

Research Community for Nanotechnology Convergence



Jacob Jones
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David Berube
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Maude Cuchiara
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Trevor Thornton
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Arizona State



Paul Westerhoff
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Arizona State



Elaine Hubal
NNCI Adv. Board
EPA



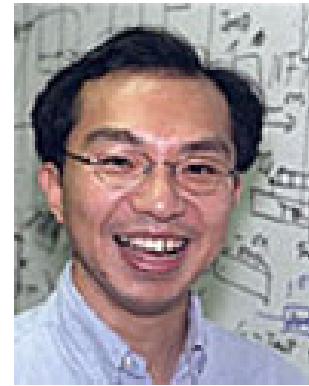
Kevin Walsh
KY Multiscale
U. of Louisville



Ross Sozzani
RTNN
NC State



Anne Njathi
RTNN
NC State



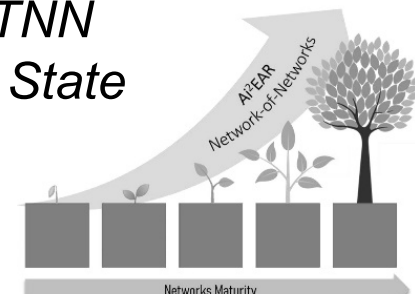
Yuhwa Lo
SDNI
UC San Diego



Yves Theriault
SDNI
UC San Diego



Phillip Strader
RTNN
NC State



Translating National Priorities into Research Progress

(March 2016)



STEPS

Science and Technologies for Phosphorus Sustainability

2021 STC led by NC State (RTNN) with NNCI sites NCI-SW (ASU) and SENIC (JSNN)

Nano for Water Sustainability - Developing Research Opportunities

← Jacob Jones <jljone21@ncsu.edu>
Dear Colleagues,

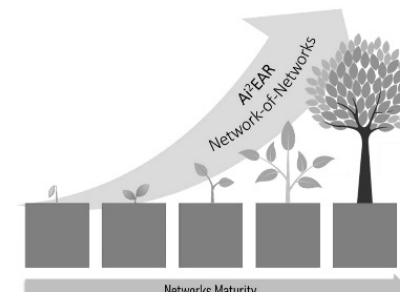
Apr 18, 2016, 1:59 PM

I am excited to share with you a new opportunity. The National Nanotechnology Initiative (NNI) recently announced a new *Nanotechnology Signature Initiative (NSI)*: **“Water Sustainability through Nanotechnology: Nanoscale Solutions for a Global-Scale Challenge.”** NSIs are multiagency initiatives that focus on specific topics that can be advanced quickly through interagency collaboration. “This initiative is designed to aid in the development of technological solutions that can alleviate current stresses on the water supply and provide methods to sustainably utilize water resources in the future.” **To meet this end, the NNI describes the use of nanotechnology for three major thrusts in water: to increase availability, improve delivery, and support development of new monitoring systems.** Significant federal dollars will be devoted to these areas by multiple agencies. (As a point of reference, in FY14, \$272 million were invested across 5 NSIs.)

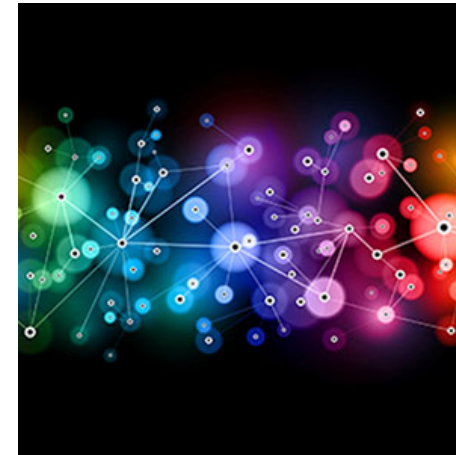
RTNN is actively working with the [Water Resources Research Institute \(WRR\)](#) to identify potential collaborations and funding opportunities for nanotechnology researchers in these areas as well as coordinate events to help connect researchers in nanotechnology and water. **In cooperation with WRR, RTNN will be hosting a lunch at NC State to elaborate on the NSI and research opportunities in more detail.** We will also discuss the potential to pursue funding opportunities across the three institutions, including but not limited to an initial [GRIP proposal](#) at NC State. **If you are interested in attending, please complete the [Doodle poll](#) to help us in determining the best date for the event.**



Internal Seed Grant
\$500k
(2017-2020)



In 2018, **Growing Convergence Research** became an NSF “Big Idea”



NSF'S 10 BIG IDEAS

The grand challenges of today—protecting **human health**; understanding the **food, energy, water** nexus; exploring the **universe** at all scales -- will not be solved by one discipline alone. They require **convergence: the merging of ideas, approaches and technologies from widely diverse fields of knowledge** to stimulate innovation and discovery.

