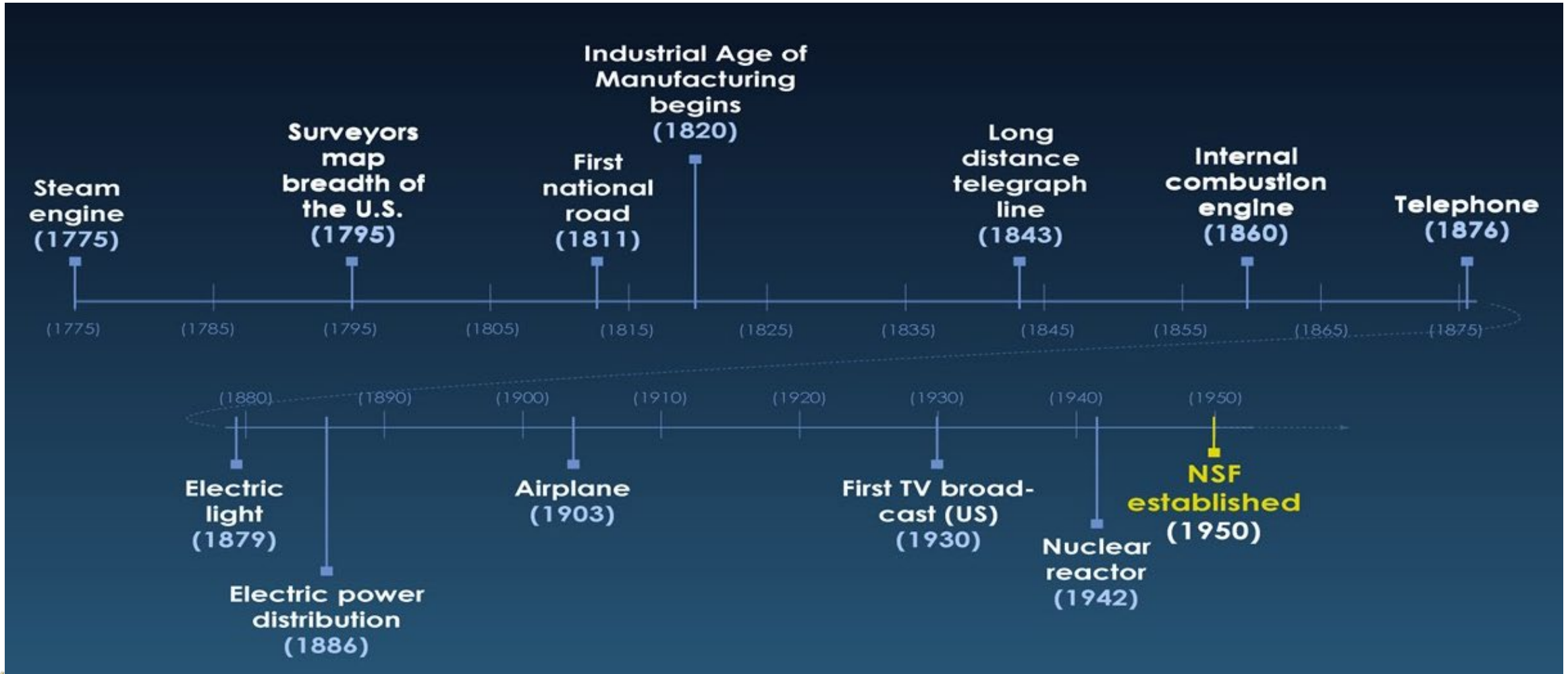


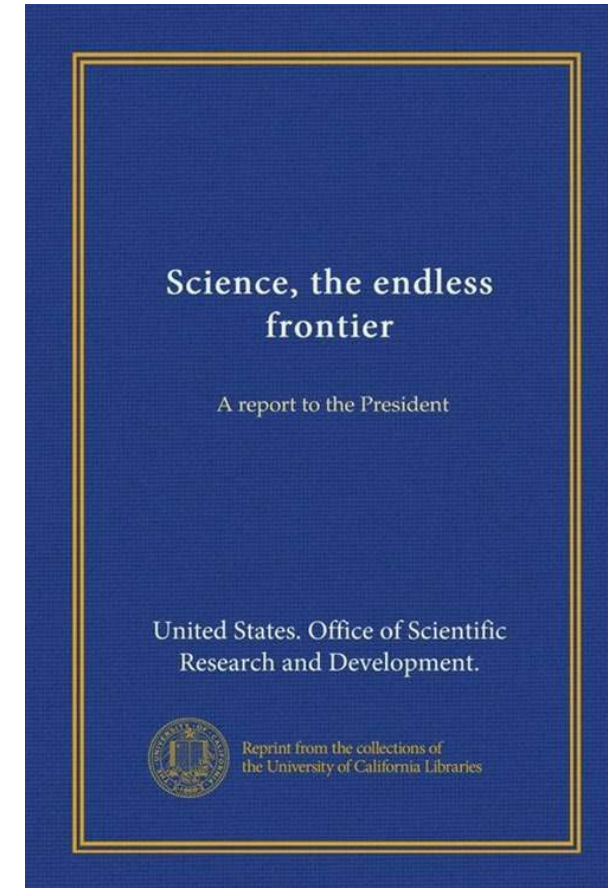
Division of Engineering Education and Centers (EEC): A Journey

Dr. José L. Zayas-Castro
Division Director



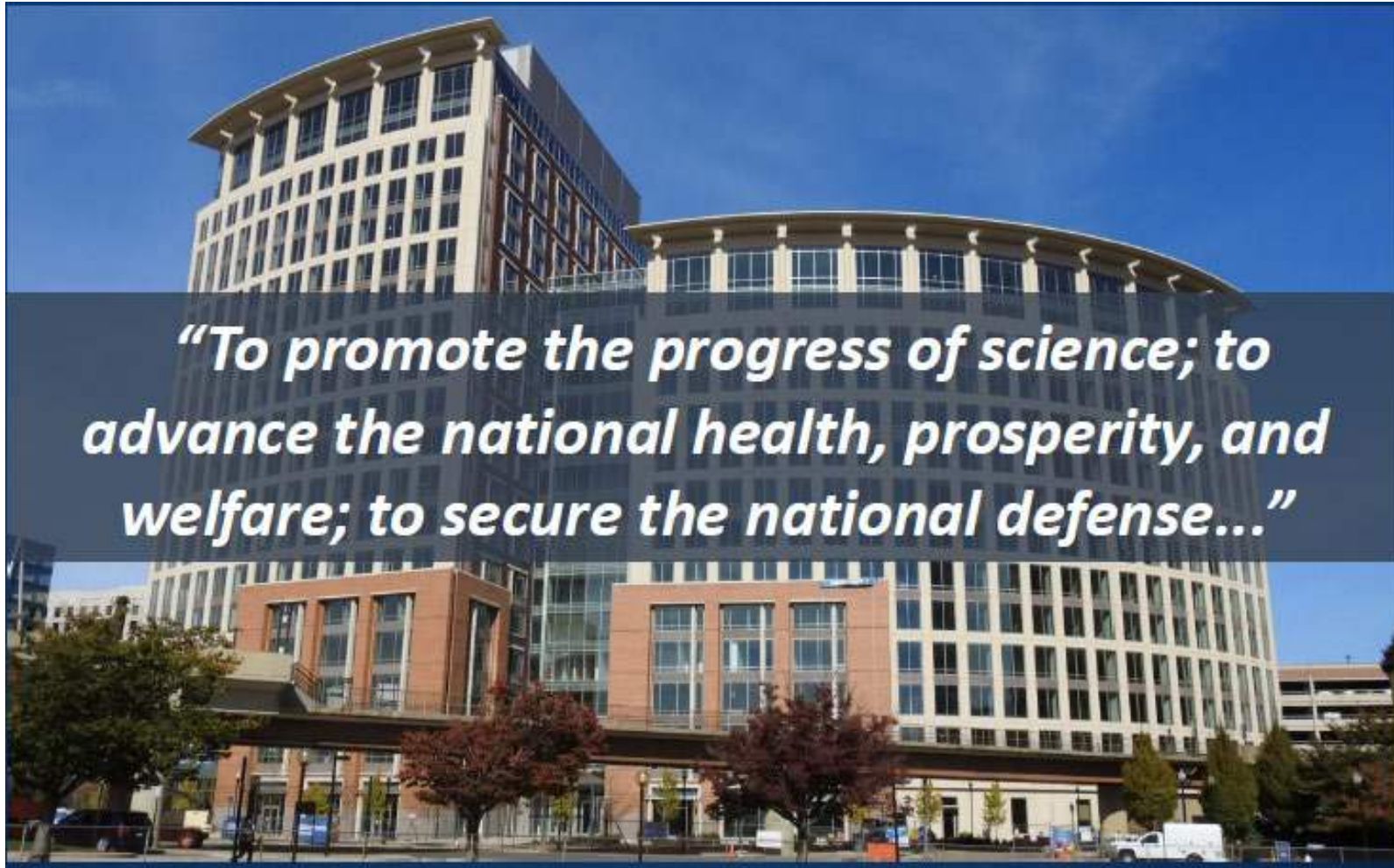
Milestones in US Engineering — Achievements

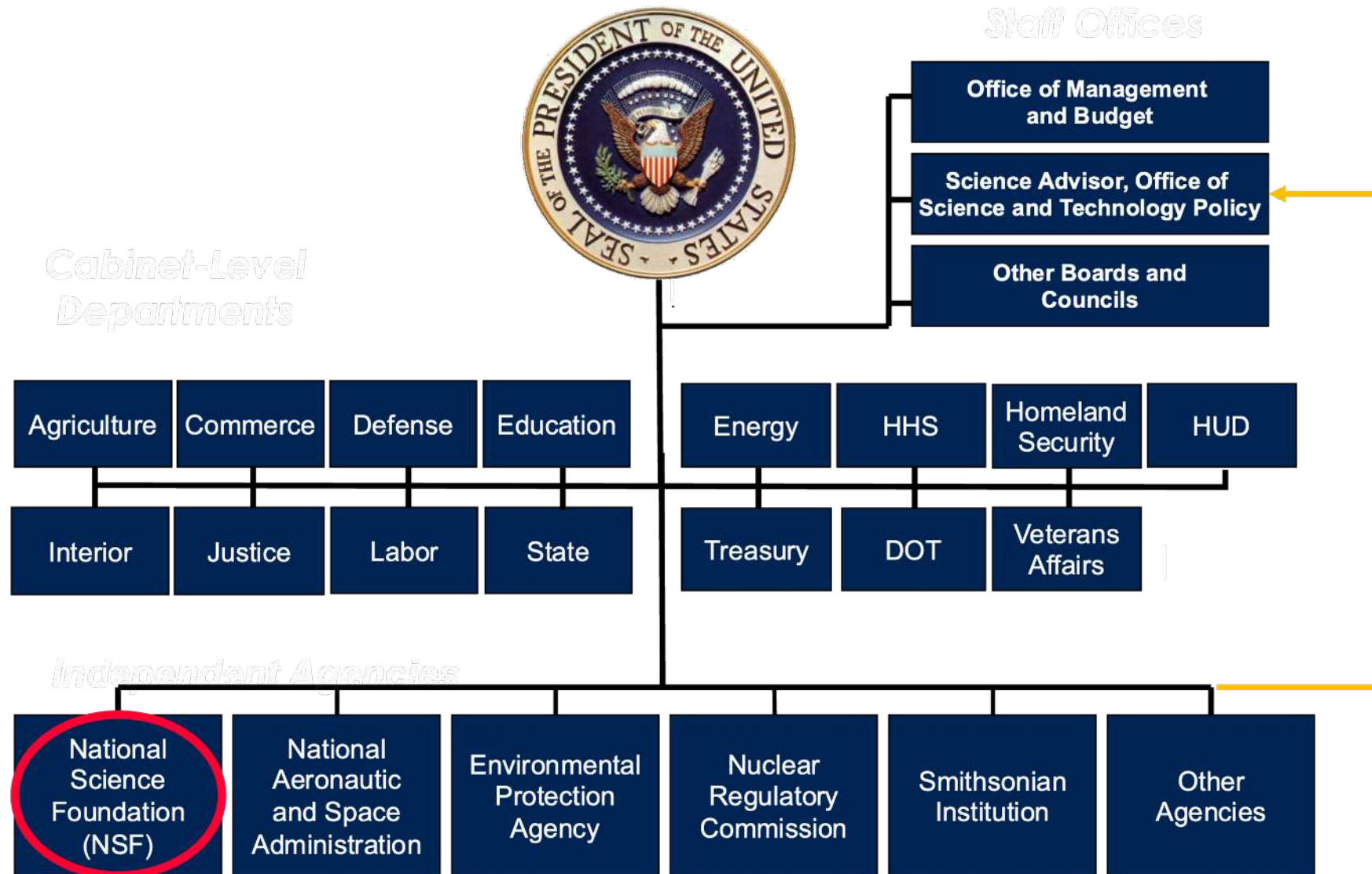




Science offers a largely unexplored hinterland for the pioneer who has the tools for his task. The rewards of such exploration both for the Nation and the individual are great. Scientific progress is one essential key to our security as a nation, to our better health, to more jobs, to a higher standard of living, and to our cultural progress.

