

A timely seed: State investment enabled seed funding to start *doing now* while others remain on the sidelines

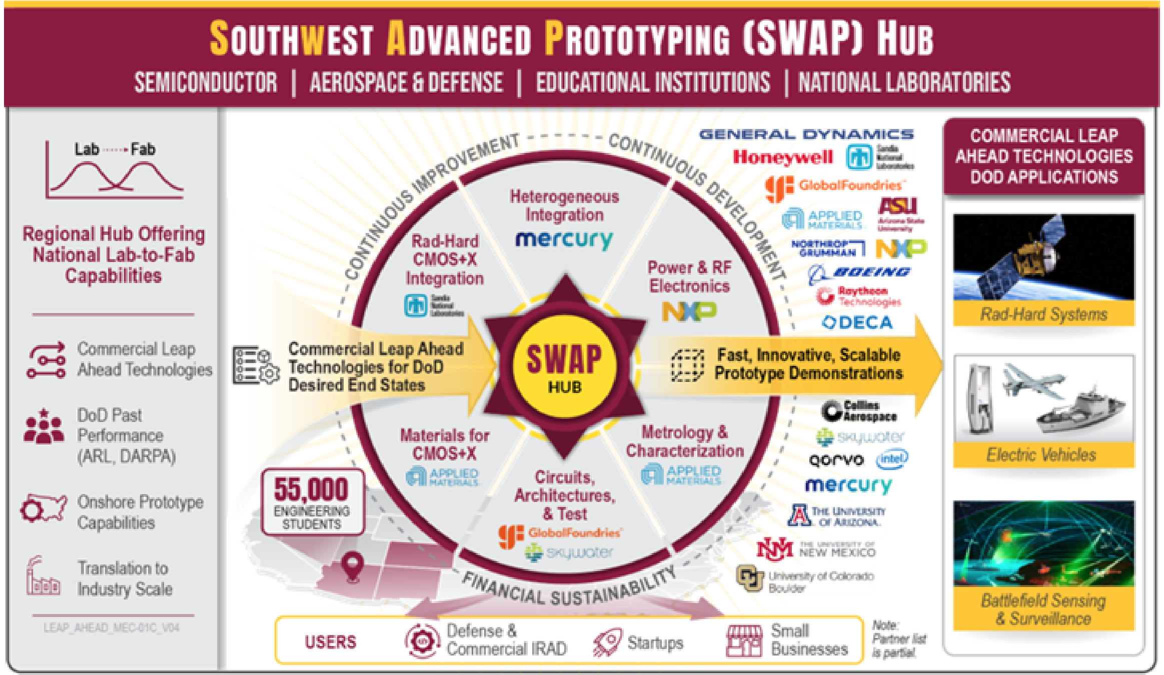


DoD Microelectronics Commons – ASU's winning bid

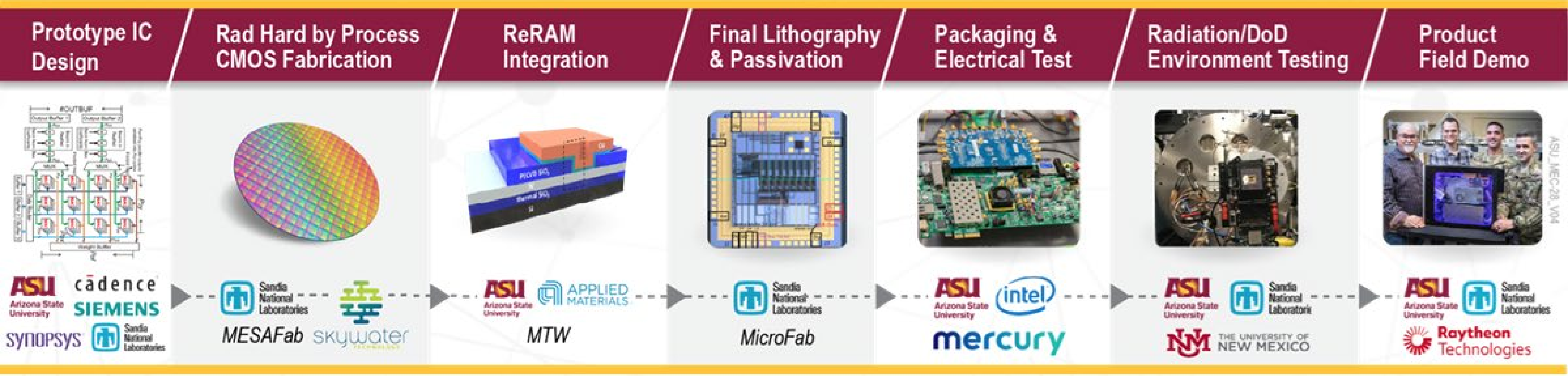
Enabling the Southwest Advanced Prototyping Hub

ASU and State investment in equipment and team for a ~$150M proposal to DoD for an ASU-led microelectronics prototyping regional hub

- More than 60 regional and national partners
- 16 FSE faculty part of the proposal submission (**6 of whom hired during the past two years**)



SWAP Hub Example Process Flow



Next steps:

- Signed contract between ASU and NSTXL
- NSTXL hosts first Microelectronics Commons Annual Meeting next week
- Call for proposals released by NSTXL; Hub members can apply for projects

Big picture…what does success look like?

Accelerating research

STCs focus on use-inspired research leveraging existing capabilities

STCs seed future research and **comprehensive partnerships** — MURI, ERC, federal joint opportunities

Translation and talent pipeline

Academia and industry partners collaborate to train a talented workforce

STCs help create start-ups, jobs and provide industry with upskilling and reskilling solutions for the present and future workforce

Catalyzing the future

Creating a thriving and robust Arizona economy

STCs advance the Arizona we want — skilled and educated workforce and opportunities

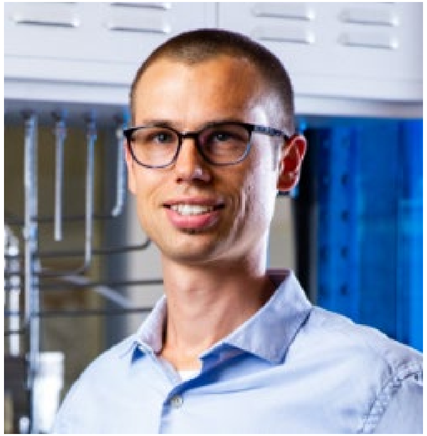
EPIC

ASU Southwest Advanced Prototyping Hub
Arizona State University

NSF Engines:
Southwest Sustainability Innovation Engine

Science and Technology Centers

AMPED
Advanced Materials, Processes and Energy Devices
Science and Technology Center



Zachary Holman

AMPED STC Director

Vice Dean for Research and Innovation,

Ira A. Fulton Schools of Engineering

Professor,
School of Electrical, Computer and Energy Engineering

AMPED

Advanced Materials, Processes and Energy Devices

Science and Technology Center

Vision

Create the materials and devices needed for broad electrification of the energy sector.

AMPED

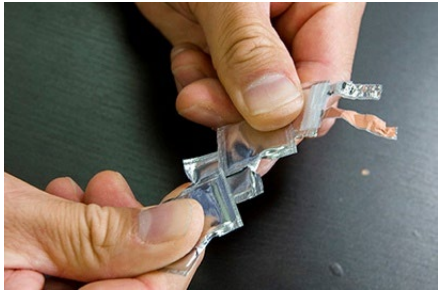
Advanced Materials, Processes and Energy Devices

Science and Technology Center

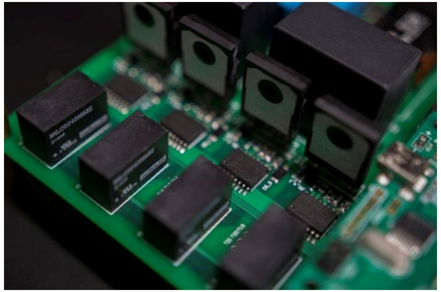
3 R&D thrusts

Solar

Batteries



Power Electronics



ARIZONA INNOVATION CHALLENGE

AWARDEES

AWARDEES

The ACA is committed to advancing companies from startup status to market domination. Previous awardees are disrupting the financial aid process for college students, creating more effective ways of fighting brain cancer, pioneering a new frontier at the edge of space in leading the way in the emerging stratosphere economy. And that's just the tip of the iceberg!

2023 Awardees

ALGOFACE
IT - Software
Carefree, AZ

DX4LIVER INC.
Bio & Life Sciences
Scottsdale, AZ

HOMER FARMS INC.
Cleantech & Renewable Energy
Phoenix, AZ

MACULA VISION SYSTEMS
Bio & Life Sciences
Oro Valley, AZ

NOBEL WORKS CORP.
Cleantech & Renewable Energy
Tucson, AZ

OXBYEL TECHNOLOGIES, INC.
Cleantech & Renewable Energy
Phoenix, AZ

SIMPLIFYANCE
IT - Software
Scottsdale, AZ

SOLSTA BY SOLID STATE NETWORKS
IT - Software
Phoenix, AZ

SUNFLEX SOLAR
Cleantech & Renewable Energy
Tempe, AZ

SWIFTCOAT
Cleantech & Renewable Energy
Phoenix, AZ

Taking batteries 'B-LO Zero'

ASU researcher Nick Rolston is developing solid-state batteries for use in environments with extreme temperatures, such as space

Nick Rolston, an assistant professor of electrical engineering at Arizona State University, is collaborating with researchers from the Swiss Federal Laboratories for Materials Science and Technology, or Empa, to develop batteries that function well in space's harsh temperatures. Photo courtesy Pexels

Solidifying batteries for space readiness

Rolston is working with a Swiss team led by Moritz H. Futscher, a scientist at Empa and co-founder and CEO of battery startup company BTRY, to develop solid-state batteries for use in space through a project called “Batteries for Low-temperature Operation < 0C,” or “B-LO Zero” for short. Solid-state batteries’ electrolytes are solids instead of liquids, so they circumvent the risk of freezing or dramatically dropping in performance, like batteries affected by recent winter weather in the United States.

“With all the cold fronts that have hit the U.S., there were some articles I saw about electric vehicles having big issues,” Rolston says. “The technology used is liquid-based electrolytes. If it’s freezing outside, the batteries may be a little bit warmer than that, but the performance drops dramatically to the point of barely being operable.”

A cryogenic chamber will be used in the B-LO Zero project's battery material testing. Photo courtesy Nick Rolston/ASU

Nidhin Kurian Kalarickal collaborates with industry to develop damage-free manufacturing methods for microelectronics

by TJ Triolo | Jan 18, 2024 | Features, Research

An electric U-Haul van has its hood open for onlookers to view at an event on the Arizona State University Tempe campus. Nidhin Kurian Kalarickal, an assistant professor of electrical engineering in the Ira A. Fulton Schools of Engineering at ASU, has developed a damage-free

Collaborating with industry to destroy damage risk

To remedy the damaging methods, Agnitron representatives approached Kalarickal, a faculty member in the School of Electrical, Computer and Energy Engineering, part of the Fulton Schools, and discussed developing a new etching process after ASU purchased a metal-organic chemical vapor deposition, or MOCVD, reactor tool from the company. The tool is used for growing semiconductor material such as gallium oxide.

“Agnitron wanted to engage with my team, and the company’s representatives were quite interested in the idea of investigating in situ etching using metal-organic precursors,” Kalarickal says.

Kalarickal and Agnitron’s method differs from traditional ones in that it uses the same basic metal-organic compound, triethylgallium, that is also used for the growth of gallium oxide in the presence of oxygen. Other methods use a different material that involves damaging energetic plasma.

When gallium oxide is heated and exposed to triethylgallium in the absence of oxygen, gallium oxide undergoes a chemical reaction, resulting in the formation of gallium suboxide. Gallium suboxide is volatile and easily escapes from the sample surface, resulting in etching.

A metal-organic chemical vapor deposition, or MOCVD, reactor from Agnitron used by Nidhin Kurian Kalarickal in his gallium oxide etching research. Photo courtesy of Nidhin Kurian Kalarickal/ASU

ACT

Advanced Communication Technologies

Science and Technology Center

Daniel Bliss

ACT STC Director

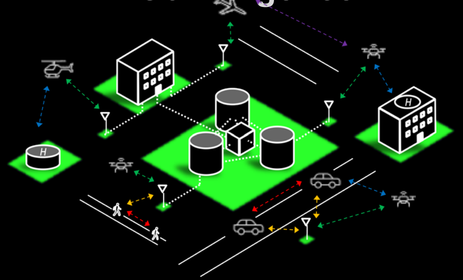
Professor,
School of Electrical, Computer and Energy Engineering

Director, ASU Center for Wireless Information
Systems and Computational Architecture

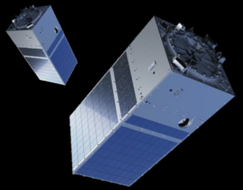
Future Wireless Needs and Desires

- Want faster, more flexible, more available communications
- Want new functionalities that we didn't know we wanted
  - Communications; sensing; positioning, navigation, and timing (PNT); environmental situational awareness; and ?
- Want lower cost, size, weight, and power

RF Convergence



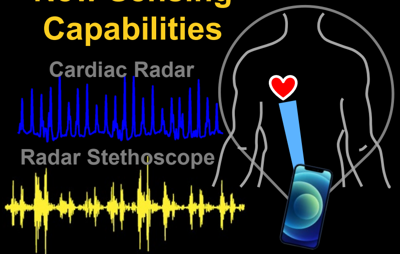
Next Generation Communications



Internet Toaster

Autonomous Vehicles

New Sensing Capabilities



Augmented Reality

Fully Immersive 3D Interactive Cat Café Simulations

Who knows why, but you know it'll happen

ACT

Advanced Communications Technologies

Science and Technology Center

Vision

Drive innovation and reduce barriers to progress in emerging wireless communications and sensing systems

Research & development, resources and training

System-driven technology needs

ASU technology development

Corporate capabilities and goals

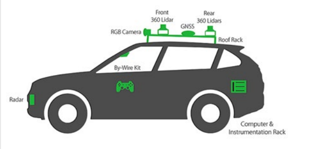
SEED FUNDING

Novel system concepts and tech

SoC development

Technologies, external programs and economic opportunities

Development Example:
Safety Testing Platform for Automated Vehicles



Training Examples:

- AI and the joy of life
- AI and Autonomous Driving

ACT

Advanced Communications Technologies

Science and Technology Center

4 R&D areas

Develop new concepts and enabling technologies for critical future applications.

Future RF Systems

Flexible Modem SoCs

Communications for Augmented Reality

Awareness for Autonomous Vehicles

EXTREME
Science and Technology Center

Kristen Parrish

EXTREME STC Thrust Lead
Associate Professor,
School of Sustainable Engineering and the Built Environment

Paul Westerhoff

EXTREME STC Co-Director
Fulton Chair of Environmental Engineering and Regents Professor, **School of Sustainable Engineering and the Built Environment**

Matt Fraser

EXTREME STC Co-Director
Professor,
School of Sustainable Engineering and the Built Environment

EXTREME

Extreme Environments

Science and Technology Center

Our vision is to address challenges of growing population centers by engineering resiliency into airborne emissions, water systems and urban heat-island impacts through innovations in monitoring, processes and materials.

Air

Water

Heat

Example Water System R&D Topics

Water “quantity” and “quality” needs exist.

Example topics identified by stakeholders include, but are not limited to:

- Processes to provide **new water sources** for people, industry, agriculture
    - e.g., brackish groundwater, wastewater reuse, atmospheric water capture
- **Brine management and zero liquid discharge** from industrial and municipal desalination or hardness treatment processes
- **Sensing and treatment** of emerging chemical and microbial pollutants
    - e.g., PFAS, *legionella pneumophila*, microplastics
- Innovative processes to **reduce/reuse/recapture water** and reduce energy footprint of cooling towers
- Strategies to **monitor, treat and augment groundwater supplies** in urban, rural, mining or agricultural parts of Arizona
- Technologies and processes that enable Fortune 500 companies to **monitor and meet “net zero water” sustainability goals by 2050**

Example Air R&D Topics

Advancing science-based air quality improvement plans for urban Arizona identified by stakeholders include, but are not limited to:

Example topics identified by stakeholders include, but are not limited to:

- Evaluation of **dust suppression approaches**
  - e.g., enzymatic or biocrust restoration of degraded agricultural land or disturbed surfaces
- Corroboration of **emission inventories**
  - e.g. analysis of current emission inventories used for planning purposes
- Sensing of **industrial air pollutants**
  - e.g., source characterization as well as indoor clean-room studies of volatile organic compounds
- Innovative materials and processes for **emission control**
  - e.g., photocatalytic devices or novel sorbent beds
- Strategies to advance emission offsets through **novel mobile source** control approaches
- Technologies and processes that enable government agencies to **advance clean air equipment deployment**

Example Heat / Thermal R&D Topics

Extreme heat is becoming common, and current built infrastructure (buildings, roads etc.) is incapable of managing resulting adverse thermal impacts.

Example topics identified by stakeholders include, but are not limited to:

- **Outdoor heat impacts workers health** reducing number of hours/days to safely perform construction or other activities
- **Thermal management near, on and within buildings** impact energy demand - novel sensing, materials and building renovation strategies are needed
- **Thermal cracking / failure of pavement and other infrastructure materials reduces infrastructure life require innovations**
  - e.g., cool roofs, building insulation materials with low carbon footprint and high efficiency, cool pavements
- Development and demonstration of **net-zero buildings** (both energy and carbon) is a national priority
- Mitigating heat while **harnessing low/grade or waste heat for beneficial uses** may create win-win solutions

MADE

Manufacturing, Automation and Data Engineering

Science and Technology Center

Binil Starly

MADE STC Director

School Director and Professor,
School of Manufacturing Systems and Networks

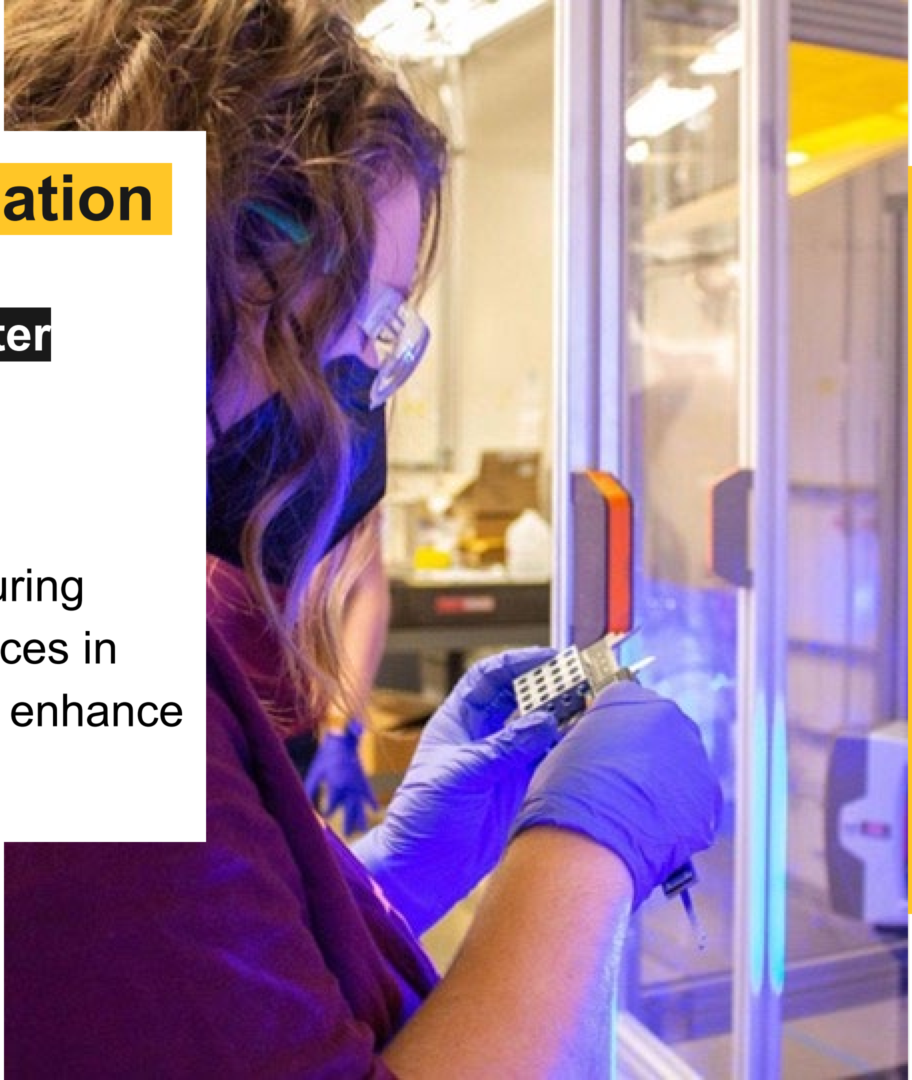
MADE

Manufacturing, Automation and Data Engineering

Science and Technology Center

Vision

Integrate fundamental manufacturing process technologies with advances in automation and data sciences to enhance manufacturing competitiveness.



