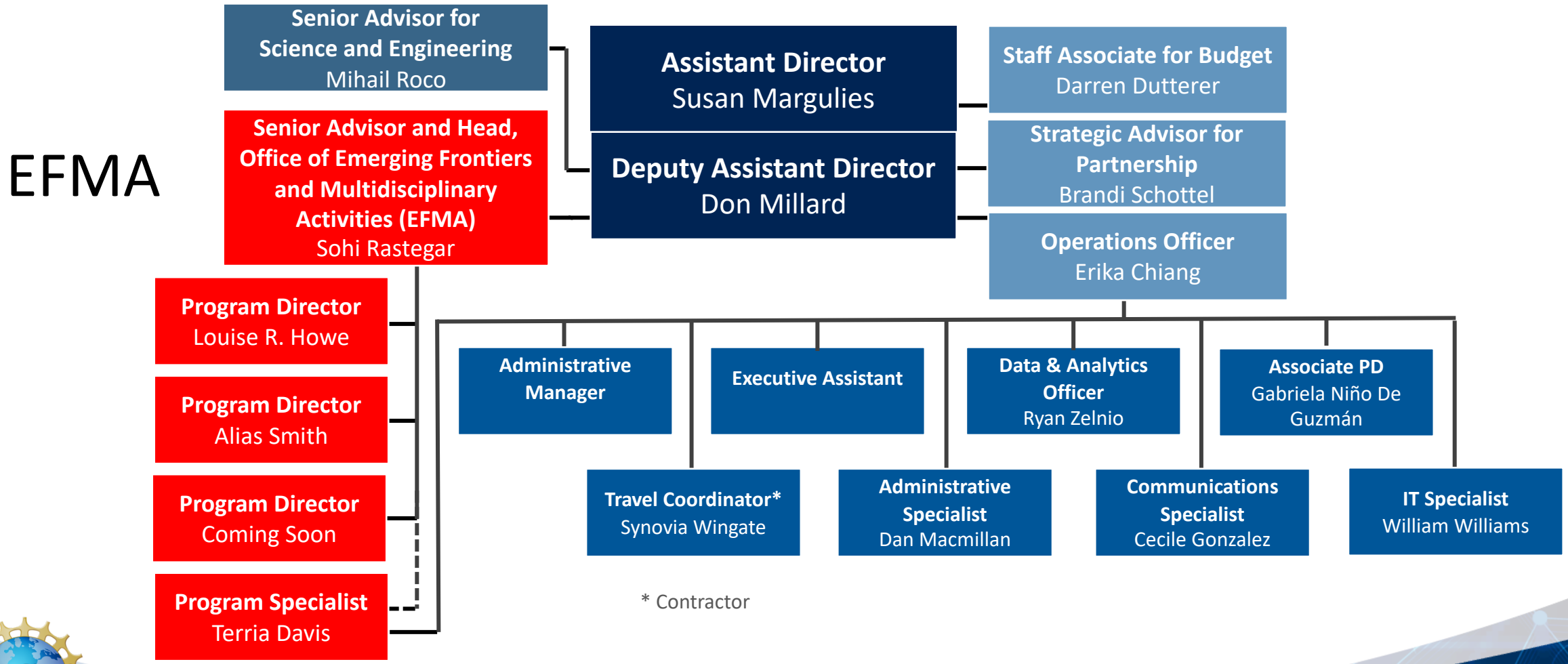
Office of Emerging Frontiers and Multidisciplinary Activities (EFMA)

Sohi Rastegar

EFMA Office Head

ENG Office of the Assistant Director (OAD)



Emerging Frontiers and Multidisciplinary Activities - I

EFRI Program – The Emerging Frontiers in Research and Innovation (EFRI) program, the signature activity of the EFMA Office, makes investments in potentially transformative research, which may lead to:

- new areas for fundamental or applied research
- new industries or capabilities that result in a leadership position for the country
- and/or significant progress on a recognized national/societal need or grand challenge

The Research Experience and Mentoring Program supports the involvement of research participants (high school students, STEM teachers, undergraduate students, faculty, & veterans) in EFRI-, ERC, and IUCRC-funded research, connecting participants with mentors and providing a rich research experience.

