An Overview of NSF Programs

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ASME Dynamic Systems and Control Conference, 2019

The National Science Foundation

Independent federal agency created by Congress in 1950

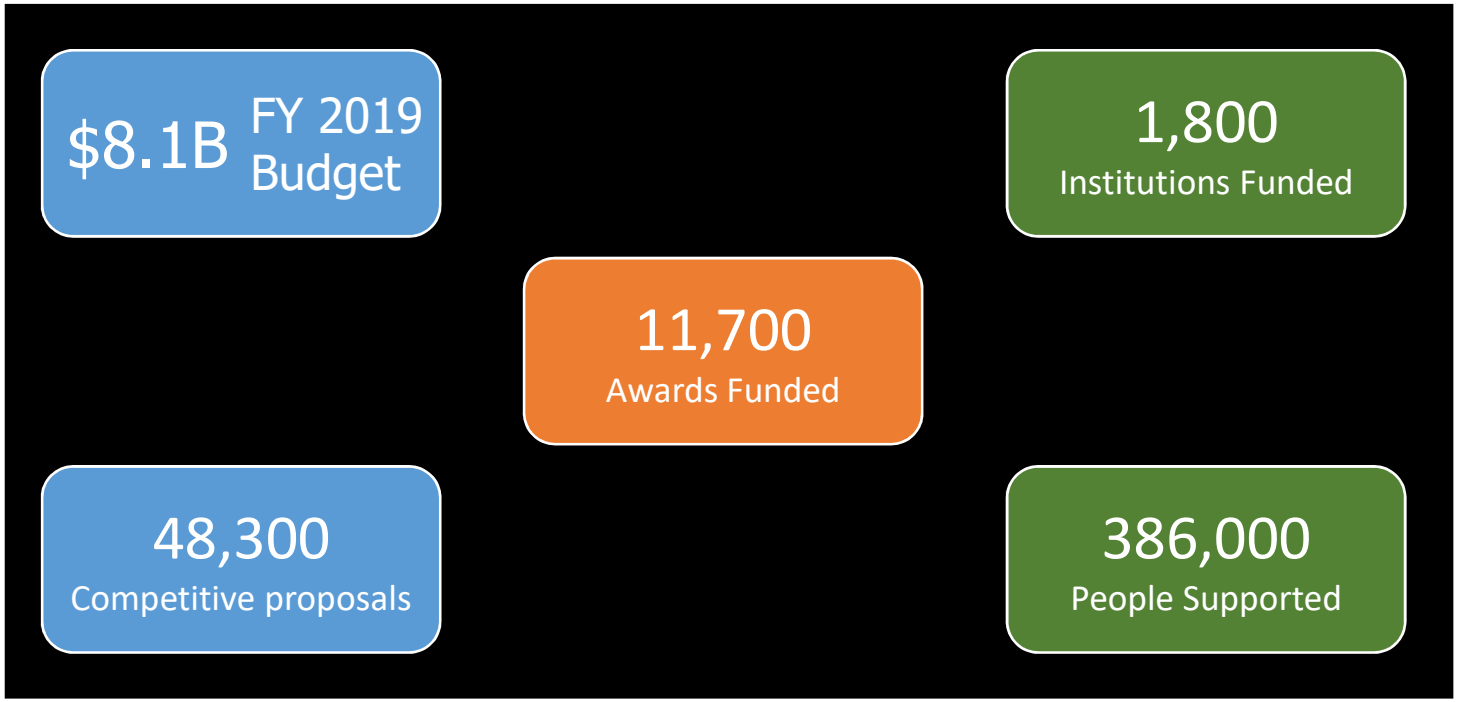
- "to promote the **progress of science**; to advance the **national health, prosperity, and welfare**; to secure the national defense"
- mandate is to keep all fields and disciplines of science and engineering (including social, but not medical sciences) research healthy and strong

Supports **fundamental research and education** across all fields of science and engineering, except for medical sciences; NSF does not support development activities (exception: SBIR/STTR)

NSF supports and encourages **potentially transformative** research; must make or enable significant scientific contributions

Ensures that research is integrated with education so that today's revolutionary work will also be **training tomorrow's top scientists and engineers**.

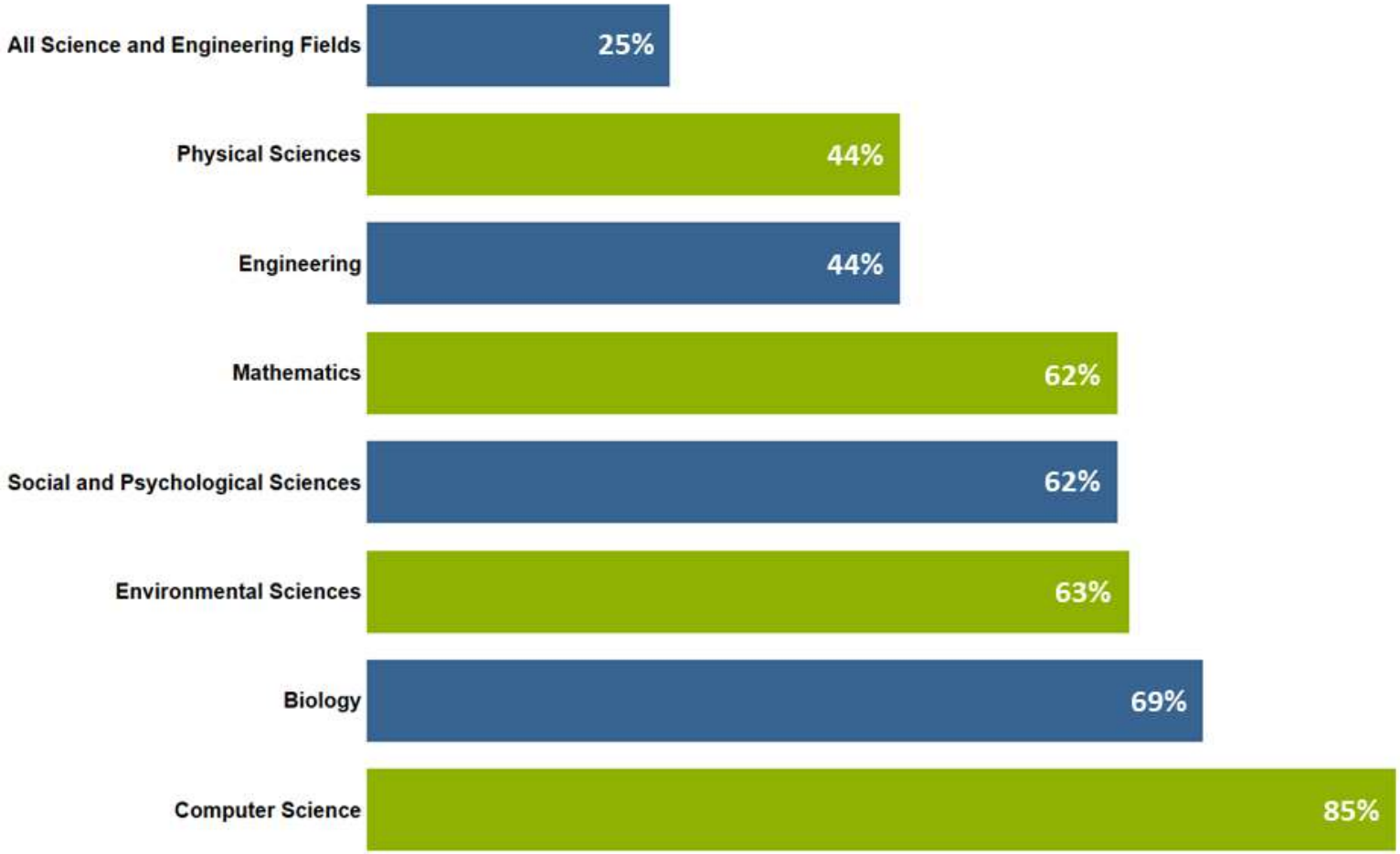
NSF by the Numbers



Source: NSF FY 2018 Performance and Financial Highlights

NSF by the Numbers

NSF Support of Academic Basic Research in Selected Fields
As a percentage of total federal support)



