2023 NSF Grants Conference: Directorate of Engineering (ENG) Programs

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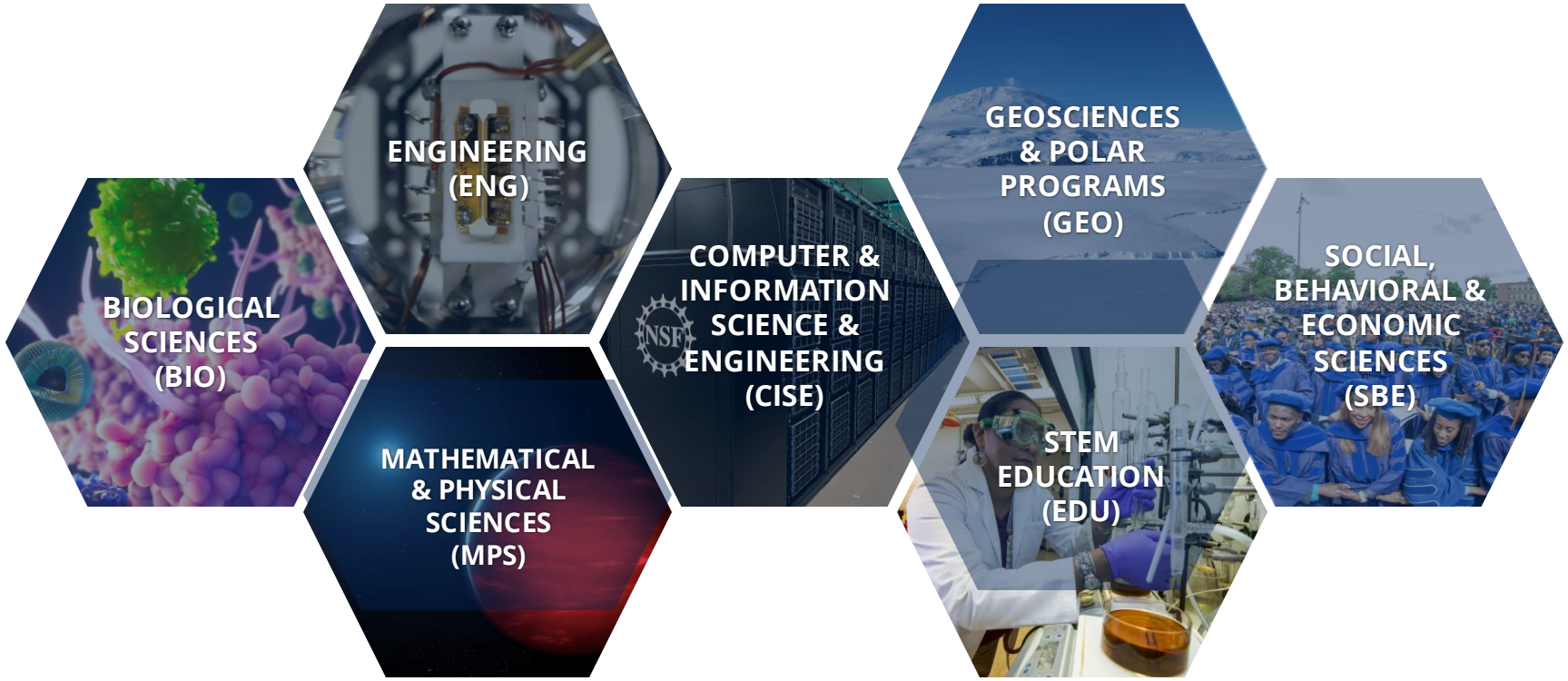
A bird's eye view of the NSF

NSF's Vision:

"A nation that leads the world in science, engineering research and innovation, to the benefit of all, without barriers to participation"

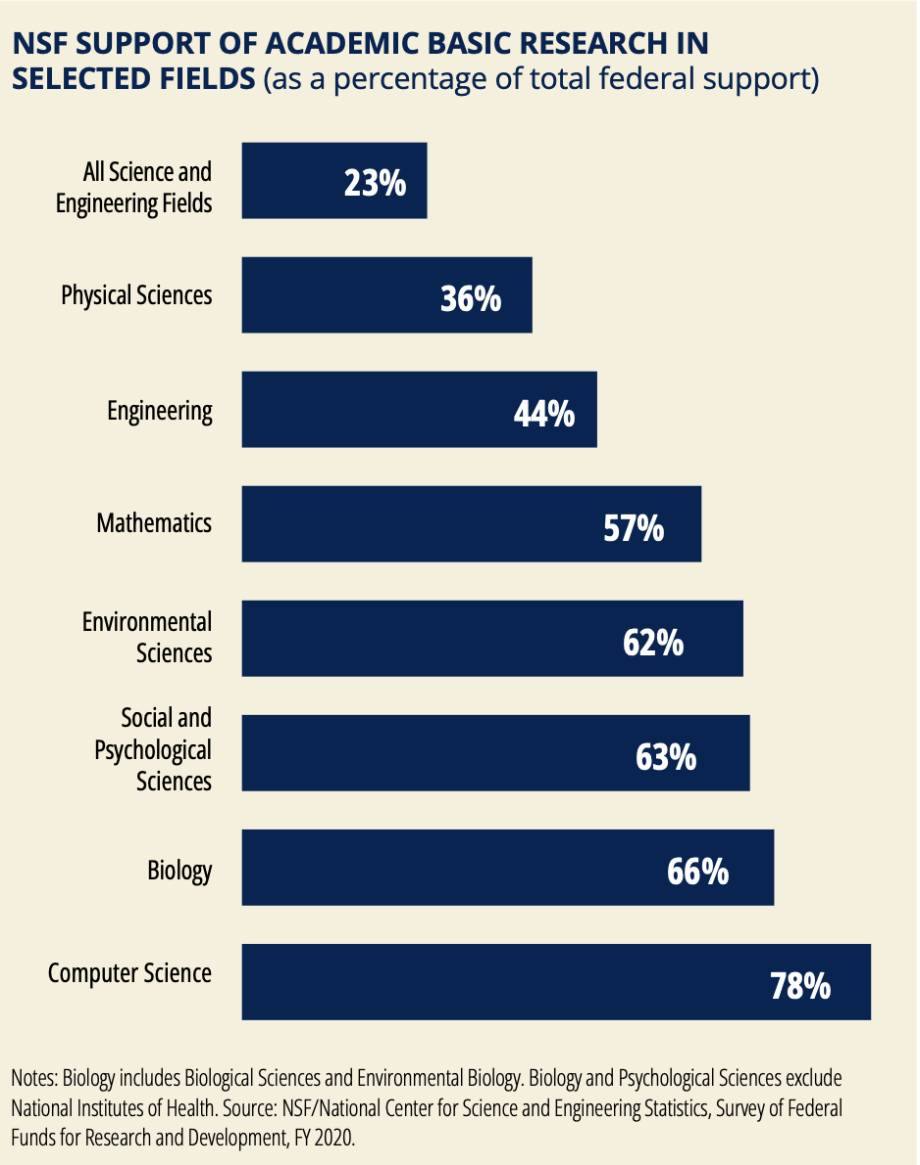


DIRECTORATE FOR TECHNOLOGY, INNOVATION AND PARTNERSHIP

Integrative Activities

International Science & Engineering

NSF's funding impact on academic research



Scale: Single investigator to mid-size teams to centers and networks

Breadth: Single discipline through convergence research

Career stage: Undergraduate to grad to postdoc to early to middle to later career