Emerging Frontiers and Multidisciplinary Activities - II

TRAILBLAZER (pilot) – The Trailblazer Engineering Impact Award program will support individual engineers and scientists who propose novel research projects with the potential to innovatively and creatively address major societal challenges, advance US leadership, and catalyze the convergence of engineering and science domains.

GERMINATION – The GERMINATION program supports the development of learning frameworks, platforms, and/or environments to enable participants to conceive research ideas and questions with potentially transformative outcomes.

Engineering Research Visioning Alliance – A unique, wholly NSF-funded organization charged with identifying and developing bold and transformative new engineering research directions, and thereby catalyzing the engineering community's pursuit of innovative, societally impactful research.

Emerging Frontiers in Research and Innovation (EFRI) Program

Mandate - Serve a critical role in helping the Directorate for Engineering identify and focus on important emerging areas in a timely manner.

Strategy:

- Community Driven - Engages the research community (through DCL) and NSF PDs to identify and fund a portfolio of projects in strategic emerging interdisciplinary areas that may not be supported with current NSF programs and in which ENG researchers play the leading role.
- Uses Potentially Transformative / High risk, High reward and Interdisciplinary as criteria for project selection
- Midscale project-funding mechanism - $2M / 4-year projects

Topic Leaders - Program Directors from ENG Divisions in collaboration with PDs from other NSF Directorates and other Federal agencies, as appropriate.

Key EFRI Criteria

TRANSFORMATIVE – Topics and projects that lead to a significant leap or paradigm shift in fundamental engineering knowledge

NATIONAL NEEDS/GRAND CHALLENGE – Strong potential for significant progress on a national need or grand challenge

INTERDISCIPLINARY – Topics and projects that require expertise of interdisciplinary teams of researchers

ENGINEERING LEADERSHIP – Topics and projects in which Engineering researchers can play a leadership role

FY07 ARES: Autonomously Reconfigurable Engineered Systems
CBE: Cellular and Biomolecular Engineering

FY08 COPN: Cognitive Optimization and Prediction
RESIN: Resilient and Sustainable Infrastructures

FY09 BSBA: Biosensing and Bioactuation
HyBi: Hydrocarbons from Biomass

FY10 SEED: Science in Energy and Environmental Design
RESTOR: Renewable Energy Storage

FY11 M3C: Mind, Machines, and Motor Control
MIKS: Engineering based on Multicellular and Interkingdom Signaling

FY12/13 BioFlex: Flexible Bioelectronics Systems
PSBR: Photosynthetic Biorefineries
ODISSEI: Origami Design for Integration Of Self-assembling Systems For Engineering Innovation

FY14/15 2-DARE: 2-Dimensional Atomic-Layer Research and Engineering

FY16/17 ACQUIRE: Advancing Communication Quantum Information Research Engineering
NewLAW: New Light and Acoustic Wave Propagation: Breaking reciprocity and time-reversal symmetry

FY18/19 CEE: Chromatin and Epigenetic Engineering
C3 SoRo: Continuum, Compliant and Configurable Soft Robotics Engineering

FY20/21 DCheM: Distributed Chemical Manufacturing
E3P: Engineering the Elimination of End-of-life Plastics

FY22/23 BRAID: Brain-Inspired Dynamics for Engineering Energy-Efficient Circuits and Artificial Intelligence
ELiS: Engineered Living Systems

FY24/25 BEGIN OI: Biocomputing through EnGINeering Organoid Intelligence
PEL: Ideas Lab: Personalized Engineering Learning (NSF 23-627)

EFRI Topics: FY07-25

EFRI 24/25: Biocomputing through EnGINeering Organoid Intelligence (BEGIN OI)

The objective of BEGIN OI is to harness the novel discoveries and advancements in biological sciences, engineering, material sciences, and computer sciences toward designing 3D *in vitro* biological systems that are capable of information processing and actuation.