Growing Convergence Research

NSF DEFINITION OF CONVERGENCE RESEARCH

1. Research Driven by a Specific and Compelling Problem
2. Deep Integration Across Disciplines



Growing Convergence Research (GCR)

PROGRAM SOLICITATION NSF 19-551



National Science Foundation

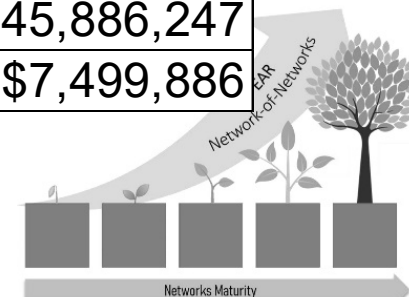
Full Proposal Deadline(s)

May 08, 2019

February 03, 2020

Start Year	Awarded to Date
2011	\$1,750,000
2012	-
2013	-
2014	-
2015	\$12,858,383
2016	\$54,937
2017	\$954,275
2018	\$33,125,841
2019	\$72,258,138
2020	\$53,752,334
2021	\$95,916,788
2022	\$45,886,247
2023	\$7,499,886

NSF-wide award search for “convergence research”

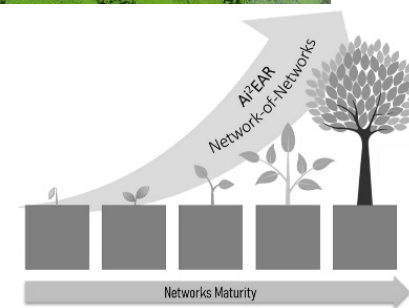


Ripe Applications for Convergence Research

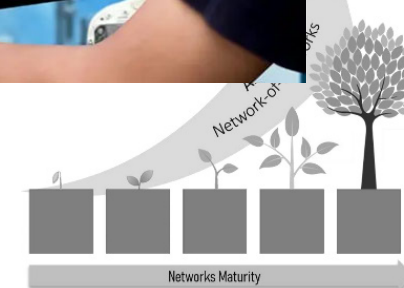
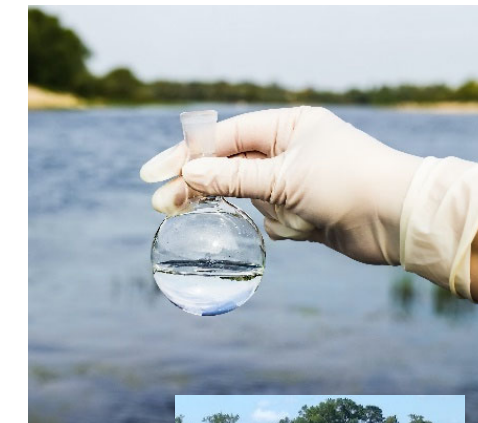
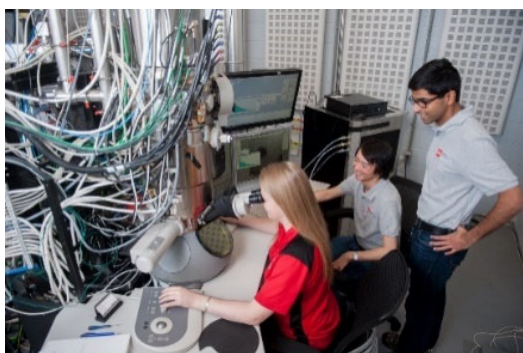
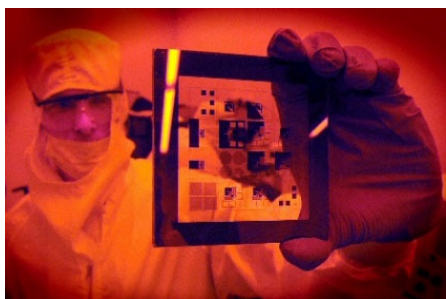
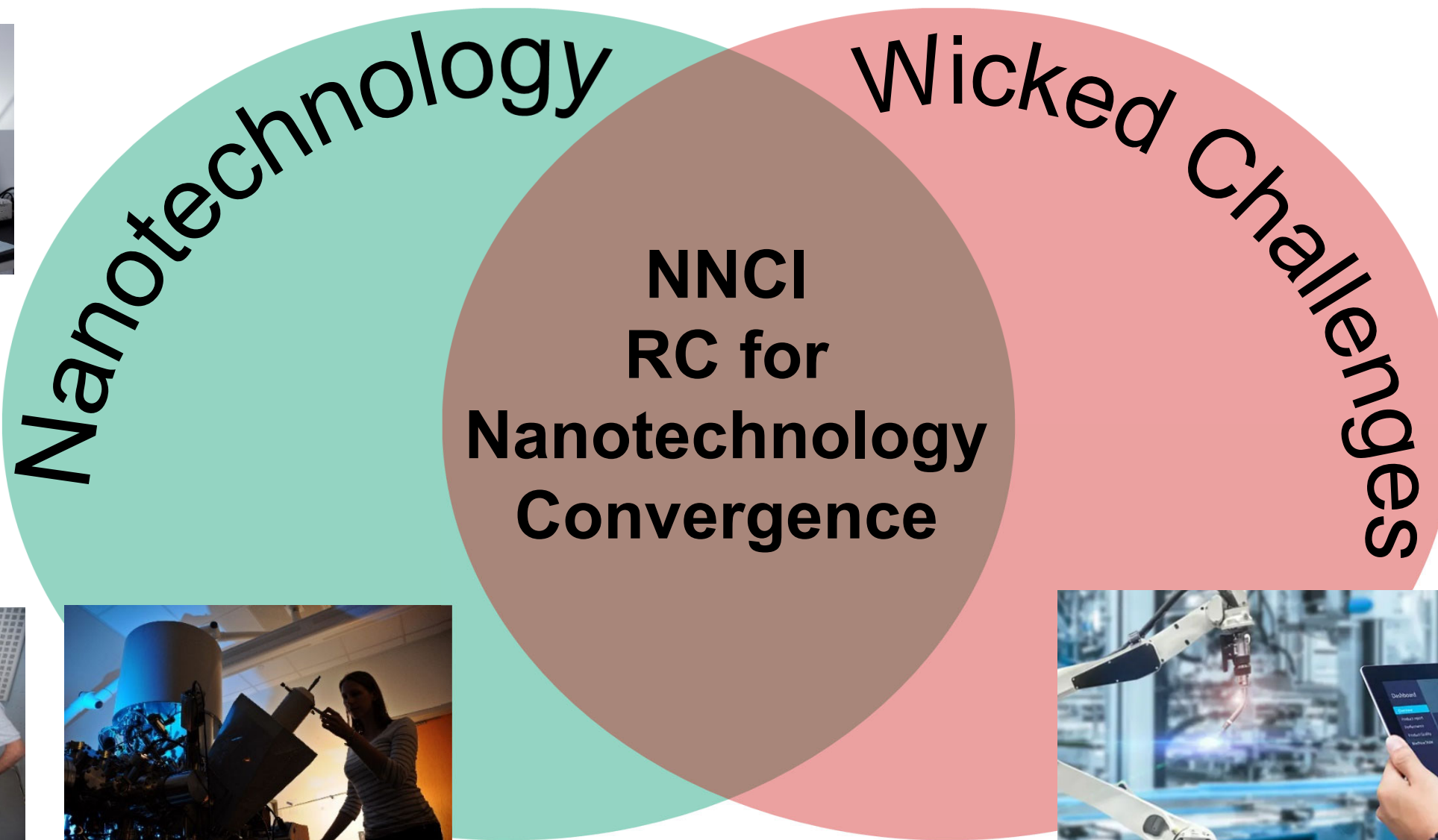
- Micro- and Nanoplastics in the Environment
- Work Beyond Mass Production