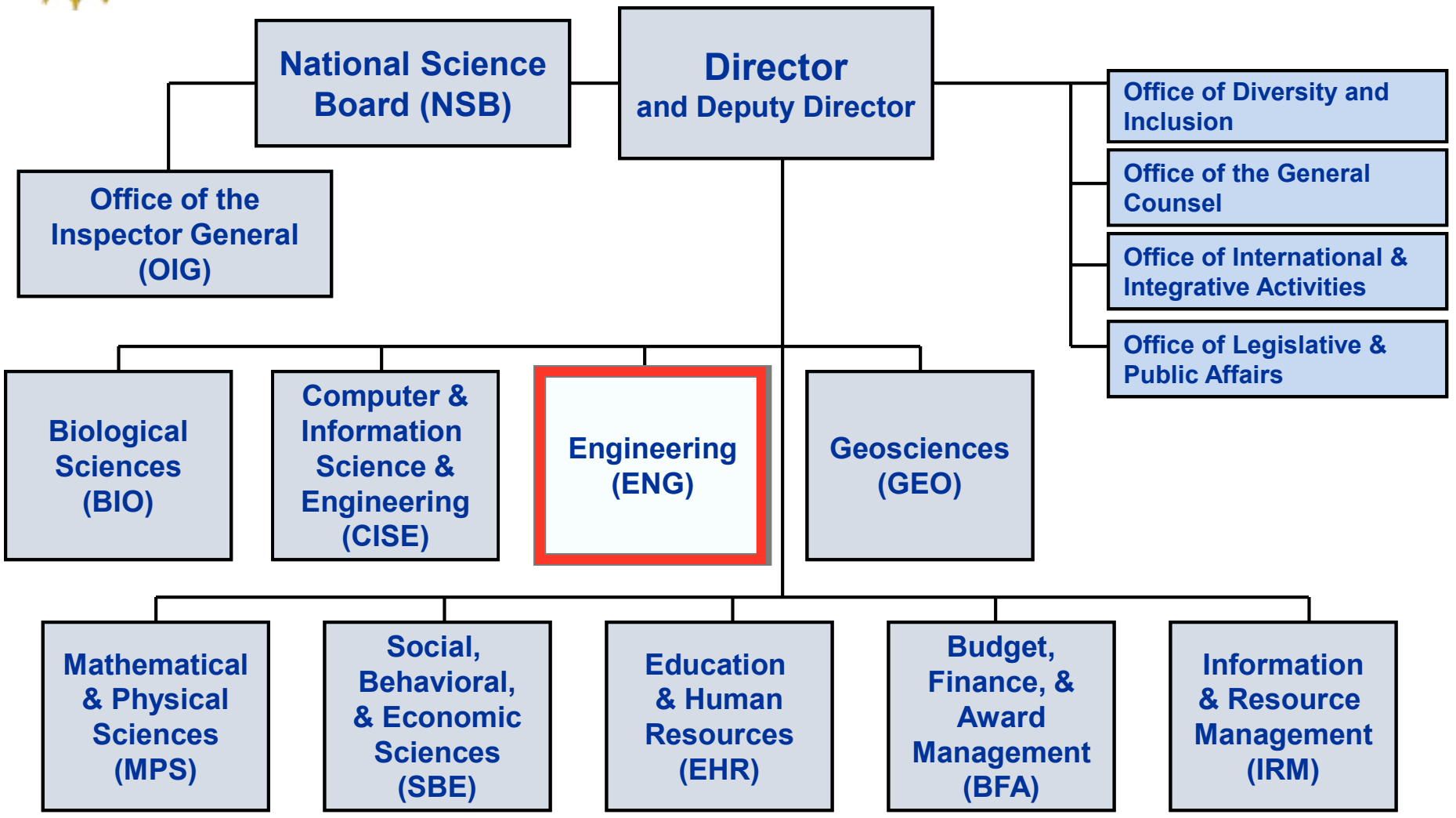
Note: Biology includes Biological Sciences and Environmental Biology. Biology and Psychological Sciences exclude National Institutes of Health
Source: NSF/National Center for Science and Engineering statistics, Survey of Federal Funds for Research and Development, FY 2016

Deadlines Removed for ENG Core Programs

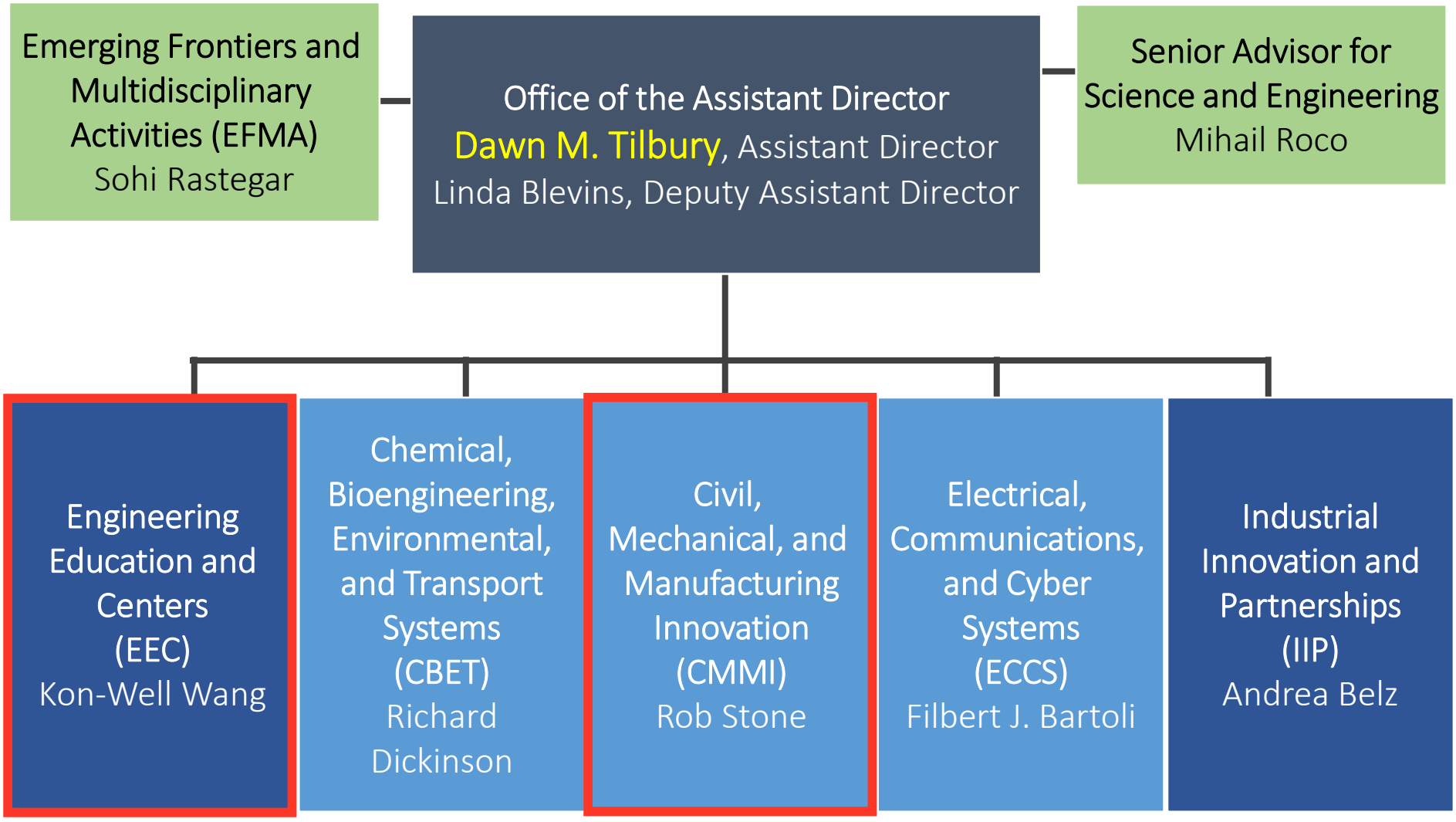
- As of August 2018, unsolicited proposals may be submitted at any time.
- Core Programs only. Solicitations and CAREER still have deadlines.
- Resubmissions: only if **substantially revised** and at least **one year from submission date**, regardless of program to which it is submitted.
- No limit to the number of pending proposals as PI or co-PI. However, each proposal must be significantly different and you cannot serve as a panelist if you have a pending proposal in that program.
- Review process and time to receive decision will not change.
- Is there an optimal time to submit a proposal?