BEGIN OI will support foundational and transformative research to advance the design, engineering, and fabrication of organoid systems that are capable of processing information dynamically while interfacing with non-living systems.

BEGIN OI supports a broad interpretation of *in vitro* biological "intelligent systems" to include capture of real-world input, autonomous processing in an engineered biological construct, and generating an output that drives an engineered system.

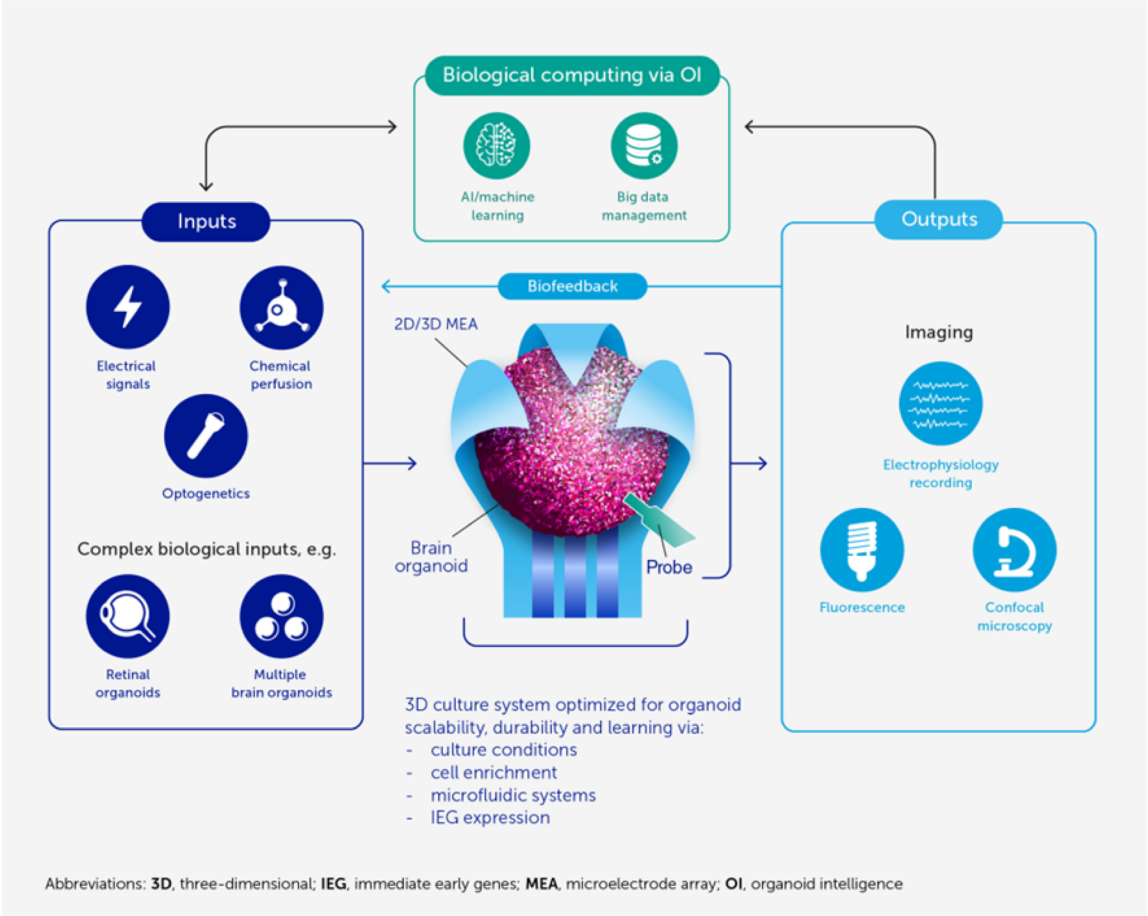
BEGIN OI asks investigators to define the bounds of "intelligence" and "learning" needed to achieve responsive and adaptive biological computing and control.