MADE

Manufacturing, Automation and Data Engineering

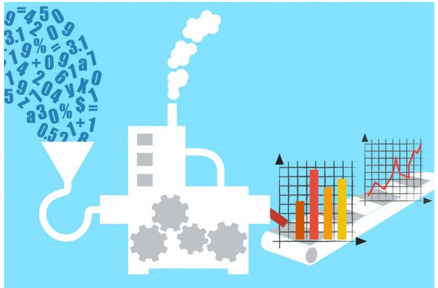
Science and Technology Center

3 R&D thrusts

Process Science and Engineering

Robotics and Automation

Data Analytics, Cyber and Artificial Intelligence



MADE

Manufacturing, Automation and Data Engineering

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Building Thematic Capability

Autonomous Manufacturing in Outer-Space Systems

Digital Twins for Microelectronics Manufacturing Systems

MADE

Manufacturing, Automation and Data Engineering

Science and Technology Center

Workforce Development

MADE will launch a series of stackable micro-credentials in the theme of Smart Manufacturing, Industrial Robotics, Microelectronics Manufacturing.

PERFORM
Science and
Technology Center

Marco Santello

PERFORM STC Director

Fulton Professor of Neural Engineering,
School of Biological and Health Systems Engineering

Senior Global Futures Scientist,
Global Futures Scientists and Scholars

PERFORM

Human Performance

Science and Technology Center

Our vision is to develop novel technologies to enhance physical and cognitive performance and improve medical prevention and interventions.

Devices

Assessment

Performance Multipliers

Example Assessment R&D Topics

Physical/physiological performance.

Cognitive well-being and emotional fitness.

Stress assessment.

Resilience and recovery.

Example Devices R&D Topics

Biomedical devices.

Wearables.

Sports and leisure equipment.

Performance data analytics.

Example Performance Multipliers R&D Topics

The relation between humans and machines.

Understanding how human-computer interfaces/human-robot interfaces can enhance human performance.

Tech Hub Strategy Development Award

Medical Device Manufacturing Multiplier Strategy Development Consortium: Phase 1

The U.S. Department of Commerce's Economic Development Administration awarded the Greater Phoenix Economic Council (GPEC) for a Tech Hubs Strategy Development Award for the proposal *Medical Device Manufacturing Multiplier Strategy Development Consortium Phase 1*. GPEC was one of 29 awardees out of 200 consortia applications. The consortium, which includes Arizona government agencies, universities, colleges and industry, is currently working on a Phase 2 application for spring 2025.

Marco Santello and Sarah Stabenfeldt (SBHSE, ASU) will serve in a leadership role in the MDM2 consortium, and ASU will contribute to lab-to-market strategies by leveraging the expertise of Skysong Innovations, ASU's tech transfer organization.

PERFORM

Human Performance

Science and Technology Center

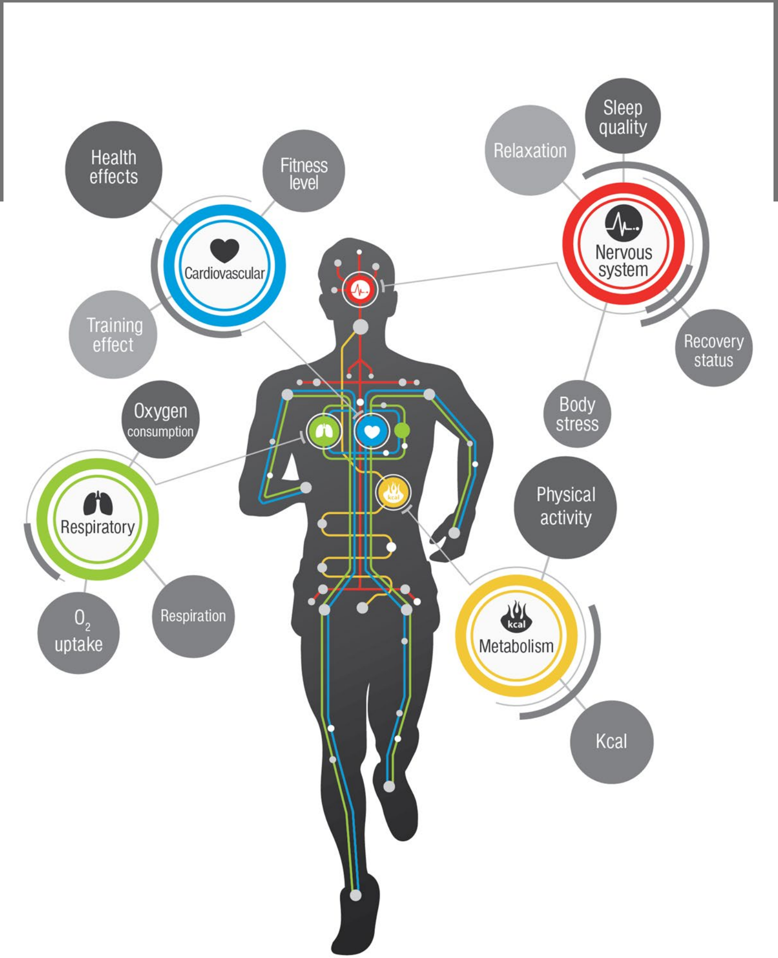
Workforce Development

Short Course launched in Fall 2023

Introduction to remote human-centric data collection and processing

Applications for sports, wellness, and healthcare industries:

- Remote human performance data recording
- Basic cloud based data storage and processing
- Data syncing, filtering and restructuring
- Sensor fusion



Partnerships with industry partners

Movement Interactive / NSF I/UCRC BRAIN

The Department of Veterans Affairs & Academia

We are pleased to announce that Movement Interactive/NSF BRAIN (ASU), has been awarded **$23B - 10-year ID/IQ contract** with the **US Department of Veterans Affairs.**

Few Examples of Existing VA – Academia Relationships

- University Affiliate Program
- Research & Development Programs
- Clinical Trial Programs
- Training & Development Policy Programs
- Innovation & Technology
- Grant Opportunities

VA | U.S. Department of Veterans Affairs Veterans Health Administration
ASPIRE LUKE Joint Venture LLC
mi Movement Interactive
SR SENIORS RISING
HOPCo
THE CORE INSTITUTE
Building Reliable Advances and BRAIN Innovations in Neurotechnology

VHA Integrated Critical Staffing Program

Dr. Eric L. Luster
Founder & CEO

Let's Connect and Collaborate!!
eluster@movement-interactive.com

Collaboration between:

- Veterans Affairs (VA)
- Arizona State University (ASU)
- Movement Interactive, Inc. (MI)

ASU gains access to VA contract via NSF Brain / Movement Interactive:

- Each SDVOSB is Required to Establish a Team of Highly-Qualified Small Businesses, Academia, Non-Profits, and Large Businesses to meet Critical Staffing and Other Requirements – **Veteran Integrated Team (VIT) Model**

Movement Interactive as a Service-Disabled Veteran Owned Business, understands the need for Universities, Research Institutes, and Non-Profit organizations to fulfill the VA mission and be positioned for future task orders, the grant set-asides, and yet-to-be-determined requirements within the VHA ICSP ordering vehicle.

New STC Sustainability Innovation

SI

Science and Technology Center

Diane Pataki

Co-Director – Science & Technology Center for Sustainability Innovation – Impact Arizona Initiative

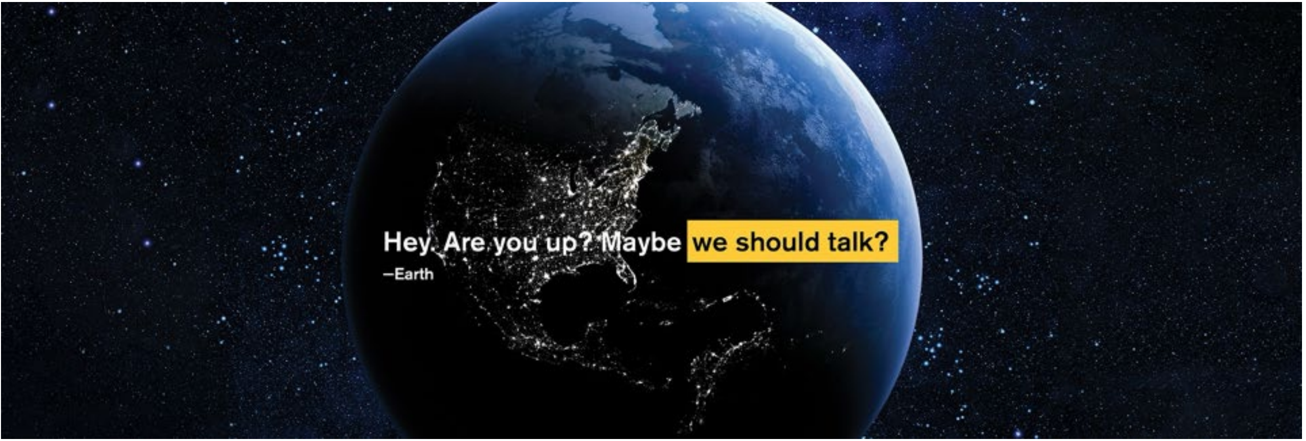
Foundation Professor of Sustainability, Deputy CEO and Science Director – Southwest Sustainability Innovation Engine

Eusebio Scornavacca

Co-Director – Science & Technology Center for Sustainability Innovation – Impact Arizona Initiative

Director: School for the Future of Innovation in Society, College of Global Futures

Julie Ann Wrigley Global Futures Laboratory
Arizona State University



The world's first comprehensive laboratory empowering visionary leaders to unite and create bold ideas for a more prosperous, equitable and resilient planetary future

globalfutures.asu.edu

Walton Center for Planetary Health

A global center for discovery and innovation

NSF Engines:
Southwest Sustainability Innovation Engine

Home | About | Partners | Leadership Team | Contact Us

http://swsie.asu.edu

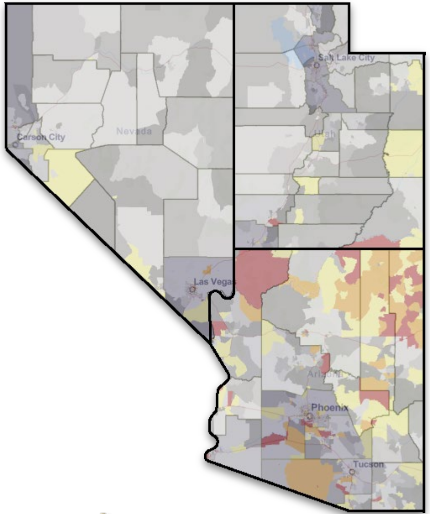
Fostering R&D, commercialization and workforce development with a $160 million federal investment

R&D	Translation	Talent + Economic Impact
• Atmospheric water harvesting tech summits • Multi-state carbon capture hub with regional test beds	• WaterSmart Innovation Conference • Knowledge Alliances Tool software development	• Workforce upskilling and Career Catalyst online platform • Entrepreneurial, technical, and municipal/managerial training

http://swsie.asu.edu

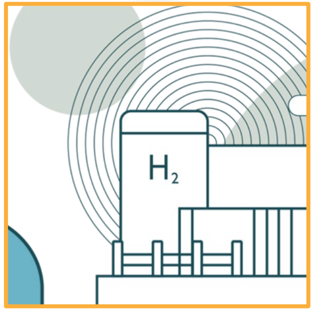
Transformative Impact in 10 years

A Southwest in which all people thrive and the economy flourishes



Clean supply

Direct capture



Use and storage

$2.7B Economic Output

15,777 Employment

33,000 Upskilled employees

$858.6M Tax Revenue

http://swsie.asu.edu

Sustainability Innovation STC

Vision: a thriving new economy that deploys Arizona's most innovative sustainability, circularity, and net zero solutions

Collaborative development and deployment of sustainability innovations in multiple sectors

Sustainability Innovation STC

Vision: a thriving new economy that deploys Arizona's most innovative sustainability, circularity, and net zero solutions

Insight

Leveraging ASU's capacity for digital technology, spatial analytics and assimilating large social and environmental datasets

Foresight

Developing scenarios and computational models of Arizona futures, leading to a next generation, multi-scale modeling and futures platform

Action

Creating actionable plans, policies and digital solutions to achieve sustainability goals and metrics

Sustainability Innovation STC

Vision: a thriving new economy that deploys Arizona's most innovative sustainability, circularity, and net zero solutions

Insight lead

Dr. Margaret Garcia
School of Engineering and the Built Environment

Foresight lead

Dr. Bhavik Bakshi
School for Engineering of Matter, Transport, and Energy
School of Complex Adaptive Systems
School of Sustainability

Action lead

Dr. Rajesh Buch
Rob and Melani Walton
Sustainability Solutions Service

Guest Speaker

Andrew Hamilton

AFRL

BRINGING IN-SPACE ASSEMBLY AND MANUFACTURING TO THE FOREFRONT OF SPACE INVESTMENT AND DEVELOPMENT

ANDREW HAMILTON

FEBRUARY 28, 2024

Distribution A: Approved for Public Release AFRL-2024-0866 Date Approved: 02-15-2024

Agenda

- Curating the Defense Industrial Base
- Myths
- Objectives
- Theory to Reality
- Challenges

AFRL/RXM – Curating the Defense Industrial Base

Uniquely addressing manufacturing & industrial base challenges

- Across manufacturing development lifecycle
- From process conception through full rate production
- Across the spectrum of aerospace technology
- For acquisition and sustainment

Manufacturing for Space Systems

Reduce cost and improve acquisition timelines through manufacturing innovations of advanced technologies for DoD space applications in LEO and beyond.

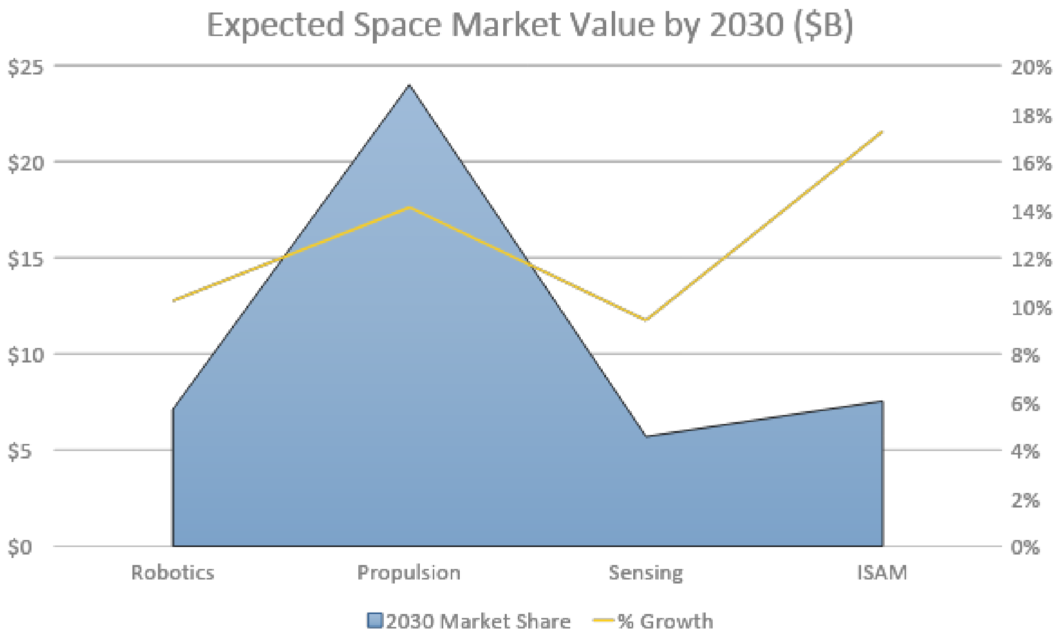
- **Proliferated Architectures**
  - Operational Resiliency
  - More Dynamic Operational Capability
  - Rapid Design & Mfg of Optimized Structures
  - Lightweight, Scalable Propulsion
- **Commoditization of Advanced Sensors**
  - Modular Phased Arrays
  - Active Passive Modules
- **Low C-SWAP Environmental Protection**
  - Lightweight Radiation Shielding
  - Efficient Thermal Management
- **In-Space Servicing, Assembly & Manufacturing**
  - Enabling Unlaunchable Subsystems
  - Eliminate Launch Mortality
  - Extend Operational Lifetime

Distribution A: Approved for Public Release AFRL-2024-0866 Date Approved: 02-15-2024