Yes … when you have put together the best possible proposal.

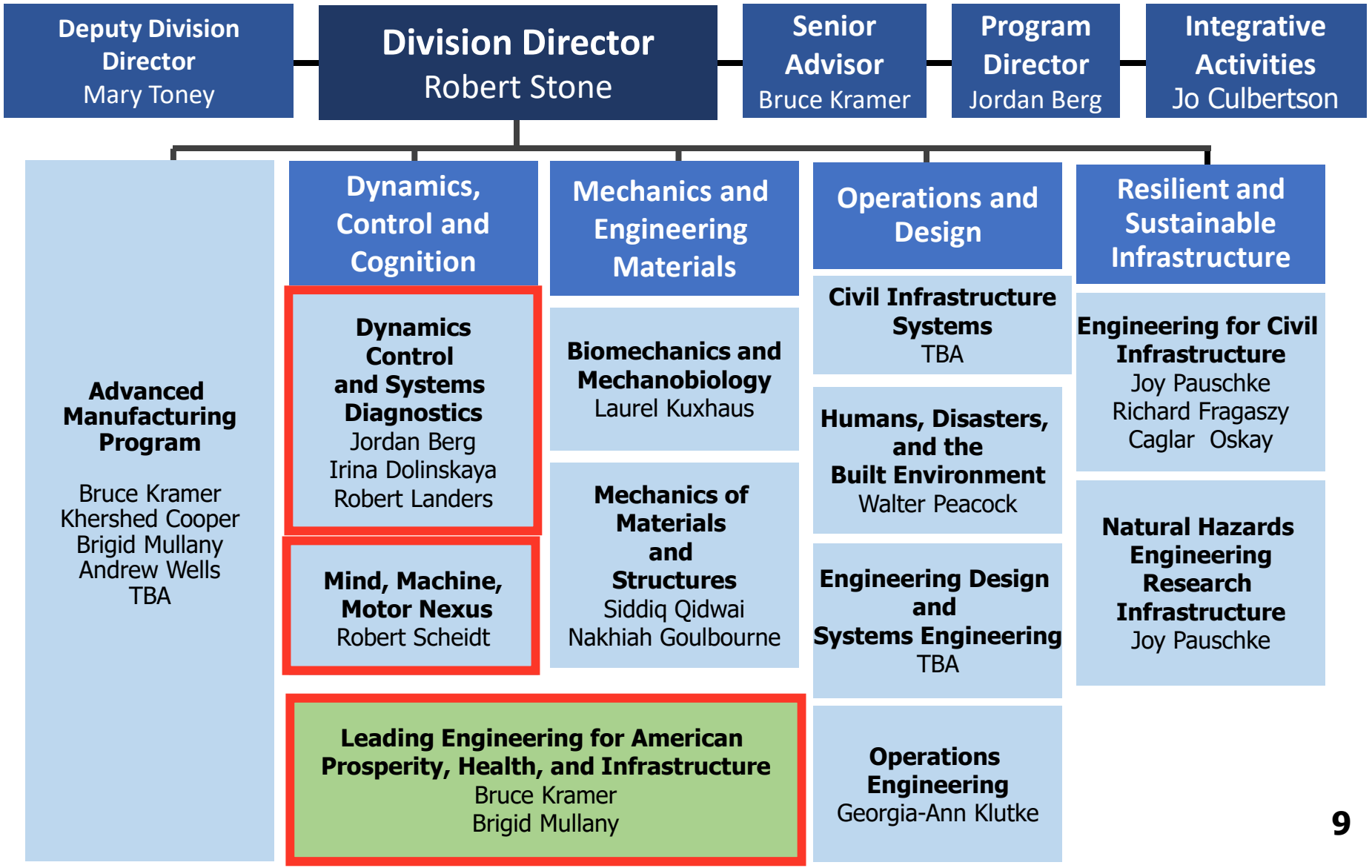
National Science Foundation Structure



NSF Engineering Directorate



Civil, Mechanical, and Manufacturing Innovation (CMMI)



Dynamics, Control, and Cognition (DCC)

The (DCC) Cluster supports fundamental research in the **modeling, analysis, diagnostics, measurement, and control of dynamical systems**. We have two programs: Dynamics, Control and Systems Diagnostics (DCSD) and Mind, Machine and Motor Nexus (M3X).

Irina Dolinskaya (DCSD)

Bob Scheidt (M3X)

Robert Landers (DCSD)

Jordan Berg (program officer)

Dynamics, Control and Systems Diagnostics (DCSD) Mission

Impact on CMMI Areas

Nanoscale to Infrastructure Scale

Dynamic Systems

- modeling
- analysis
- controls
- diagnostics

DCSD: Broader Impact

"The Broader Impact criterion encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes."

- NSF **does not require** specific activities. In fact, Broader Impacts do not have to be activities. The effect on technology, an industry, health, etc. are valid Broader Impacts.
- The **proposal** identifies specific outcomes and explains why they are desired.
- Broader Impacts should not be a laundry list of things.
- Broader Impacts should be **substantial**.