National Science Foundation Mission (est. 1950)





What We Support



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



Breadth: Single discipline through convergence research



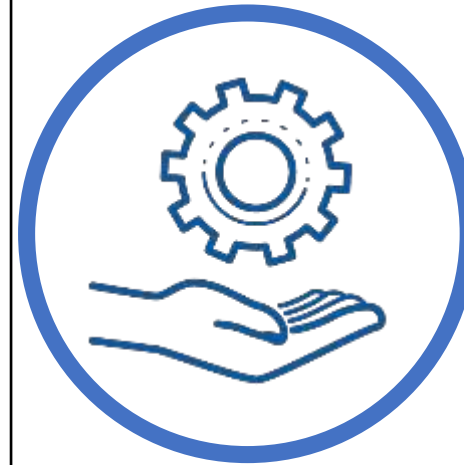
Career stage: Undergraduate to grad to postdoc to early to middle to later career



Innovation cycle: Basic research through translational research



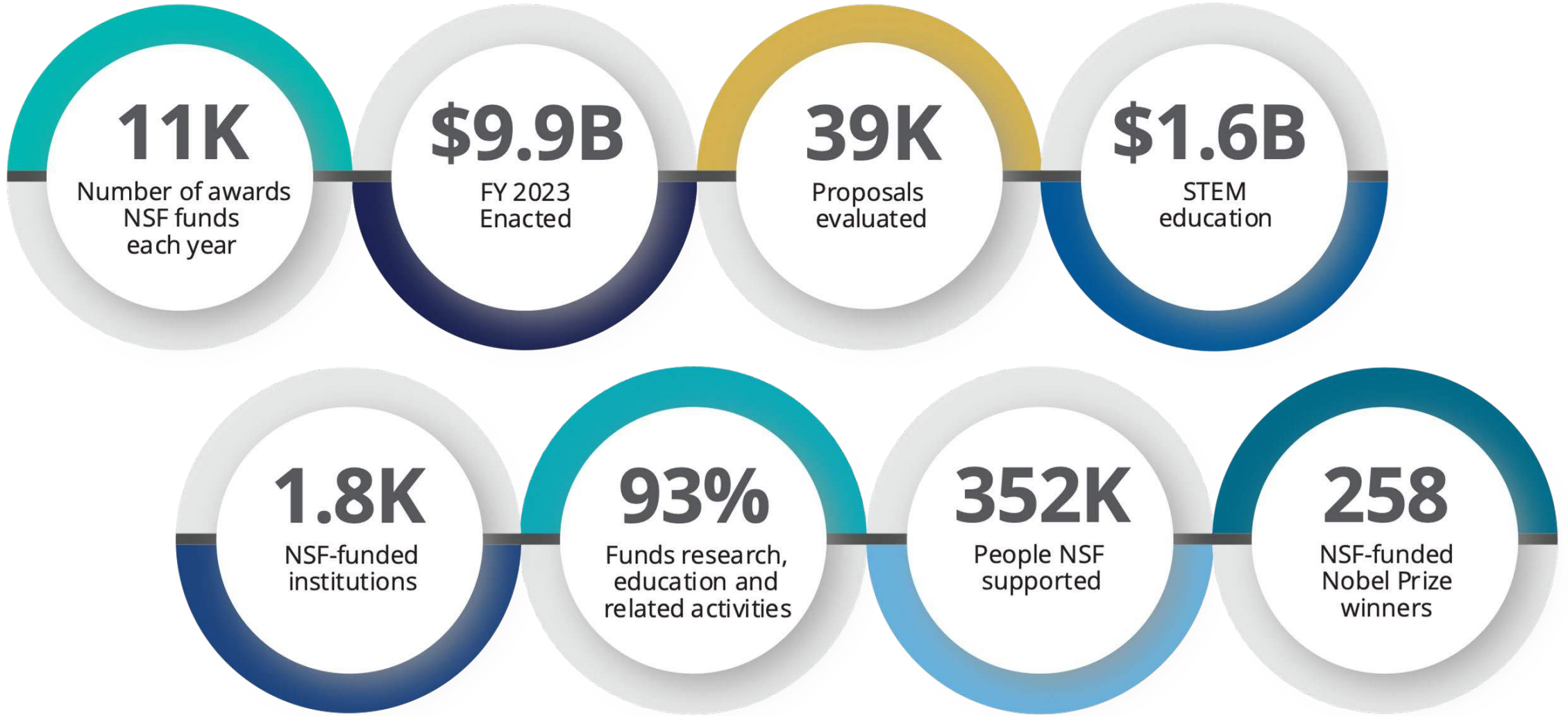
**CURIOSITY-DRIVEN
DISCOVERY-BASED
EXPLORATIONS**