- Affordable and Universal Access to Clean Water
- Per- and polyfluoroalkyl substances (PFASs)
- Phosphorus and nitrogen pollution in water resources



Images from <https://avadaenvironmental.com/2019/04/18/microplastics/>,
<http://www.waterencyclopedia.com/Da-En/Desert-Hydrology.html>,
<https://www.conserve-energy-future.com/causes-effects-and-solutions-to-eutrophication.php>



Research Community for Nanotechnology Convergence



Research Community for Nanotechnology Convergence

Nanotechnology facilities of the future will play central roles in tackling **WICKED** and **GLOBAL** challenges that require convergence approaches and, in many cases, shared facilities may require MAJOR ADAPTATION to facilitate convergence

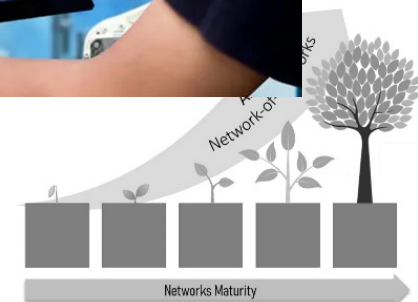
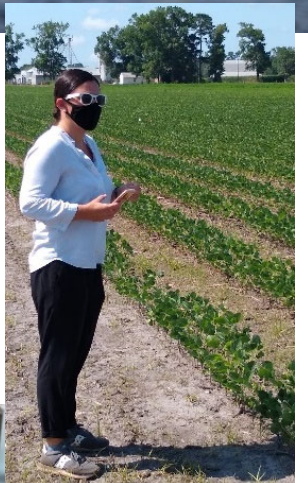
The R.C. **GOAL** is to bring together researchers and staff from diverse disciplines and perspectives, facilitate their collaboration, and work toward a common vision with both productive outputs and outcomes