EFRI 24/25: BEGIN OI
Research Threads

Thread 1: Biocomputing Theory and Modeling

Thread 2: Biology-Integrated Culture Maintenance and Hardware Systems

Thread 3: Ethical, Legal, and Social Implications (ELSI)



Adapted from DOI 10.3389/fsci.2023.1017235

MUST ADDRESS ALL 3 THREADS

NSF 24-508 BEGIN OI Solicitation
Key Dates for FY25

Sept 12th, 2024	Letter of Intent Due (required)
Dec 12th, 2024	Full Proposal Deadline
Early 2025	Proposal Review

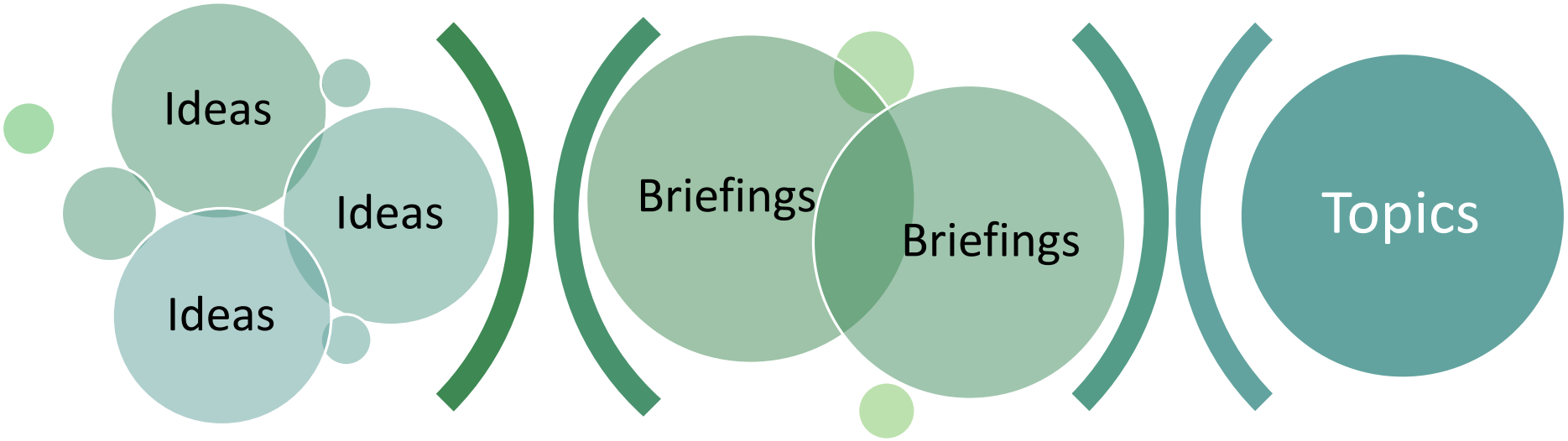
Lead PD:
Steven Peretti
speretti@nsf.gov

NSF 23-012: Research Experience and Mentoring (REM)

- The goal is to provide mentoring and research experience opportunities to STEM students and/or educators that may ultimately enhance their career and academic trajectories while enhancing ENG-supported research.
- REM supplements may be requested by grantees with current EFRI awards, as well as by Engineering Research Centers (ERCs) and Industry-University Cooperative Research Centers (IUCRCs).
- REM participants are invited to present their findings at an annual meeting:
  - Annual Emerging Researchers National (ERN) Conference in STEM, *or*
  - Annual REM meeting