ISAM Myths and Misconceptions

ISAM isn't… Science Fiction

ISAM Market Value	
2030	
$7.55B	17.3% CAGR



Data from: Report Linker

ISAM isn't… New

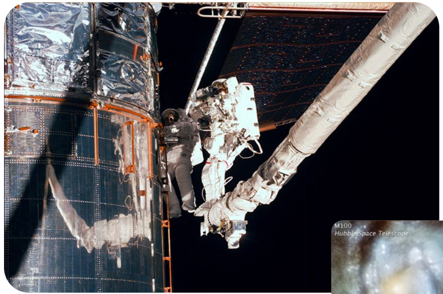
- RPO
- Servicing
- Assembly/Mfg

1961 -1972 – Gemini and Apollo

1973 – Skylab

1984 – Solar Maximum Mission

1993 - 2009 – Hubble Space Telescope



1998 – Present – International Space Station

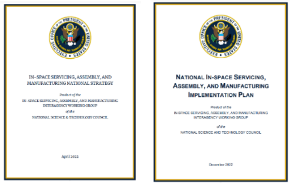
2005 – NASA DART

2007 – DARPA Orbital Express

2015 - 2025 – NASA OSAM-1 and 2

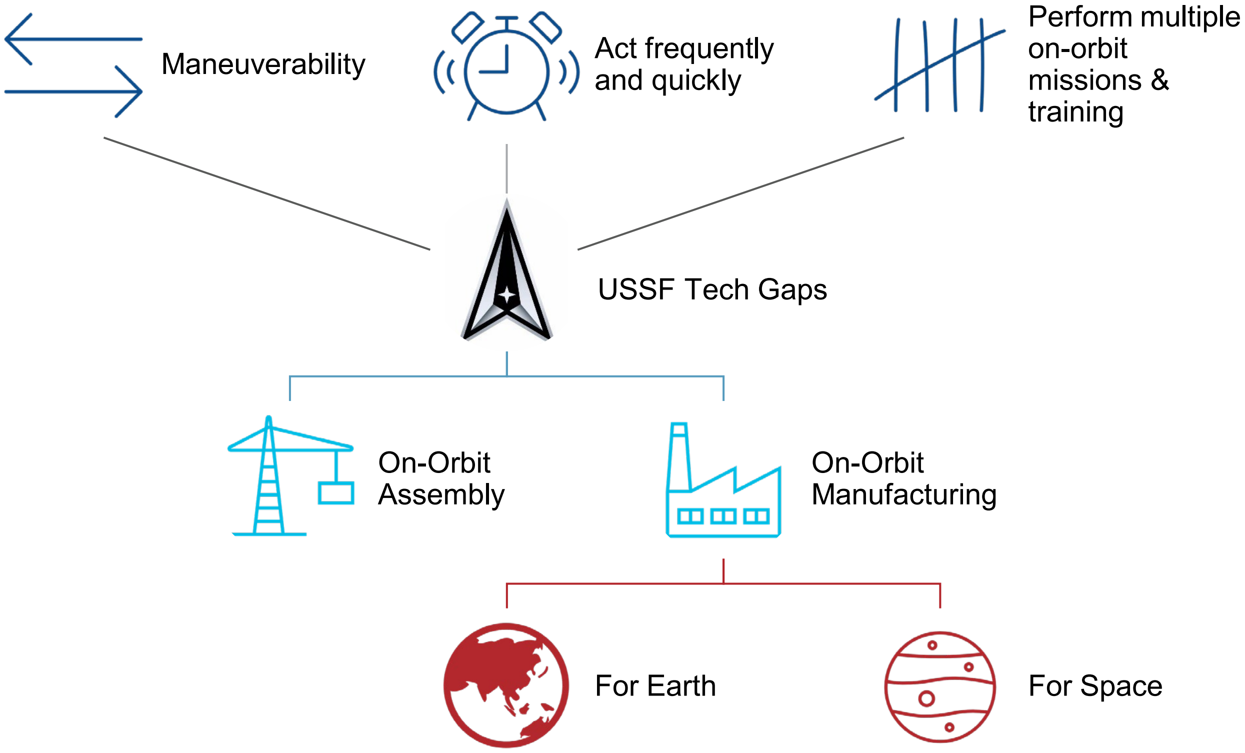
2021 – DAF SpaceWERX Orbital Prime

2022– White House ISAM National Strategy & Implementation Plan



Future – DoD SSPIDR, RSGS, NOM4D and more!

ISAM isn't… Just For Space



Objectives

On-Orbit Assembly and Manufacturing

- Resilience
- Rapid response
- Dynamic space operations

Theoretical Framework to Reality

Autonomous materials joining

Robotic handling, manipulation & assembly

Operations assembly and sequence planning

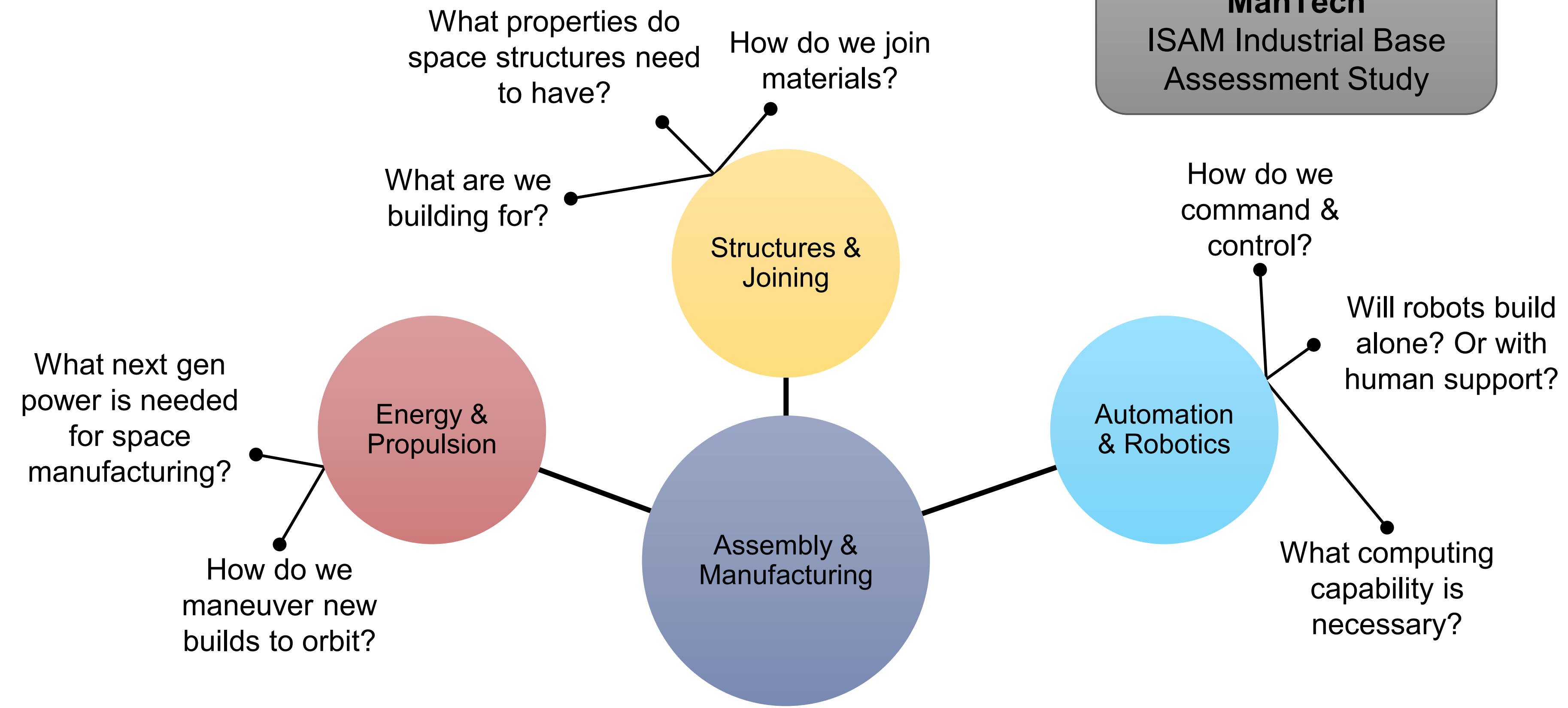
Integration and attachment of utilities and other systems

MIT Bill-E assembling “Voxels”, 2019

Based on: Dorsey, et al., 2012

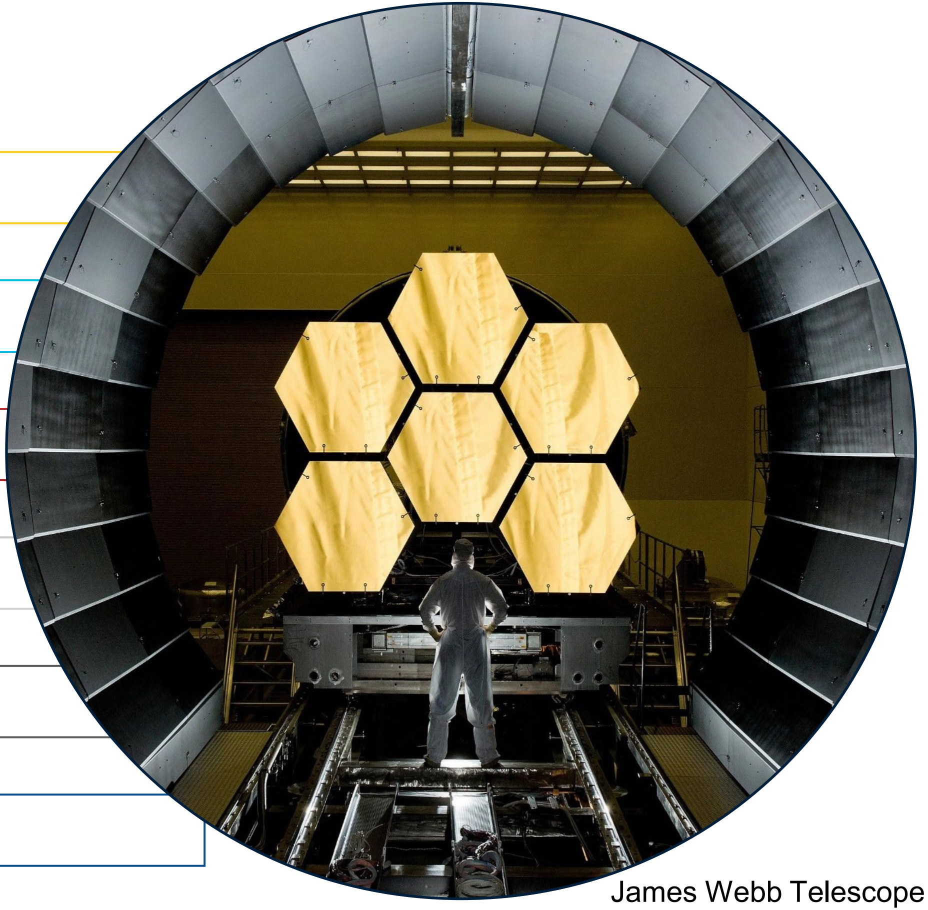
Strategic Questions for ISAM

In Progress: **DAF ManTech**
ISAM Industrial Base Assessment Study



Challenges

- Collaboration
- Tech advancement & maturation
- Reliable & valid space testing
- Tech push vs. tech pull
- Creativity vs. practicality
- Buy-In



James Webb Telescope

Closing Comments

Fill tech gaps
- Enable ISAM

Focus on goals
- Resilience
- Rapid response
- Dynamic operations

Collaboration is key

Questions?

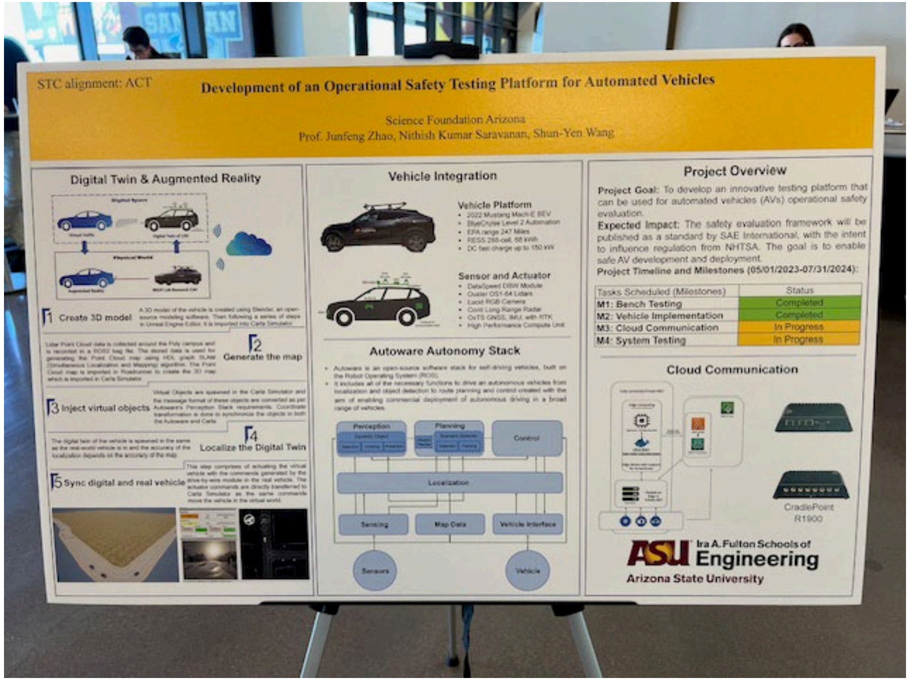
STC Poster Session

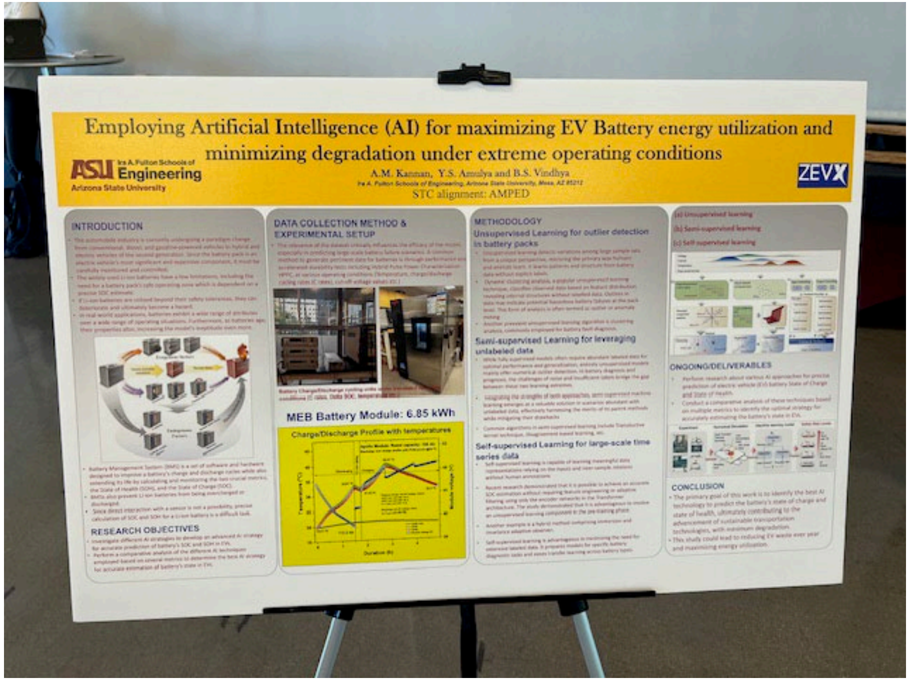
Please visit with PIs and students

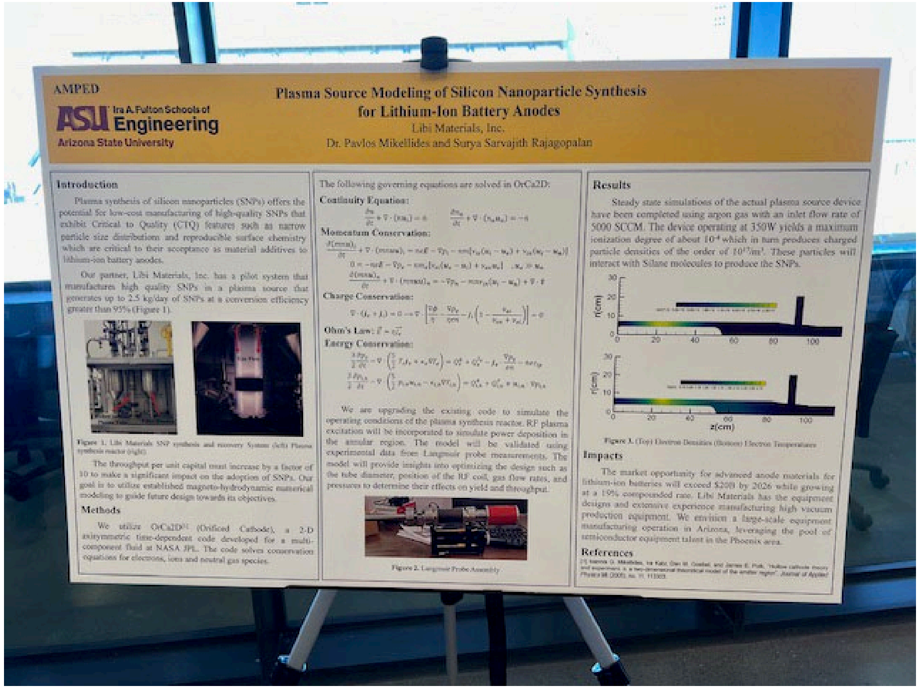
STC-Industry Partner Project Poster Displays

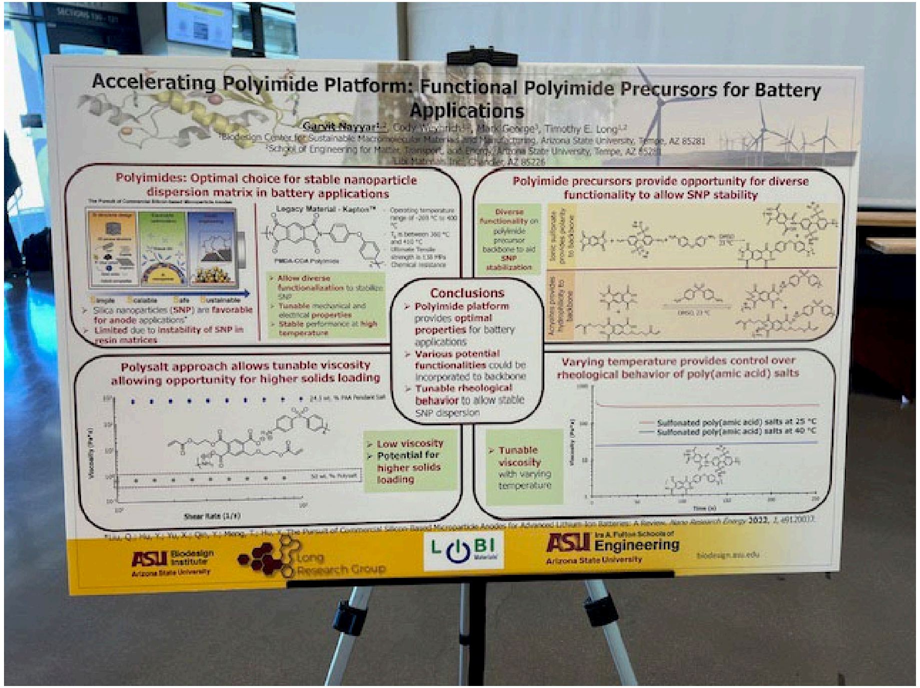
Science and Technology Center

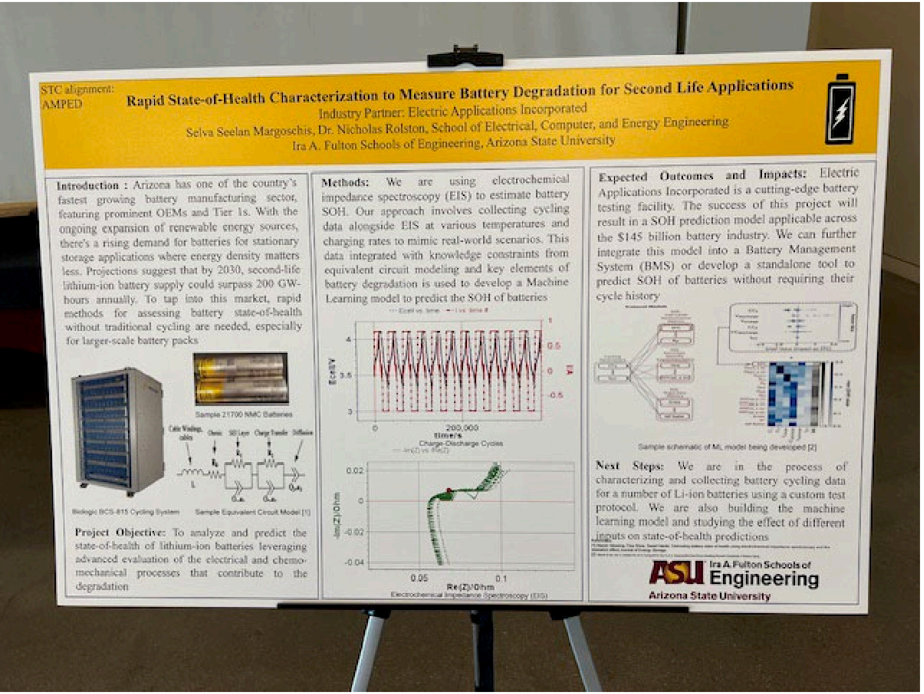
STC	Industry Partner	ASU PI	Graduate Student
ACT	Science Foundation Arizona	Junfeng Zhao	Nithish Kumar Saravanan, Shun-Yen Wang
AMPED	Zero Electric Vehicles	A.M. Kannan	Sai Amulya Yellapragada, Vindhya Bellalacharvu Srinivasa
AMPED	LiBi Materials	Pavlos Mikellides	Surya Rajagopalan
AMPED	LiBi Materials	Timothy Long	Garvit Nayyar
AMPED	Electric Applications Inc	Nicholas Rolston	Selva Seelan Margoschis
AMPED	Northrop Grumman	Trevor Thornton	Mihilat Manahile
EXTREME	Alarivean	Sergio GARCIA SEGURA	Jesus Moron-Lopez, Andre L. Magdaleno
EXTREME	Creative Paving Solutions	Kamil Kaloush	Jolina Karam, Fouzan Alfouzan, Manoj Venkat Sairam Illipilli
EXTREME	GAF Materials Corporation	Jose Medina	Mohammed Alhozaimy, Hasna Elmagri, Jolina Karam
MADE	Scientific Systems Company, Inc.	Paulo Shakarian	Kaustuv Mukherji
MADE	Densec ID, LLC	Michael Kozicki	Jesly Joseph
PERFORM	Mayo Clinic Scottsdale, Arizona	Ayan Banerjee	Riya Sudhakar Salian