What NSF/CMMI/DCSD is NOT Looking for

Research that is supported by other federal agencies

Pure academic exercises with no clear motivation or little relevance to our society

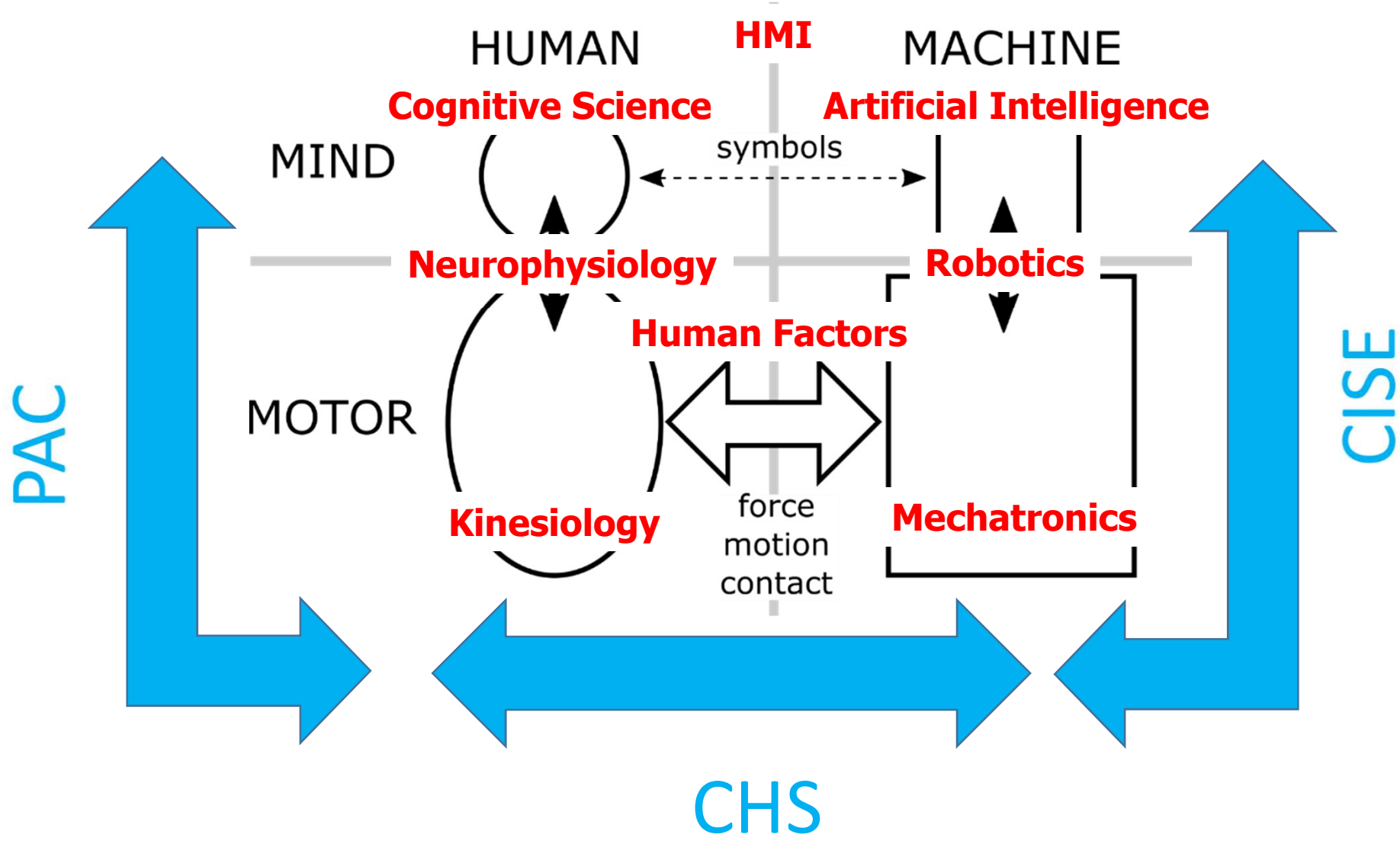
Development of artifacts (e.g., device, product, process): probably applied research or development

Incremental research that

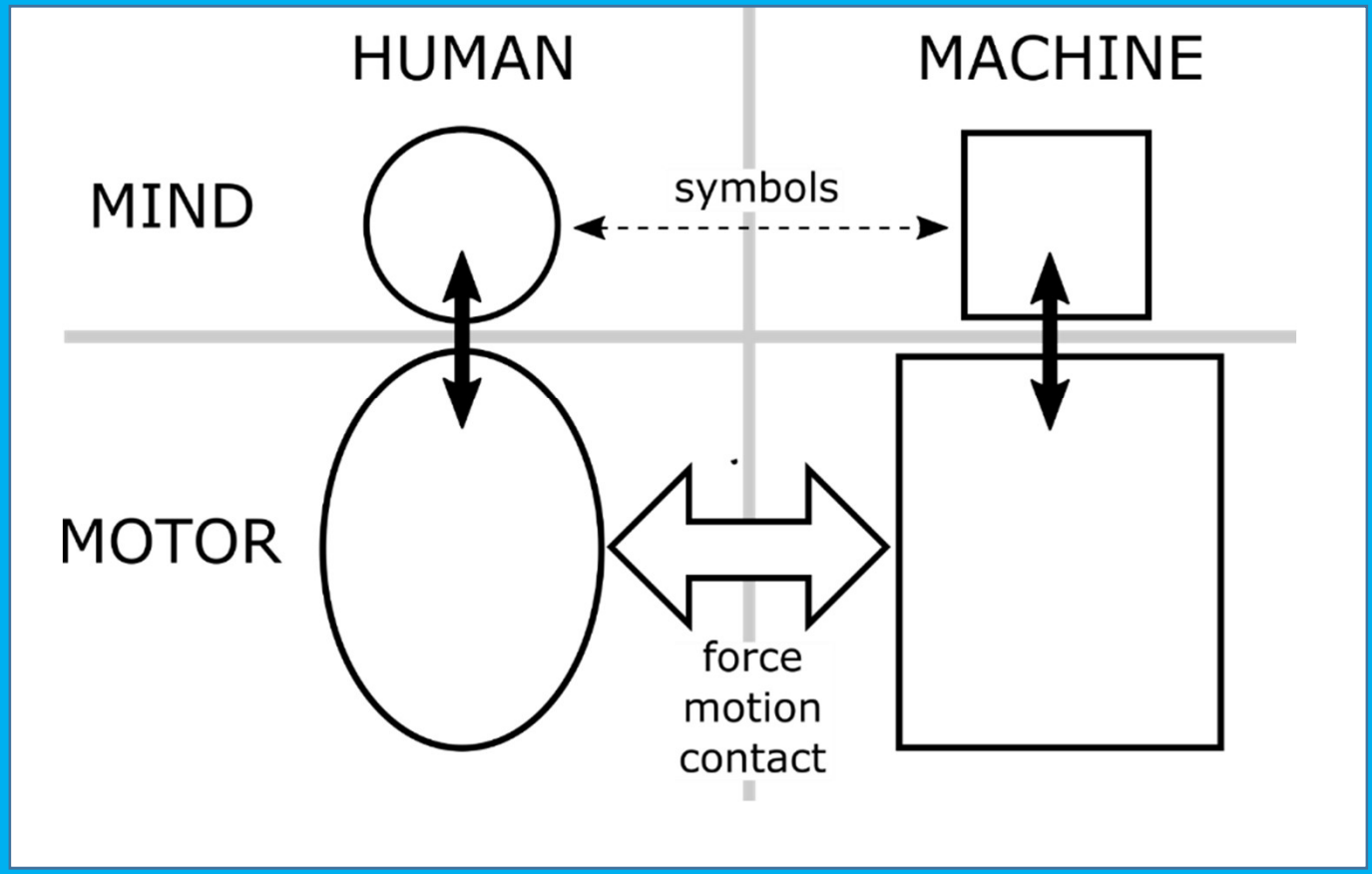
- Adds on or modifies the existing frameworks in a marginal way
- Applies techniques from other fields without comprehension of their appropriateness
- Lack theoretical foundations or generalizability, relying solely on empirical data

M3X: Mind, Machine and Motor Nexus

Bob Scheidt (rscheidt@nsf.gov)



M3X: Mind, Machine and Motor Nexus



M3X

M3X: Mind, Machine and Motor Nexus

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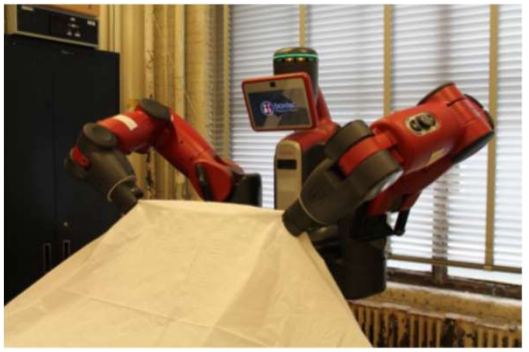
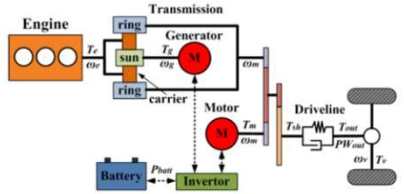


Novel dynamics arise through physical coupling of adaptive human and robotic systems.