**USE-INSPIRED,
SOLUTIONS-FOCUSED
INNOVATIONS**



NSF by the Numbers



NSF's MAJOR PRIORITIES



STRENGTHENING
ESTABLISHED NSF



INSPIRING
MISSING MILLIONS



ACCELERATING TECHNOLOGY
AND INNOVATION

Advance Emerging Industries for National and Economic Security

Build a Resilient Planet

Create Opportunities Everywhere

Strengthen Research Infrastructure

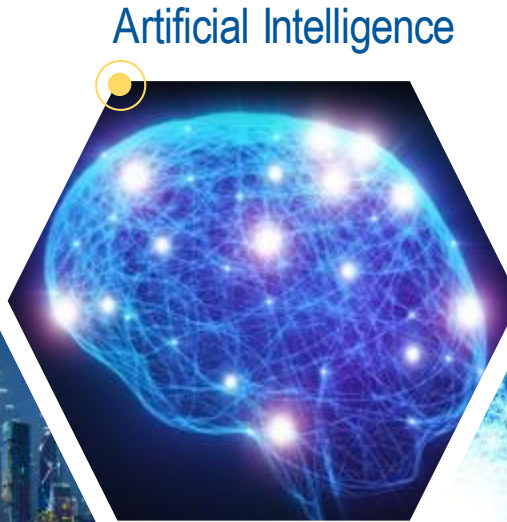
Emerging Industries



Advanced
Manufacturing



Advanced
Wireless



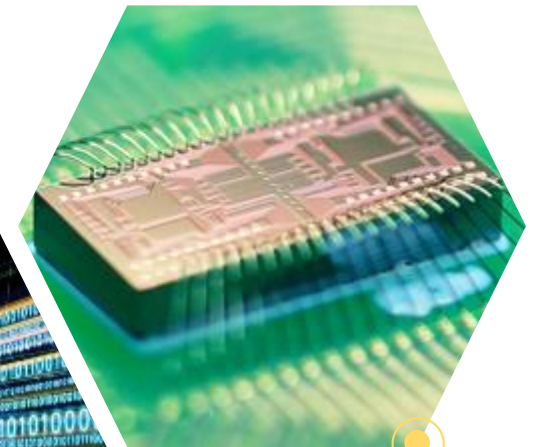
Artificial Intelligence



Biotechnology



Quantum Information
Technology



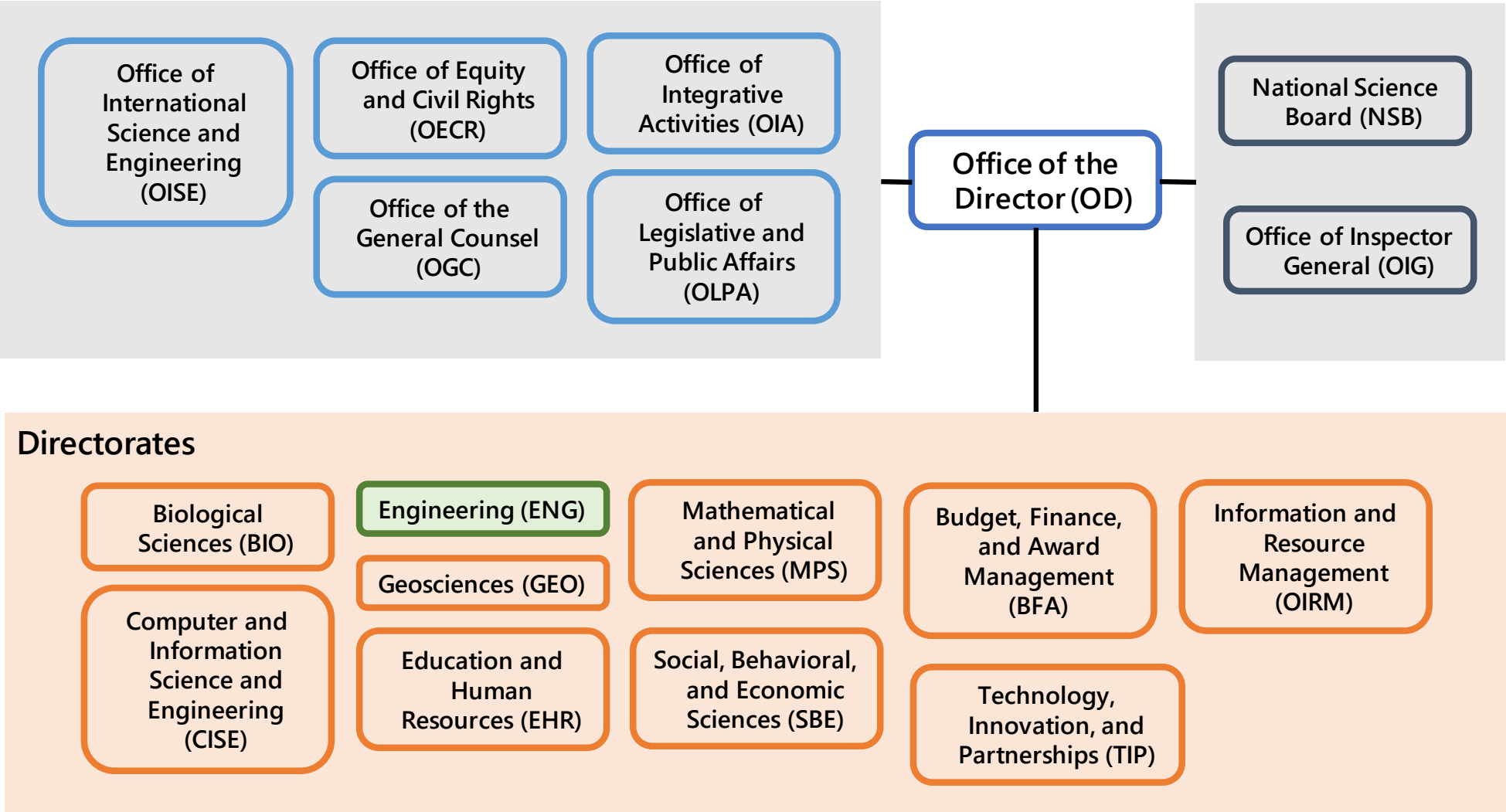
Semiconductors and
Microelectronics

NSF's Eight Research Directorates

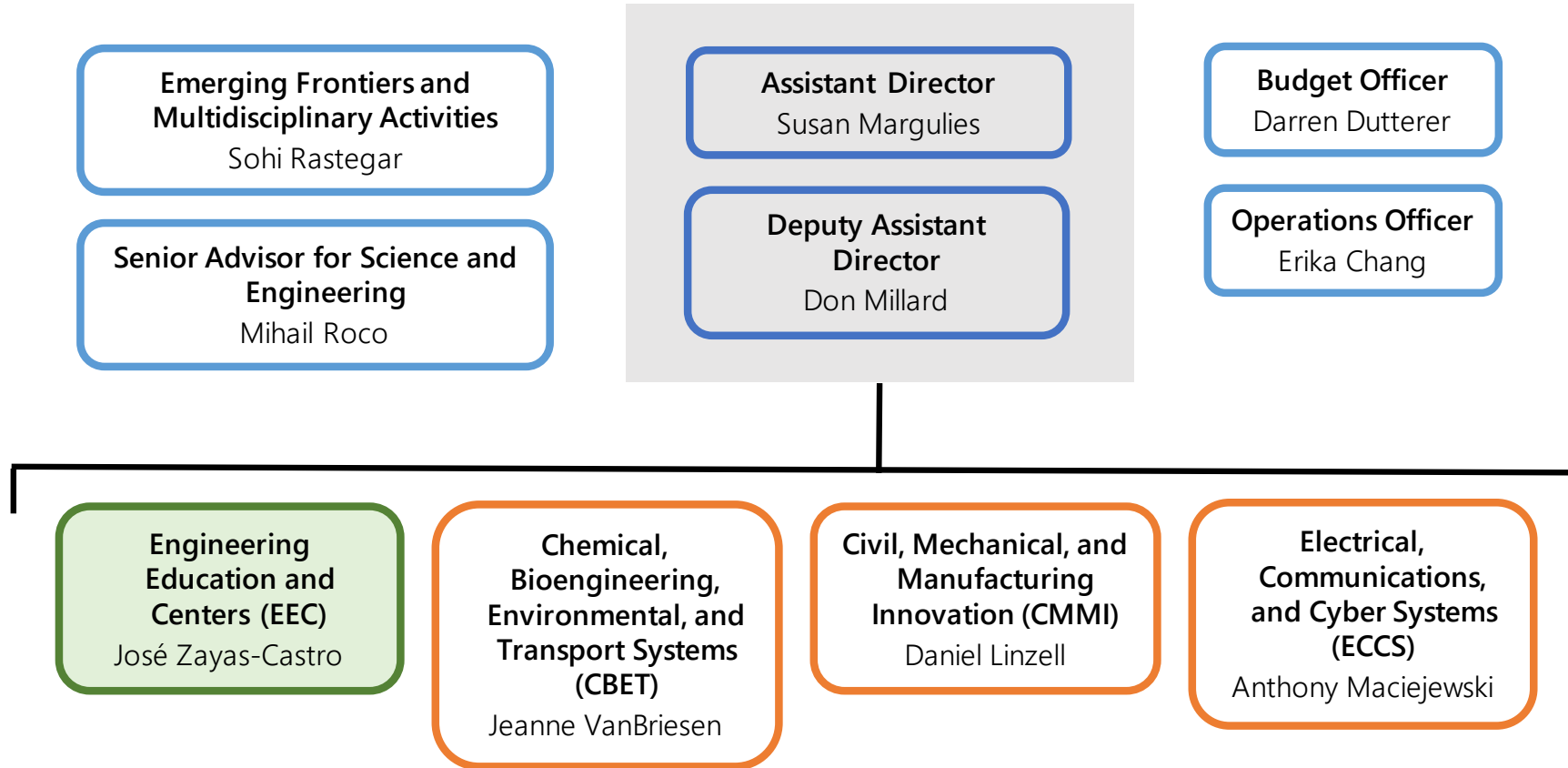


TECHNOLOGY, INNOVATION AND PARTNERSHIPS (TIP)