Innovation cycle: Basic research through translational research

You are at the heart of NSF's mission

NSF Directorate for Engineering (ENG)

ENG Office of the Assistant Director

Emerging Frontiers and Multidisciplinary Activities (EFMA)	Chemical, Bioengineering, Environmental, and Transport Systems (CBET)	Civil, Mechanical, and Manufacturing Innovation (CMMI)	Electrical, Communications, and Cyber Systems (ECCS)	Engineering Education and Centers (EEC)
Emerging Frontiers in Research and Innovation	Chemical process systems	Advanced manufacturing	Communications, circuits, and sensing systems	Engineering centers
	Engineering biology and health	Engineering for civil infrastructure (NHERI)	Electronics, photonics, and magnetic devices	Engineering education
	Environmental engineering and sustainability	Operations and design	Energy, power, control, and networks	Engineering workforce development
	Transport phenomena	Mechanics and engineering materials		Broadening participation
		Dynamics, control, and cognition		

ENG by the Numbers: FY 2023

$793M
research budget

152
ENG staff

6,009
proposals

444
panels

25% competitive award funding rate

1,506
competitive awards

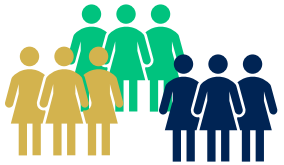
22,644
people

312
institutions

8,962
senior researchers

653
other professionals

377
postdoctoral associates



7,736
graduate students

4,916
undergraduate students

NSF Engineering Strategic Plan

MISSION

To transform our world for a better tomorrow by driving discovery, inspiring innovation, enriching education, and accelerating access

VISION

NSF Engineering will be a global leader in identifying and catalyzing fundamental engineering research, innovation, and education.

GOALS

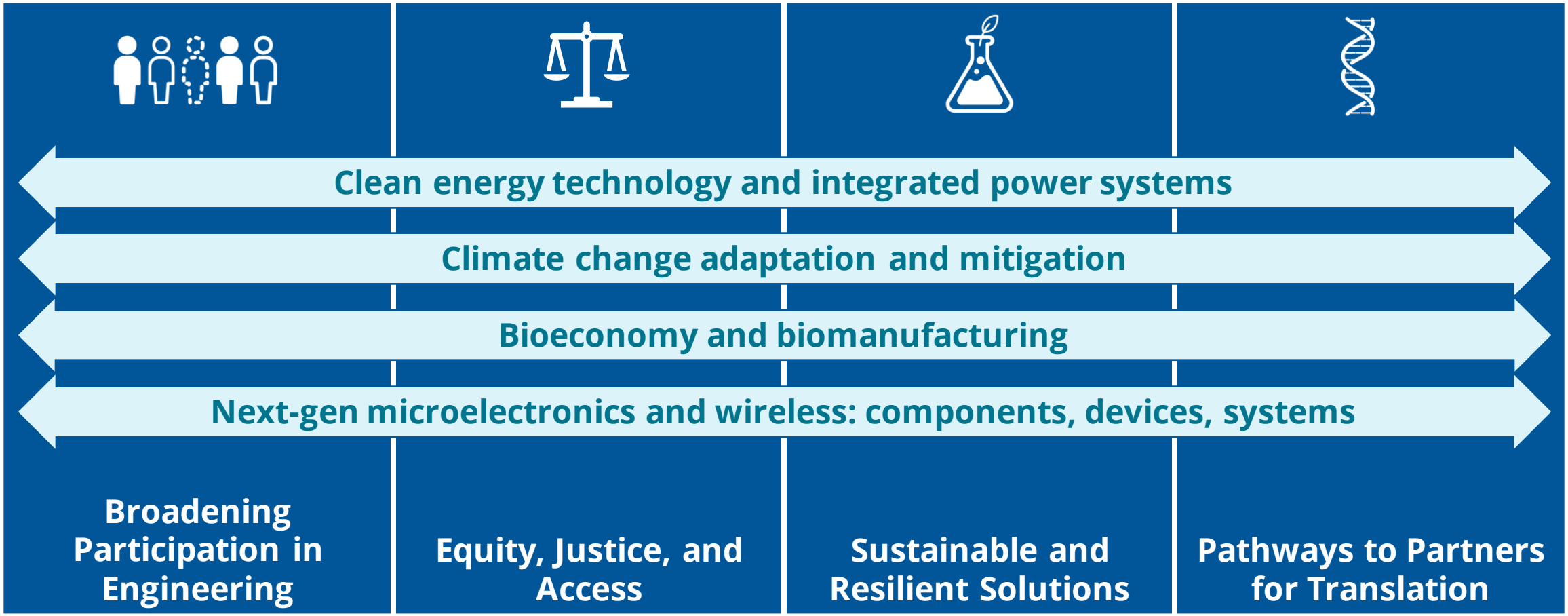
Propel
U.S. leadership in transformational engineering approaches to problems with societal impact

Expand
opportunities for people

Catalyze
purposeful partnerships

Goal: Propel US Leadership in Transformational Engineering Approaches to Problems with Societal Impact

Investing in Cross-ENG Strategic Priorities



Coordinate — Collaborate — Co-fund

Clean Energy

Clean Energy Technology RAISE, EAGER, and Conference Awards

- Conference proposals to initiate new collaborations (NSF 23-108)
- RAISE and EAGER proposals (NSF 23-109)
- Topics for both are:
  - Hydrogen, fusion, and/or geothermal technologies
  - Industrial heat and/or energy efficiency technologies
  - Offshore wind/wave technologies
  - Critical materials for clean energy technologies
  - Net-zero fuels and bioenergy
  - Education and workforce development

Critical Aspects of Sustainability (CAS): Innovative Solutions to Climate Change

Supports basic research aimed at improving the sustainability of resources

- Reducing energy use and greenhouse gas emissions
- Energy innovations that mitigate climate change
- Enhancing GHG sequestration
- Accelerating strategies for climate change adaptation

FY 2024: ***Rolling submission via DCL NSF 21-124***

Clean Energy

CBET Fluid Dynamics Program

PD 23-1443:
https://new.nsf.gov/funding/opportunities/fluid-dynamics

Partnership with Dept. of Energy (DOE) Wind Energy Technologies Office opportunity on wind and ocean energy harvesting

- submissions accepted at any time

NSF-DOE Geothermal INTERN – grad student traineeships

- NSF 23-024 submissions accepted at any time
- Support available for 15-20 grad students
- Up to $55,000 for up to 6 months traineeship
- Hosts: Non-academic organization engaged in geothermal energy research and technology

Climate Change Adaptation and Mitigation

Civil Infrastructure research for climate change Mitigation and Adaptation (CLIMA)

- NSF 23-079 EAGER proposal submissions accepted at any time

Planning Proposals to Catalyze Innovative and Inclusive Wildland Fire Science through Diverse Collaborations

- NSF 22-122 submissions accepted at any time

Expanding Access to Research Infrastructure

Mid-Scale Research Infrastructure provides experimental research capabilities in the range between the Major Research Instrumentation ($6M) and Major Facilities ($100M) thresholds.