M3X projects pursue:

- INTEGRATED treatment of human & machine intent, perception, and behavior
- HOLISTIC analysis of cognition and embodiment in the human and machine
- BI-DIRECTIONAL exploration of how mind and motor function interact in the manipulation of machines, and how machines may shape and influence the human mind and motor function
- CONVERGENT research developing new theories and their physical manifestation



M3X: Mind, Machine and Motor Nexus

Supported activities must strongly integrate across disciplines to enable discoveries that would not otherwise be possible

The program will not consider proposals that do not integrate physical considerations in a fundamental way

- *PIs proposing pure artificial intelligence or pure machine learning research are referred to funding opportunities in the Directorate for Computer and Information Science and Engineering (CISE)*

M3X does *not* support disaggregated, parallel efforts from individual disciplines or investigators

- CAREER proposals may require some leniency in this regard

Looking Ahead: Ten Big Ideas

Navigating the New Arctic

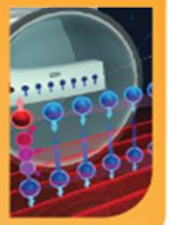
Harnessing Data for 21st Century Science and Engineering

Work at the Human-Technology Frontier: Shaping the Future

RESEARCH IDEAS

Understanding the Rules of Life: Predicting Phenotype

The Quantum Leap: Leading the Next Quantum Revolution



Windows on the Universe: The Era of Multi-messenger Astrophysics

PROCESS IDEAS

Growing Convergent Research at NSF

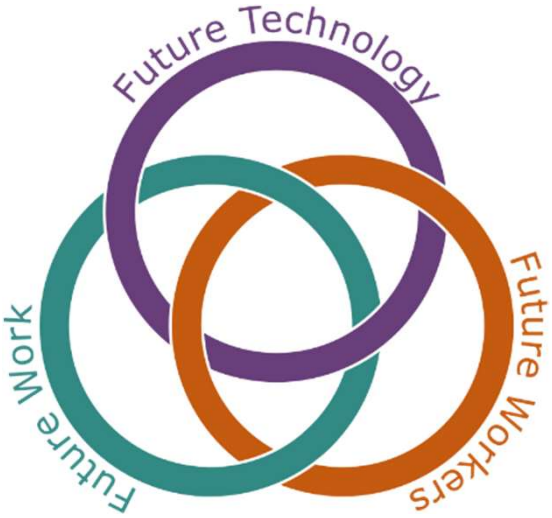
NSF-Includes: Enhancing Science and Engineering through Diversity

Mid-scale Research Infrastructure

NSF 2050: Seeding Innovation

The Future of Work at the Human-Technology Frontier (FW-HTF)

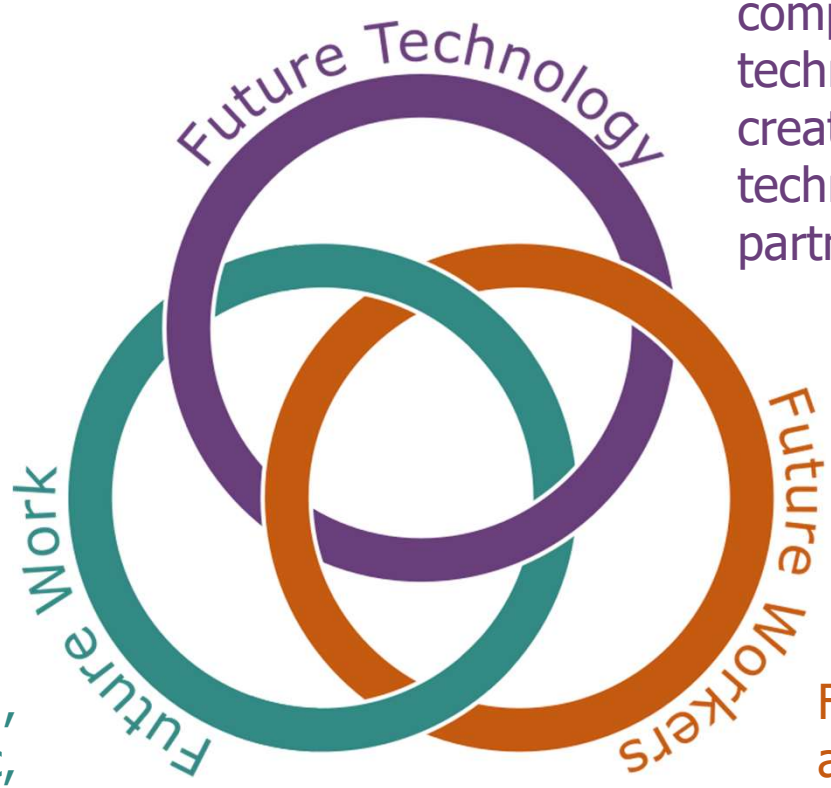
Image: AB Volvo



NSF's investment in research on the future of work, focusing on difficult and complex research questions surrounding technology innovation, workers, and the interdependencies of technology, human work, lifelong learning, and society.

The Future of Work at the Human-Technology Frontier (FW-HTF)

Engineering & computer science technologies to create human-technology work partnerships



Analyses of societal, economic, educational and national contexts, including benefits and risks

Fundamental principles and support of individual workers, work teams, workplaces, and work organizations

Image from the NSF-funded Polar Geospatial Center

Solicitation NSF 19-511.

One of the NSF's 10 Big Ideas, NNA tackles convergent scientific challenges in the rapidly changing Arctic that are needed to inform the economy, security, and resilience of the Nation, the circumpolar region and the globe.

NNA Major Goals and Key Components

- Improved understanding of Arctic change and its ***local and global*** effects that capitalize on innovative and optimized observation infrastructure, advances in understanding of fundamental processes, and new approaches to modeling ***interactions among the natural environment, built environment, and social systems***.
- New, enhanced research communities that are ***diverse, integrative, and well-positioned*** to carry out productive research at the intersections of Arctic natural and built environments and social systems.
- Research outcomes that inform U.S. ***national security and economic development needs*** and ***enable resilient, sustainable Arctic communities***.