STC alignment: ACT
Development of an Operational Safety Testing Platform for Automated Vehicles
Science Foundation Arizona
Prof. Junfeng Zhao, Nithish Kumar Saravanan, Shun-Yen Wang
Digital Twin & Augmented Reality
1 Create 3D model
2 Generate the map
3 Inject virtual objects
4 Localize the Digital Twin
5 Sync digital and real vehicle
Vehicle Integration
Vehicle Platform
Sensor and Actuator
Autoware Autonomy Stack
Perception
Planning
Control
Localization
Sensing
Map Data
Vehicle Interface
Sensors
Vehicle
Project Overview
Project Goal: To develop an innovative testing platform that can be used for automated vehicles (AVs) operational safety evaluation.
Expected Impact: The safety evaluation framework will be published as a standard by SAE International, with the intent to influence regulation from NHTSA. The goal is to enable safe AV development and deployment.
Project Timeline and Milestones (05/01/2023-07/31/2024):
Tasks Scheduled (Milestones)
Status
M1: Bench Testing
Completed
M2: Vehicle Implementation
Completed
M3: Cloud Communication
In Progress
M4: System Testing
In Progress
Cloud Communication
CradlePoint
R1900
Ira A. Fulton Schools of Engineering
Arizona State University


Employing Artificial Intelligence (AI) for maximizing EV Battery energy utilization and minimizing degradation under extreme operating conditions
Ira A. Fulton Schools of Engineering
Arizona State University
A.M. Kannan, Y.S. Amulya and B.S. Vindhya
STC alignment: AMPED
ZEVX
INTRODUCTION
RESEARCH OBJECTIVES
DATA COLLECTION METHOD & EXPERIMENTAL SETUP
MEB Battery Module: 6.85 kWh
Charge/Discharge Profile with temperatures
METHODOLOGY
Unsupervised Learning for outlier detection in battery packs
Semi-supervised Learning for leveraging unlabeled data
Self-supervised Learning for large-scale time series data
ONGOING/DELIVERABLES
CONCLUSION


AMPED
Ira A. Fulton Schools of Engineering
Arizona State University
Plasma Source Modeling of Silicon Nanoparticle Synthesis for Lithium-Ion Battery Anodes
Libi Materials, Inc.
Dr. Pavlos Mikellides and Surya Sarvajith Rajagopalan
Introduction
Methods
The following governing equations are solved in OrCa2D:
Continuity Equation:
Momentum Conservation:
Charge Conservation:
Ohm's Law:
Energy Conservation:
Results
Impacts
References


Accelerating Polyimide Platform: Functional Polyimide Precursors for Battery Applications
Polyimides: Optimal choice for stable nanoparticle dispersion matrix in battery applications
Polyimide precursors provide opportunity for diverse functionality to allow SNP stability
Conclusions
Polyimide platform provides optimal properties for battery applications
Various potential functionalities could be incorporated to backbone
Tunable rheological behavior to allow stable SNP dispersion
Polysalt approach allows tunable viscosity allowing opportunity for higher solids loading
Varying temperature provides control over rheological behavior of poly(amic acid) salts
Low viscosity
Potential for higher solids loading
Tunable viscosity with varying temperature
ASU Biodesign Institute
Long Research Group
Ira A. Fulton Schools of Engineering
Arizona State University


STC alignment:
AMPED
Rapid State-of-Health Characterization to Measure Battery Degradation for Second Life Applications
Industry Partner: Electric Applications Incorporated
Selva Seelan Margoschis, Dr. Nicholas Rolston, School of Electrical, Computer, and Energy Engineering
Ira A. Fulton Schools of Engineering, Arizona State University
Introduction : Arizona has one of the country's fastest growing battery manufacturing sector, featuring prominent OEMs and Tier 1s. With the ongoing expansion of renewable energy sources, there's a rising demand for batteries for stationary storage applications where energy density matters less. Projections suggest that by 2030, second-life lithium-ion battery supply could surpass 200 GW-hours annually. To tap into this market, rapid methods for assessing battery state-of-health without traditional cycling are needed, especially for larger-scale battery packs
Sample 21700 NMC Batteries
Biologic BCS-815 Cycling System
Sample Equivalent Circuit Model [1]
Project Objective: To analyze and predict the state-of-health of lithium-ion batteries leveraging advanced evaluation of the electrical and chemo-mechanical processes that contribute to the degradation
Methods: We are using electrochemical impedance spectroscopy (EIS) to estimate battery SOH. Our approach involves collecting cycling data alongside EIS at various temperatures and charging rates to mimic real-world scenarios. This data integrated with knowledge constraints from equivalent circuit modeling and key elements of battery degradation is used to develop a Machine Learning model to predict the SOH of batteries
Charge-Discharge Cycles
Re(Z)/Ohm
Electrochemical Impedance Spectroscopy (EIS)
Expected Outcomes and Impacts: Electric Applications Incorporated is a cutting-edge battery testing facility. The success of this project will result in a SOH prediction model applicable across the $145 billion battery industry. We can further integrate this model into a Battery Management System (BMS) or develop a standalone tool to predict SOH of batteries without requiring their cycle history
Sample schematic of ML model being developed [2]
Next Steps: We are in the process of characterizing and collecting battery cycling data for a number of Li-ion batteries using a custom test protocol. We are also building the machine learning model and studying the effect of different inputs on state-of-health predictions
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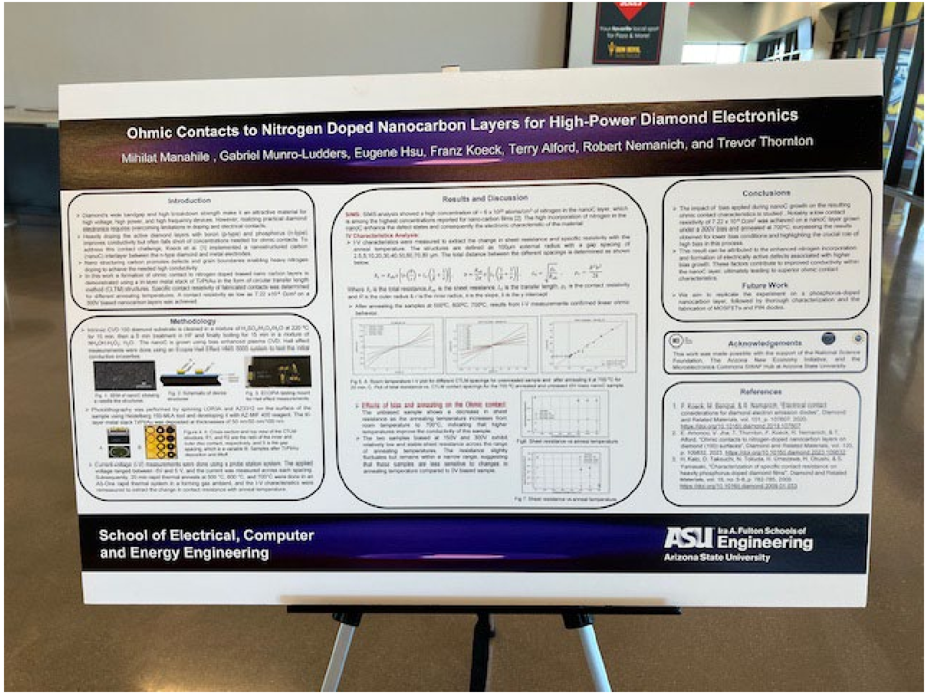
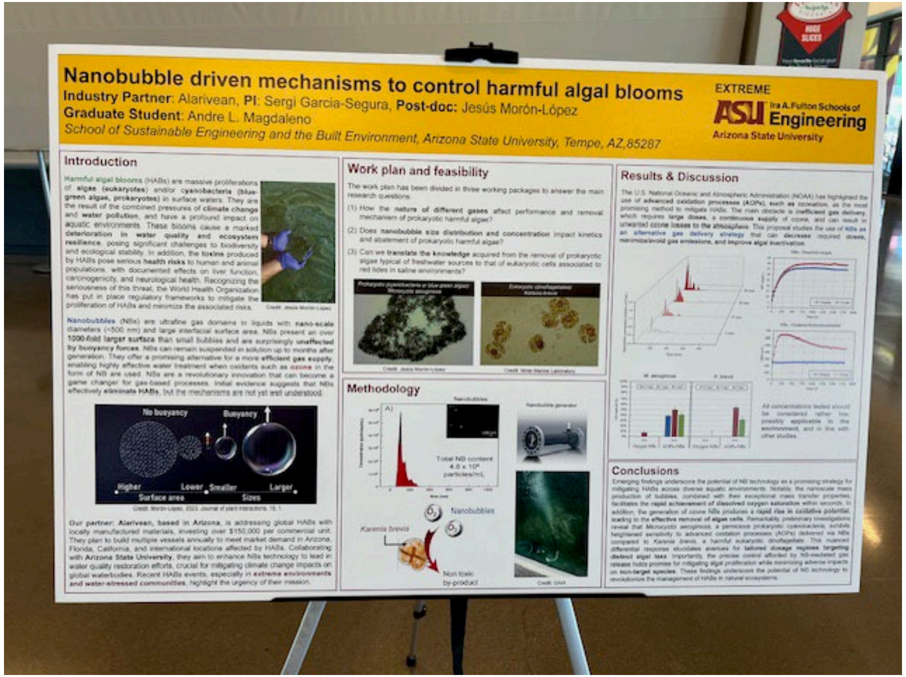
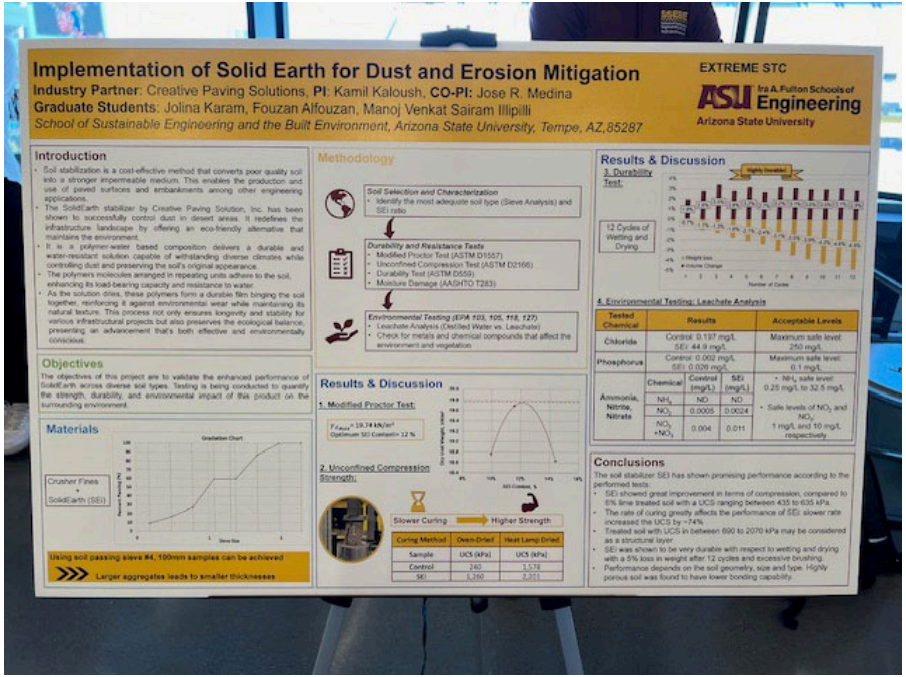
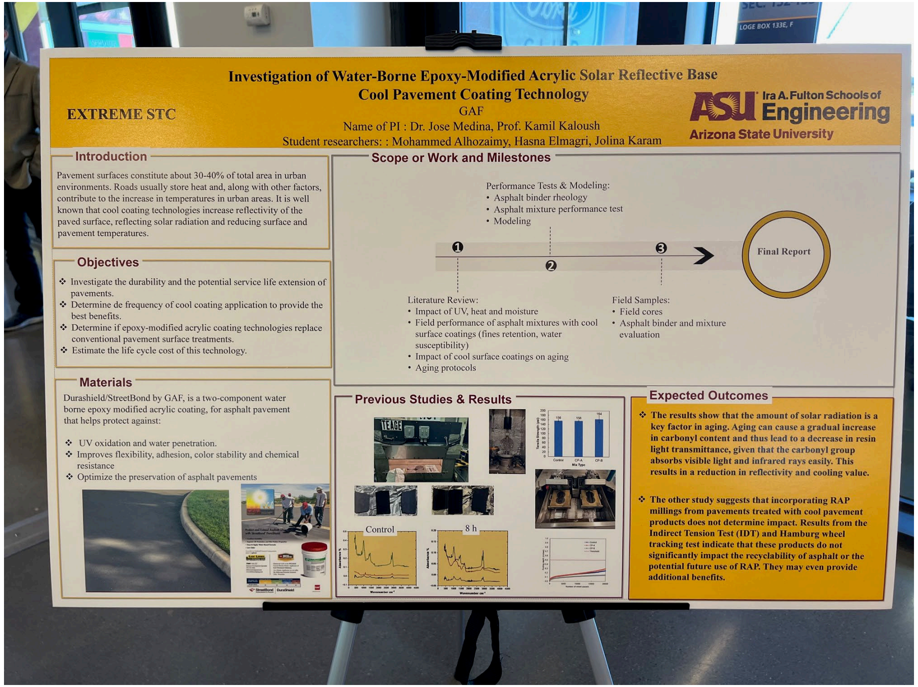
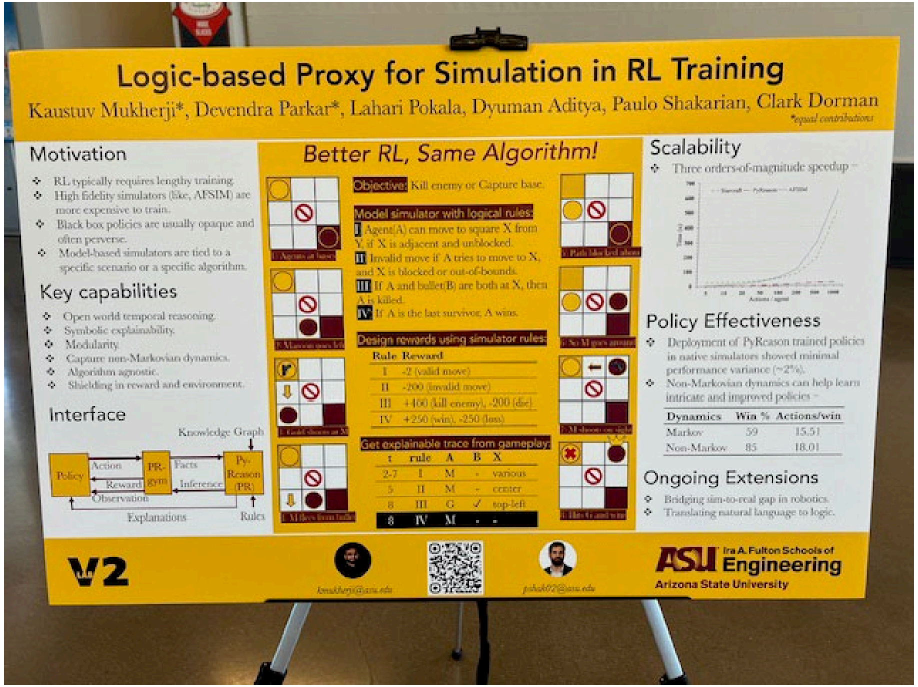
Arizona State University

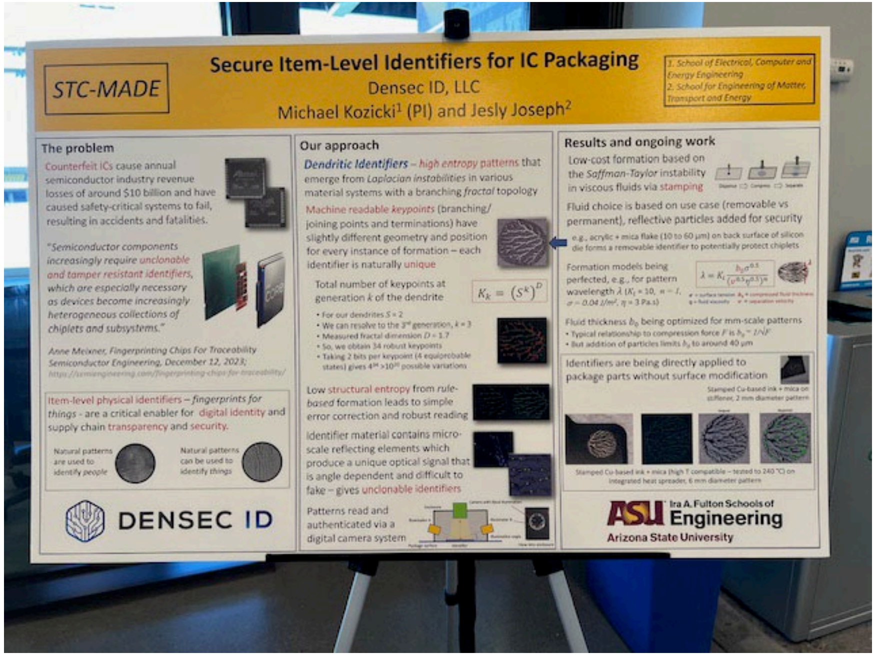

Ohmic Contacts to Nitrogen Doped Nanocarbon Layers for High-Power Diamond Electronics
Mihilat Manahile , Gabriel Munro-Ludders, Eugene Hsu, Franz Koeck, Terry Alford, Robert Nemanich, and Trevor Thornton
Introduction
Methodology
Results and Discussion
Conclusions
Future Work
Acknowledgements
References
School of Electrical, Computer
and Energy Engineering
ASU Ira A. Fulton Schools of Engineering
Arizona State University