- Mid-scale RI-1 (<$20M) *NSF 22-637*
- Mid-scale RI-2 ($20-100M) *NSF 23-570 invited proposals due December 18, 2023*
- Dear Colleague Letter: Mid-scale RI — Engineering Conferences
  NSF 22-075 continuous submission

Other ENG Infrastructure Investments:

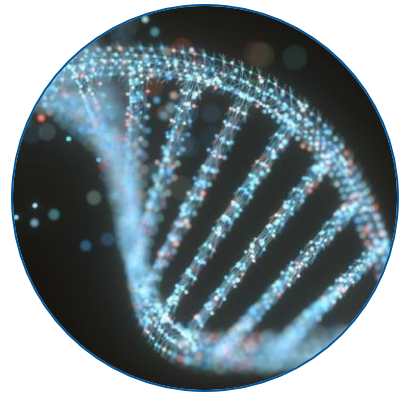
National Nanotechnology Coordinated Infrastructure – 16 user facility sites

- **www.nnci.net**

Natural Hazards Engineering Research Infrastructure – 8 experimental facilities, cyberinfrastructure

- **www.designsafe-ci.org**

Bioeconomy: Biotechnology Research



Emerging Frontiers in Research and Innovation (EFRI): Biocomputing through EnGINeering Organoid Intelligence (BEGIN OI)

- To advance the design, engineering, and fabrication of organoid systems that can process information dynamically while interfacing with non-living systems
- NSF 24-508 letters of intent (required) due January 17, 2024; full proposals due February 22, 2024

Bioinspired Design Collaborations to Accelerate the Discovery-Translation Process (BioDesign)

- To inform and generate new directions for engineered systems, devices, materials or products
- NSF DCL 23-055 deadlines vary by program

Sentinel Systems that Detect, Recognize, Actuate, and Mitigate Emergent Biological Threats (DREAM Sentinels)

- For sensing and responding to known and unknown biological threats
- NSF DCL 22-077 continuous submission

Future Manufacturing Research

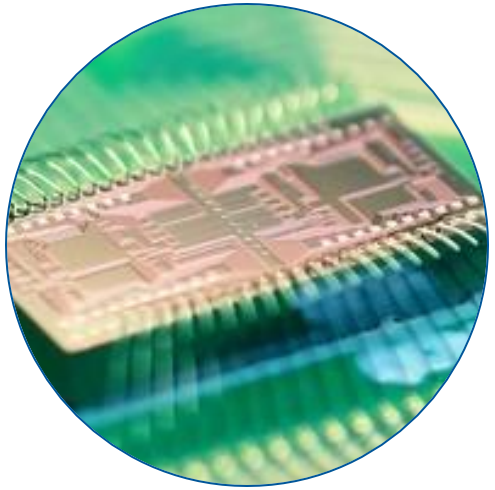
Future Manufacturing

- For manufacturing that either does not exist today or exists only at such small scales that it is not viable
- FY 2020-2023: ~$135 million in new projects
  - Biomanufacturing
  - Cyber-manufacturing
  - Eco-manufacturing
- FY 2023: $35 million in 21 projects

Next Generation Supply Chains

- NSF DCL 23-080 submissions accepted at any time

Next-Gen Microelectronics: Semiconductor Lab to Fab



Supplements for Access to Semiconductor Fabrication (ASF)

- NSF DCL 22-113 proposals accepted at any time

Advanced Chip Engineering Design and Fabrication (ACED Fab)

- NSF 22-636 proposals under review

Next-Gen Microelectronics: Quantum Technologies

Dear Colleague Letter: Quantum Manufacturing

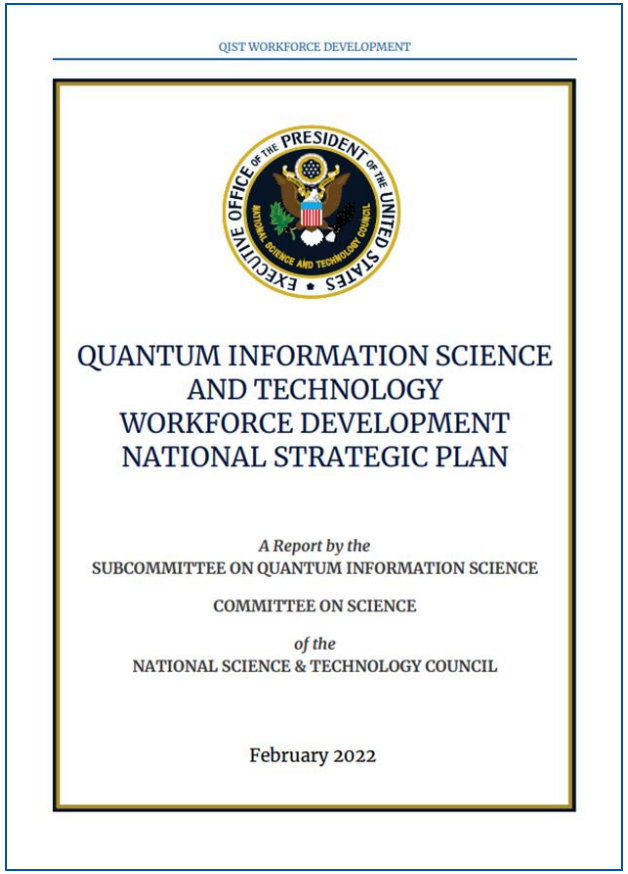
- NSF 22-074 continuous submission of EAGER and standard research proposals

Expanding Capacity in Quantum Information Science and Engineering NSF (ExpandQISE)

- NSF 23-551 - $38 million from across NSF in 22 projects in FY 2023….