The Research Community topic is **DYNAMIC** and introduces a new convergence research area annually:

2021: Convergence in Nanotechnology for Food and Nutrition Security

2022: Convergence in Nanotechnology and Additive Manufacturing

2023: TBD



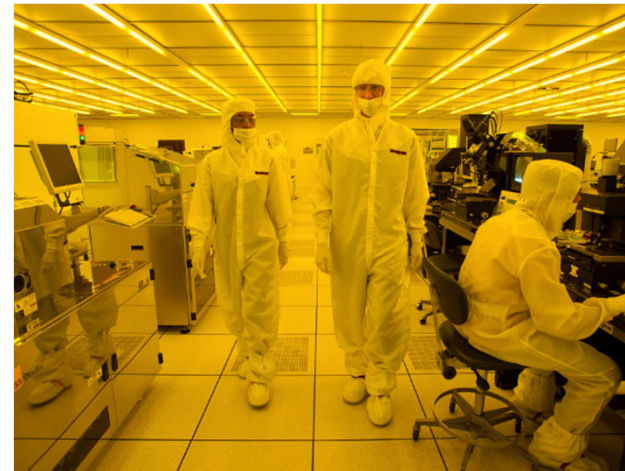
2021: Convergence in Nanotechnology for FOOD & NUTRITION SECURITY

The **PANDEMIC** made food & nutrition security much more obvious to many

March 16, 2020, during start of global pandemic.
Photo taken by presenter.



How can our NNCI labs best help mitigate these issues?




2021: Convergence in Nanotechnology for FOOD & NUTRITION SECURITY

March 9, 2021, event identifying and engaging stakeholders

How can open-access university facilities best support food and nutrition security?
 Help Guide Future Efforts by Participating in a Half-Day NNCI Workshop
 March 9, 2021
 10 am – 2 pm (Eastern)
 Learn more at go.ncsu.edu/nano-food-security

PLENARY SPEAKERS



Prof. Antje Bäumner
 University of Regensburg
Can distributed nanotechnology as evidenced in new sensor developments enable the advancements required for a sustainable farm-to-fork process?



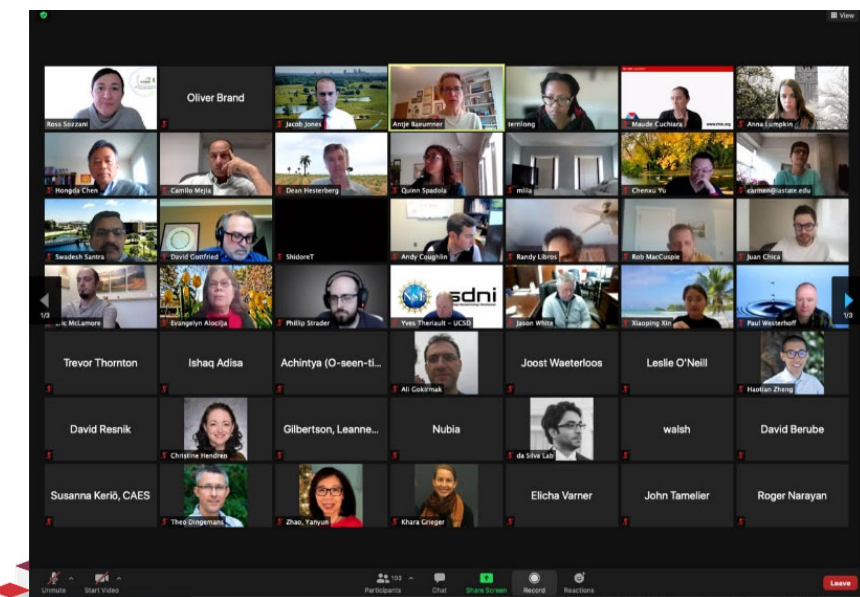
Dr. Hongda Chen
 USDA
Opportunities and challenges of nanotechnology towards sustainable food and nutrition security

NANOTECHNOLOGY-FOCUSED BREAKOUT SESSIONS

Precision agriculture	Sensors	Enhanced food	Pest management	Packaging
Water treatment	Nutrient management	Animal disease	Climate-change-resilient food	And more!

OUTCOMES
 A workshop report with findings from the breakout groups will be broadly disseminated to inform and guide future open-access facility efforts and research.