National Robotics Initiative (NRI 2.0)

Ubiquitous Collaborative Robots (Co-Robots)

- Vision of robots as commonplace as today's cellphones
- Enhance *scale* and *variety* of tasks
  (health, assistive, service, manufacturing, agriculture, environment, land, sea, air, space, education, …)
- Enrich *Quality of Life* and *Quality of Work*

NRI 2.0 Research Themes

- **Scalability**: Coordinate effectively with people and other robots; perceive, plan, act, and learn in face of uncertainty and complexity; robust and safe operation

- **Customizability**: adapt to variety of tasks, people, environments; natural, multi-modal interaction; personalized interactions

- **Lowering barriers to entry**: Easy-to-use, inexpensive hardware and software; testbeds

- **Societal impact**: Economic, legal, social, ethical, and educational impact on people and workforce

NRI 2.0 Project Classes

- **Foundational**: ≤3yr, $250,000 - $750,000
  - Research ***fundamental techniques, theories, and technologies*** that directly support development, use, or acceptance of ubiquitous co-robots in society
  - Should contribute to one, or more, of the research themes
- **Integrative**: ≤4yr, $500,000 - $1,500,000
  - Research into ***innovative integration*** of technologies leading to complete co-robotic systems.
  - **Required** to evaluate rigorously on physical robots, preferably in real-world settings

Cyber Physical Systems

Cyber-Physical Systems (CPS) are engineered systems that are built from, and depend upon, the seamless integration of computation and physical components. Advances in CPS will enable capability, adaptability, scalability, resiliency, safety, security, and usability that will expand the horizons of these critical systems.

"Systems of interest will be at the same time transformative and translational"

Small (April 1–12, 2019): $500K up to 3 years

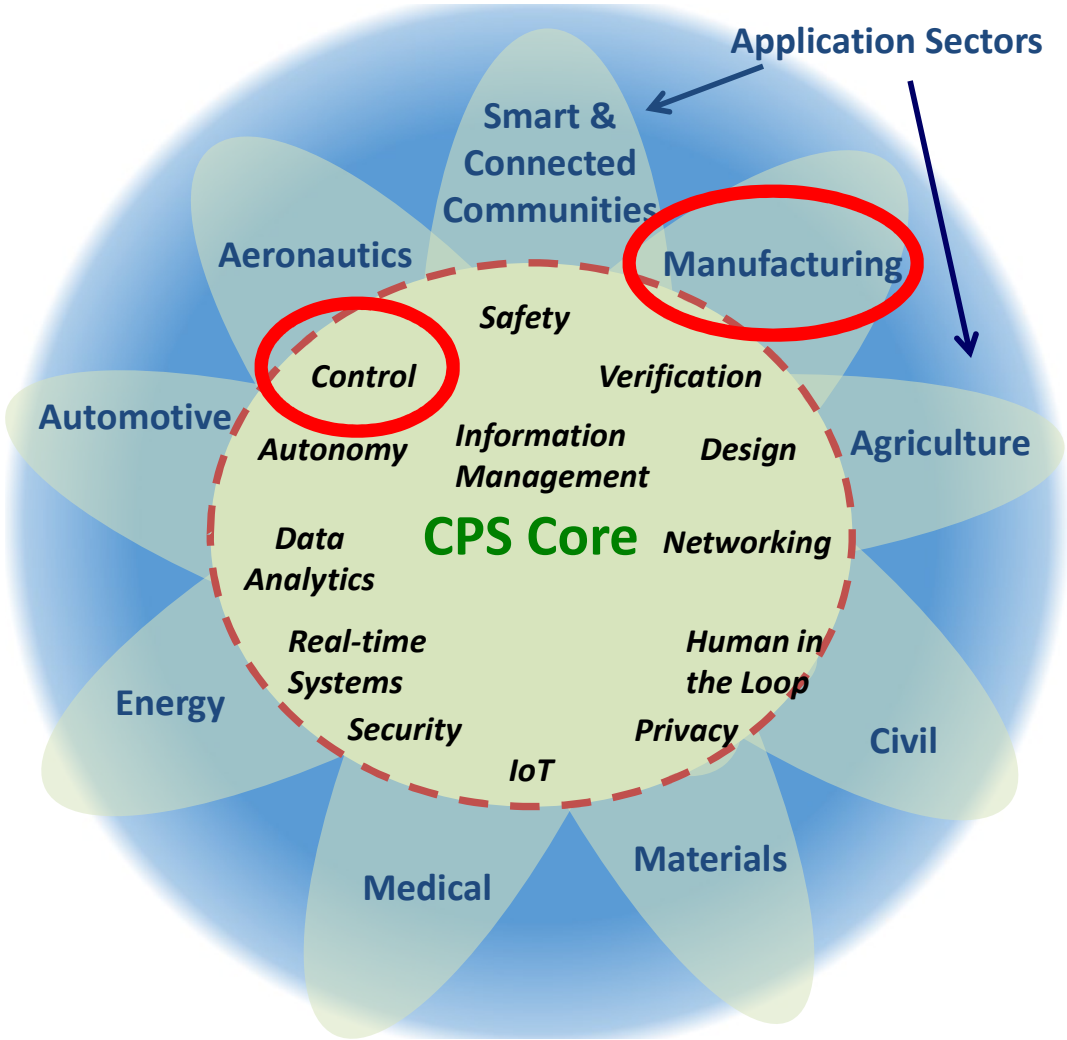
Medium (April 1–12, 2019): $500K – $1.2M up to 3 years

Frontier (September 12–26, 2019) : $1.2M – $7M for 4–5 years

Anticipate 35–45 awards and total funding of $51.5M

A person can only be involved in at most 2 proposals.

Cyber Physical Systems



There are panels focused on Controls (Jordan and Robert) and Manufacturing (Bruce)!

Cyber Physical Systems

- Cross-disciplinary collaborative research leading to fundamental insights
- Projects balancing theory with experimentation
- Both new perspectives on existing CPS and revolutionary new concepts
- Accelerated transition to practice
- Effective use of testbeds
- Basic research for synergistic collaboration with **mission agencies**

- Application Domains
- Research Areas
- *CPS Challenges*

Leading Engineering for America's Prosperity, Health, and Infrastructure (LEAP HI)

NSF 17-602

- **Defines goals not achievable through a series of small, short-term projects**
- **Incorporates knowledge and methods not normally included in CMMI proposals**
- **Emphasis on planning, coordination and management (Research Integration Plan)**
- **Emphasis on leadership and communication (Leadership Section): Upfront and close involvement of university communications professionals**

- Leadership Role for Engineering
- Fundamental Research
- Societal Impact
  - Economic Competitiveness
  - Quality of Life
  - Public Health
  - Essential Infrastructure
- Research Integration Plan
- Engineering Leadership Plan
- $1-2 million total for up to 5 years

LEAP HI: Timeline & Stipulations

- **LEAP HI Program Coordinators**
  - Bruce Kramer, bkramer@nsf.gov and Brigid A. Mullany, bmullany@nsf.gov
- **Prepare a 2-page summary including:**
  - A description of the societal challenge that will be addressed,
  - A clear identification of the critical gaps in current understanding that will be researched, and
  - A brief explanation of the scientific basis for the proposed research that highlights the novelty and promise of the proposed methods for bridging current knowledge gaps.
- **Letter of Intent Due July 15th Annually**
  - Used to select reviewers for your proposal
  - Provide enough detail to make that possible
- **Full Proposal Submission Window: September 1 -15 Annually**
  - No individual may be a PI, co-PI or Senior Investigator on more than one LEAP HI proposal in a given year
  - No limit on the number of LEAP HI submissions from a given institution
  - "Collaborative Proposals" are not allowed. Partner institutions must be funded by subcontracts from the submitting institution

Submitting Proposals

Pre Submission

- Seek advice from successful grant writers
- Send project summary to (and call or visit) Program Manager (PM)
- Volunteer to be a panelist (cannot if you have a pending proposal in program)
- Follow program submission guidelines
- Five elements: Intellectual Merit and Broader Impacts, **transformative**, plan (including measures of success), team qualification, adequate resources
- Think about the appropriate duration and budget for your project …
  – is it well justified?