National Quantum Virtual Lab

- NSF 23-604 proposals due November 30, 2023



Goal: Expand Opportunities for People

Broadening Participation in Engineering: **NSF 22-514**

- Planning and Conference Grants: ***accepted anytime***
- Research in Broadening Participation in Engineering: ***accepted anytime***
- Inclusive Mentoring Hubs: ***target date: 3rd Wed in Nov***
  - Connect and dynamically build networks for racial and ethnic groups not sufficiently represented
  - Could engage students, faculty, academic leaders, postdoctoral and career transitioning researchers, small businesses and industry professionals, K-12 educators, or others
- Centers for Equity in Engineering: ***target date: 3rd Wed in Nov***
  - Catalyze culture change in engineering colleges to create equitable and inclusive practices that recruit and retain a diverse community of students

Revolutionizing Engineering Departments (RED)

The goal is to catalyze revolutionary changes to the education of the next generation of engineers while expanding the reach of changes that have proven effective.

- ***NSF 23-553*** *focuses on:* **"**RED Two-Year**"**
  - For radically new approaches among two-year institutions to expand pathways to engineering and engineering technology education

- Watch the recorded webinar:

https://new.nsf.gov/funding/opportunities/iuseprofessional-formation-engineers

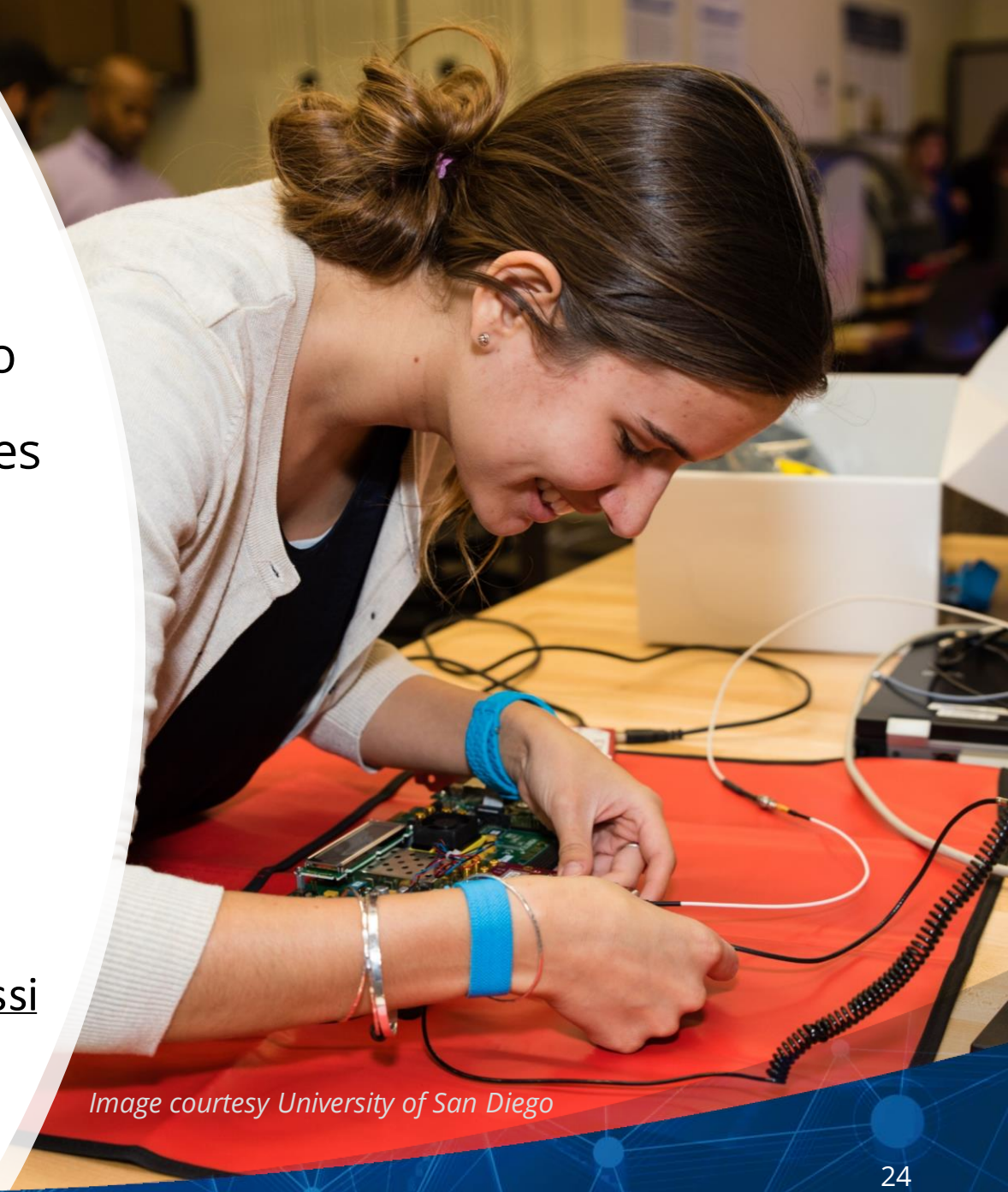


Image courtesy University of San Diego

Early Career Support

- Engineering Postdoctoral Fellowship Program
  - Places early career PhDs in engineering fields in university research postdoctoral fellowships
  - **Contact: efellows.asee.org**

- Engineering Research Initiation
  - Support for investigators who have yet to receive research funding from Federal Agencies and who are at non-R1 institutions.
  - ***NSF 22-595 proposals under review***

- Faculty Early Career Development Program (CAREER)
  - Annual ENG CAREER proposal-writing workshop
  - ***NSF 22-586 deadline July 24, 2024***

Workforce Development Opportunities

REU: Research Experiences for Undergraduates sites and supplements: NSF 23-601 **deadline August 21, 2024**

RET: Research Experiences for Teachers sites and supplements: NSF 24-503 **deadline January 29 and October 9, 2024**

VRS: Veterans Research Supplement Program: Veterans - Undergraduates, grad students, teachers. NSF 23-161 **accepted anytime**

START Supplements: Skills Training in Advanced Research and Technology for Community College students/faculty in NSF Centers: IUCRC and ERC: nsf.gov/START, **accepted anytime**

REM Research Experiences and Mentoring Supplement NSF 23-012: cohorts of high school students/teachers, undergraduates, faculty, and veterans. **accepted Aug-Nov each year**

INTERN supplements: Non-academic Research Internships for Graduate Students nsf.gov/INTERN **accepted anytime**

Today's job market for graduate students

57% of Ph.D. and 81% of master's STEM graduates start careers in **non-academic jobs**