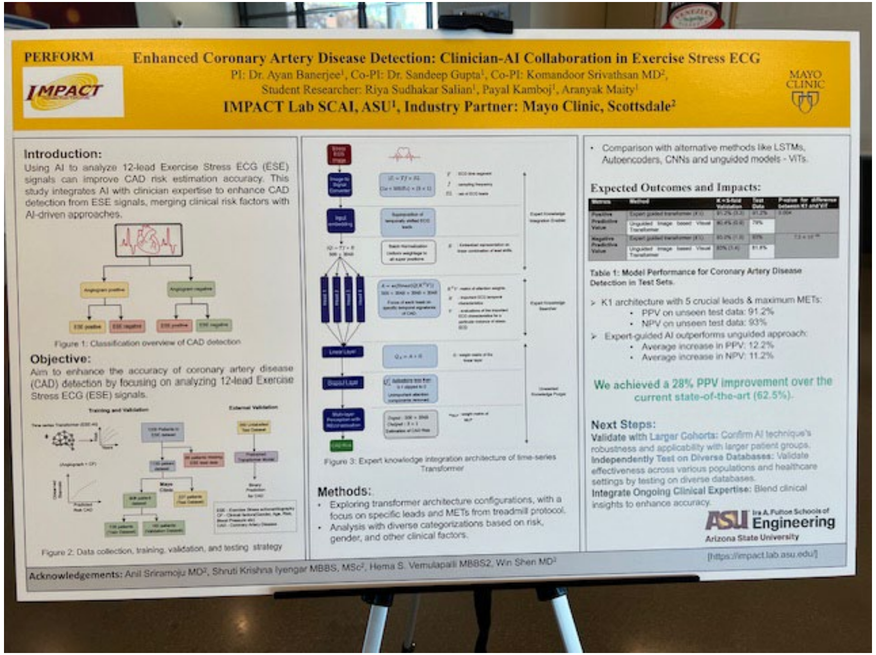

Nanobubble driven mechanisms to control harmful algal blooms
Industry Partner: Alarivean, PI: Sergi Garcia-Segura, Post-doc: Jesús Morón-López
Graduate Student: Andre L. Magdaleno
School of Sustainable Engineering and the Built Environment, Arizona State University, Tempe, AZ,85287
EXTREME
ASU Ira A. Fulton Schools of Engineering
Arizona State University
Introduction
Work plan and feasibility
Results & Discussion
Methodology
Conclusions
No buoyancy
Buoyancy
Higher
Lower
Smaller
Larger
Surface area
Sizes
Nanobubbles
Karenia brevis
Non toxic by-product


Implementation of Solid Earth for Dust and Erosion Mitigation
Industry Partner: Creative Paving Solutions, PI: Kamil Kaloush, CO-PI: Jose R. Medina
Graduate Students: Jolina Karam, Fouzan Alfouzan, Manoj Venkat Sairam Illipilli
School of Sustainable Engineering and the Built Environment, Arizona State University, Tempe, AZ,85287
EXTREME STC
ASU Ira A. Fulton Schools of Engineering
Arizona State University
Introduction
Methodology
Results & Discussion
Objectives
Materials
Conclusions
Soil Selection and Characterization
Durability and Resistance Tests
Environmental Testing
1. Modified Proctor Test
2. Unconfined Compression Strength
3. Durability Test
4. Environmental Testing: Leachate Analysis
Slower Curing
Higher Strength


Investigation of Water-Borne Epoxy-Modified Acrylic Solar Reflective Base
Cool Pavement Coating Technology
GAF
Name of PI : Dr. Jose Medina, Prof. Kamil Kaloush
Student researchers: : Mohammed Alhozaimy, Hasna Elmagri, Jolina Karam
EXTREME STC
ASU Ira A. Fulton Schools of Engineering
Arizona State University
Introduction
Pavement surfaces constitute about 30-40% of total area in urban environments. Roads usually store heat and, along with other factors, contribute to the increase in temperatures in urban areas. It is well known that cool coating technologies increase reflectivity of the paved surface, reflecting solar radiation and reducing surface and pavement temperatures.
Objectives
Investigate the durability and the potential service life extension of pavements.
Determine de frequency of cool coating application to provide the best benefits.
Determine if epoxy-modified acrylic coating technologies replace conventional pavement surface treatments.
Estimate the life cycle cost of this technology.
Materials
Durashield/StreetBond by GAF, is a two-component water borne epoxy modified acrylic coating, for asphalt pavement that helps protect against:
UV oxidation and water penetration.
Improves flexibility, adhesion, color stability and chemical resistance
Optimize the preservation of asphalt pavements
Scope or Work and Milestones
Performance Tests & Modeling:
Asphalt binder rheology
Asphalt mixture performance test
Modeling
Literature Review:
Impact of UV, heat and moisture
Field performance of asphalt mixtures with cool surface coatings (fines retention, water susceptibility)
Impact of cool surface coatings on aging
Aging protocols
Field Samples:
Field cores
Asphalt binder and mixture evaluation
Final Report
Previous Studies & Results
Control
8 h
Expected Outcomes
The results show that the amount of solar radiation is a key factor in aging. Aging can cause a gradual increase in carbonyl content and thus lead to a decrease in resin light transmittance, given that the carbonyl group absorbs visible light and infrared rays easily. This results in a reduction in reflectivity and cooling value.
The other study suggests that incorporating RAP millings from pavements treated with cool pavement products does not determine impact. Results from the Indirect Tension Test (IDT) and Hamburg wheel tracking test indicate that these products do not significantly impact the recyclability of asphalt or the potential future use of RAP. They may even provide additional benefits.


Logic-based Proxy for Simulation in RL Training
Kaustuv Mukherji*, Devendra Parkar*, Lahari Pokala, Dyuman Aditya, Paulo Shakarian, Clark Dorman
*equal contributions
Motivation
RL typically requires lengthy training.
High fidelity simulators (like, AFSIM) are more expensive to train.
Black box policies are usually opaque and often perverse.
Model-based simulators are tied to a specific scenario or a specific algorithm.
Key capabilities
Open world temporal reasoning.
Symbolic explainability.
Modularity.
Capture non-Markovian dynamics.
Algorithm agnostic.
Shielding in reward and environment.
Interface
Knowledge Graph
Policy
Action
Reward
Observation
PR-gym
Facts
Inference
PyReason (PR)
Explanations
Rules
Better RL, Same Algorithm!
Objective: Kill enemy or Capture base.
Model simulator with logical rules:
I Agent(A) can move to square X from Y, if X is adjacent and unblocked.
II Invalid move if A tries to move to X, and X is blocked or out-of-bounds.
III If A and bullet(B) are both at X, then A is killed.
IV If A is the last survivor, A wins.
Design rewards using simulator rules:
Rule Reward
I -2 (valid move)
II -200 (invalid move)
III +400 (kill enemy), -200 (die)
IV +250 (win), -250 (loss)
Get explainable trace from gameplay:
t rule A B X
2-7 I M - various
5 II M - center
8 III G ✓ top-left
8 IV M - -
Scalability
Three orders-of-magnitude speedup
Policy Effectiveness
Deployment of PyReason trained policies in native simulators showed minimal performance variance (~2%).
Non-Markovian dynamics can help learn intricate and improved policies
Dynamics Win % Actions/win
Markov 59 15.51
Non-Markov 85 18.01
Ongoing Extensions
Bridging sim-to-real gap in robotics.
Translating natural language to logic.
V2
ASU Ira A. Fulton Schools of Engineering
Arizona State University


STC-MADE
Secure Item-Level Identifiers for IC Packaging
Densec ID, LLC
Michael Kozicki1 (PI) and Jesly Joseph2
1. School of Electrical, Computer and Energy Engineering
2. School for Engineering of Matter, Transport and Energy
The problem
Counterfeit ICs cause annual semiconductor industry revenue losses of around $10 billion and have caused safety-critical systems to fail, resulting in accidents and fatalities.
"Semiconductor components increasingly require unclonable and tamper resistant identifiers, which are especially necessary as devices become increasingly heterogeneous collections of chiplets and subsystems."
Anne Meixner, Fingerprinting Chips For Traceability Semiconductor Engineering, December 12, 2023;
Item-level physical identifiers – fingerprints for things - are a critical enabler for digital identity and supply chain transparency and security.
Natural patterns are used to identify people
Natural patterns can be used to identify things
DENSEC ID
Our approach
Dendritic Identifiers – high entropy patterns that emerge from Laplacian instabilities in various material systems with a branching fractal topology
Machine readable keypoints (branching/joining points and terminations) have slightly different geometry and position for every instance of formation – each identifier is naturally unique
Total number of keypoints at generation k of the dendrite
Low structural entropy from rule-based formation leads to simple error correction and robust reading
Identifier material contains micro-scale reflecting elements which produce a unique optical signal that is angle dependent and difficult to fake – gives unclonable identifiers
Patterns read and authenticated via a digital camera system
Results and ongoing work
Low-cost formation based on the Saffman-Taylor instability in viscous fluids via stamping
Fluid choice is based on use case (removable vs permanent), reflective particles added for security
Formation models being perfected, e.g., for pattern wavelength
Fluid thickness being optimized for mm-scale patterns
Identifiers are being directly applied to package parts without surface modification
Ira A. Fulton Schools of Engineering
Arizona State University


PERFORM
IMPACT
Enhanced Coronary Artery Disease Detection: Clinician-AI Collaboration in Exercise Stress ECG
PI: Dr. Ayan Banerjee1, Co-PI: Dr. Sandeep Gupta1, Co-PI: Komandoor Srivathsan MD2,
Student Researcher: Riya Sudhakar Salian1, Payal Kamboj1, Aranyak Maity1
IMPACT Lab SCAI, ASU1, Industry Partner: Mayo Clinic, Scottsdale2
MAYO CLINIC
Introduction:
Using AI to analyze 12-lead Exercise Stress ECG (ESE) signals can improve CAD risk estimation accuracy. This study integrates AI with clinician expertise to enhance CAD detection from ESE signals, merging clinical risk factors with AI-driven approaches.
Figure 1: Classification overview of CAD detection
Objective:
Aim to enhance the accuracy of coronary artery disease (CAD) detection by focusing on analyzing 12-lead Exercise Stress ECG (ESE) signals.
Figure 2: Data collection, training, validation, and testing strategy
Figure 3: Expert knowledge integration architecture of time-series Transformer
Methods:
Exploring transformer architecture configurations, with a focus on specific leads and METs from treadmill protocol.
Analysis with diverse categorizations based on risk, gender, and other clinical factors.
Comparison with alternative methods like LSTMs, Autoencoders, CNNs and unguided models - ViTs.
Expected Outcomes and Impacts:
Table 1: Model Performance for Coronary Artery Disease Detection in Test Sets.
K1 architecture with 5 crucial leads & maximum METs:
PPV on unseen test data: 91.2%
NPV on unseen test data: 93%
Expert-guided AI outperforms unguided approach:
Average increase in PPV: 12.2%
Average increase in NPV: 11.2%
We achieved a 28% PPV improvement over the current state-of-the-art (62.5%).
Next Steps:
Validate with Larger Cohorts: Confirm AI technique's robustness and applicability with larger patient groups.
Independently Test on Diverse Databases: Validate effectiveness across various populations and healthcare settings by testing on diverse databases.
Integrate Ongoing Clinical Expertise: Blend clinical insights to enhance accuracy.
Ira A. Fulton Schools of Engineering
Arizona State University
[https://impact.lab.asu.edu/]
Acknowledgements: Anil Sriramoju MD2, Shruti Krishna Iyengar MBBS, MSc2, Hema S. Vemulapalli MBBS2, Win Shen MD2

STC
Project Showcases

AMPED

STC Project with Safe-Li

Jerry Lin

AMPED

Advanced Materials, Processes and Energy Devices

Science and Technology Center

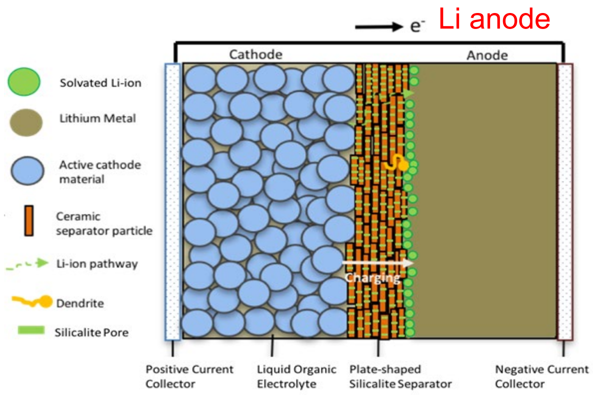
High Performing Lithium-Metal Batteries (LMB) with Zeolite Separator-Scaling Up Zeolite Synthesis

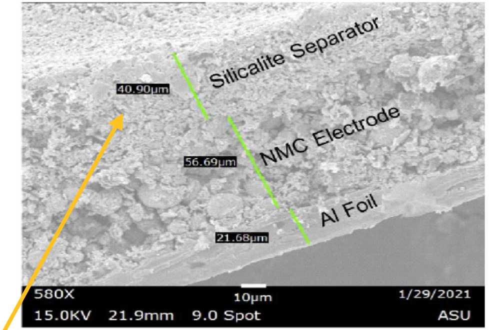
PI:	Jerry Lin
Industry Partner:	Safe-Li LLC
Project Goal:	To scale up synthesis of 2D zeolite crystals, characterize the zeolite crystals and study performance of the coin cell LMB made of the 2D zeolite synthesized by the scaled method.
Impact:	Establish method for large scale synthesis of 2D zeolite crystals to support the R&D efforts to commercialize novel LMB and for eventual commercial production of the new high energy density new LMB

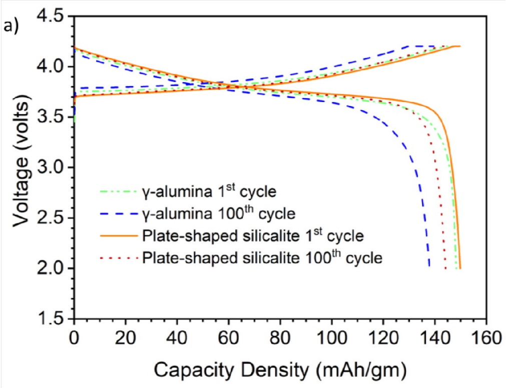
AMPED

Advanced Materials, Processes and Energy Devices

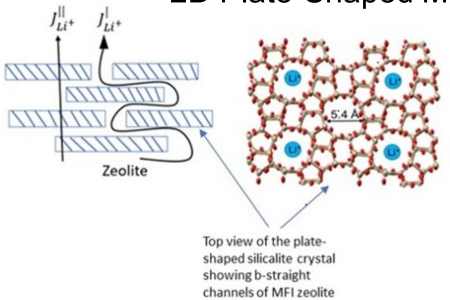
Science and Technology Center

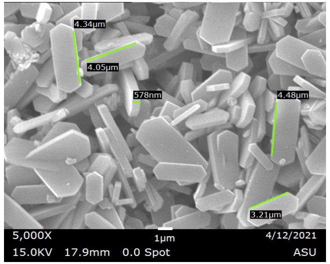






2D Plate-Shaped Microporous Zeolite Crystals





Focus: Develop a new, stable, high energy density lithium-metal batteries (LMB)

Challenge: To scale up synthesis of such 2D zeolite for R and D efforts and commercial production of LMB

AMPED

Advanced Materials, Processes and Energy Devices

Science and Technology Center

Technology

ASU Lin Lab – Ceramic (Zeolite) Separator Platform Technology:
- 3 Patent Applications Filled (ASU)
- 1 New Patent Disclosure (patent application in progress) (ASU+Safe-Li)

Products

Fire-Safe Li-ion batteries (safety)

High-energy density Li-metal batteries (energy density)

Green-Swan Partners – Ventur Builder

ASU

Safe-Li LLC (Jan 2022)

Safe-LiMax LLC (Aug 2023)

Jerry Lin (co-founder and Chief Science Officer)

Shell (Game Change Program)

Customers

Batteries and EV Manufactories

Arizona STC

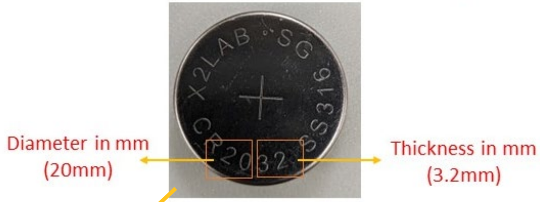
AMPED

Advanced Materials, Processes and Energy Devices

Science and Technology Center

Scaling Up in Action on Safe Li-Ion Batteries

From Lab (coin cells at ASU)



Powder and separator coating

1 Ah pouch cells

Impact of the STC Project

STC Project is focused on developing high-energy density lithium-metal batteries (LMB) – a game change technology for energy storage:

Energy density ~ 400-600 Wh/kg (doubling LIB)

The impact of successful development of the new zeolite separator based lithium-metal batteries is obvious for

- Partners: GSP, Safe-Li LLC, Safe-LiMax LLC, Shell, ASU
- Industries: Batteries, EV and Energy Storage Industries
- Arizona

ASU Lab will conduct research to develop a technique to scale up 2D Zeolites:

a) Identifying conditions to scaling up synthesis of 2D plate-shaped zeolites,

b) Characterizing plate-shaped zeolites synthesized under different conditions

c) Fabricating LMB coin cells and testing their performance with scaled zeolites

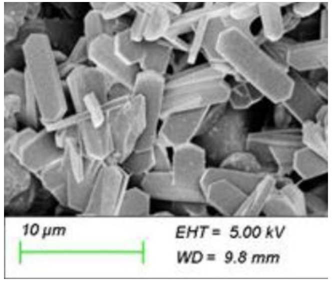
d) Making large quantity of plate-shaped zeolite for future pouch cell R and D.

ASU Lab will prepare plate-shape zeolites in sufficient quantity to Safe-LiMax LLC on scaling up lithium metal batteries.