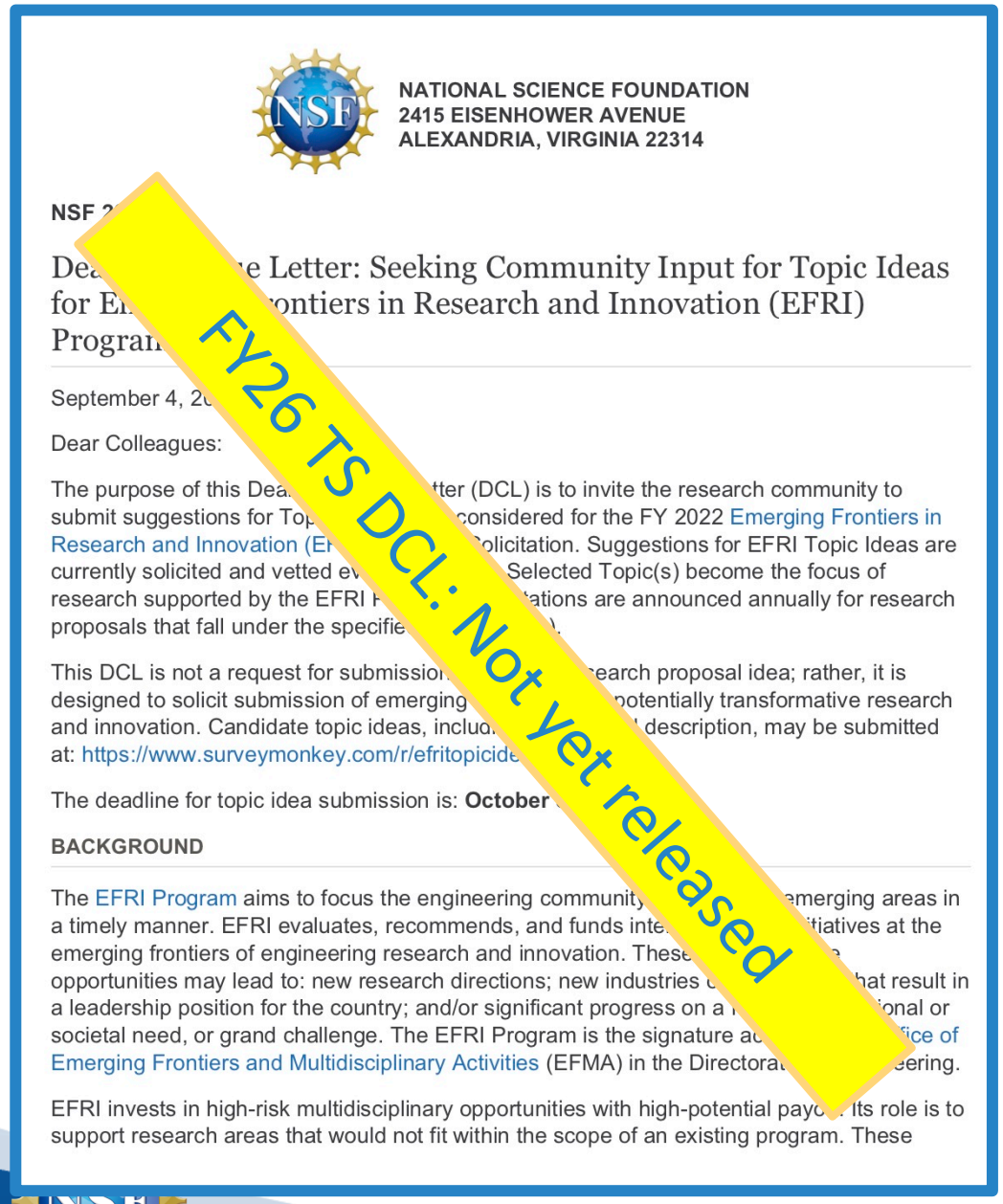
Lead PD:
Alias Smith
alismith@nsf.gov

EFRI Topic Selection



external + internal

academia + industry + government



NATIONAL SCIENCE FOUNDATION
2415 EISENHOWER AVENUE
ALEXANDRIA, VIRGINIA 22314

NSF 2

Dea e Letter: Seeking Community Input for Topic Ideas for E ontiers in Research and Innovation (EFRI) Progra

September 4, 2

Dear Colleagues:

The purpose of this Dea tter (DCL) is to invite the research community to submit suggestions for Top considered for the FY 2022 Emerging Frontiers in Research and Innovation (E olicitation. Suggestions for EFRI Topic Ideas are currently solicited and vetted ev Selected Topic(s) become the focus of research supported by the EFRI H tations are announced annually for research proposals that fall under the specifie