83% of **Ph.D. Engineers** start careers in industry or government

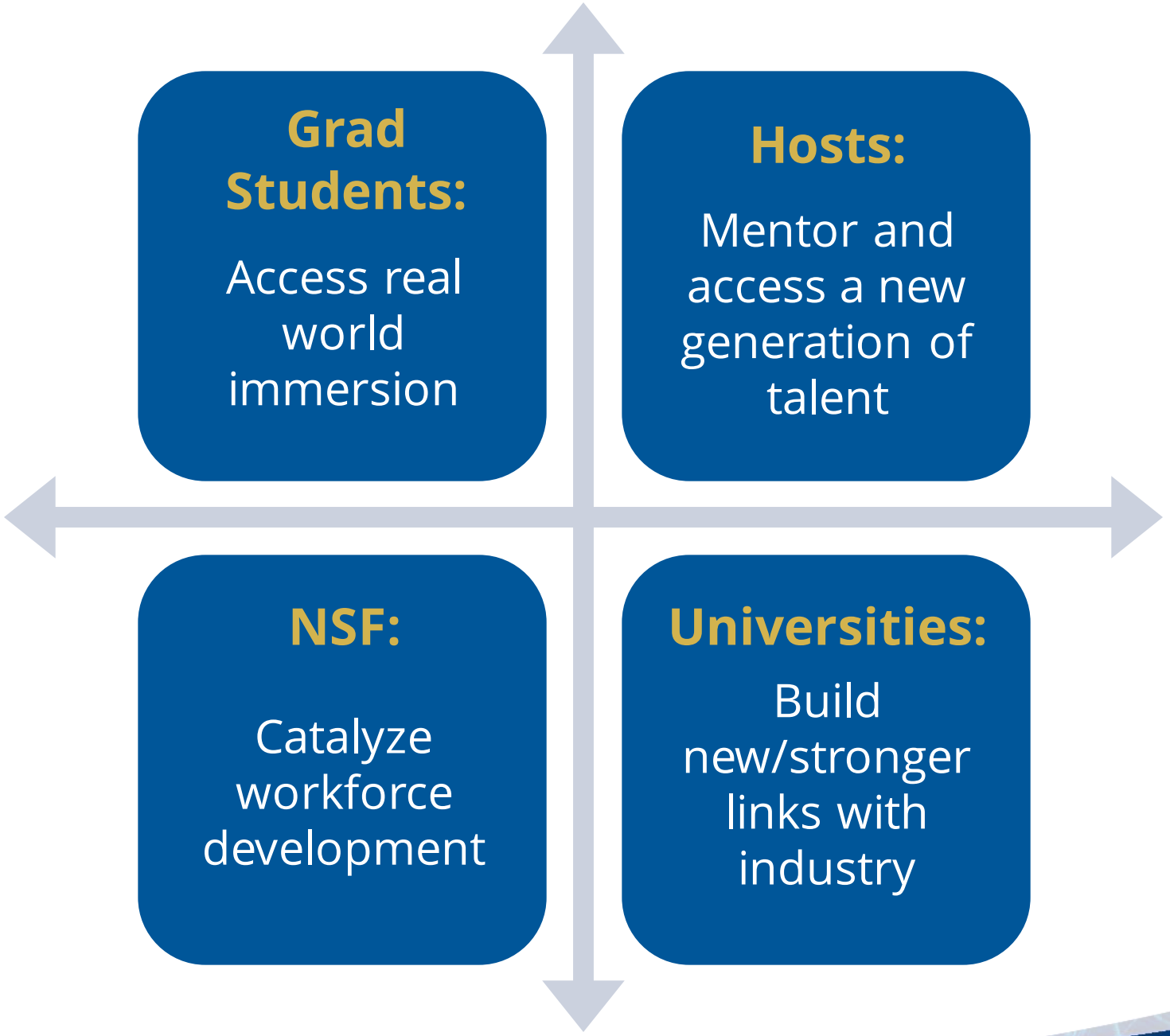
NSF INTERN program was created to **help better prepare** NSF-supported grad students for professional careers

NSF supports a huge talent pool of 40,000+ Graduate students!

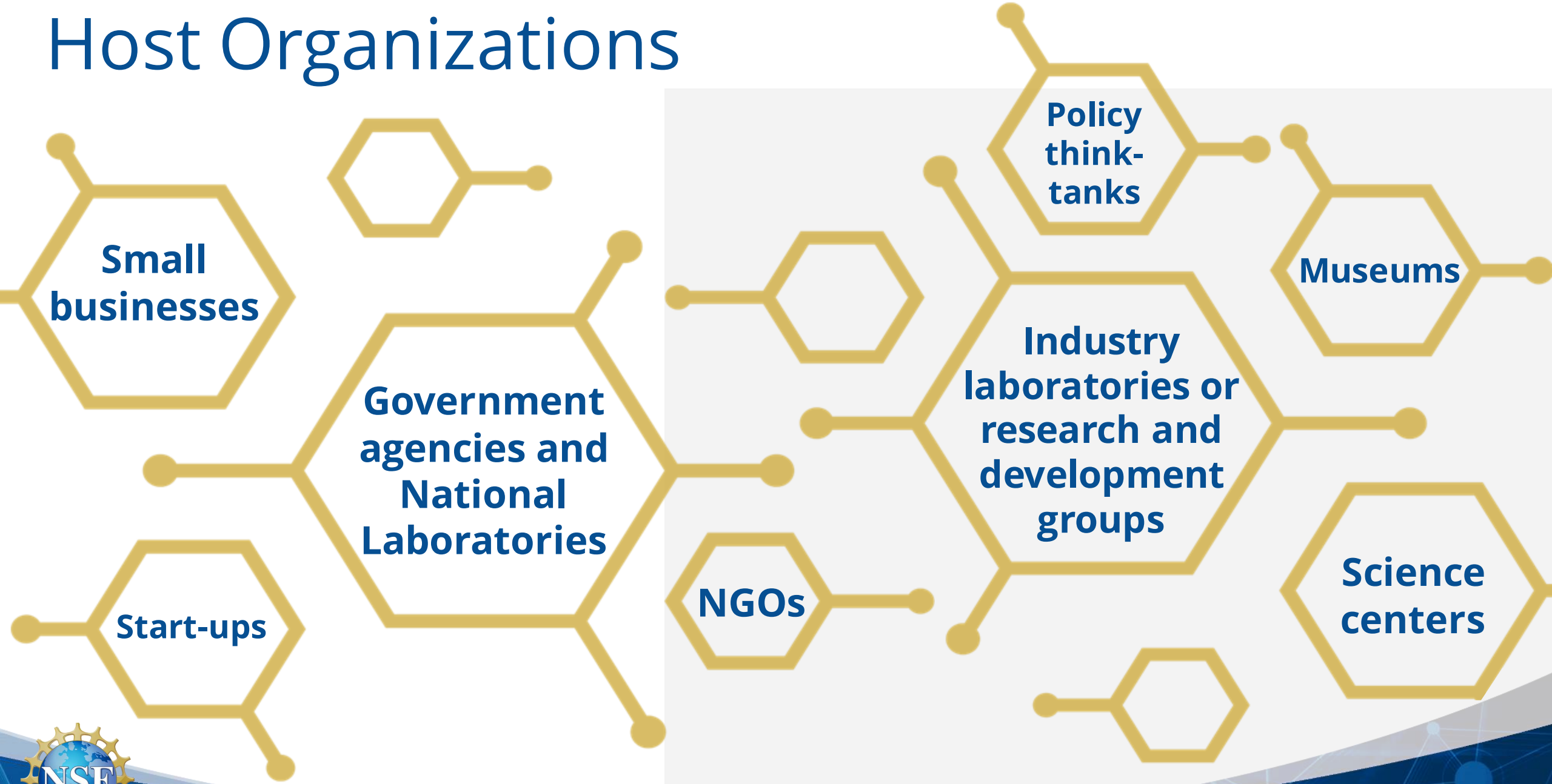
NSF INTERN : Immersive Exposure to hard and soft skills!