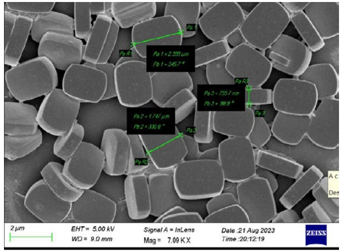
Next Steps

Three methods (KISH, FATE and DHAR) have been studied for synthesis of 2D plate-shaped zeolite crystals

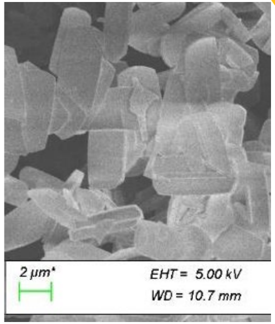
KISH Method



FATE Method



DHAR Method



This method is most promising in terms of zeolite characteristics and scalability

Milestones:

1st month – Acquiring a 1-2.5 L autoclave and chemicals,

5th month – synthesis and structure confirmation of 2D zeolite at scale of 5 g/batch,

9th month – confirming the electrochemical performance of the LMB cells with the separator made of the new 2D zeolite crystals,

12th month – synthesis of 200-300 g of 2D zeolites for subsequent LMB pouch cell R and D efforts.

MADE
STC Project with Densec

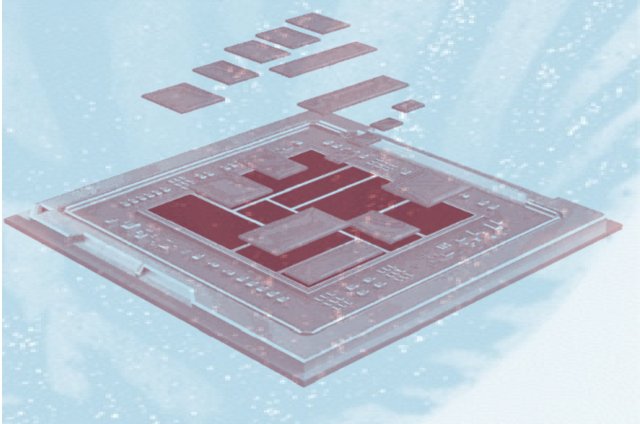
Michael Kozicki

MADE

Manufacturing, Automation and Data Engineering

Science and Technology Center

Secure Item-Level Identifiers for IC Packaging



PI: Michael N. Kozicki

Professor – Electrical, Computer and Energy Engineering, ASU

Co-founder and CTO (hardware) – Densec ID, LLC

Industry Partner: Densec ID

Project Goal: Adaptation of Dendritic Identifier technology to integrated circuits

Expected Impact: Higher levels of trust and assurance in microelectronics supply chains

Ira A. Fulton Schools of Engineering

Arizona State University

DENSEC ID

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Manufacturing, Automation and Data Engineering

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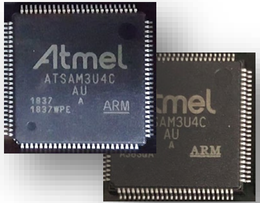
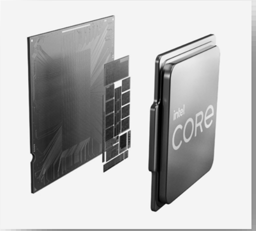
Counterfeit ICs cause annual semiconductor industry revenue losses of around **$10 billion** (1.6% of the global market)



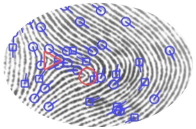
Fake chips have caused safety-critical systems to fail, resulting in **accidents and fatalities**

This problem will worsen with greater use of ***heterogeneous integration*** **-** devices no longer contain a single die made in a safe environment but become assemblies of **chiplets** from ?



"Semiconductor components increasingly require **unclonable** and **tamper resistant identifiers**..."

"These **fingerprints** provide **traceability**, which contributes to process improvements and yield learning and enable tracking for a **tightly managed supply chain**."



Anne Meixner "Fingerprinting Chips For Traceability" Semiconductor Engineering, December 12, 2023.

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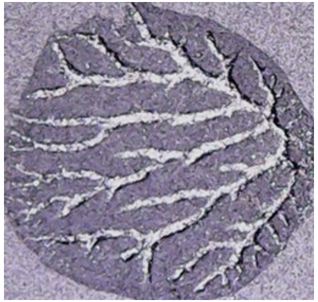
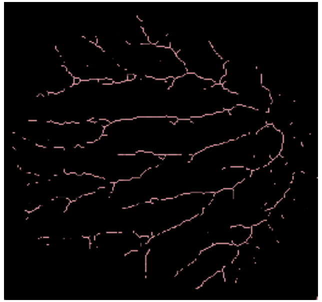
Science and Technology Center

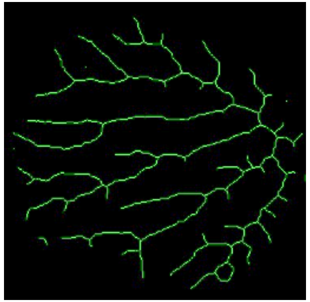
Introducing the Dendritic Identifier – *a fingerprint for things*



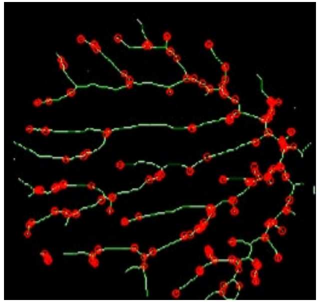
Inexpensive and versatile



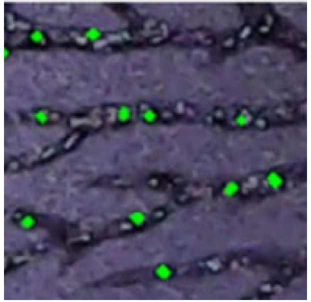
Naturally unique



Digitally robust



Machine readable



Unclonable and secure

Links to data in the cloud

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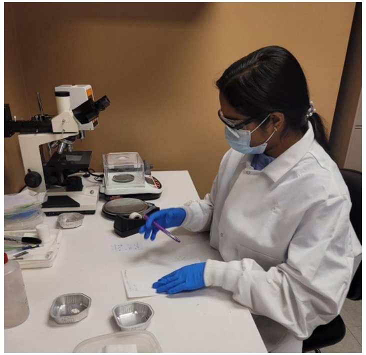
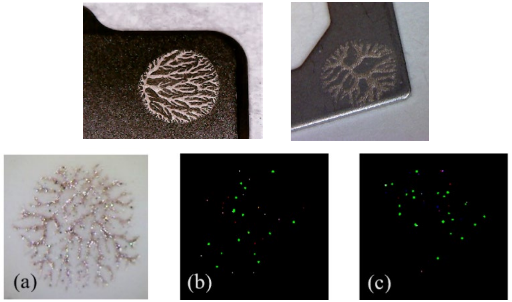
The impact of STC funding has been broad



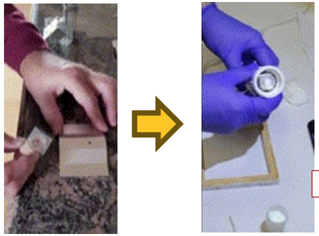
Student training

$$\lambda = K_l \frac{b_0 \sigma^{0.5}}{(v^{0.5}\eta^{0.5})^n}$$

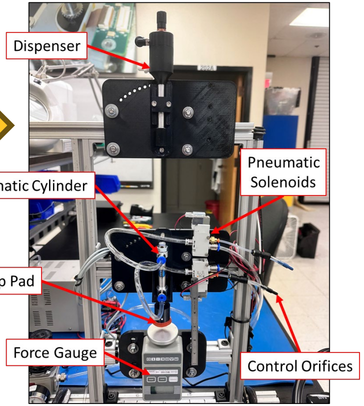
Data gathering and model development



Technology demonstration



TRL improvement



PADT

MADE

Manufacturing, Automation and Data Engineering

Science and Technology Center

Arizona and Global impact

A more transparent and secure supply chain benefits companies across the spectrum

Materials	Equipment	IDM/Foundry	OSAT	Aero/defense

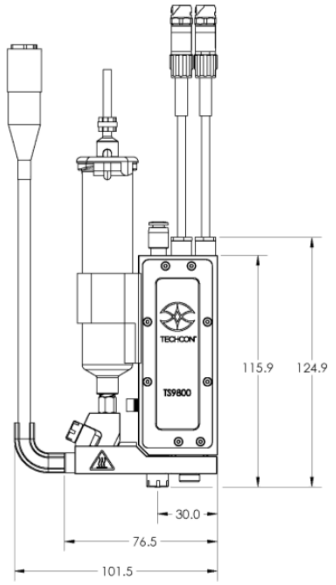
Next steps

Complete semi-automated identifier formation system

Continue materials and process research to allow us to create mm-scale patterns on *any* component

Engage with DoD via FFRDCs and trusted fabs

Engage with industry via CHIPS Act programs



Thank you!

DENSEC ID

www.densecid.com

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Suite 3031
Phoenix AZ 85028

480 241 2707

info@densecid.com

Today's Summit

Process for STC projects

semi-annual cycle

FEB

MAR

APR

MAY

JUN

Projects Begin
Collaborative R&D projects co-funded by the STC and industry partners; 3-6 projects awarded per STC at ~1 PhD student level

Research project funding

This matrix indicates the fraction of the direct project costs that will be paid for by STC funds; the balance of the direct costs will be paid for by the project industry partner. Both contributions are subject to indirect costs that may depend on the IP terms of the project.

STC / Stakeholder Partner fractions of project direct costs

Small for-profit (company and affiliate has <= 500 employees)	**Large for-profit** (company and affiliate has > 500 employees)	**Non-profit or state/local government**
70% / 30%	55% / 45%	40% / 60%

Intellectual property

Intellectual property ("IP") terms for a given sponsored project are negotiated on a case-by-case basis. The terms may depend on the sponsor's desired rights, the preferences of ASU faculty and leadership, the nature of the technology and industry, ASU's investment in the development of the IP, funding sources, applicable law and regulations, and other factors.
To simplify negotiations, below are frameworks that may be available for a sponsored project.

For additional options, please contact ASU research advancement staff.

Sponsor's rights; corresponding cost →

No IP Rights

- Available to local/state government agencies and non-profits
- Sponsor has no rights in project IP
- Sponsor pays F&A totaling 57% of direct project costs*

Exclusive Option

- Available to for-profit companies
- Time-limited option to negotiate an exclusive royalty-bearing license to project IP
- Sponsor reimburses patent expenses
- Sponsor pays F&A (but no upfront administrative fee), totaling 67.7% of direct project costs*

NERF

- Available to for-profit companies
- Non-exclusive, royalty-free license to project IP
- Time-limited option to negotiate an exclusive royalty-bearing license
- Sponsor reimburses patent expenses
- Sponsor pays F&A plus upfront administrative fee, totaling 85% of direct project costs*

* Current minimum rate as of January 2022

Process for STC projects

semi-annual cycle

FEB MAR APR MAY JUN

ASU ITIS
Industry/ASU discussions of R&D challenges identify key topical areas for STC thrusts

Funding Opportunity Announcement (FOA)
Call for proposals that are responsive to key topical areas within the STC thrusts

FOA written by STC Directors and Thrust Leads

Proposers Submission
Project description, budget (reflects STC/industry split), and letter of commitment from industry partner

Any team with an ASU PI and an industry partner is eligible

Proposers Review
Criteria: Alignment with FOA, likely impact on STC and NEI goals, plan and feasibility, team, industry commitment, appropriate budget

Review panel includes STC Director, Thrust Leads, industry rep, ASU administration

Projects Begin
Collaborative R&D projects co-funded by the STC and industry partners; 3-6 projects awarded per STC at ~1 PhD student level

Research Thrust Breakout Sessions

Breakout Sessions

Let's agree to

1. **Stay on topic.**
2. **Honor the brisk pace.** (and facilitator)
3. **Make space for industry voices.**
4. **Have an exploration mindset.**
   (not problem solving or project pitching)

Breakout Sessions

Multimodal Thinking

Diverge

- No judgement, no limits
- Go for quantity!
- Yes, and…
- Be bold! Anything is possible, What if…

Converge

- Strategic sorting
- Go for quality!
- Inclusive attitude, look for similarities and affinities

Breakout Sessions

Let's explore!

1

Introductions & Review FOA topics

10-15 m

Keep them brief: Name, role, organization

2

DIVERGE, individually:
What topics need to be added to the FOA?
Which topics are you interested in pursuing?

5-10 m

Diverge: everyone write your own thoughts (silently)

3

CONVERGE, together:
Discuss suggestions.
Prioritize the topics and clarify rationale.

25-30 m

Converge: everyone share your suggestions, discuss, prioritize

Breakout Session

AMPED
Photovoltaics
Lead: Zak Holman

MADE
Process Science & Engineering
Lead: Keng Hsu

SI
Data and Digital Insight
Lead: Margaret Garcia

AMPED
Batteries
Lead: Candace Chan

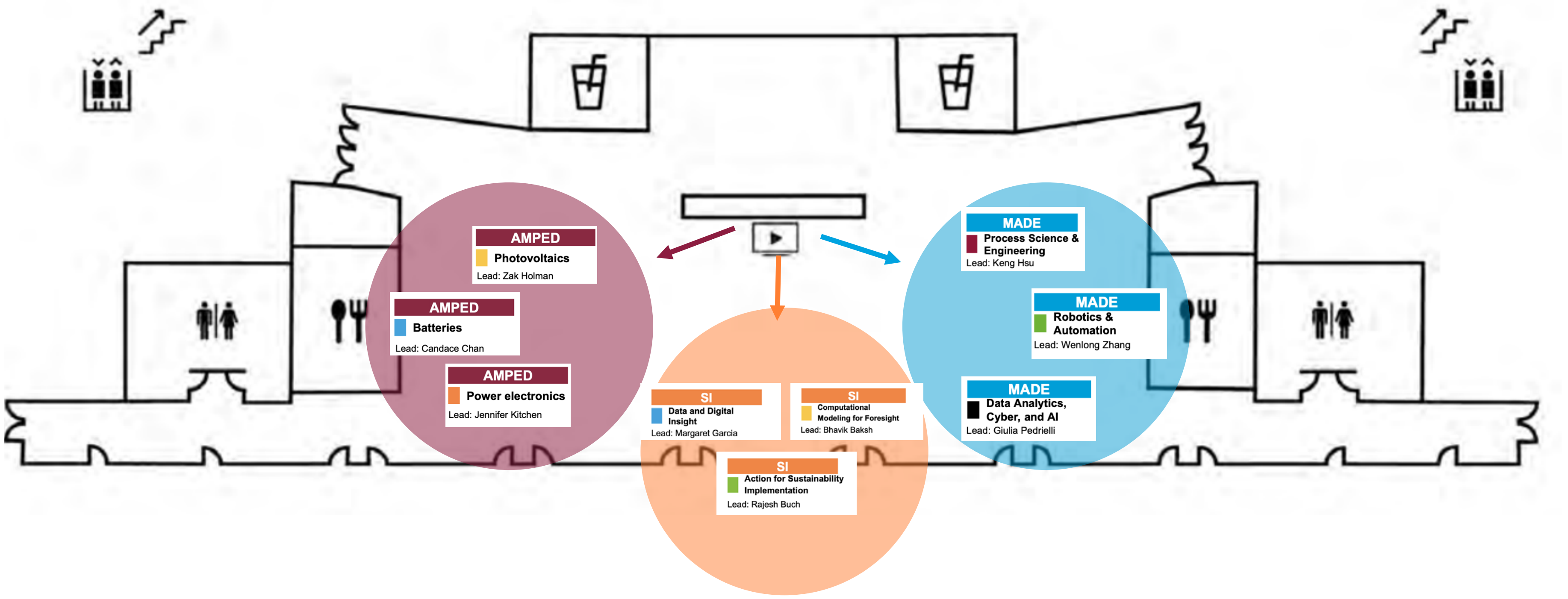
MADE
Robotics & Automation
Lead: Wenlong Zhang

SI
Computational Modeling for Foresight
Lead: Bhavik Bakshi

AMPED
Power electronics
Lead: Jennifer Kitchen

MADE
Data Analytics, Cyber, and AI
Lead: Giulia Pedrielli

SI
Action for Sustainability Implementation
Lead: Eusebio Scornavacca



AMPED
Photovoltaics
Lead: Zak Holman
AMPED
Batteries
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Data and Digital Insight
Lead: Margaret Garcia
SI
Computational Modeling for Foresight
Lead: Bhavik Baksh
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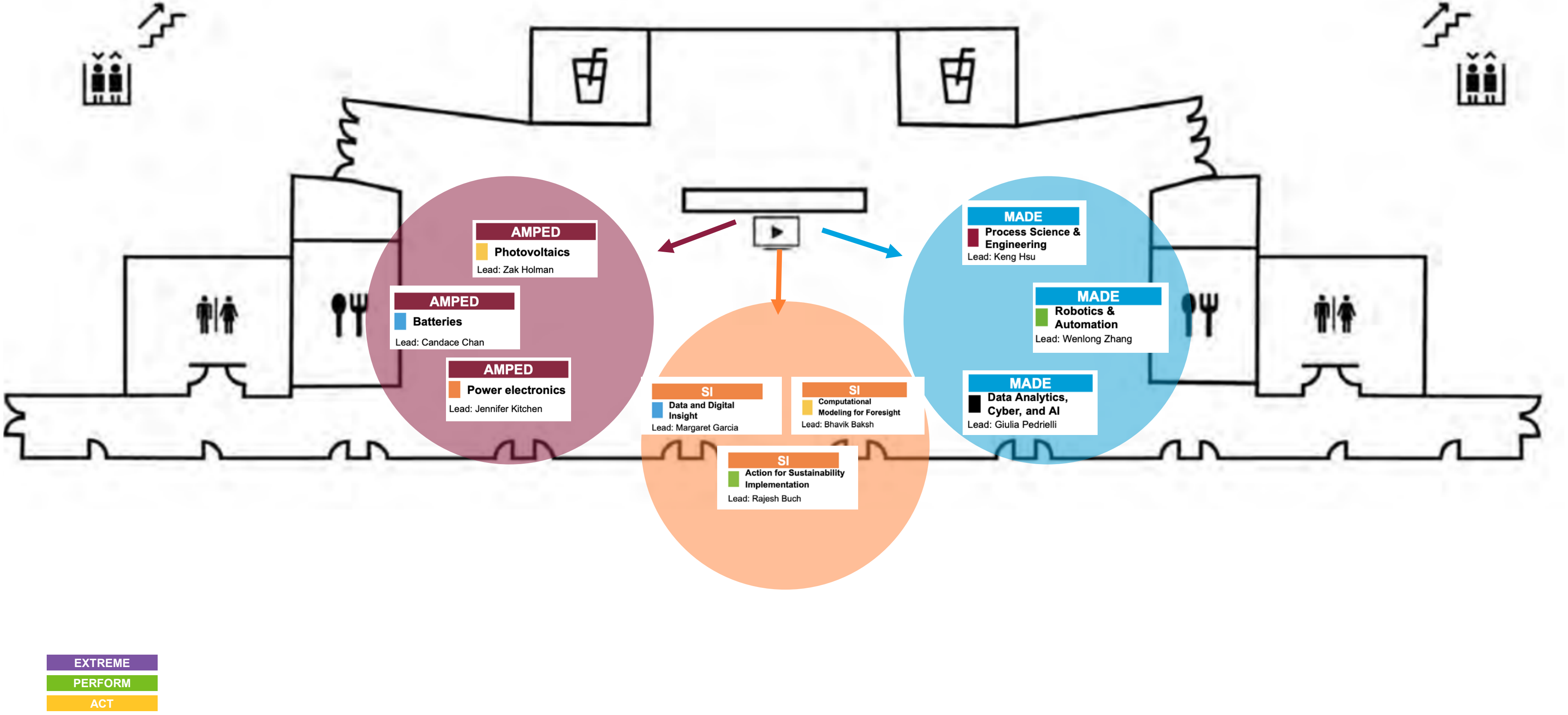
Action for Sustainability Implementation
Lead: Rajesh Buch
MADE
Process Science & Engineering
Lead: Keng Hsu
MADE
Robotics & Automation
Lead: Wenlong Zhang
MADE
Data Analytics, Cyber, and AI
Lead: Giulia Pedrielli

Please break then join your Thrust

You have 15 minutes to take a break and visit the Poster Session.