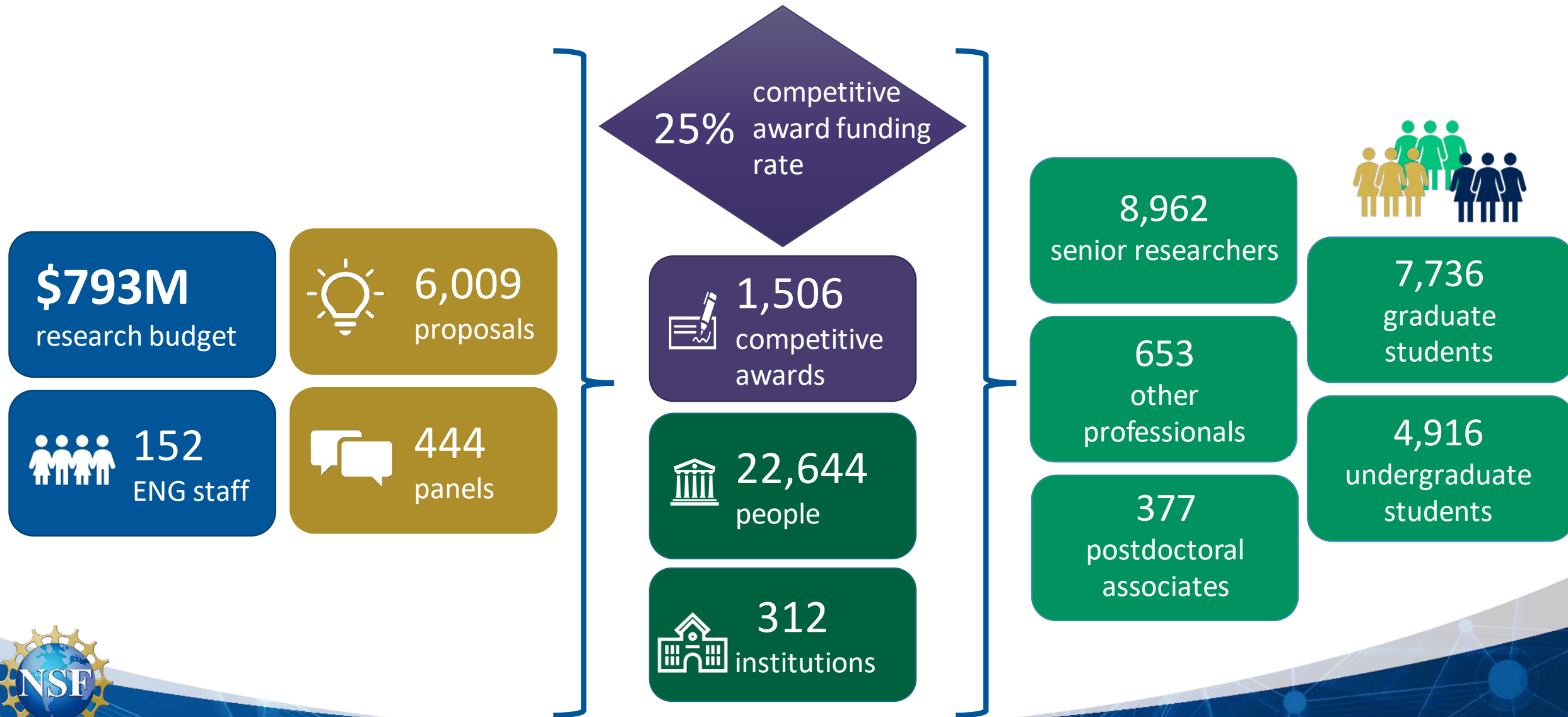
NSF Organizational Chart



NSF Directorate for Engineering



ENG by the Numbers: FY 2023



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

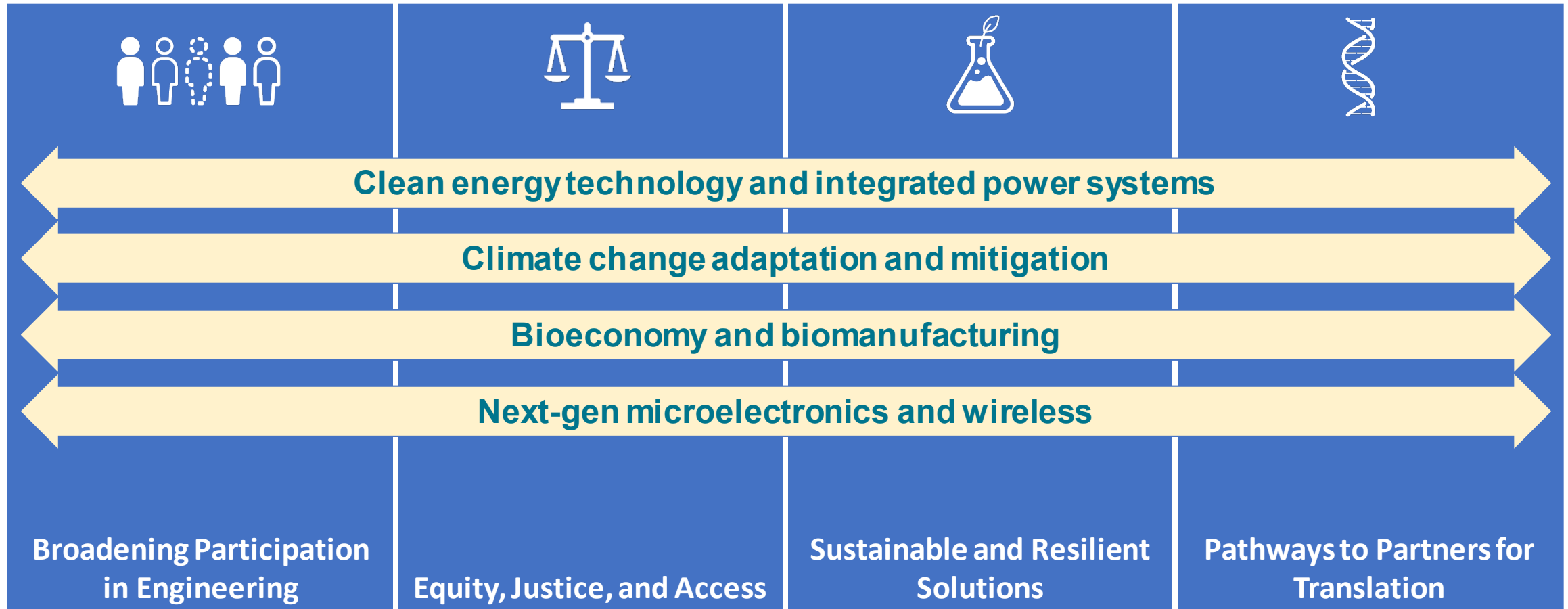
opportunities for people

Catalyze

purposeful partnerships



Investing in Cross-ENG Strategic Priorities



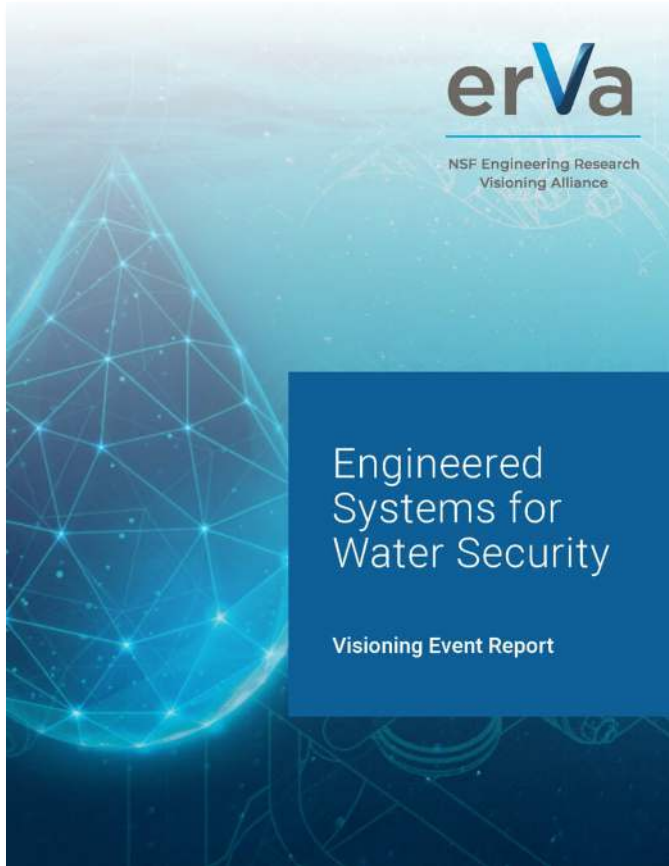
Coordinate

Collaborate

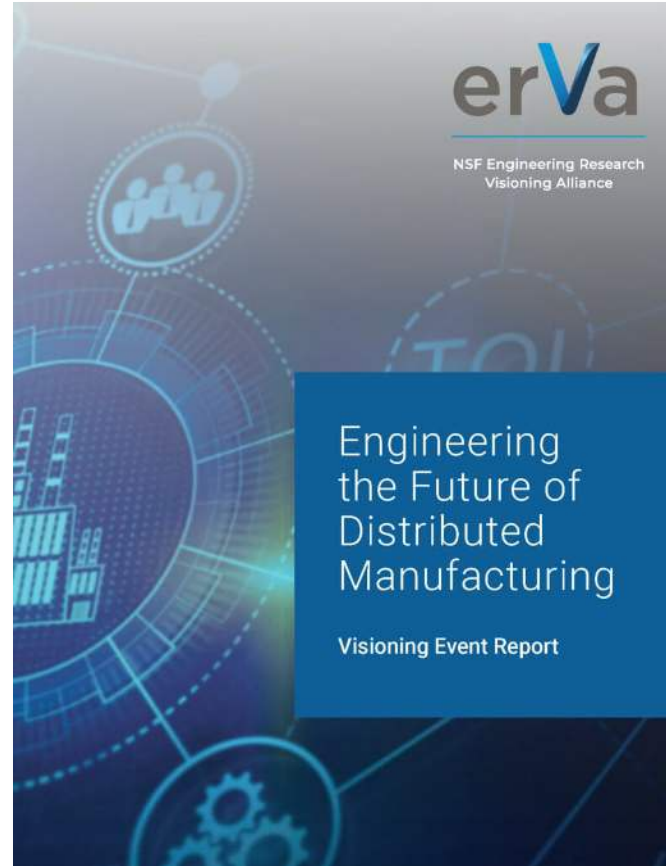
Co-fund



Engineering Research Visioning Alliance



July 2023



October 2023

**Transforming Women's Health
Outcomes through Engineering**

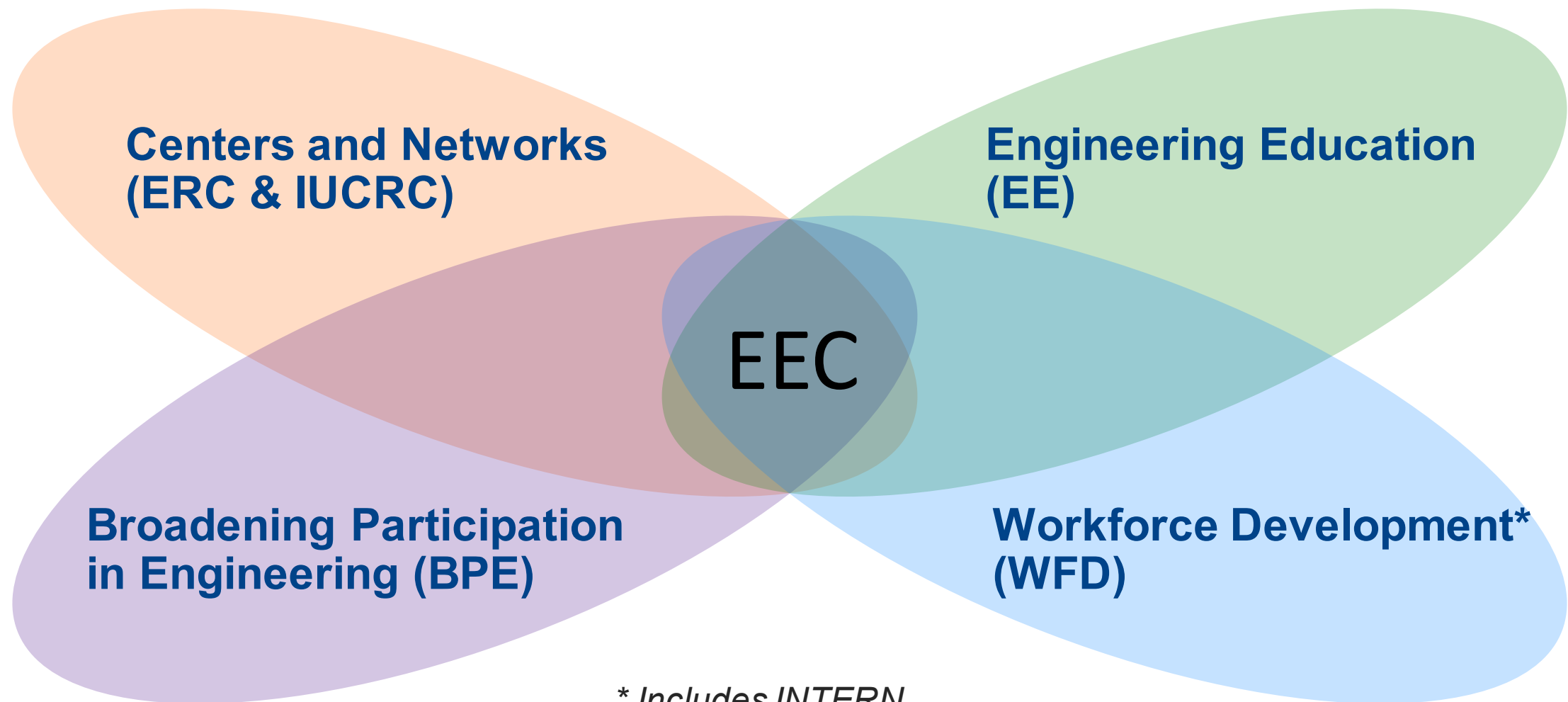
Visioning Event
June 5-6, 2024
Columbus, OH

www.ervacommunity.org





Engineering Education and Centers (EEC): Four Intertwined and Interdependent Clusters



Division of Engineering Education and Centers (EEC)

We invest in the creation of 21st century engineers and discovery of technologies through **transformational center-based research**, research in **education** and **broadening participation** and **workforce development** in engineering.

For more info about EEC, visit:
<https://www.nsf.gov/eng/eec/about.jsp>



Centers & Networks (Centers)

- Discover and launch ubiquitous future technologies (ERC)
- Prepare next generation innovation leaders (ERC & IUCRC)
- Basic research of shared interest to academia and industry (IUCRC)



Engineering Education (Eng. Ed.)

- Fundamental research in the formation of engineers (RFE, RIEF)
- Translation of fundamental research into practice (RED)



Workforce Development (WD)

- Builds human capital through research experiences - undergraduates (REU), teachers (RET), veterans (REV)
- Teach Eng., E4USA, REU/RET mega site, INTERN

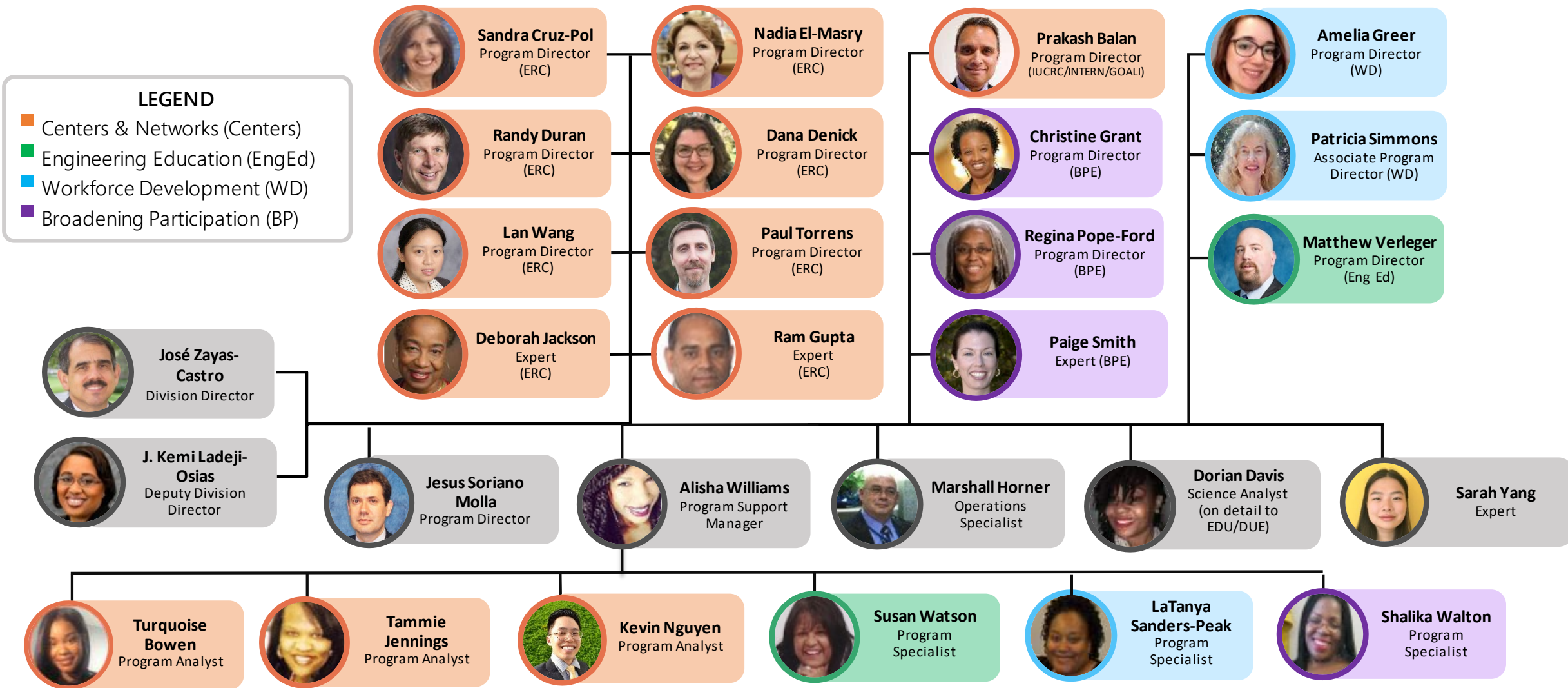


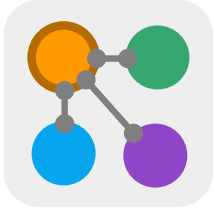
Broadening Participation in Eng. (BPE)

- Improve preparation, increase participation, and ensure contributions of underrepresented groups in engineering
- NSF INCLUDES



Division of Engineering Education and Centers





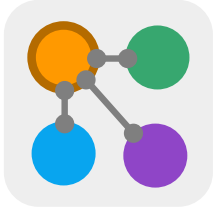
Engineering Research Centers (ERC) Program

Originally launched in 1984 based largely on guidelines proposed by the NAE (1983), and updated to Gen-4 in 2019 (NSF 19-503)

Goals:

- Perform transformative research
- Prepare the next generation of leaders
- Strengthen the competitiveness of the U.S.