Two headline speakers to draw in participation
IRB approval to record transcripts of breakout rooms for research purposes
~150 registrants: academics, industrial representatives, government agency employees, NGOs, various partners and stakeholders including consortia, policy fellows and directors, etc.
>100 participants

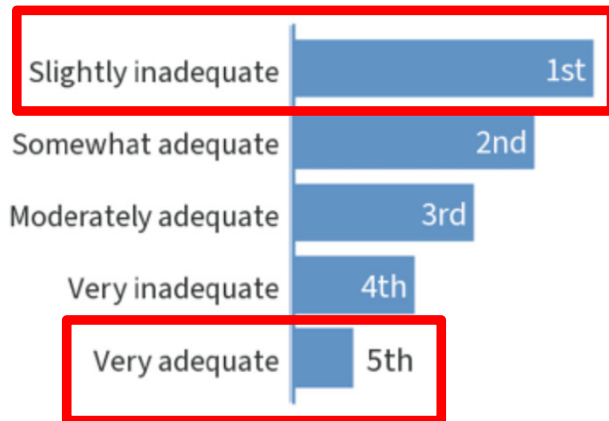


2021: Convergence in Nanotechnology for FOOD & NUTRITION SECURITY

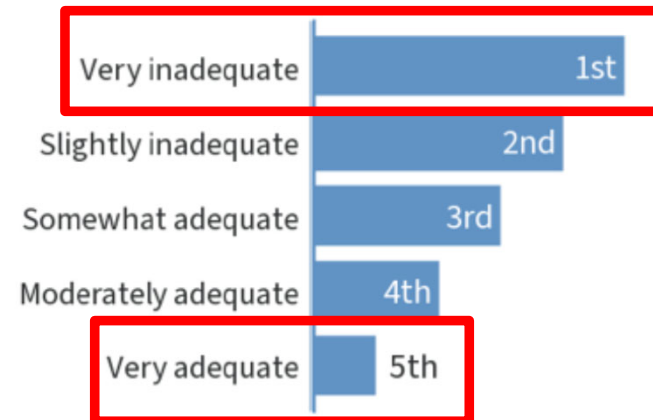
March 9, 2021, event identifying and engaging stakeholders

Example PolLEV Questions for Room 4 (Food Products)

Are the **CURRENT** shared instrumentation and facilities (including field sites, research greenhouses, pilot plants, etc.) adequate to support **TODAY'S** needs in food products?



Are the **CURRENT** shared instrumentation and facilities (including field sites, research greenhouses, pilot plants, etc.) adequate to support **FUTURE** needs in food products?



Word cloud showing relative frequency of various words and phrases used in Room 1 –

Used to farm codes for content analysis



2021: Convergence in Nanotechnology for FOOD & NUTRITION SECURITY

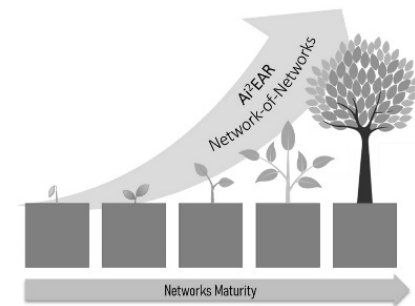
Ongoing activity: David Berube and Anne Njathe are conducting IRB-approved interviews with several experts in this area to derive further context.

Top Take-Away: NNCI Could Accelerate Reaching Non-Traditional Disciplines

For some attendees, this was the **first-ever invitation** to provide input to a shared facility

NNCI was encouraged to consider how to diversify **disciplinary expertise of facility staff**, e.g. through hiring practices or offering professional development opportunities to existing staff members to expand into new areas

NNCI was encouraged to **engage stakeholders from non-traditional areas in future planning**, e.g. advisory boards, steering committees or the Research Communities themselves



2021 Research Area (Food & Nutrition Security) Scales Back as Complementary Initiatives Emerge



2021 STC led by NC State with
NNCI sites ASU and JSNN



The Internet of Things for Precision Agriculture
an NSF Engineering Research Center

2020 ERC led by UPenn



2022 ERC led by Texas Tech with
NNCI sites GT and MIT

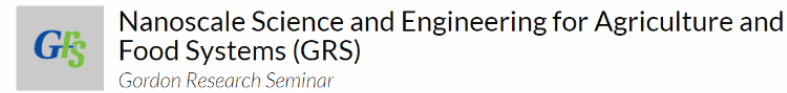
2022 NSF Nanoscale Science and Engineering Grantees Conference

December 7-8, 2022



NSE 2022 Home
Conference Program
Conference Registration

Grantees Conference: Nanotechnology for Sustainable Society



Convergence of Nanotechnology with Food and Agriculture

June 18 - 19, 2022

Chairs
Ying Wang and Antonia-Teodora

Workshop to Identify Convergent Nanotechnology Approaches for Precision Delivery of Active Agents in Plants

September 19-20, 2022
Carnegie Mellon University, Pittsburgh, PA

Sponsored by:

CRU Fertilizer AgriTech Forum

September 7-9, 2022 • Dallas, TX, USA

INFRAMES

Convergent research for more sustainable materials

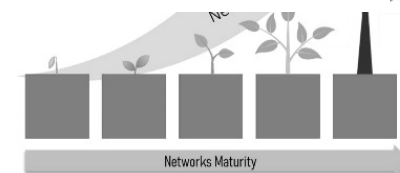
Learn more about INFRAMES »

The International Network For Researching, Advancing, and Assessing Materials for Environmental Sustainability (INFRAMES) assesses the sustainability of the materials our society produces.