Submitting Proposals

Post Submission

- Be patient – there is nothing you can do at this point
- Proposals are binned into Primary Consideration, Secondary Consideration, Do Not Consider, and Not Discussed in Panel (triaged)
- Panelist provide PM guidance, PM recommends awards, Division Director concurs, Division of Grants and Awards makes grant to university

Post Review

- If awarded: do great work and turn in annual and final reports on time
- If declined: read reviews, set them aside for a week …, and carefully seek to understand reviews (mentors and PM) and determine how (if) to resubmit

Relevant Funding Mechanisms

Unsolicited Core Programs (ENG – anytime)

Special Solicitations (some are annual, some only once)

- Assistant Professors – CAREER
- Relevant Solicitations – CPS, CDS&E, NRI, LEAP HI
- Big Ideas – HDR, FW-HTF, NNA
- Major Equipment – MRI
- Traineeships – NRT, REU Site
- Industrial – GOALI, I/CORP, PFI, I/UCRC, SBIR/STTR

Supplemental Awards (e.g., INTERN, REU)

EAGER, RAPID (anytime, external review not required)

Conferences, Workshops (anytime)

CAREER

Foundation-wide activity that offers NSF's most prestigious awards for faculty members beginning their independent careers

Provides stable support at a sufficient level and duration to enable awardees to develop careers as outstanding researchers and educators who effectively integrate teaching, learning, and discovery

High Priority for Engineering

- ENG **minimum** award size is $500,000
- Due 3rd Thursday in July

Note: the CAREER award is not just a research award, it is a career development award

GOALI: Grant Opportunities for Academic Liaison with Industry

- Two paths to receiving GOALI funding
  - Full proposals competing for new funding
  - **Supplemental funding requests** on active awards
- At least one industrial co-PI must be listed on the **Cover Sheet** at the time of submission although the industrial participant cannot use or receive any NSF funds
- IP Agreement
  - Academic and industry partners should agree in advance as to how Intellectual Property (IP) rights will be handled
  - Cover issues of publication and patent rights
- Industry co-PI Participation Confirmation Letter
  - State the degree of industrial participation
  - Detail any support that the industry partner is providing to the academic partner
  - Present what critical intellectual contribution is being made by the industry partner

INTERN: Non-Academic INTERNships for Graduate Students

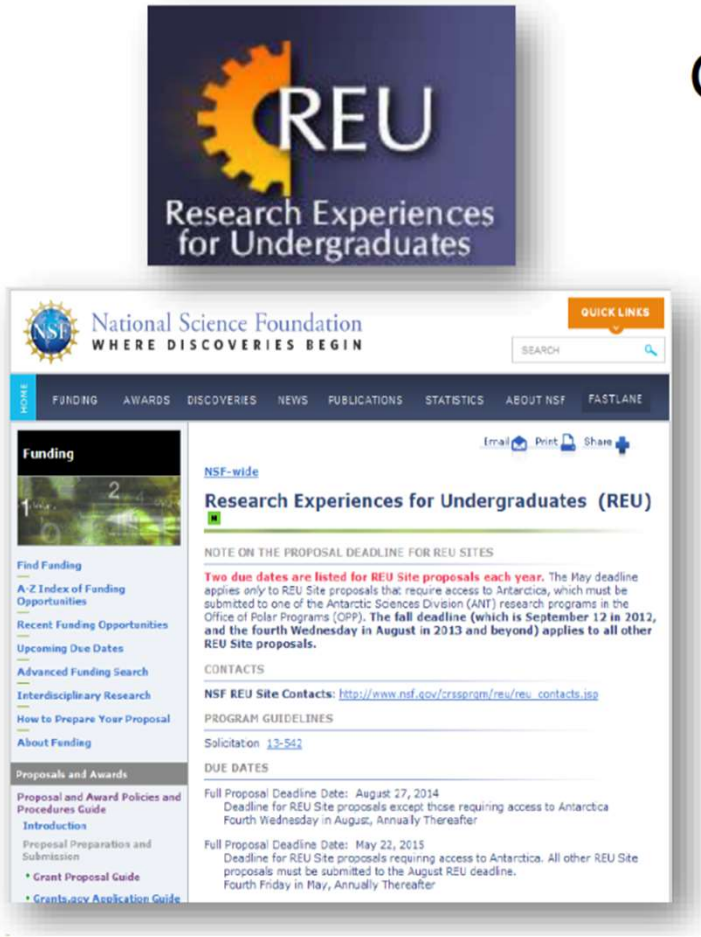
- 55% of PhD STEM Graduates find jobs outside academia
- 79% of master's degree graduates secure non-academic jobs
- NSF supports ~40,000 graduate students
- Breadth of experiences needed beyond deep domain expertise and academic research expertise
  - Business and economics
  - Project and time management
  - Communication: written and oral
  - Strategic thinking
  - Innovation and entrepreneurship
  - Health and safety
  - Law and ethics

https://www.nsf.gov/statistics/2016/nsb20161/#/figure/fig03-10
Science and Engineering Indicators 2016.

INTERN: Non-Academic INTERNships for Graduate Students

- Host organizations may include
  - Industry laboratories or research and development groups
  - Start-ups or small businesses
  - Government agencies and National Laboratories
  - Policy think-tanks
  - Non-profit organizations
- Supplemental funding to any active NSF research grant
- Up to six months per internship for up to $50,000 (can be submitted any time)
- Requires intellectual property agreement prior to funding
- Graduate student eligibility
  - Must be supported on an active NSF award
  - Must have completed at least one year in their graduate program
  - International students are eligible

Research Experiences for Undergraduates



Goals:

- Initiate and conduct projects that engage a number of undergraduate students in research.
- Involve in research students who might not otherwise have the opportunity, particularly those from academic institutions where research programs are limited.

CMMI: $8000/student, 1 student/project or 2 if at least one is underrepresented in engineering. Submit Oct. 1st – March 31st.

Engineering Design Supplements

Program Objectives:

- Provide support for a student design project related to the advancement in knowledge that are expected from an NSF research award.

Key Components :

- Supplements (normally $4000 per award per year) should support the design process – not student time
- Projects should be open-ended student design projects and are expected to have a mentoring and assessment structure, such as a course or a student organization
- The projects should either:
  - Apply the advancements of knowledge that come from the original award
  - Design a system that complements or augments the existing award
- These supplements are available through programs in CBET, CMMI, and ECCS – but final discretion on consideration of supplements is up to the individual Program Director
- See DCL 19-078 for more details

Team Projects

- Curiosity and Use-Inspired Research
- Small, Medium and Large Team Projects
- Inter- and multi-disciplinary research
- Trans-disciplinary and convergent research