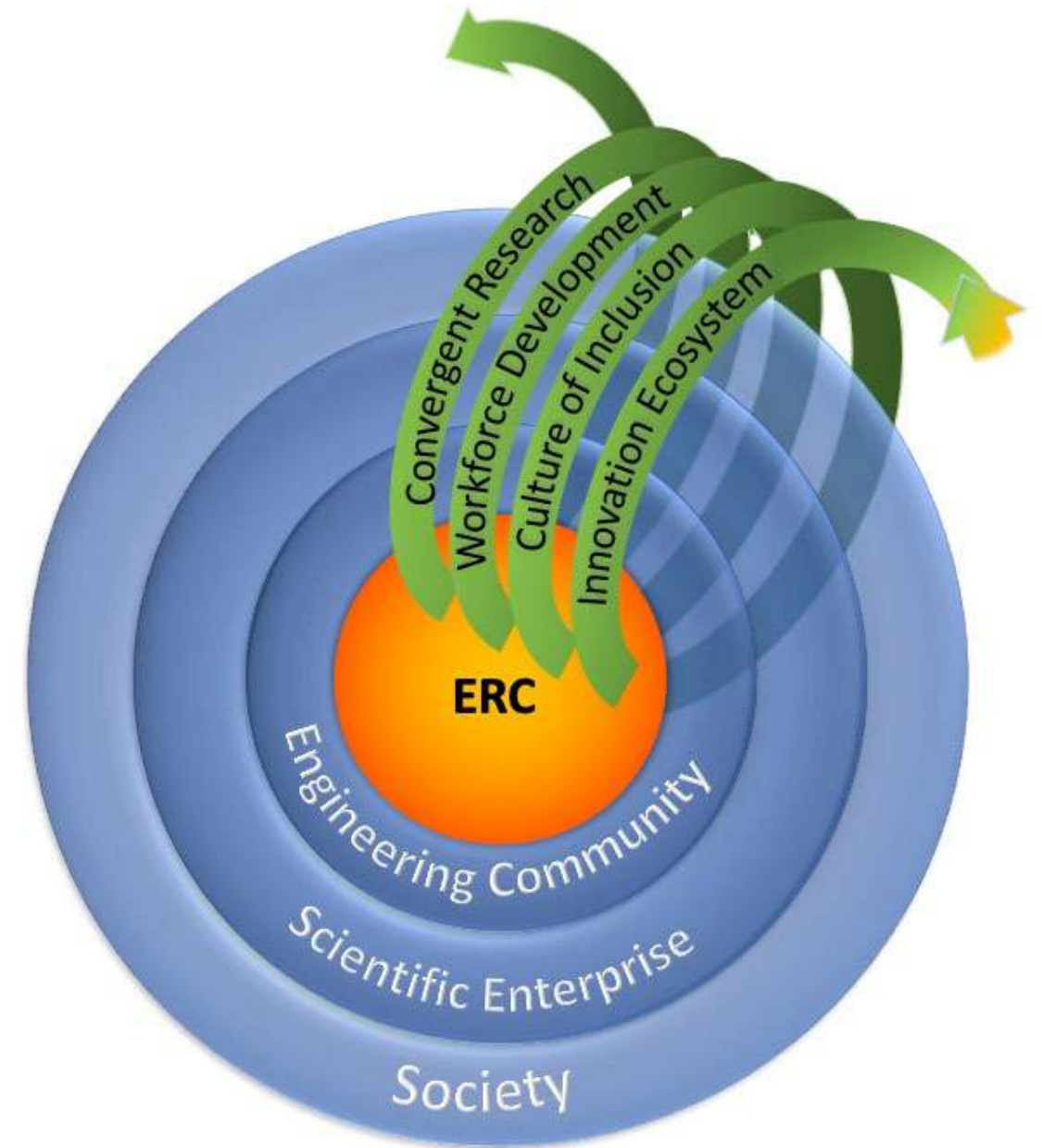


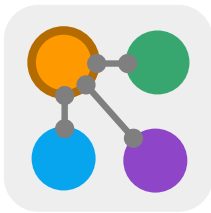


Gen-4 ERC

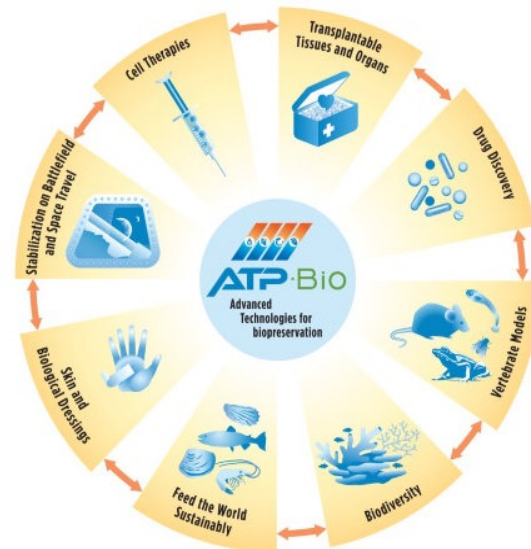
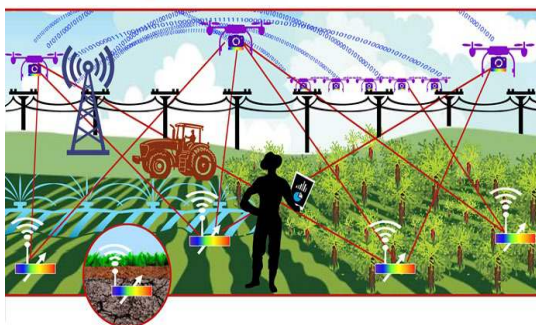
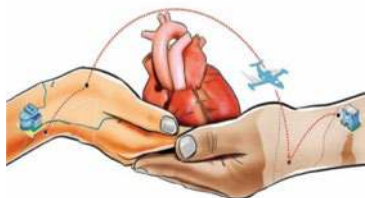
Four interconnected **foundational components**:

- Convergent Research
- Workforce Development
- Culture of Inclusion
- Innovation Ecosystem



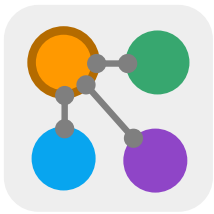


Current Gen-4 ERCs



FY 2020

- **Advancing Sustainability through Powered Infrastructure for Roadway Electrification (ASPIRE)** - Create sustainable, equitable and widespread electrification of vehicles by creating low-cost, ubiquitous, and worry-free charging infrastructure.
- **Advanced Technologies for Preservation of Biological Systems (ATP-Bio)** - Stop biological time - cryogenically cool, hold and re-warm living materials (cells, tissues, organs and whole organisms), extend ability to bank and transport
- **Center for Quantum Networks (CQN)** - Create foundations for the future quantum internet by developing key quantum technologies and new functional building blocks connecting quantum processors over local and global scales.
- **Internet of Things for Precision Agriculture (IoT4Ag)** - Ensure food, energy and water security with new systems to increase crop production while minimizing energy and water use and environmental impacts of agricultural practices.