Please join your chosen Thrust table by 11:00. you'll have just under one hour for the breakout session.



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Robotics & Automation
Lead: Wenlong Zhang
MADE
Data Analytics, Cyber, and AI
Lead: Giulia Pedrielli
EXTREME
PERFORM
ACT

Break then Breakout Sessions

Welcome back!

Please find a seat quickly so we can hear some closing remarks and wrap up

Facilitators

Please post your results in the space designated for your group

Next Steps

Process for STC projects
semi-annual cycle

FEB

MAR

Funding Opportunity Announcement (FOA)
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JUN

Projects Begin
Collaborative R&D projects co-funded by the STC and industry partners; 3-6 projects awarded per STC at ~1 PhD student level

Watch for Save-the-Date

Industry Technology and Innovation Summit

Fall 2024

Arizona State University

stc@asu.edu

Ira A. Fulton Schools of Engineering

Julie Ann Wrigley Global Futures Laboratory

Results

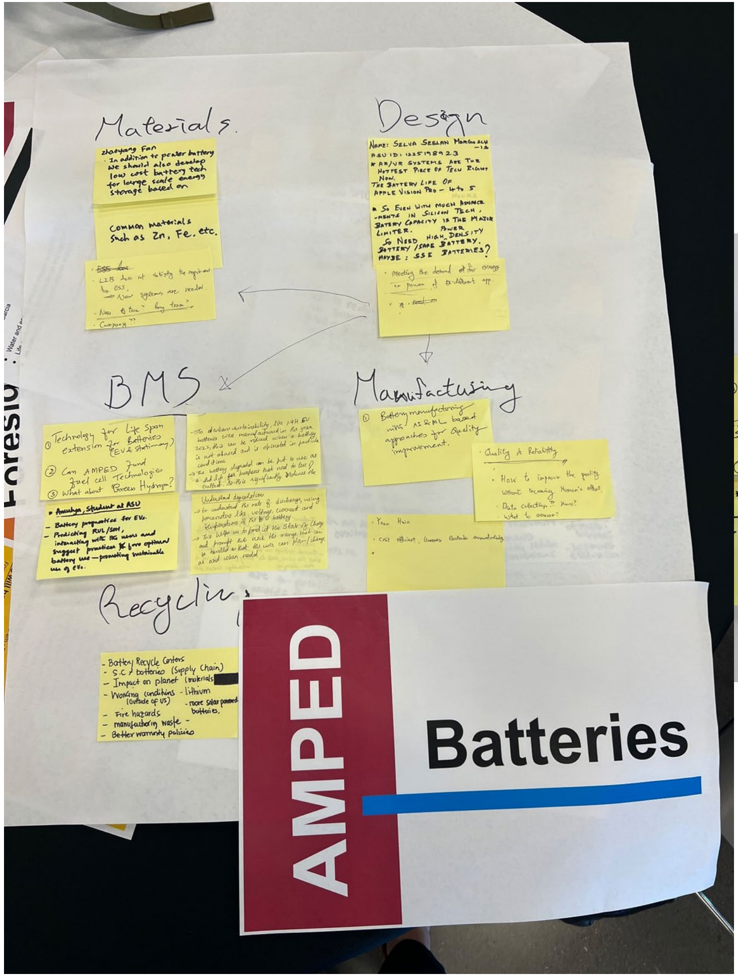
Results

AMPED

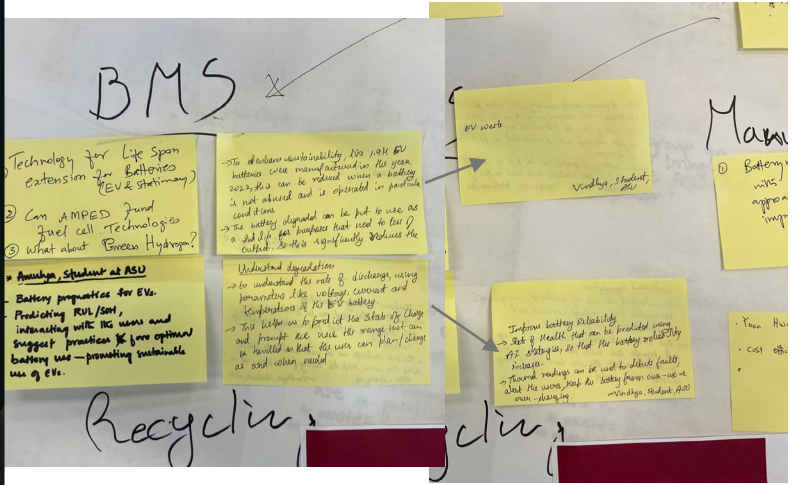
Batteries

Lead: Candace Chan

Names/Attendees



front and back



Results

AMPED

Batteries

Lead: Candace Chan

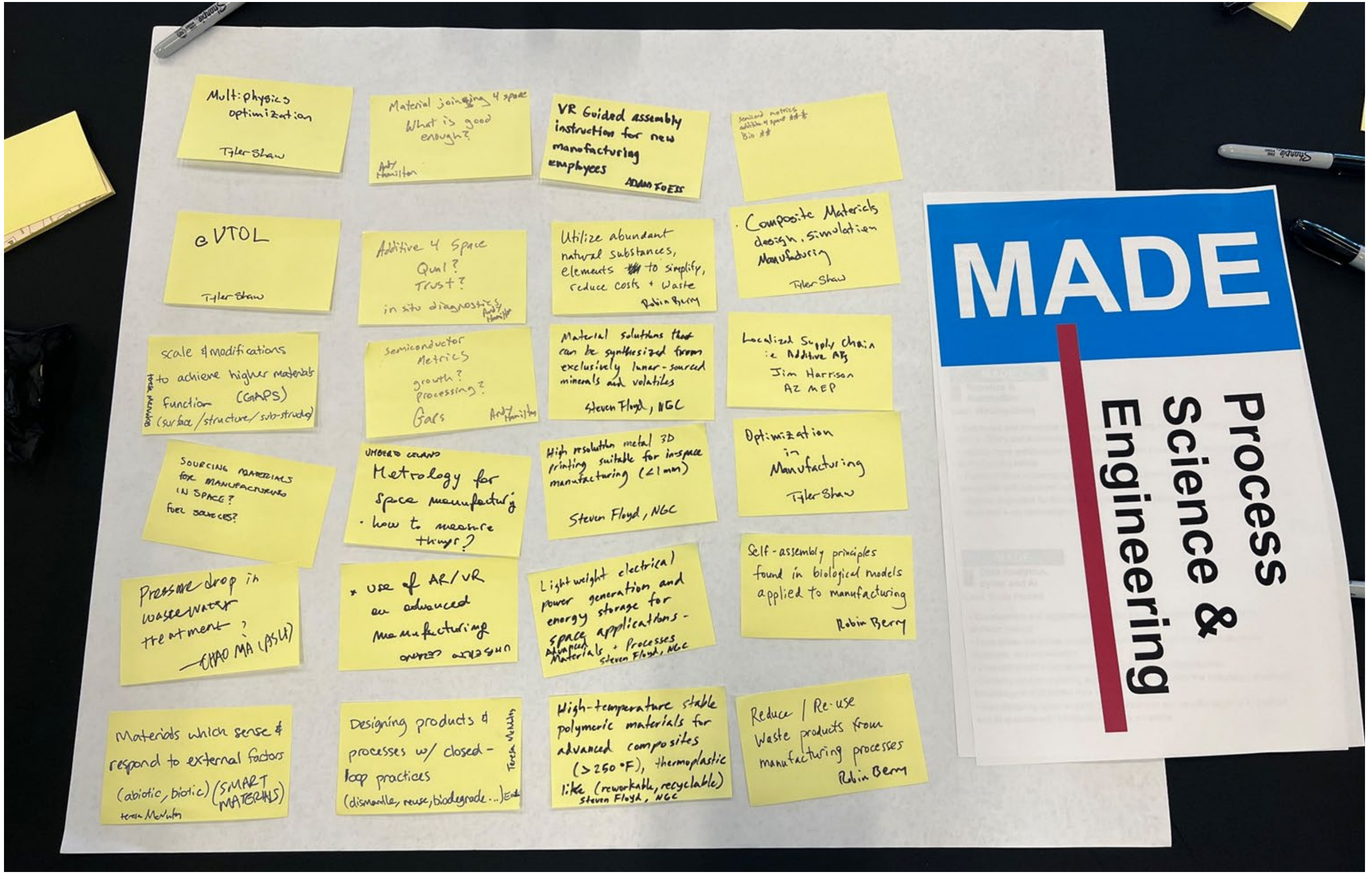
Names/Attendees

- Materials
  - Zhaoyang Fan - In addition to power battery we should also develop low cost battery tech for large scale energy storage based on
  - Common materials such as Zn, Fe, etc.
  - Lib does not satisfy the requirements for ESS, new systems are needed
  - New team? long team? company??
- BMS
  - Technology for life span extension for batteries (EV & stationary)
  - Can AMPED fund fuel cell technologies
  - What about Green Hydrogen
  - Amulya, student at ASU - Battery prognostics for EVs
  - Predicting RUL/SOM. interacting with the users and suggest practices for optimal battery use - promoting sustainable use of EVs
  - To enhance sustainability, like 1.9M EV batteries were manufactured in the year 2023, this can be reduced when a battery is not abused and is operated in particular conditions
  - Understand degradation
  - to understand the state of discharge using parameters like voltage, current, and temperature of the EV battery
  - This helps us to predict the State of Charge and prompt the user of the range that can be travelled so that the user can plan/change as and when needed
- Recycling
  - Battery recycle centers
  - S.C batteries (supply chain)
  - Impact on planet (materials)
  - Working conditions (outside of us)
  - Lithium
  - More solar powered batteries
  - Fire hazards
  - Manufacturing waste
  - Better warranty policies
- Design
  - Selva Seelan Margoschis, IS - AR/VR systems are the hottest piece of tech right now, the battery life of apple vision pro is 4-5 hours, so even with much advancements in silicon tech, battery capacity is the major limiter. So need high power density battery/safe battery, maybe SSE Batteries?
  - Meeting the demand for energy or power of different applications
- Manufacturing
  - Battery manufacturing using AI and ML based approaches for quality improvement
  - Quality and reliability: How to improve the quality without increasing human's effort? Data collection?? How? What to measure?
  - Yoon Hwa - Cost efficient, greener ?????

MADE

Process Science & Engineering

Lead: Keng Hsu



Results

MADE

Process Science & Engineering

Lead: Keng Hsu

- Multiphysics optimization - Tyler Shaw
- eVTOL - Tyler Shaw
- Scale and modifications to achieve higher materials function (GAPS) (surface/structure/sub-structure) - Teresa
- Materials joining 4 space, what is good enough? - Andy Hamilton
- Additive 4 space qual? trust? in situ diagnostics - Andy Hamilton
- Semiconductor metrics, growth? processing? - Andy Hamilton
- Metrology for space manufacturing, how to measure things? - Umberto Lelano
- Use of AR/VR for advanced manufacturing
- Designing products and processes w/ closed-loop practices (dismantle, reuse, biodegrade,...) - Teresa
- VR Guided assembly instruction for new manufacturing employees - Adam Foess
- Sourcing materials for manufacturing in space? Fuel sources
- Pressure drop in wastewater treatment? - Chao Ma
- Materials which sense and respond to external factors (abiotic,biotic) (Smart materials) - Teresa
- Utilize abundant natural substances, elements to simplify, reduce costs + waste - Robin Berry
- Material solutions that can be synthesized from exclusively lunar-sourced minerals and volatiles - Steven Floyd, NGC
- High resolution metal 3D printing suitable for in-space manufacturing (<1mm) - Steven Floyd
- Lightweight electrical power generation and energy storage for space applications - advanced materials and processes - Steven Floyd
- High temperature stable polymeric materials for advanced composites (>250F), thermoplastic like (reworkable, recyclable) - Steven Floyd
- Composite Materials design, simulation, manufacturing - Tyler Shaw
- Localized Supply Chain ie additive MRs - Jim Harrison AZ MEP
- Optimization in Manufacturing - Tyler Shaw
- Self-assembly principles found in biological models applied to manufacturing - Robin Berry
- Reduce/Re-use waste products from manufacturing processes - Robin Berry

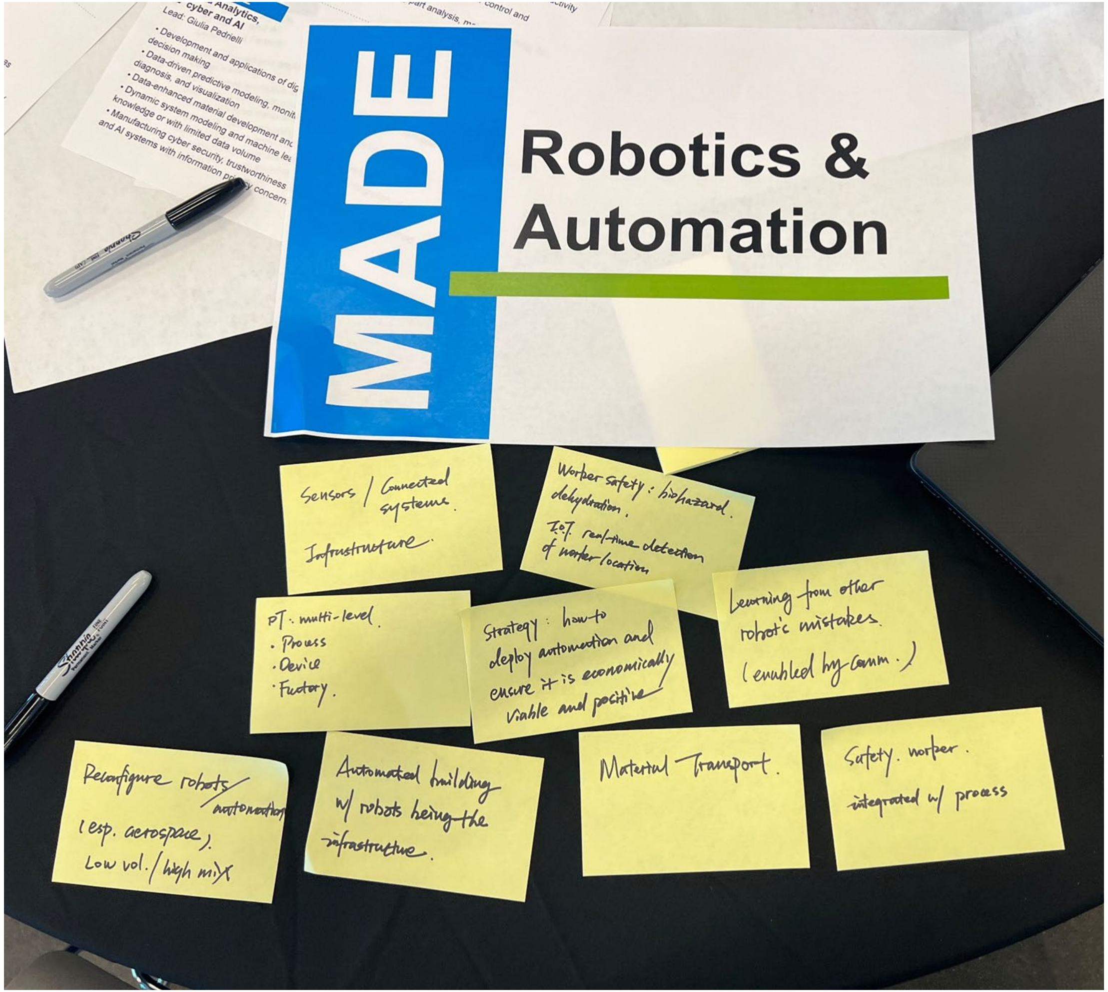
Results

MADE

Robotics & Automation

Lead: Wenlong Zhang

Names/Attendees



Results

MADE

Robotics & Automation

Lead: Wenlong Zhang

Names/Attendees

- Sensors/Connected systems. Infrastructure
- PT multi-level. Process, device, factory
- Worker safety: biohazard. dehydration
- I.O.T real-time detection of worker location
- Learning from other robotic mistakes (enabled by comm)
- Strategy: how to deploy automation and ensure it is economically viable and positive
- Reconfigure robots/automation (esp. aerospace) low vol/high mix
- Automated building w/ robots being the infrastructure
- Material Transport
- Safety. Worker. integrated w/ process

Results

MADE

Data Analytics, Cyber, and AI

Lead: Giulia Pedrielli

Names/Attendees

ITIS Feb 28,2024
MADE FOA Topic: Data Analytics, cyber and AI
Table Discussion
Facilitator: Sangram Redkar
Participants:
Cary Tantlinger
President @ CJT Business Analyst and Sales | Sales, Marketing Consulting
Cynthia Pickering
Tony Libera
AI Knowledge Graph guy from ASU (seated between Tony and Cary)
AI LMM Comms guy from ASU (seated between Cynthia and Sangram)

Of the five seed topics, topics 1 and 4 were further discussed by the six participants at the table. Topic 5 also surfaced towards the end as related to the other two topic discussions.

1. Development and applications of digital twin for simulation and real-time decision making
2. Data-driven predictive modeling, monitoring, causal analysis, root-cause diagnosis, and visualization
3. Data enhanced material development and design optimization
4. Dynamic system modeling and machine learning with the integration of domain knowledge or with limited data volume
5. Manufacturing cyber security, trustworthiness and regularization of AI method and AI systems with information privacy concerns.