This DCL is not a request for submissio earch proposal idea; rather, it is designed to solicit submission of emerging otentially transformative research and innovation. Candidate topic ideas, includ description, may be submitted at: https://www.surveymonkey.com/r/efritopicide

The deadline for topic idea submission is: **October**

BACKGROUND

The EFRI Program aims to focus the engineering community emerging areas in a timely manner. EFRI evaluates, recommends, and funds inte itiatives at the emerging frontiers of engineering research and innovation. These opportunities may lead to: new research directions; new industries hat result in a leadership position for the country; and/or significant progress on a ional or societal need, or grand challenge. The EFRI Program is the signature ac fice of Emerging Frontiers and Multidisciplinary Activities (EFMA) in the Directora eering.

EFRI invests in high-risk multidisciplinary opportunities with high-potential payo Its role is to support research areas that would not fit within the scope of an existing program. These

FY26 TS DCL: Not yet released

Topic Suggestion DCL

- Call for EFRI Topic Suggestions
- Open to all
- Ideas submitted through electronic survey interface
  - ✓ Description
  - ✓ Transformative
  - ✓ Addressing a national need or grand challenge
  - ✓ Leadership role for Engineering
- DUE DATE: TBD

PD: Louise R Howe

GERMINATION

Motivating Question: Can effective pedagogical frameworks, platforms and/or nurturing experiential environments be designed that train academic researchers to formulate research questions that result in transformative impacts on key societal needs?

Goal: Stimulate new approaches for cultivating a risk-taking and impact-driven research culture.

Funded Approaches:

Mindfulness for creativity; Rethinking institutional support structures; Leveraging diverse knowledge communities; Exploring incentive models; Developing Question Formulation Techniques; “Matchmaking platform” for engineers and communities; Post-doc bootcamp; Reverse engineering entrepreneurship training; Socioeconomic contextualization for Chemistry students; Overcoming barriers to engineering graduate student recruitment and retention.

NSF 21-594: GERMINATION of Research Questions for Addressing Societal Challenges

Solicitation NSF 21-594 invited proposals to design, test, evaluate and implement innovative frameworks, platforms and/or environments that will increase the ability of academic researchers, from graduate students through to mid-senior career faculty, to formulate research questions and ideas that have the potential to address critical societal challenges.

In order to catalyze development of novel approaches, while simultaneously expanding the reach of pilot approaches already exhibiting promise, two tracks were offered:

- GERMINATION Innovation: Exploratory studies (EAGERS; ≤$300K)
- GERMINATION Expansion: Implementation and scaling of evidence-based strategies ($500K-$1M/award)

PD: Louise R Howe

NSF 23-629: Trailblazer Engineering Impact Award
Pilot Activity

The NSF Trailblazer Engineering Impact Award (TRAILBLAZER) program aims to support individual engineers and scientists who propose novel research projects with the potential to innovatively and creatively address major societal challenges, advance US leadership, and catalyze the convergence of engineering and science domains.

The TRAILBLAZER program will support individual engineers and scientists who have demonstrated a capacity for research excellence and creativity.

Proposed projects are required be a new research direction for the PI.

Awards from this pilot are anticipated in August 2024.

PD: Alias Smith
alismith@nsf.gov

NSF 23-627: Personalized Engineering Learning (PEL) Ideas Lab

The goal of the Personalized Engineering Learning Ideas Lab was to extend engineering education research to enable advanced personalization in pedagogy and assessment in a K-12 or higher education context.

Three broad areas were identified as possible avenues to advance knowledge:

- Personalized engineering education
- Multimodal sensing for personalized learning systems
- Team-based personalized learning.

Awards from this one-time activity are anticipated in August 2024.

Lead PD:
Matthew Verleger
mverlege@nsf.go

NSF Engineering Research Visioning Alliance

Facilitate the generation of visions for engineering research, including both short and medium/long range visions, for the Nation.