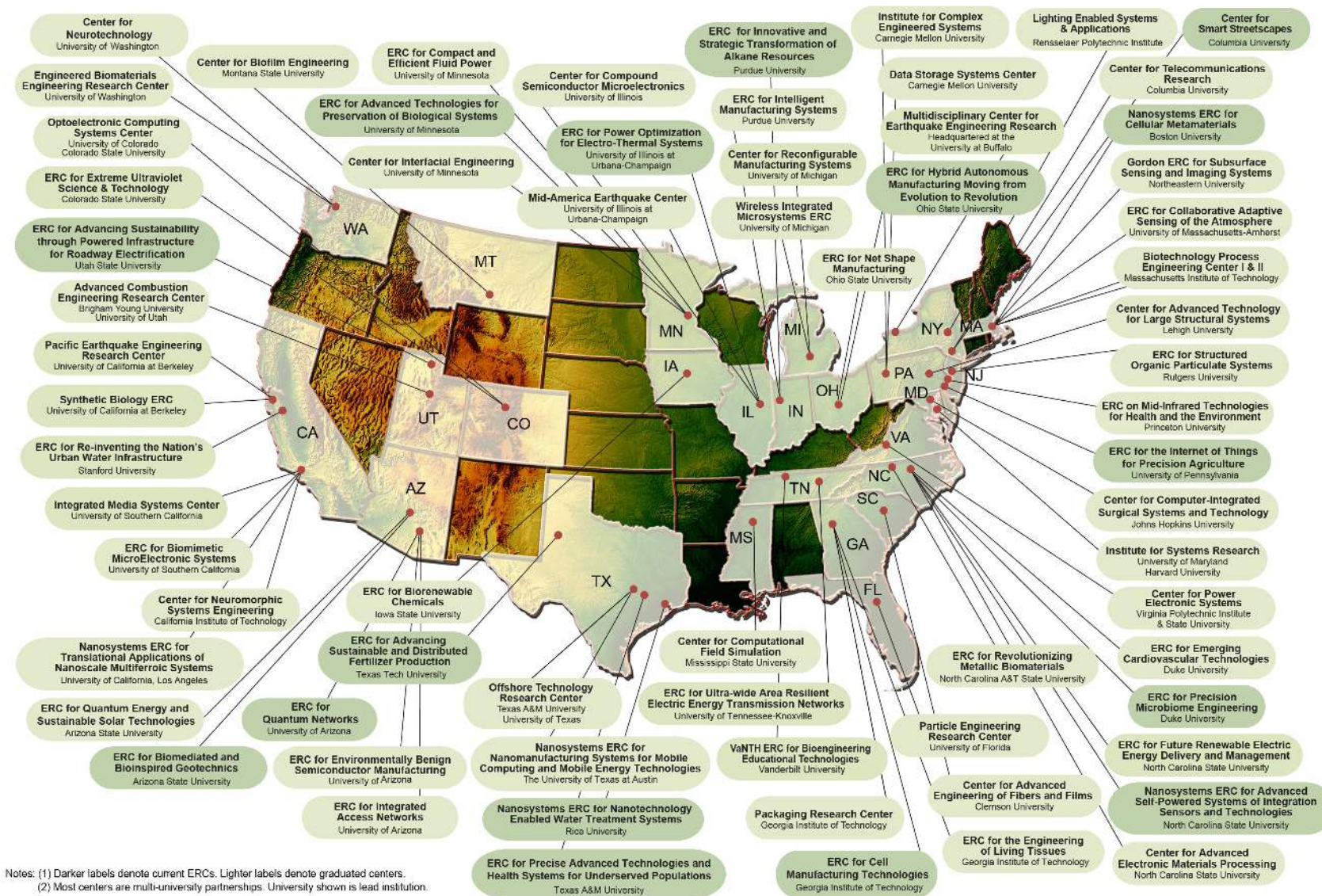
New Gen-4 ERCs



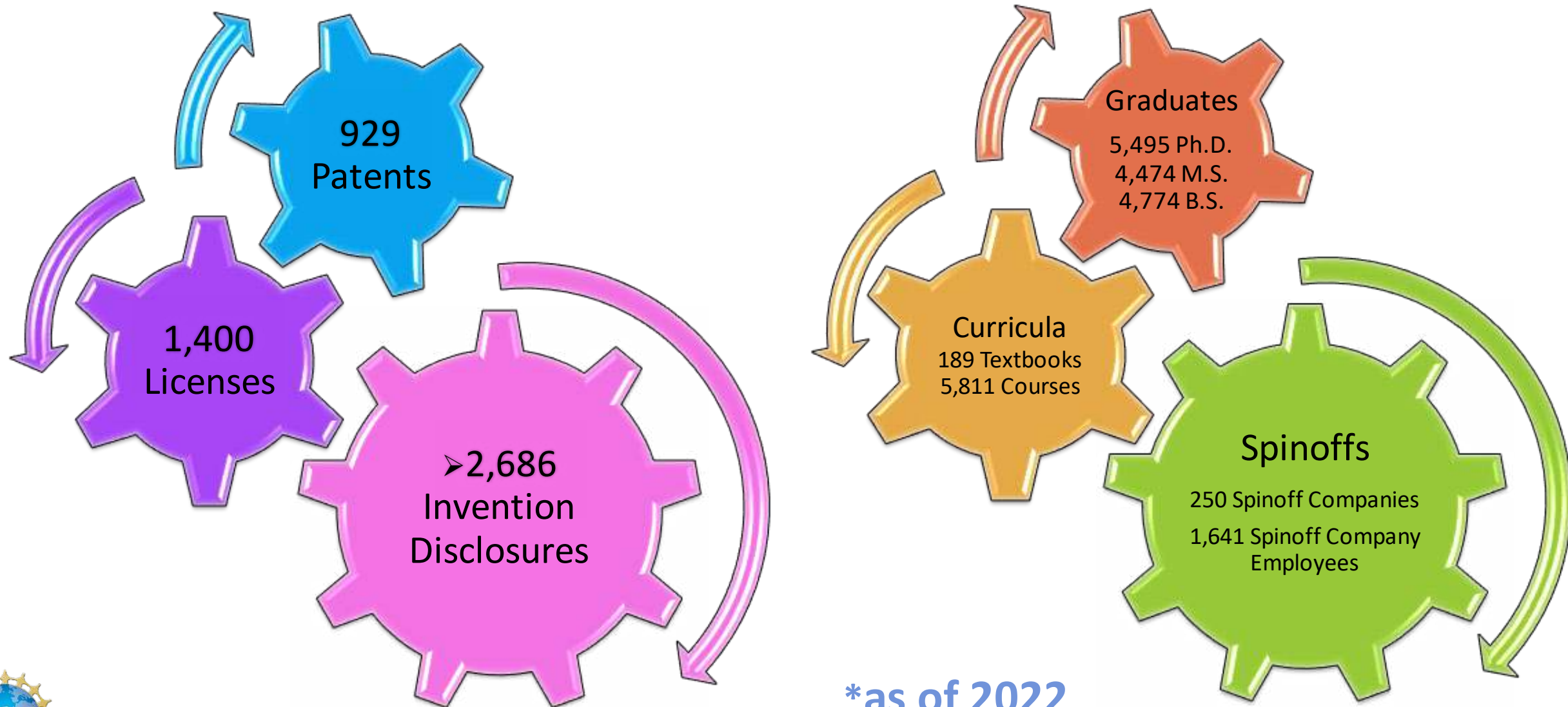
FY 2022

- **Center for Advancing Sustainable and Distributed Fertilizer Production (CASFER)** – Enabling resilient and sustainable food production by developing next generation, modular, distributed, and efficient technology for capturing, recycling, and producing decarbonized nitrogen-based fertilizers (NBFs).
- **Center for Smart Streetscapes (CS3)** - Advance livable, safe, and inclusive communities through real-time, hyperlocal streetscape applications
- **Hybrid Autonomous Manufacturing Moving from Evolution to Revolution (HAMMER)** - Accelerating the development and deployment of intelligent, autonomous manufacturing systems, enabling mass customization in local production facilities.
- **Precision Microbiome Engineering (PreMiEr)** - Creating microbiome technologies that address challenges at the interface of human health and the built environment, promoting the proliferation of beneficial microorganisms and preventing colonization by infectious agents.

NSF Engineering Research Centers, 1985-2023

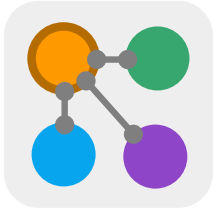


ERC Program Achievements since 1985*



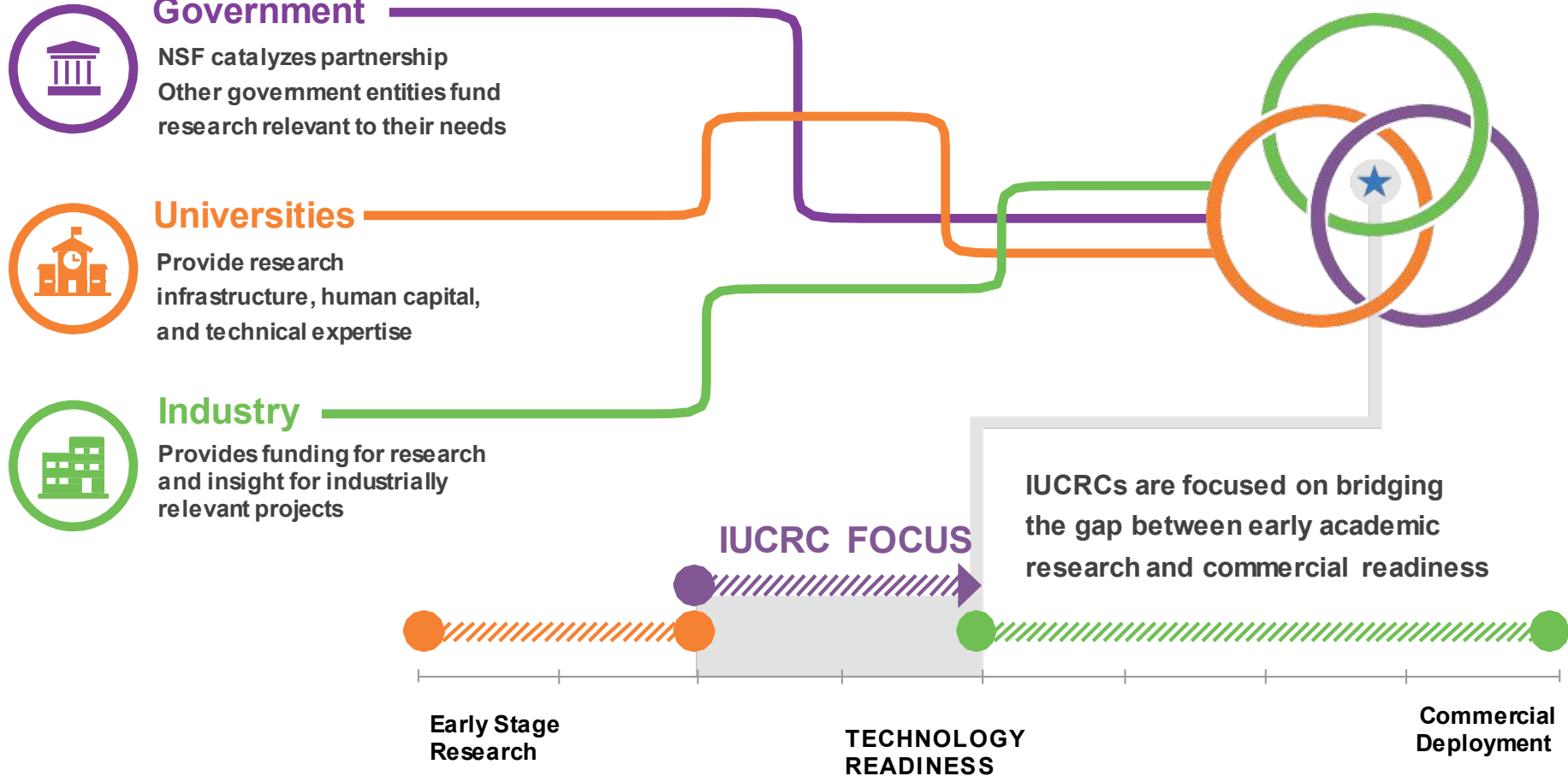
*as of 2022

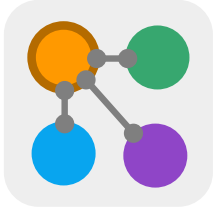




Industry-University Research Partnerships (IUCRC) Program

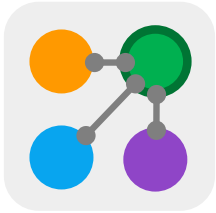
Execute cutting-edge pre-competitive basic research in science and engineering to drive innovation and societal impact (NSF 20-570).





Gen-4 ERC Distinguishing Features

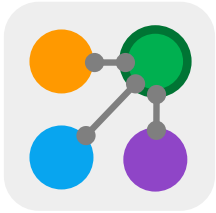
- **Engineering systems** focus
- 10-year strategic plan to overcome fundamental technical barriers
- Faculty committed to **convergent research**, multi-institutional/multi-disciplinary team
- Emphasis on **societal impact**



Engineering Education Programs

- Research in the Formation of Engineers (RFE), [PD 19-1340](#)
- Research Initiation in Engineering Formation (RIEF), [NSF 20-558](#)
- Revolutionizing Engineering Departments (RED), [NSF 23-553](#)
- CAREER in Engineering Education





Overview of EEC Engineering Education

- Encourages **educational research** to create and support an **innovative and inclusive technical workforce** for the future.
- Supports research that advances our understanding of **how people become engineers**, explores **diverse pathways to and through degree programs**, and examines **how changes in engineering education spread**.
- **Funding Mechanisms:**
 - Unsolicited Research
 - CAREER
 - Conferences & Workshops
 - EARly-concept Grants for Exploratory Research (EAGER)
 - Rapid Response Research (RAPID)

Professional Formation of Engineers

Introductions to the profession at any age

Development of deep technical and professional KSAs in both formal and informal settings

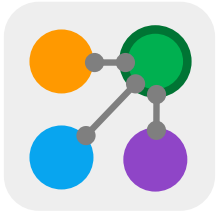
Development of outlooks, perspectives, ways of thinking, knowing, and doing

Development of identity as an engineer and its intersection with other identities

Acculturation to the profession, its standards, and norms



**PFE: the formal and informal processes and value systems by which people become engineers.*



Revolutionizing Engineering Departments (RED)

Track 1

RED Innovation
projects develop new, revolutionary approaches and change strategies.

Track 2

RED Adaptation and Innovation projects adapt and implement evidence-based organizational change strategies.

Track 3

RED 2-Year projects develop radically new approaches among multiple two-year institutions to expand pathways to engineering.



Developing Changemaking Engineers (1519453)

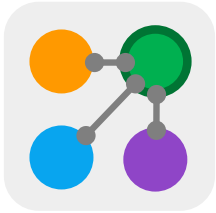
- Focused efforts on connecting social to technical by creating 5 new courses and modules to embed social context traditional engineering courses
- Challenges include defining engineering, incorporating sociotechnical, and changing culture



Innovation Beyond Accommodation: Leveraging Neurodiversity for Engineering Innovation (1920761)

- Focused efforts on moving beyond limitations of traditional engineering education by creating a radically inclusive department
- Advance personalized learning, increase recruitment and retention of neurodivergent students, improve learning outcomes, and leverage potential for breakthroughs





RED History

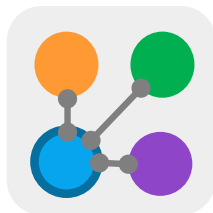
26

Projects funded in
RED history from ENG,
EDU, and CISE

- Common threads across these projects: focus on ***organizational and cultural change*** within the departments, involving students, faculty, staff, and industry in rethinking what it means to provide an engineering program.
- The RED programs are changing department culture and contributing to literature on organizational change - not simply changing curriculum or pedagogy.