Sponsored by:

Organizing committee:

- Dr. Gregory Lowry, Carnegie Mellon
- Dr. Nicola Steinmetz, UC San Diego
- Dr. Juan Pablo Giraldo, UC Riverside
- Dr. Kurt Ristow, Purdue University
- Dr. Christina Handman, Appalachian State University



2022: Convergence in Nanotechnology and ADDITIVE MANUFACTURING

KY Multiscale-led activity

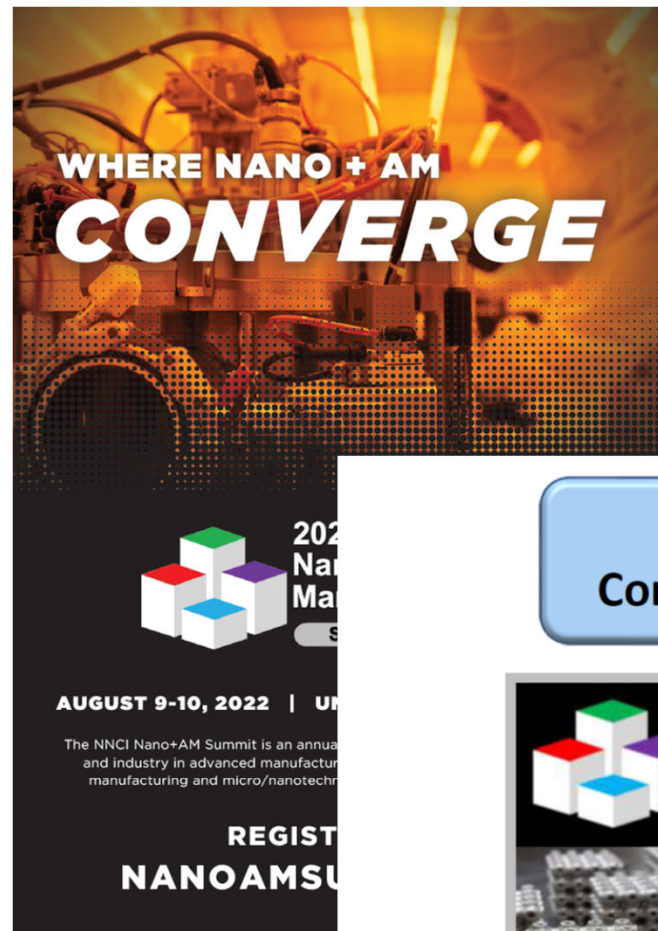
19 self-identified disciplines of respondents including bioengineering, computer science, organic materials, and safety and health

Many self-reported “Additive Manufacturing” as their discipline

2022 NNCI Nano+Additive Manufacturing Convergence Summit and NNCI REU Convocation

Keynotes emphasized convergence:

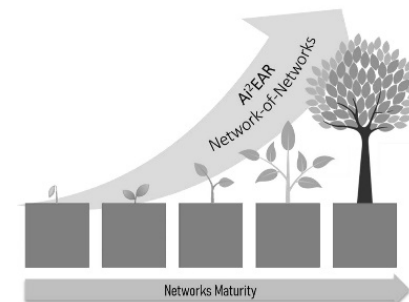
- Neural interfaces by J. Rogers
- Entrepreneurship by K. Petersen
- AM for the Medical Field by O. Harryson



www.nanoamsummit.com

Louisville, KY
August 9-10, 2022

4



2022: Convergence in Nanotechnology and ADDITIVE MANUFACTURING

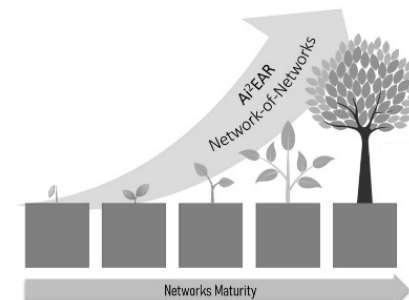
Convergent Manufacturing: A Future of
Additive, Subtractive, and
Transformative Manufacturing:
Proceedings of a Workshop (2022)



*“[Christina] Baker also inquired about the potential for **integrating nanoscale additive manufacturing into larger-scale additive manufacturing**, and [Julia] Greer described this integration... as a real challenge... according to Greer, the most important aspects missing from additive manufacturing are **in situ diagnostics** (i.e., the ability to diagnose whether the part being produced will have the desired quality, and the ability to make those decisions in real time) and more data for machine learning.”*