- Technical training and skills
- Innovation and entrepreneurship
- Business and economics
- Strategic thinking
- Working in diverse teams
- Project and time management
- Communication written & oral

INTERN Benefits



Host Organizations



Supplements for Non-Academic Research Internships for Graduate Students (INTERN)

- Up to $55K for up to 6 months for internship with host.
- International students OK.
- Funds: travel, tuition and fees, health insurance, stipend, temporary relocation costs, materials + faculty co-mentoring.
- 250+ INTERNs supported each year

Governed by Intellectual Property (IP) agreement between university and Host. NSF waives its IP rights.

A growing list of INTERN opportunities…

NSF has several INTERN funding opportunities of interest to engineers

1. NSF 21-013 The broad opportunity …"*the* INTERN DCL"
2. NSF 21-029 : INTERN Opportunities at Air Force Research Laboratory (AFRL)
3. NSF 23-024 : Geothermal Energy INTERN – partnered with DOE

Watch this page for future announcements from the INTERN program:
www.nsf.gov/INTERN

Goal: Catalyze Purposeful Partnerships

GOALI: **G**rant **O**pportunities for **A**cademic **L**iaison with **I**ndustry

- Basic research with strong academic-industrial collaboration
- Available NSF-wide as a specialized type of Proposal (or Supplement) that can be submitted to most programs
- Typical grant is 3-5 years and $100-150K per year.
- Requires an industrial partner (industry co-PI)
- Up to 1/3rd funds for eligible small business partner

NEW feature!

- Requires intellectual property agreement completed in advance of funding

Faculty & Students: Industrial collaboration, education and training

Industry: Access top university research capacity and talent

NSF: Catalyze transformative research & collaborations

Universities: Build pathways to new/stronger links with industry

https://new.nsf.gov/policies/pappg/23-1/ch-2-proposal-preparation#2F5

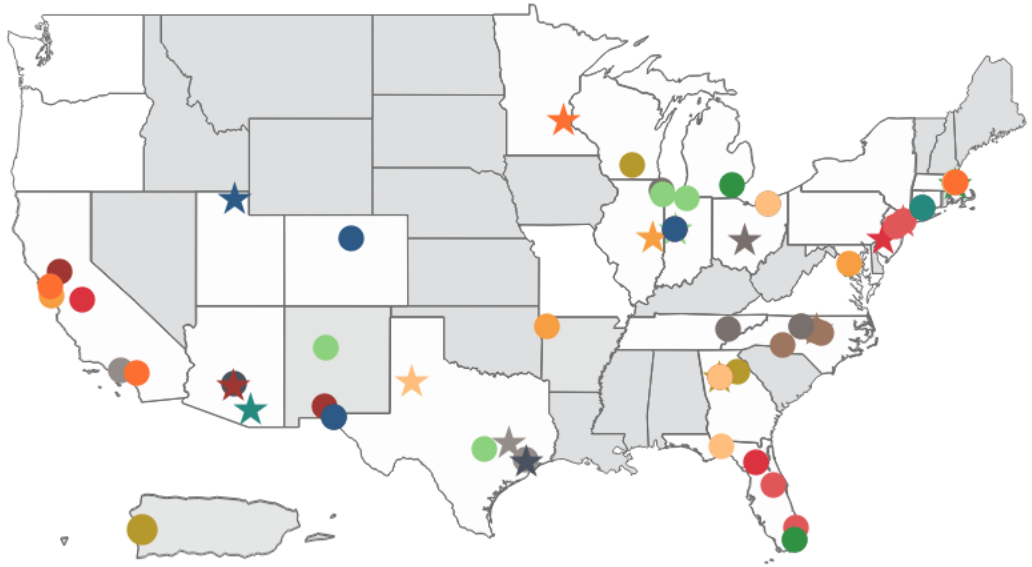
NSF Engineering Research Centers

The ERC program supports broad, multidisciplinary high-impact and high-risk/high-payoff engineering research.

Gen-4 ERCs emphasize integrating convergent research, engineering workforce development, a culture of diversity and inclusion, value creation and innovation for societal impact.

- *NSF 22-580 competition underway*
- Investment of up to $156 million for up to 6 awards in summer 2024

15 ERCs involve 42 unique institutions and 241 industrial participants in FY 2022.



ERCs span 33 distinct jurisdictions, including Puerto Rico and Washington, DC, with 5 EPSCoR jurisdictions, and include 10 MSIs in FY 2022.

1985 through 2023	
79	ERCs
250	Spinoffs
1,400	Licenses
2,740	Invention disclosures
950	Patents
190	Textbooks
14,900	Students

FY 2022 Engineering Research Centers

ERC for Advancing Sustainable and Distributed Fertilizer Production

- Enables resilient and sustainable food production by developing efficient, modular, and distributed technology for capturing, recycling, and producing decarbonized nitrogen-based fertilizers.

ERC for Hybrid Autonomous Manufacturing Moving from Evolution to Revolution

- Accelerates the development and deployment of intelligent, autonomous manufacturing systems, enabling mass customization in local production facilities.