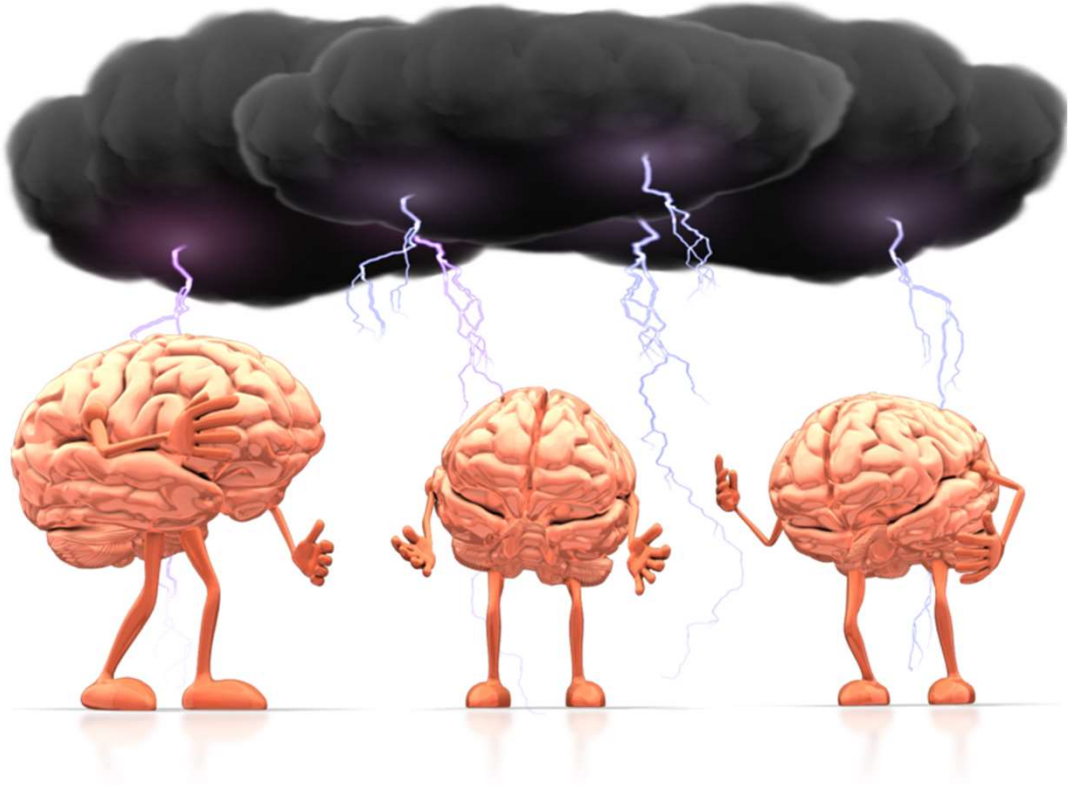
- Ask the right (research) questions

Convergent Research

- **Convergence** is an approach to problem solving that cuts across disciplinary boundaries.
- **Convergent** engineering is a deeply collaborative, team-based engineering approach for defining and solving important and complex societal problems (NAE, 2017).
- **Convergent** research has the strong potential to lead to transformative solutions or new fields of study.
- https://www.nae.edu/113283.aspx

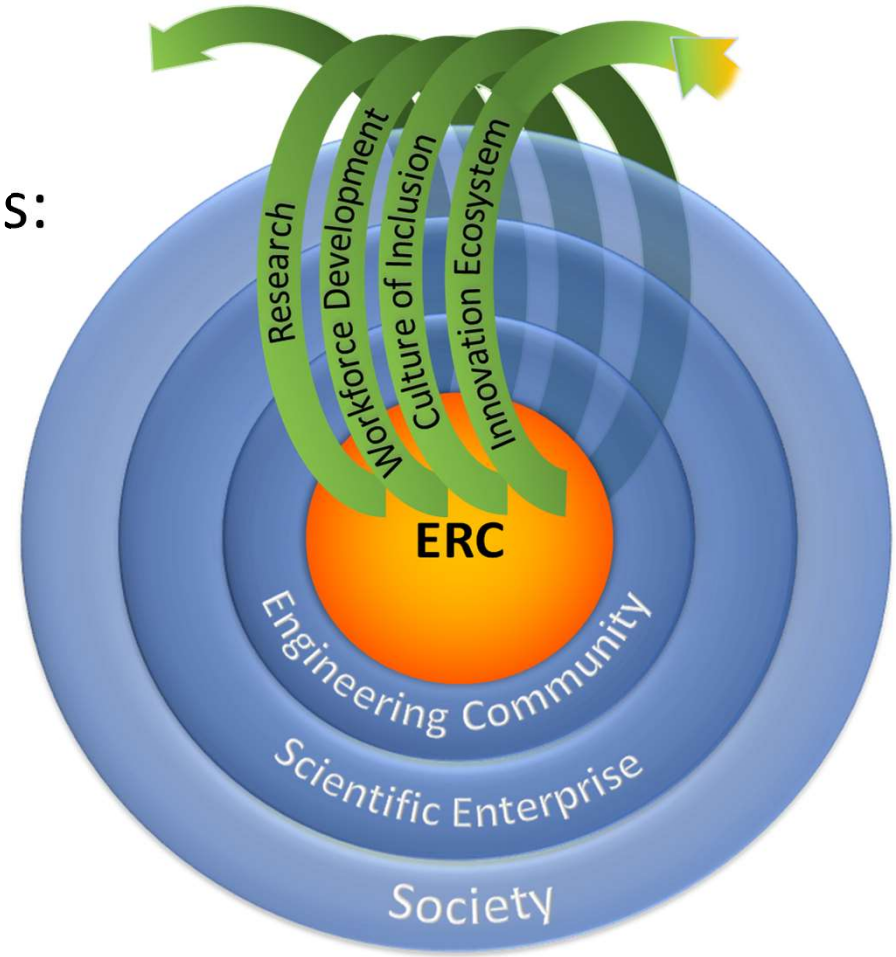
Effective Teams, Diversity and Inclusion

- Effective team projects strongly benefit from:
  - Best practice from team science
  - Diversity
  - Inclusive environment



The ERC Model

- Foundational Components:
  - Convergent Research
  - Engineering Workforce Development
  - Diversity and Culture of Inclusion
  - Innovation Ecosystem
- Areas of Impact:
  - Engineering Community
  - Scientific Enterprise
  - Society



10:15 AM – 12:30 PM	**Social Innovation and Impact** *Designing Research for Innovation and Social Impact* [Recording] [Slides] Dean Chang, Associate Vice President, Academy for Innovation & Entrepreneurship, University of Maryland *Multi-Level Social Systems and Social Change* [Recording] [Slides] Jennifer Cross, Associate Professor, Department of Sociology, Colorado State University **Panel** [Recording] *Diversity for Convergence and Capacity Building* James Moore, Vice Provost for Diversity and Inclusion, Ohio State University *Anticipating Social Implications to Advance Goals* [Slides] Eleonore Pauwels, Research Fellow—Emerging Cybertechnologies, United Nations University
1:30 – 3:00 PM	***Team Science and Transdisciplinary Research*** *Team Science: Current State of Knowledge* [Recording] [Slides] Kara Hall, Director, Science of Team Science Team, NCI, National Institutes of Health **Panel** [Recording] *Transdisciplinary Research: Principles, Processes, and Products* [Slides] Shalini Misra, Assistant Professor, Urban Affairs and Planning, Virginia Tech University *The Role of Bridging Individuals* Jonathan Kramer, Director for Interdisciplinary Science, SESYNC
3:30 – 5:00 PM	**Bringing It All Together for Successful Convergence Research** [Recording] [Slides] L. Michelle Bennett, Director, Center for Research Strategy, National Institutes of Health***PI/Co-PI Activity followed by Discussion/Questions***

Resources

- Gen-4 ERC Program landing page: https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505599
- ERC Association Website: http://erc-assoc.org/
- *A New Vision for Center-Based Engineering Research:* https://www.nap.edu/catalog/24767
- *Convergence*: https://www.nap.edu/catalog/18722
- *Enhancing the Effectiveness of Team Science*: https://www.nap.edu/catalog/19007
- ERC planning grant ”training”: https://ercbiennial.asee.org/2018-pgw/program/


Thank you!
For a copy of this presentation e-mail
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