We began with a particular application domain, raised by Cary Tantlinger: using smart phones indoors to find location and based on the indoor location, provide tailored information and alerts. His idea was to use the built in camera(s) and a corpus of images tagged with GPS meta data, along with most recent GPS data from the phone's owner and location of the building with its known geomapping. Use case examples included wayfinding in a Hospital, Finding the way to the room for your meeting in an office building. Important challenges discussed included:

- optimization when data is sparse and bandwidth is low, e.g.
- use in 3rd world countries.
- Multi-modal sensory vision (beyond lidar) especially in busy environments
- Standards for securitizing AI bots
- Intelligent policy and safety handling by AI bots (user intent model)
- Protecting privacy and anonymity of users (so they don't feel like they are under surveillance)
- How many images needed to train the system and provide a quality experience for the current context of the user (Marvin Minsky's law - too many and AI system will provide randomized vs. intelligent response)

Results

SI

Data and Digital Insight

Lead: Margaret Garcia

Names/Attendees

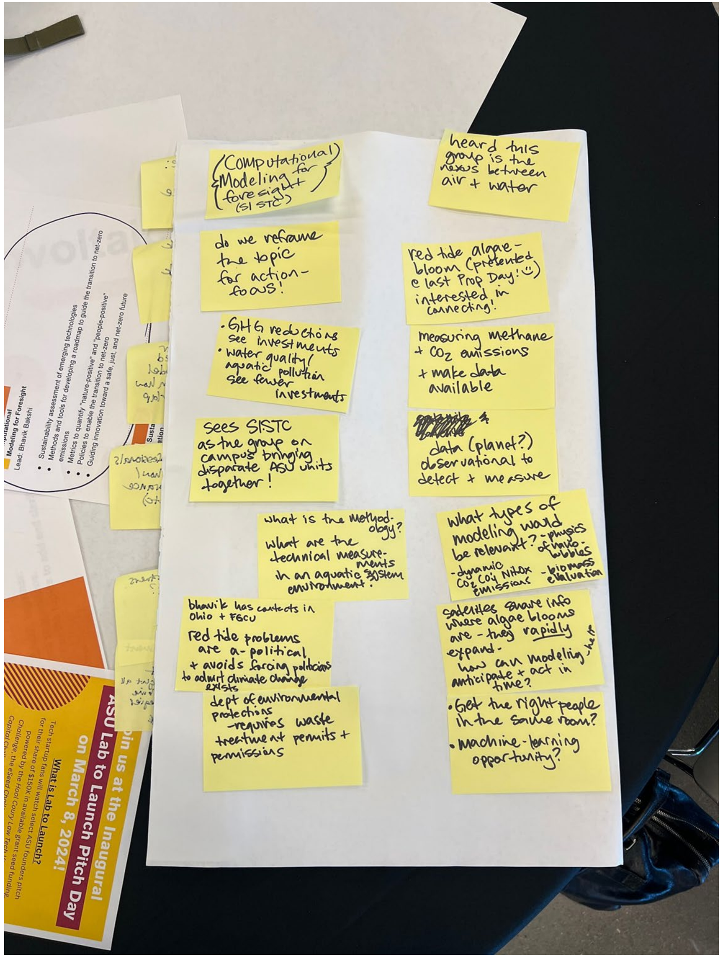
- Land management parking issue, traffic jam, Emission-Electrification EV Interaction
- MSFT, AZ Autoreporting, Electricity Data Chemical Data center
- Identify drivers of resource use (material, water, energy) and waste production (including emissions)
- Increasing Daily Activity
- Defining individual up to enterprise/community behaviors that can be measured to drive insights and changes for reduced carbon footprints
- Using 1st party data to drive green discounts and improved both outcomes
- User centric solutions
- Training Approach Designed Early in the Process
- User remote sensing to monitor data centers? Heat/humidity monitoring
- Make AI data farms net zero water, carbon, energy
- Using AI to solve key w,e,carbon tech barriers/chemicals
- AI for analysis to collect data governance for external ?????
- Validation of output
- Sustainable -> customer discovery
- Qualitative research
- How many point of use water systems are used, and why are people buying them?
- How can data analytics, Amazon purchases, etc inform the market today
- Will point of use water systems transform water demand like solar pv are?
- How can we avoid use of chemicals in water systems?

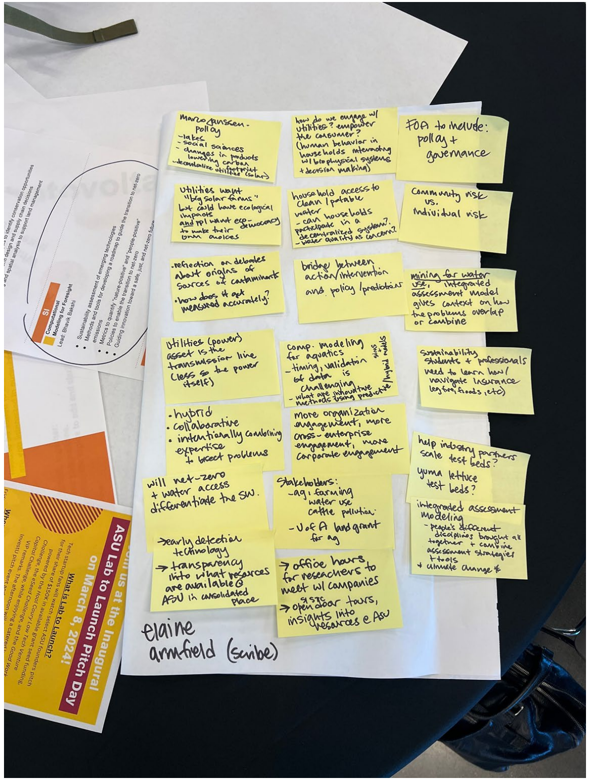
SI

Computational Modeling for Foresight

Lead: Bhavik Bakshi

Names/Attendees





Results

SI

Computational Modeling for Foresight

Lead: Bhavik Bakshi

- Heard this group is the nexus between air and water
- Do we reframe the topic for action-focus!
- red tide algae - bloom (presented at last prop day!) interested in connecting
- GHG reductions see investments
- Water quality/aquatic pollution see fewer investments
- Measuring methane+CO2 emissions+make data available
- Sees SI STC as the group on campus bringing disparate ASU units together!
- data (planet?) observational to detect + measure
- What is the methodology? What are the technical measurements in an aquatic system environment?
- What types of modeling would be relevant? -physics of nano-bubbles, dynamic CO2 CO4 NitOx emissions, biomass evaluation
- Satelites share info where algae blooms are-they rapidly expand
- How can modeling anticipate and act in time?
- Bhavik has contacts in Ohio and FGCU
- Red tide problems are a-political + avoids forcing politicians to admit climate change exists
- Dept of environmental protections requires waste treatment permits + permissions
- Get the right people in the same room?
- Machine learning opportunity
- Marco Janssen - policy, lakes, social sciences, changes in products lowering carbon footprint, decentralize utilities (solar)
- How do we engage w/ utilities? empower the consumer? (human behavior in households interacting w/biophysical systems + decision making)
- Utilities want “big solar farms” but could have ecological impacts and ppl want ecodemocracy to make their own choices
- Household access to clean/potable water
- Can households participate in a decentralized system?
- Water quality as concern?
- Reflection on debates about origins of sources of contaminants
- How does it get measured accurately?
- Bridge between action/intervention and policy/predictions
- Utilities(power) asset is the transmission line (less so the power itself)
- Comp. modeling for aquatics
- Timing,validation of data is challenging
- What are innovative methods using predictive/hybrid sims + models
- Hybrid
- Collaborative
- Intentionally combining expertise to bisect problems
- More organization engagement, more cross-enterprise engagement, more corporate engagement
- Will net-zero + water access differentiate the SW.
- Stakeholders: ag, farming water use cattle pollution, UofA land grant for ag
- Early detection technology
- Transparency into what resources are available at ASU in consolidated place
- Office hours for researchers to meet w/ companies
- SI STC open door tours, insights into resources at ASU
- FOA to include: policy + governance
- Community risk vs individual risk
- Mining water use, integrated assessment model gives context on how the problems overlap or combine
- Sustainability students + professionals need to learn how/navigate insurance leg,fire,floods,etc.
- Help industry partners scale test beds?
- integrated assessment modeling -peoples different disciplines brought all together + combine assessment strategies + tools
- *climate change*

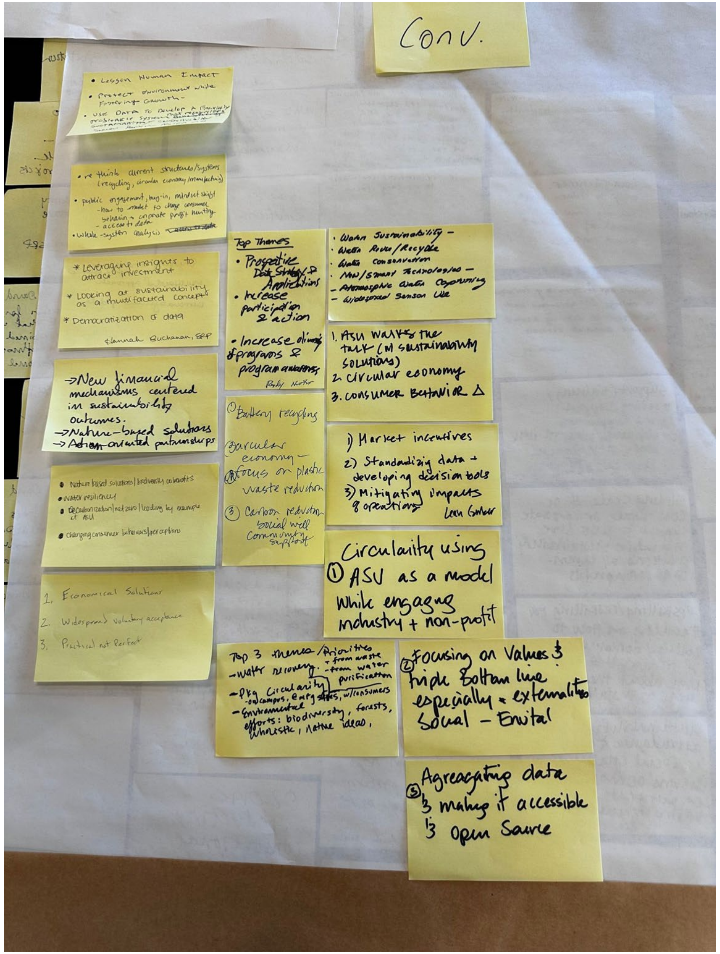
Results

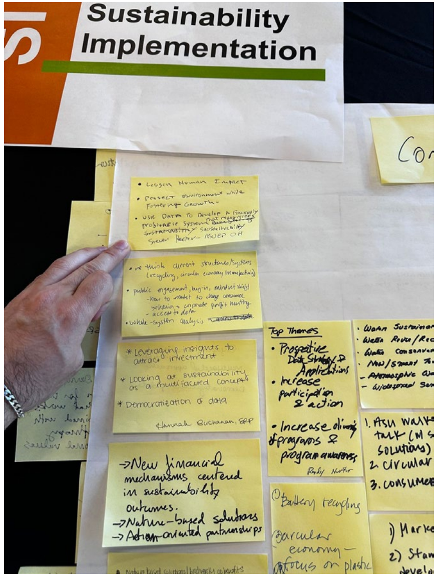
SI

Action for Sustainability Implementation

Lead: Eusebio Scornavacca

Names/Attendees



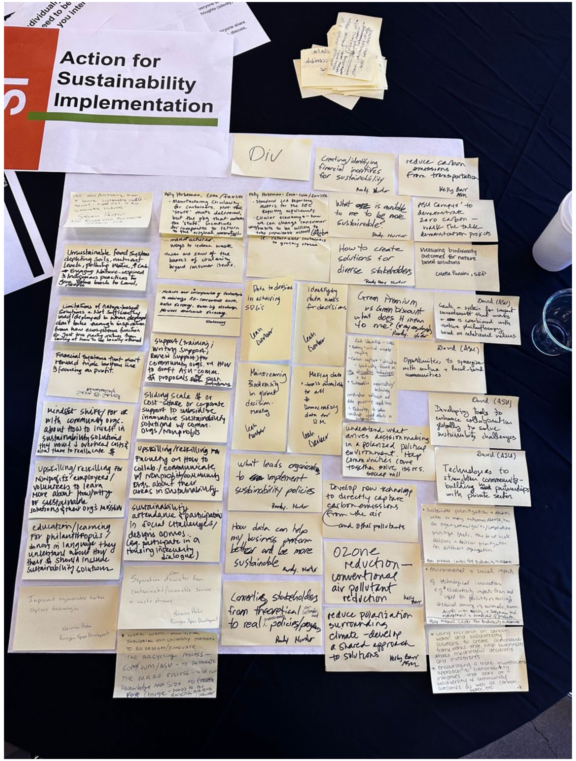


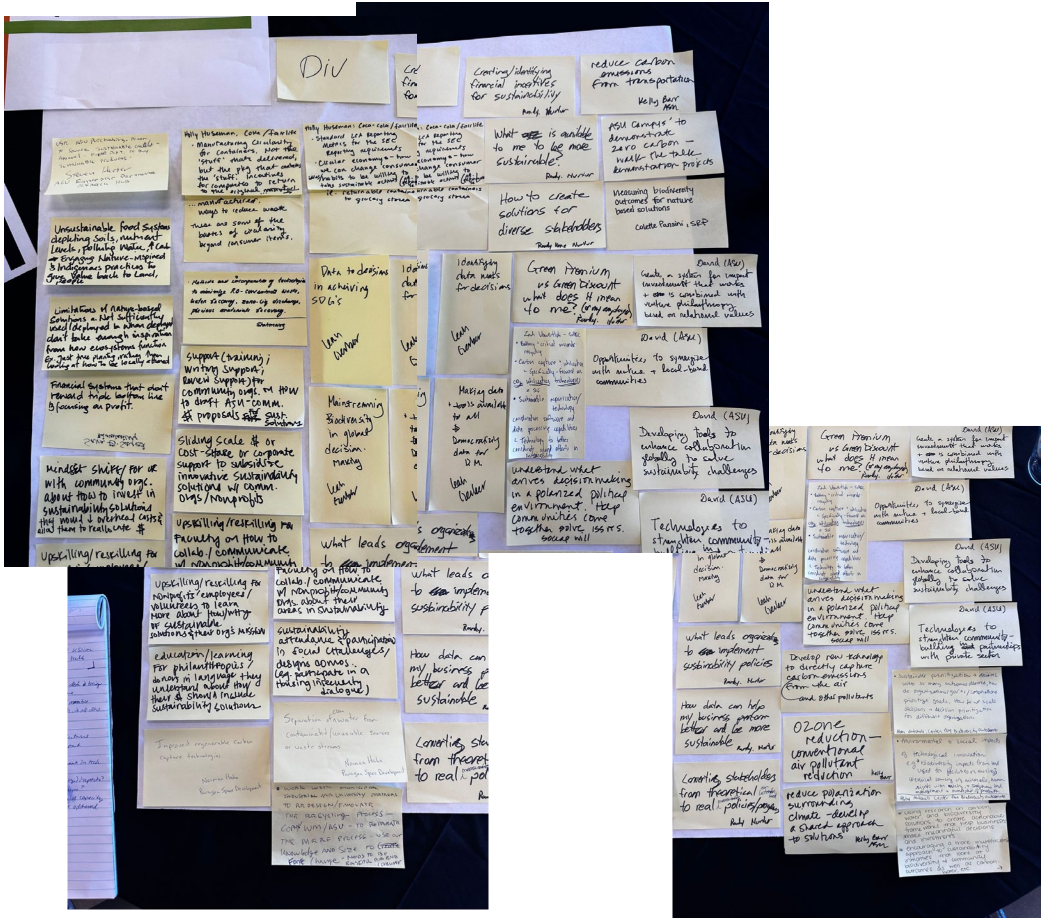
Results

SI

Action for Sustainability Implementation

Lead: Eusebio Scornavacca





SI

Action for Sustainability Implementation

Lead: Eusebio Scornavacca

Names/Attendees

DIVERGE

- Use ASU purchasing power to source sustainable ???? - apparel - force dept. to buy sustainable products - Steven Herper, ASU enterprise Partners Outreach Hub
- Unsustainable food systems depicting soils, nutrient levels, polluting water, engaging nature-inspired and indigenous practices to give value back to land,people
- Limitations of nature-based solutions a. not sufficiently used/deployed . When deployed dont take enough inspiration from how ecosystems function. Ex. just tree planting rather than looking at how to be locally attuned
- Financial systems that dont reward triple bottom line & focusing on profit
- Mindset shift/for or with community orgs. about how to invest in sustainability solutions that would decrease overhead costs and allow them to reallocate money
- Holly Huseman - Coke/Fairelife - manufacturing circularity for containers. Not the ‘stuff’ thats delivered but the pkg that contains the ‘stuff’. incentives for companies to return to the original manufacturer. Ways to reduce waste. These are some of the types of circularity beyond consumer items.
- Methods and incorporation of technologies to minimize RO-concentrate waste, water recovery, zero-liq discharge, precious materials recovery.
- Support (training; writing support; review support) for community orgs. on how to draft ASU-comm $ proposals for sust. solutions
- Sliding scale $ or cost-share or corporate support to subsidize innovative sustainability solutions w/ comm orgs/nonprofits
- Holly Huseman: Coca-Cola/fairlife - Standard LCA reporting metrics for the SEC reporting requirements. Circular economy + how we can change consumer ideas/habits to be willing to take sustainable actions i.e. returnable containers to grocery stores
- Data to decisions in achieving SDGs - Leah Gerber
- Identifying data needs for decisions - Leah Gerber
- Mainstreaming Biodiversity in global decision making - Leah Gerber
- Making data + tools available to all, democratizing data for D.M. - Leah Gerber
- Creating/identifying financial incentives for sustainability - Randy Vane, Nurtur
- What is available to me to be more sustainable? Randy, Nurtur
- How to create solutions for diverse stakeholders. Randy Vane, Nurtur
- Green premium vs green discount what does it mean to me? (or my employer) Randy Nurtur
- Zach Venvertloh - GPEC - Battery + critical minerals recycling. Carbon capture + utilization, specifically focused on CO_2 utilization techniques ie SAF. Sustainable organization technology coordination software and data processing capabilities, technology to better coordinate shared efforts in sustainability
- Understand what areas decision making in polarized political environment. Help communities come together solve issues.
- Reduce carbon emissions from transportation - Kelly Barr ASU
- ASU Campus’ to demonstrate zero carbon - walk the talk demonstration projects
- Measuring biodiversity outcomes for nature based solutions - Colette Pansini, SRP

Results

SI

Action for Sustainability Implementation

Lead: Eusebio Scornavacca

CONVERGE

- Lessen human impact
- Protect environment while fostering growth
- Use data to develop a financially profitable system that recognizes sustainability - Steven Harper ASU EP OH
- Rethink current structures/systems (recycling, circular economy/manufacturing)
- Public engagement, buy-in, mindset shift - how to market to change consumer behavior + corporate profit hunting - access to data
- Whole-system analysis
- Leveraging insights to attract investment
- looking at sustainability as a multifaceted concept
- democratization of data - Hannah Buchanan, SRP
- New financial mechanisms centered in sustainability outcomes
- Nature-based solutions
- Action-oriented partnerships
- Prospective data strategy + applications
- increase participation + action
- Increase diversity of programs and program awareness. Randy, Nurtur
- Nature based solutions|biodiversity co benefits
- water resiliency
- Decarbonization|net zero| leading by example at ASU
- Changing consumer behaviors|perceptions
- Economical solutions
- Widespread voluntary acceptance
- Practical not perfect
- Battery recycling
- circular economy-focus on plastic waste reduction
- Carbon reduction, social community support
- Water recovery from waste and water purification
- Pkg circularity on campus, @ mfg sites, w/ consumers
- Environmental efforts: biodiversity, forests, wholistic, native ideas

- Water sustainability
- Water reuse/recycle
- Water conservation
- New/smart technologies
- Atmospheric water capturing
- Widespread sensor use
- ASU walks the talk (w/ sustainability solutions)
- Circular economy
- Consumer behavior
- Market incentives
- Standardizing data + developing decision tools
- Mitigating impacts of operations - Leah Gerber
- Circularity using ASU as a model while engaging industry + non-profit
- Focusing on value & triple bottom line especially externalities - Social - Environmental
- Aggregating data and making it accessible and open source