ERC for Precision Microbiome Engineering

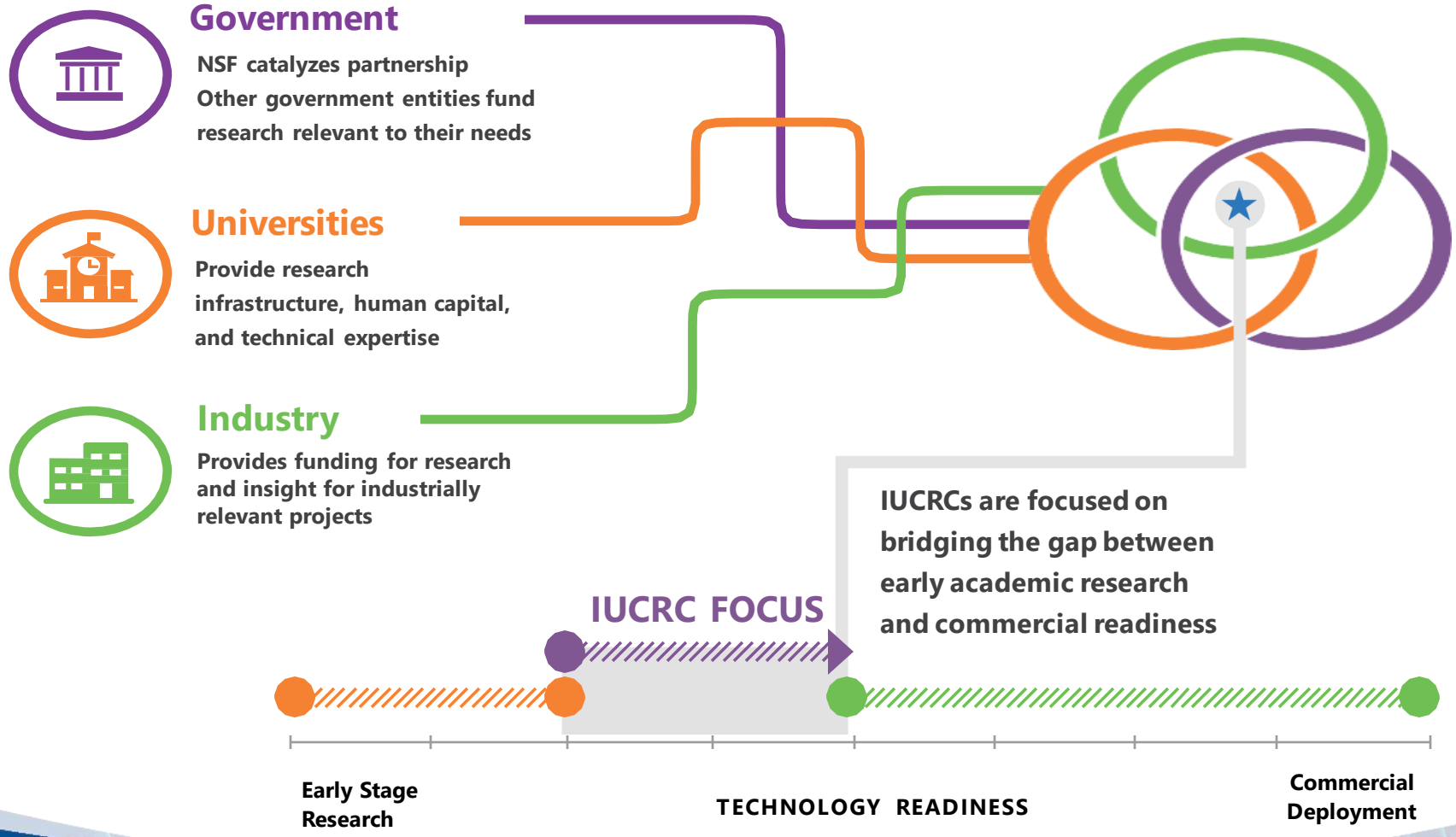
- Creates microbiome technologies that address challenges at the interface of human health and the built environment.

ERC for Smart Streetscapes

- Forges livable, safe, and inclusive communities through real-time, hyperlocal technologies for streets and their surroundings

Industry-University Cooperative Research Centers (IUCRC)

Execute cutting-edge pre-competitive basic research in science & engineering to drive innovation and societal impact



IUCRC – Nationwide Portfolio

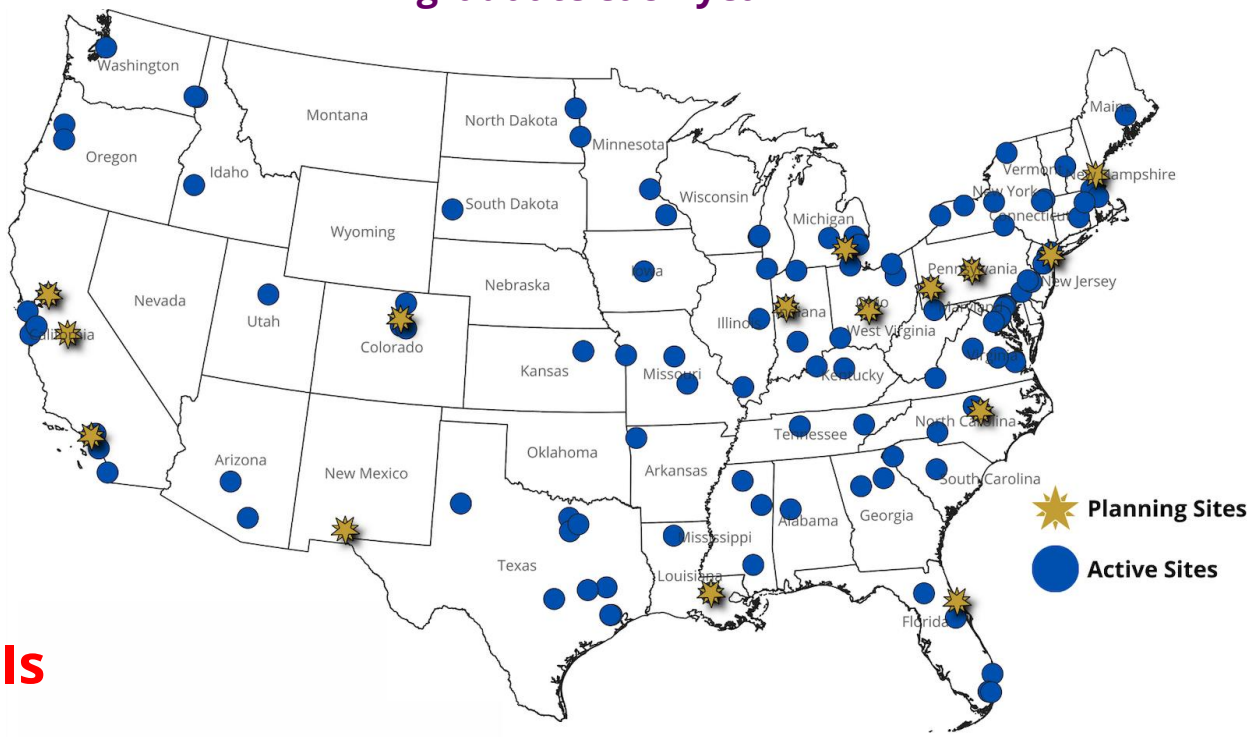
~ 500 – 700
Center-trained students graduate each year

80+
Active Centers

120+
U.S. Universities

24
EPSCoR Sites

15
MSIs



800+
Member Organizations

1180+
Memberships

20+
Federal Agencies

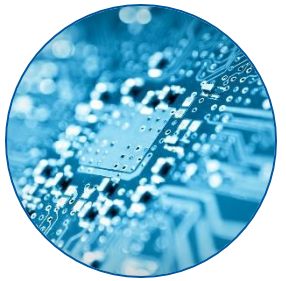
Members ~$60M
NSF ~$20M

*Source: NSF award 1732084 survey data

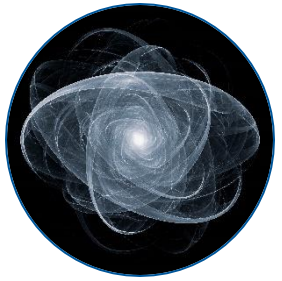
IUCRC – Broad Areas and Research Themes

- **Advanced Electronics and Photonics**
- **Advanced Manufacturing**
- **Advanced Materials**
- **Biotechnology**
- **Civil Infrastructure Systems**
- **Energy and Environment**
- **Forensic science**
- **Geosciences**
- **Health and Safety**
- **IT, Communication, and Computing**

Wide open to transformative new center ideas!