- Visioning Events: Obtain and integrate input from all stakeholders with interest in engineering research, including academia, industry, professional societies and other non-profits, government agencies, and the public.
- Reports, Outreach: Communicate coordinated information on the research visions and priorities in engineering research to these stakeholders.
- Events, Reports, Outreach: Strengthen connectivity across these diverse stakeholders and increase coordination among the engineering disciplinary communities.

ERVA PI Team

Anthony Boccanfuso
Co-PI
UIDP

Charles Johnson-Bey
Co-PI
Booz Allen Hamilton

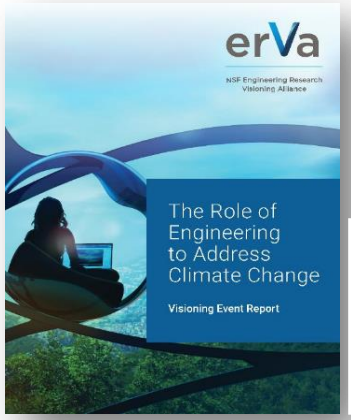
Dorota A. Grejner-Brzezinska
PI
The Ohio State University

Pramod Khargonekar
Co-PI
UC, Irvine

Edl Schamiloglu
Co-PI
University of New Mexico

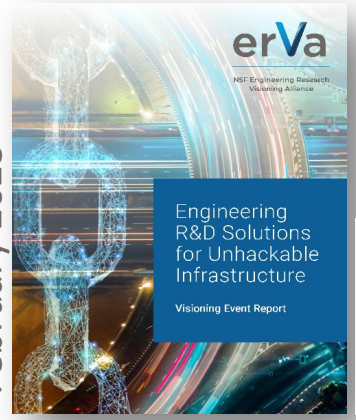
ERVA Published Reports

August 2022



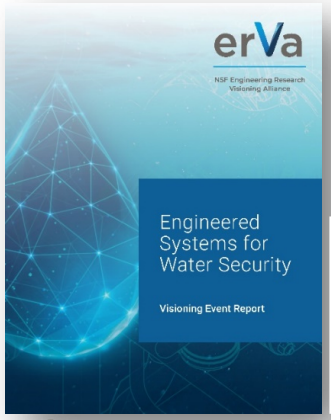
October 2022

February 2023

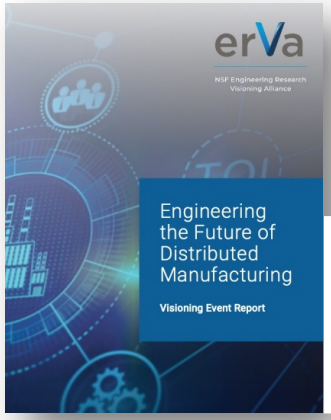


April 2023

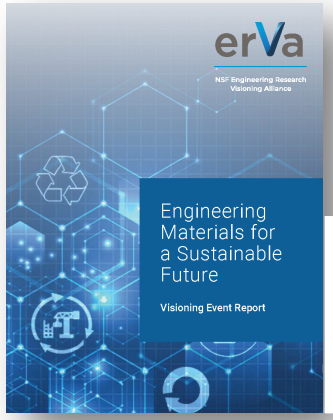
July 2023



October 2023



February 2024



May 2024

Get Involved!

Follow the ERVA community:

ERVAcommunity.org

@ERVAcommunity

#ERVAcommunity

info@ervacommunity.org

Click to become an ERVA Champion!

PD: Louise R Howe

Open Call for Visioning Event Themes

Help ERVA Identify and Develop Transformative New Engineering Research Priorities

What critical issue could engineering positively impact with the right resources?

EFMA Opportunities

- EFRI BEGIN OI – Steve Peretti, speretti@nsf.gov
- EFRI Research Experience & Mentoring – Alias Smith, alismith@nsf.gov
- TRAILBLAZER – Alias Smith, alismith@nsf.gov
- EFRI Topic Ideas – Louise R. Howe, lhowe@nsf.gov
- GERMINATION – Louise R. Howe, lhowe@nsf.gov
- Engineering Research Visioning Alliance – Louise R. Howe, lhowe@nsf.gov

NSF