*“[Kimani] Toussaint commented that as new disciplines emerge, more crosstalk would be beneficial. He proposed that postsecondary institutions **update their paradigm for education to a ‘convergent education model’** that emphasizes a common lexicon, teamwork, and problem-solving across traditional disciplinary boundaries.”*

*“[Vinayak] Dravid encouraged the **professional societies to offer cross-training** (e.g., bootcamps).”*



Proposed 2023 Topic:

Nanotechnology Opportunities for Addressing Climate Change

NSF Engineering Research Visioning Alliance (ERVA)

The image shows a screenshot of the ERVA website and a report cover. The website header includes the ERVA logo, the text "NSF Engineering Research Visioning Alliance", and a "GET INVOLVED" button. Below the header, there is a navigation menu with "HOME", "ABOUT", "EVENTS", "TASK FORCES", and "PARTNERS". The main content area features a large image of a person in a yellow raincoat working on a laptop, with the text: "A diverse, inclusive and engaged partnership that enables an array of voices to impact national research priorities." Below this, there are two columns: "Who is ERVA?" and "What is ERVA doing?". The report cover, titled "The Role of Engineering to Address Climate Change Visioning Event Report", features the ERVA logo and a person sitting in a futuristic chair.

ERVA's first report (2022)

Synergistic Engineering Research Opportunities to Address Climate Change

Climate change is an enormously complex topic, spanning many engineered systems that impact not only CO₂ emissions from fuels, but also the health of people, water systems, ecosystems, and infrastructure. The fundamental research topics prioritized to address climate change include:

The infographic consists of four colored boxes, each with an icon and text. The top-left box is green and contains the text "ENERGY STORAGE, TRANSMISSION, AND CRITICAL MATERIALS" with a battery icon. The top-right box is blue and contains the text "GREENHOUSE GAS (GHG) CAPTURE AND ELIMINATION" with a house and plant icon. The bottom-left box is dark blue and contains the text "RESILIENT, ENERGY-EFFICIENT, AND HEALTHFUL INFRASTRUCTURE" with a bridge icon. The bottom-right box is dark grey and contains the text "WATER, ECOSYSTEMS, AND GEOENGINEERING ASSESSMENT" with a water drop icon.

Cross-cutting thrusts:

01

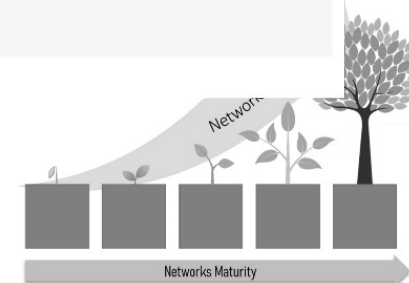
Focus on critical materials in all engineered systems, especially in extraction, separation, recycling and upcycling, and energy conversion, as well as carbon dioxide (CO₂) mitigation.

02

Invest in sensor, sensing, and communication capabilities to facilitate data compilation and analysis.

03

Enable and strategically exploit artificial intelligence (AI) modeling for forecasting and trend analyses.



Proposed 2023 Topic: Nanotechnology Opportunities for Addressing Climate Change

A Comprehensive and Inclusive Vision for Addressing Climate Change



Topics of particular importance to pursue include:

- **Convergent solutions that remove social barriers** and provide universal, affordable access to renewable energy sources and energy-saving devices;
- **Addressing the utility-scale solar and community acceptance conundrum** by enhancing multi-use land applications for solar and wind and identifying effective methods for community engagement;
- **Creating efficiencies and increasing impact** by investing the time and resources to create and leverage multinational programs of sufficient scale and that equally weigh both technical and social benefits;
- **Communicating energy use and carbon emissions without complex jargon** and confusing arrays of units for building heating and cooling, transportation systems, food systems, and consumer goods;
- **Advancing energy use tied to reduced carbon emissions in all aspects of daily life**, ranging from fossil fuels to consumer materials and goods used in daily activities; and
- **Incentivizing transitions** to energy conservation, efficiency, and renewable energy solutions.

Synergistic Engineering Research Opportunities to Address Climate Change

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Cross-cutting thrusts:

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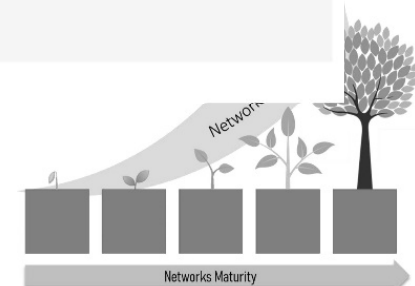
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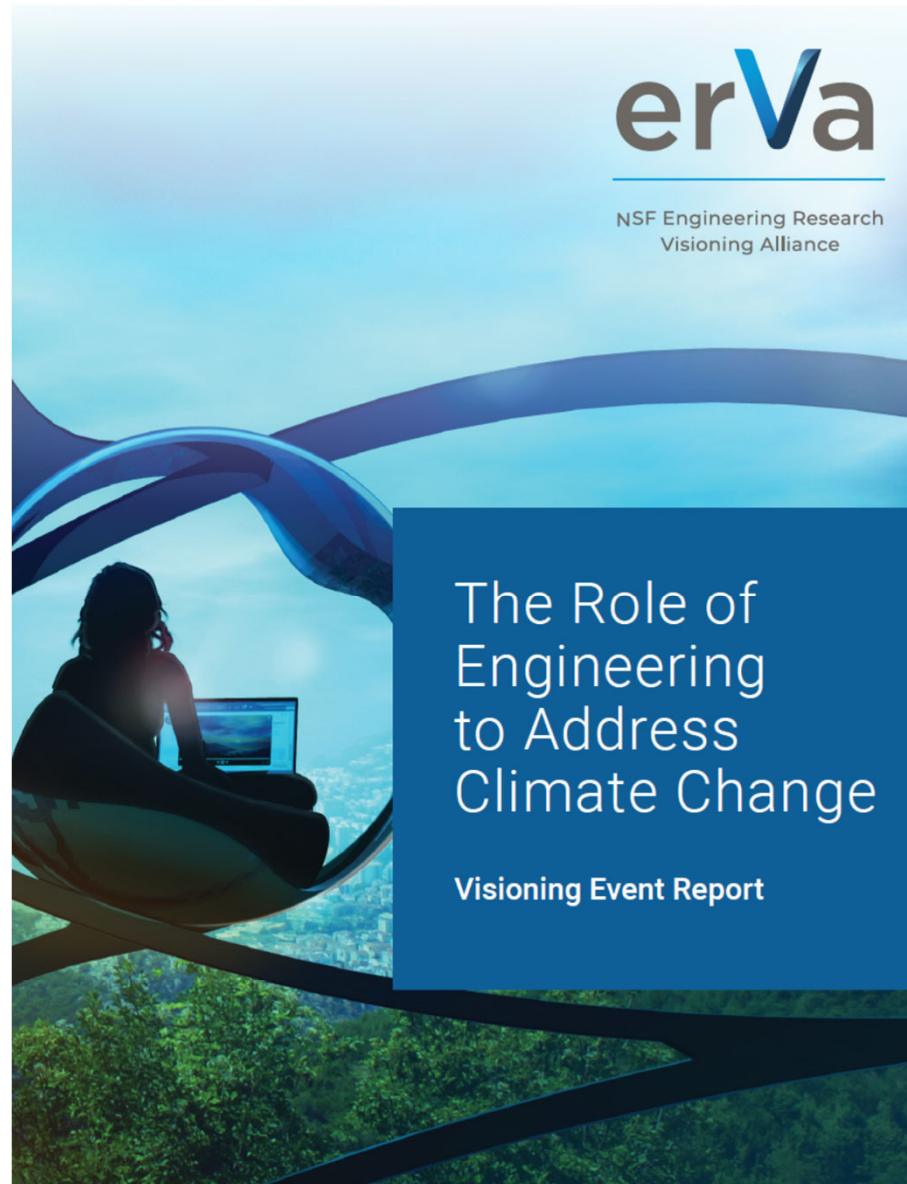
03

Enable and strategically exploit artificial intelligence (AI) modeling for forecasting and trend analyses.



Proposed 2023 Topic:

Nanotechnology Opportunities for Addressing Climate Change



Could this Research Community advance nanotechnology directions and contributions to these challenges through a 2023 topic of?:

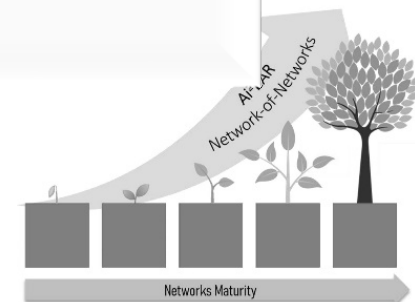
“Nanotechnology Opportunities for Addressing Climate Change”

“Nanotechnology Opportunities for Sensors and Communications for Addressing Climate Change”

“Nanotechnology Opportunities for Addressing Greenhouse Gas Capture and Elimination”

etc.

Main activity: Online meetings/workshops to identify and highlight nanotechnology opportunities in these area, e.g. related to R&D in the ERVA report.



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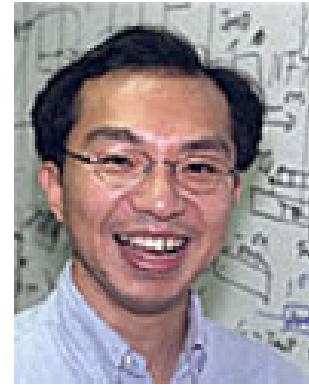
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