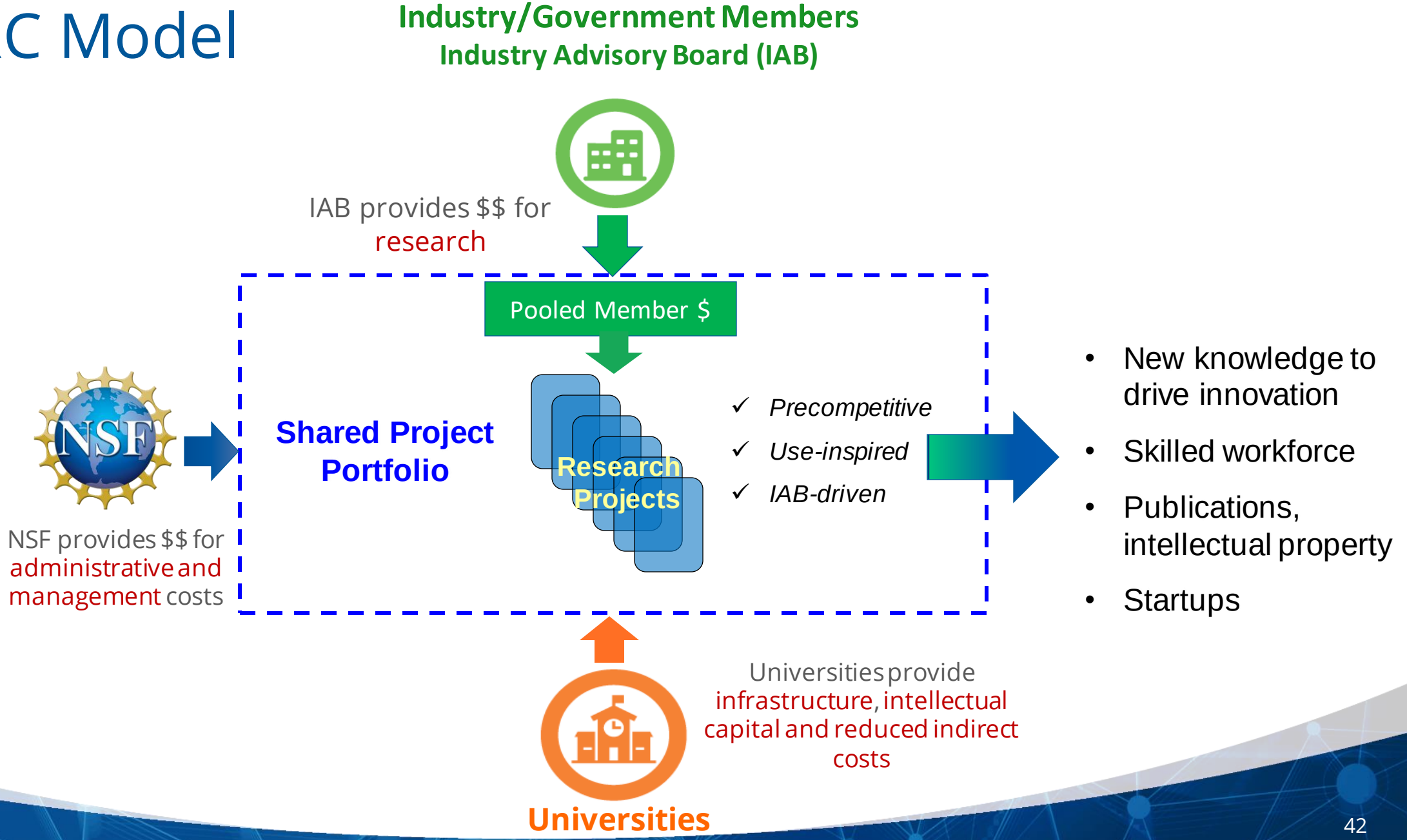
Center for Advanced Semiconductor Chips with Accelerated Performance (ASAP), University of Illinois at Urbana-Champaign



Center for Quantum Technologies, Purdue University, Indiana University, and University of Notre Dame

Center for Soil Technologies, University of Southern California, Iowa State, University of Connecticut, and University of Washington

IUCRC Model


Industry/Government Members
Industry Advisory Board (IAB)
IAB provides $$ for research
Pooled Member $
NSF
NSF provides $$ for administrative and management costs
Shared Project Portfolio
Research Projects
✓ Precompetitive
✓ Use-inspired
✓ IAB-driven
Universities provide infrastructure, intellectual capital and reduced indirect costs
Universities
• New knowledge to drive innovation
• Skilled workforce
• Publications, intellectual property
• Startups

An IUCRC example:
AMBIC: Advanced Mammalian Biomanufacturing Center

The mission of AMBIC is to develop enabling technologies, knowledge, design tools and methods that apply and integrate genome-based and systems technologies to fast-track upstream biomanufacturing processes and advances

Universities Involved

Johns Hopkins University

University of Delaware

Clemson University

UMass Lowell

University of Maryland

Annually
NSF: $750K
Members: ~$1.8 M

Center Members

908devices, abbvie, Agilent, Amgen, apc, Biogen, Boehringer Ingelheim, Bristol Myers Squibb, AstraZeneca, KBI Biopharma, Lonza, ucb, Merck, Genentech, ThermoFisher Scientific, Janssen, Regeneron, Takeda, Sanofi, Lilly, gsk, Evonik, Pfizer, NIST, MilliporeSigma, Asimov, FUJIFILM Diosynth biotechnologies, REGENXBIO, Sartorius, Incyte, cytiva, Daiichi-Sankyo, WuXi Biologics Global Solution Provider

NSF

A few key takeaway messages…

- **Learn** about what has been funded in your area of interest: **nsf.gov/awardsearch**
- **Explore** open opportunities **nsf.gov/funding**
- **Contact** the program director early and seek input.
  - Read funding announcements and start with an introductory email with a succinct description of your need for NSF support
- **Contribute** your knowledge and expertise as a Reviewer
- **Share** your suggestions for new initiatives/programs that NSF should consider

Volunteer to Review ENG Proposals!

- Learn about leading-edge work
- Understand NSF merit review
- Network with other experts
- Serve the STEM community

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nsf.gov/news

Connect with the Engineering Directorate!

www.nsf.gov/eng/connect.jsp

We seek to Transform our world for a better tomorrow!

by driving discovery, inspiring innovation, enriching education, and accelerating access

- Propel transformational engineering impact
- Expand opportunities for people
- Catalyze purposeful partnerships

Thank you!

Prakash G. Balan, pbalan@nsf.gov