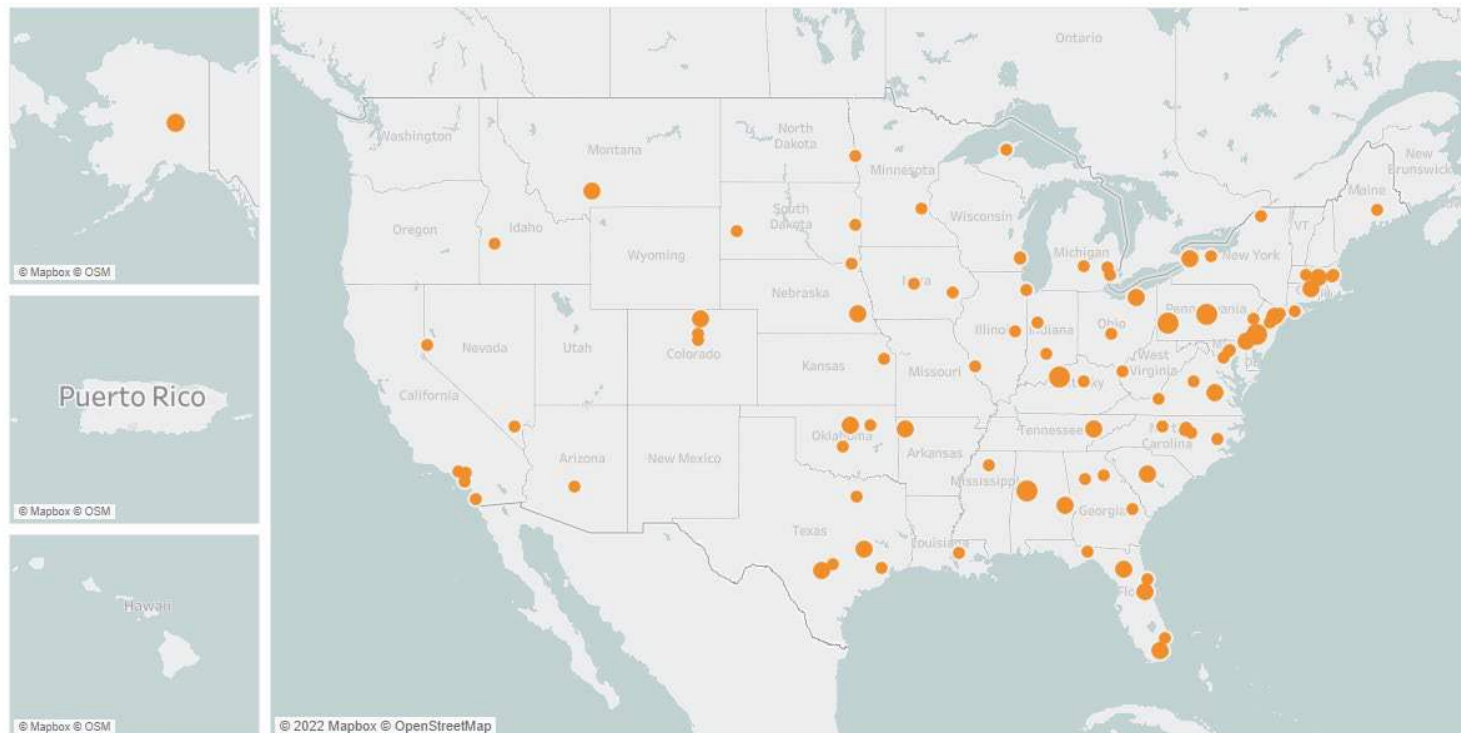


Change doesn't ***start with*** the syllabus, change ***shows up*** in the syllabus.



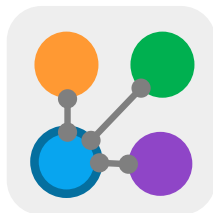
Research Experience for Undergraduates Sites (REU)

- Supports participation of undergraduate students in all research areas supported by ENG
- Encourages pursuit of graduate education
- Promotes integration of research and education
- Develops a diverse and competitive workforce



FY23: **143** active sites in **43** states*

** As of May 1, 2023*



REU Sites Program

The NSF invests ~\$70M per year on the REU sites program across all directorates. **About a fourth** of REU sites are funded in the Engineering Directorate.

NSF

600+ active sites at universities, field stations, observatories, museums, and other research facilities around the United States and abroad

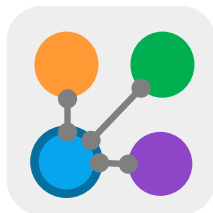
6000+ undergraduate students annually

ENG

143 active sites at 106 institutions

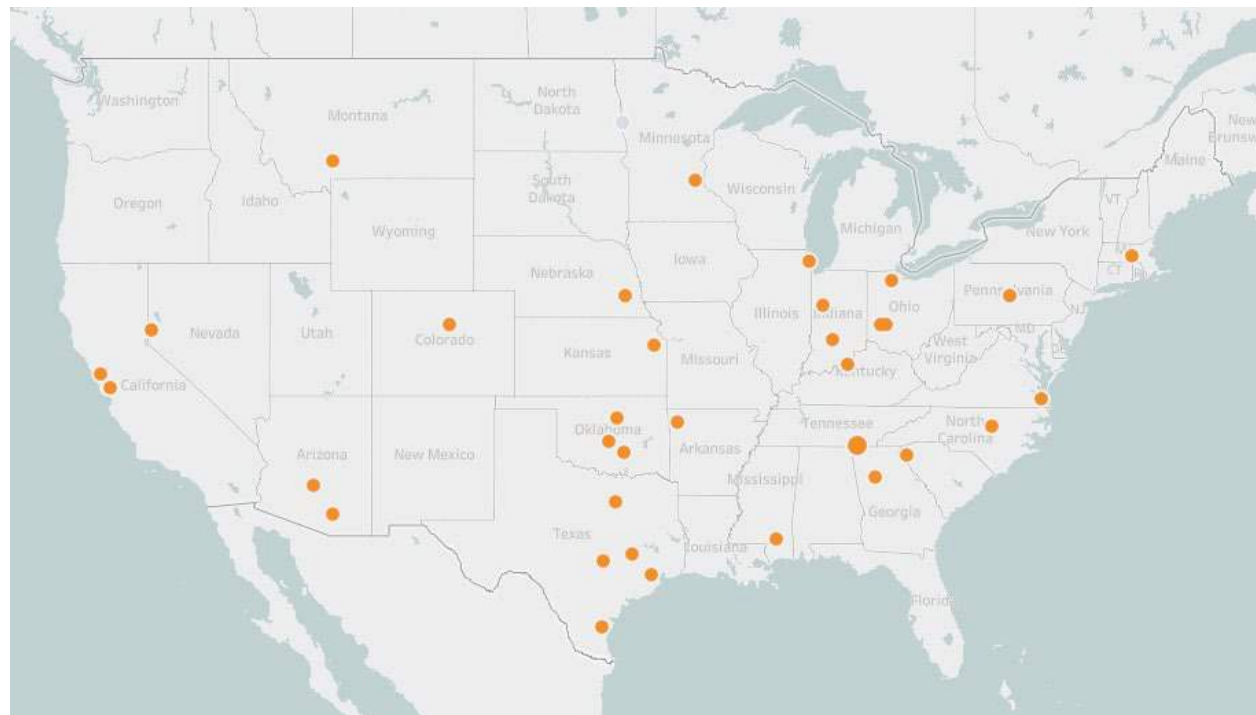
1500+ undergraduate students annually





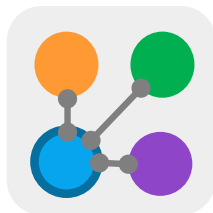
Research Experience for Teachers Sites (RET)

- Supports pre-service, in-service K-12 STEM teachers and community college faculty in ENG research
- Participants translate research experiences into classroom activities
- Facilitates professional development
- Provides instructional opportunities – via grad student mentorship, involvement in K-12 classroom activities



FY23: **44** active sites in **25** states

** As of May 1, 2023*



Research Experience for Teachers (RET) (NSF 21-606)

The RET Program Supports pre-service, in-service K-12 STEM teachers and community college faculty in ENG and CISE research.

- Translation of research experiences into classroom activities
- Grad student professional development through mentorship and involvement in K-12 classroom activities
- Partnerships with Industry to address workforce needs

40 active ENG sites in 25 states, serving **400+ STEM teachers and community college faculty** annually.

Sites

Deadline – Mid-October annually

- Max \$200,000 / year
- 10+ K12 or Community College Faculty / year
- ~6 weeks per summer, 3 years

Supplements

No Deadline – supplements existing awards

- Up to \$10,000 per participant / year
- ~ 1-2 participant / year



INTERN: An early investment in graduate student training and professional development

Building the next generation science and engineering workforce



www.nsf.gov/INTERN

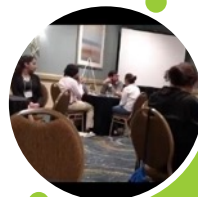




Broadening Participation in Engineering



Transform engineering cultures



Aggressively **recruit** and **retain** tenure track faculty



Innovate **curriculum** and **teaching** approaches



Increase access to engineering



Understand the barriers





Broadening Participation in Engineering (NSF 22-514)

Strengthens the future U.S. engineering workforce by enabling and encouraging the participation of all citizens in the engineering enterprise via 4 tracks

Track 1

Planning and
Conference
Grants

*(no submission
deadline)*

(range 50-100K)

Track 2

Research on
Broadening
Participation in
Engineering

*(no submission
deadline)*

(range 300-400K)

Track 3

Inclusive
Mentoring Hubs
(IMHubs)

NEW!

(range 800K)

Track 4

Centers for
Equity in
Engineering
(CEE)

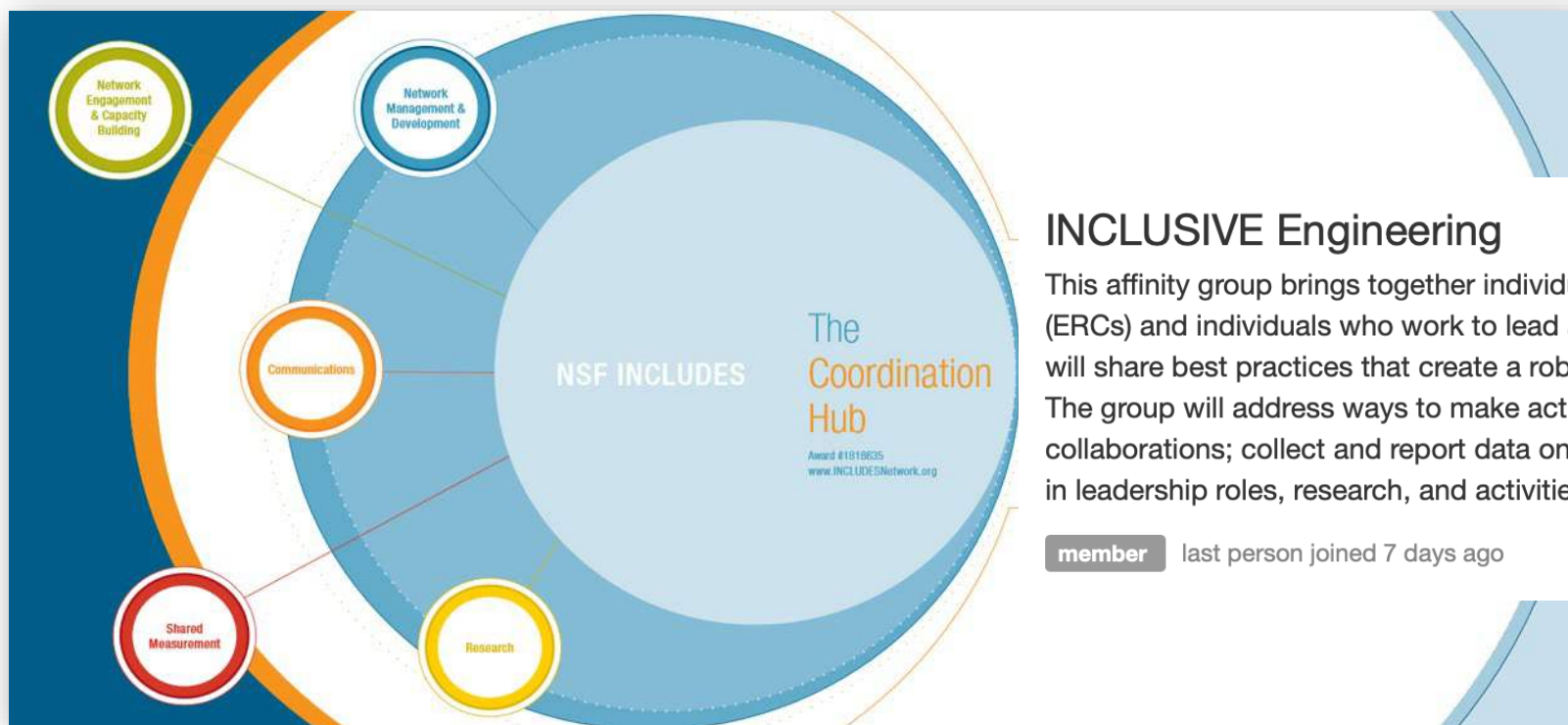
NEW!

(range 1.2 mil)





NSF INCLUDES: Inclusion Across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science



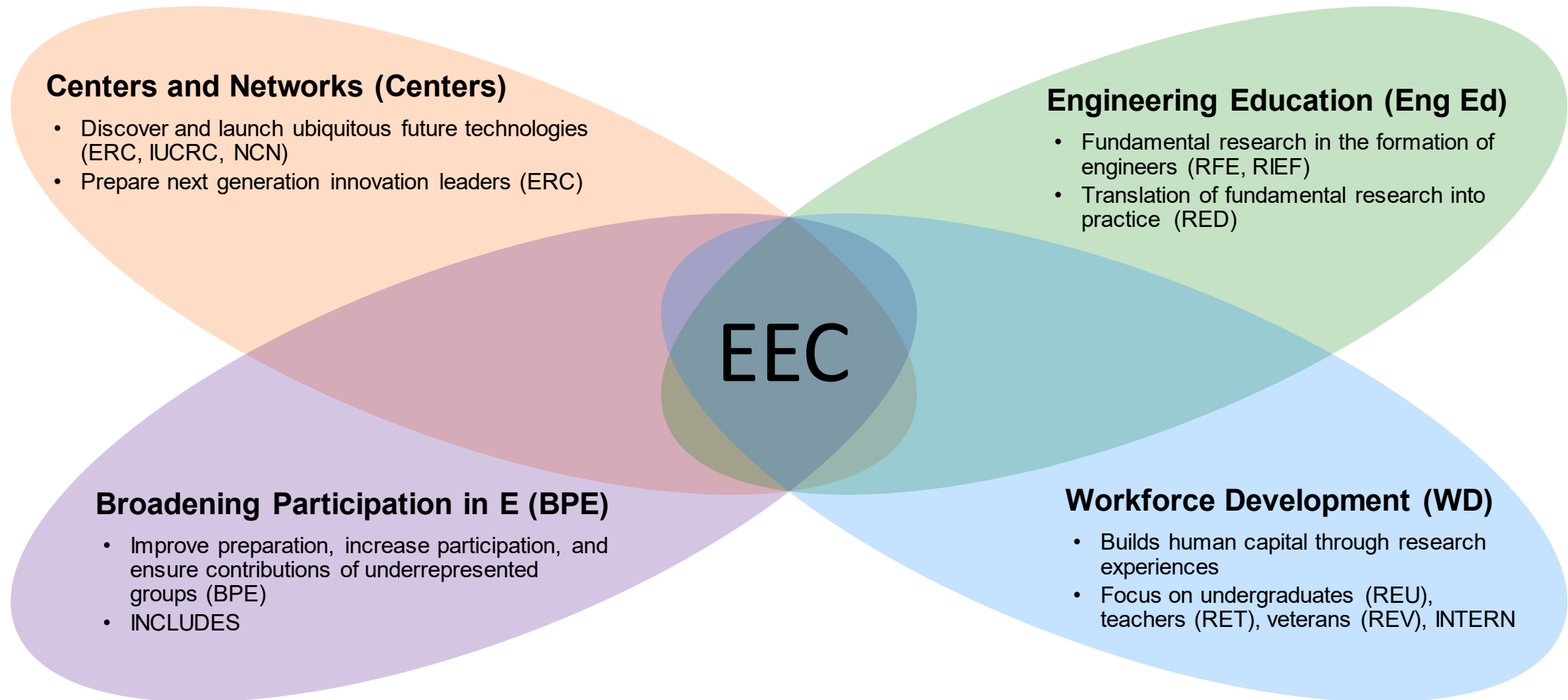
INCLUSIVE Engineering

This affinity group brings together individuals from NSF-funded Engineering Research Centers (ERCs) and individuals who work to lead and support NSF-funded INCLUDES initiatives. Members will share best practices that create a robust culture of inclusion and diversity in both programs. The group will address ways to make activities and resources accessible and inclusive; develop collaborations; collect and report data on diversity; and include people with diverse characteristics in leadership roles, research, and activities.

member last person joined 7 days ago

<https://www.includesnetwork.org>





A “living laboratory” to address societal grand challenges,
educate & develop a diverse workforce, and promote innovation

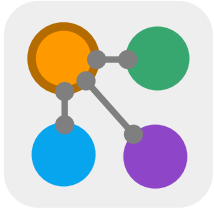
Thank You





Our World is **ENGINEERED**





IUCRC Program Framework

IAB provides \$\$ for **research**
(90% industry funds
are for research)



Industry/Government Members
Industry Advisory Board (IAB)

Pooled Member \$



NSF provides funding
for **administrative and**
management costs

**Shared Project
Portfolio**

**Research
Projects**

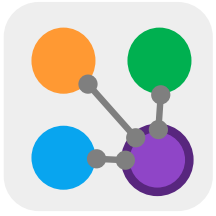
- ✓ *Precompetitive*
- ✓ *Use-inspired*
- ✓ *IAB-driven*

Value derived
from portfolio



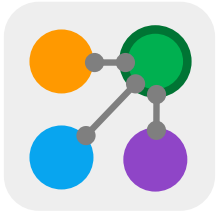
Universities provide
infrastructure, intellectual capital
and reduced indirect costs





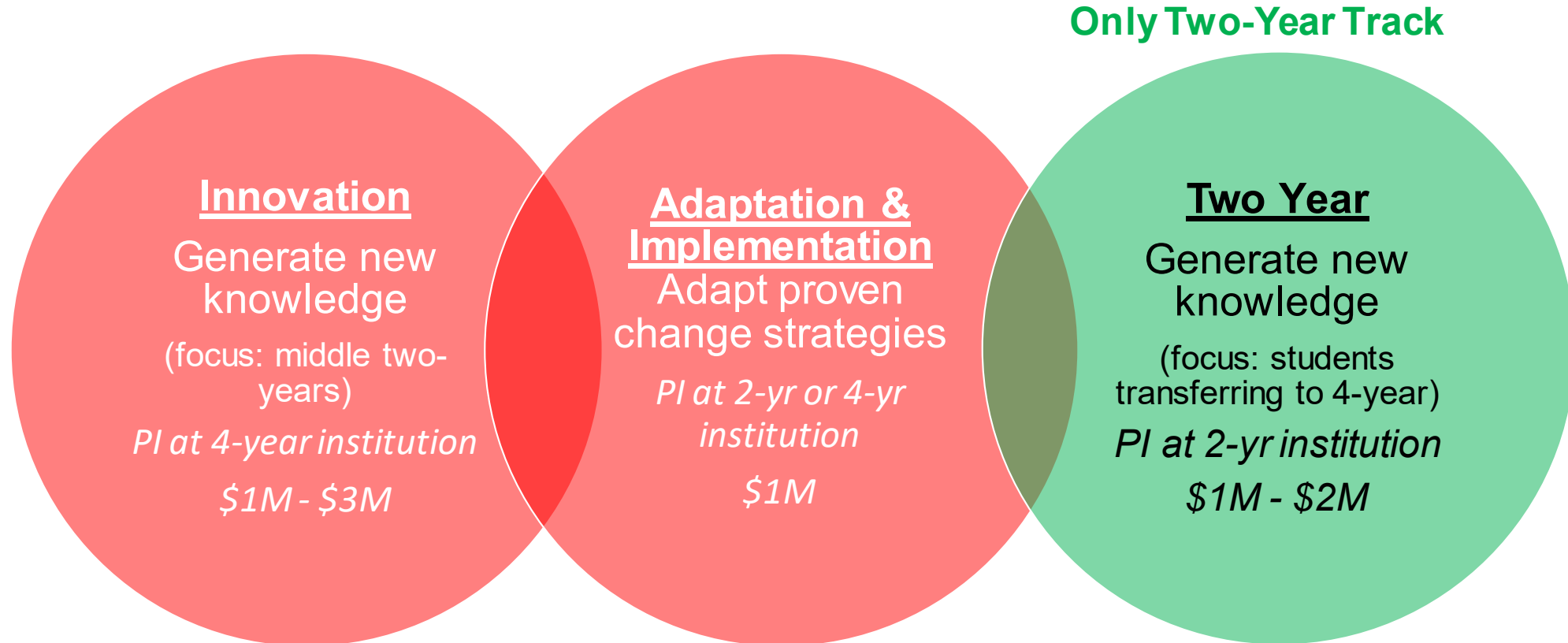
Broadening Participation in Engineering

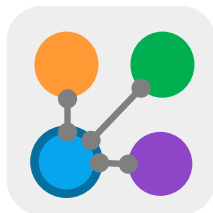
- Broadening Participation in Engineering
- CAREER
- Early-concept Grants for Exploratory Research (EAGER)
- Rapid Response Research (RAPID)



RED Solicitation Overview (NSF 23-553)

- Catalyze revolutionary approaches in **engineering & engineering technology** departments
- Multi-institution Partnerships – Two-Year track (required)

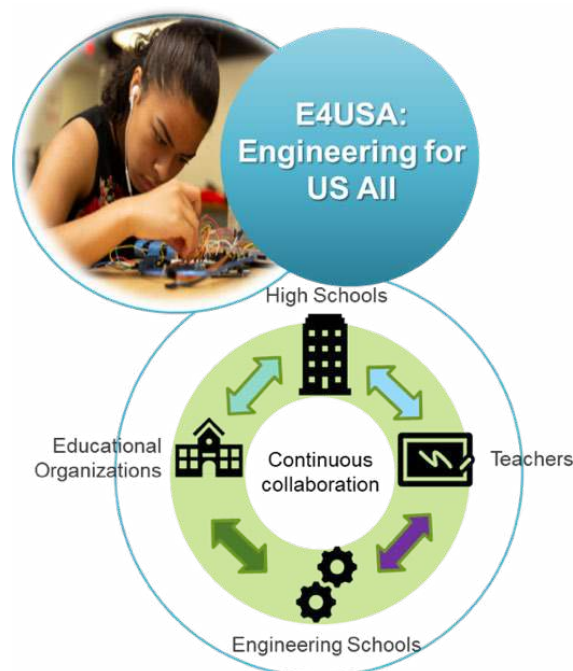




Workforce Development Initiatives



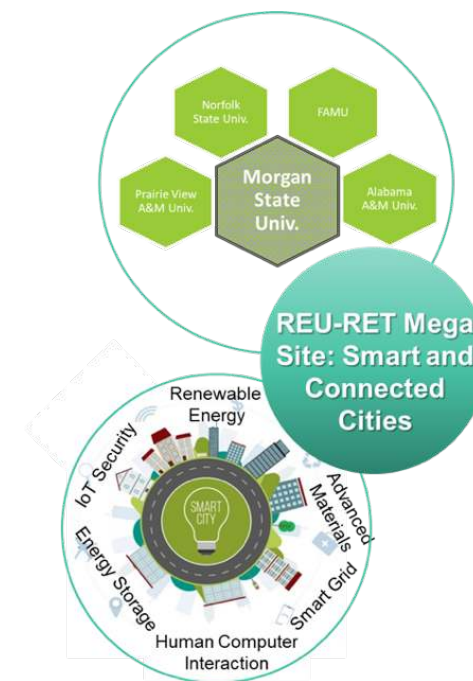
A digital library of engineering curricula for K-12 educators to make applied science and math come alive through engineering design; 3.3 M unique annual users



High School Engineering Pilot: Earn College engineering credit; 1400 high school juniors and seniors, 40 high schools across the nation; supported by 100+ Engineering Deans.



Pilot Partnership between e4usa + FIRST Robotics: overcome institutional barriers; broaden K12 engineering participation & exposure at a national scale



Pilot ECE Consortium of 14 HBCUs and 1 Hispanic Serving Institution; integrated multi-institution site to enhance impact on students & teachers

