National Science Foundation (NSF)
Information and Funding Opportunities

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Dr. Jordan Berg (jberg@nsf.gov): M3X, EFRI, FW–HTF
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Dr. Eduardo Misawa (emisawa@nsf.gov): ERC, NRT
The National Science Foundation

Independent federal agency created by Congress in 1950
  o "to promote the *progress of science*; to advance the *national health, prosperity, and welfare*; to secure the national defense”
  o 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

$8B  
FY 2017  
budget request

93%  
Funds research,  
education and  
related activities

50,000  
Proposals

12,000  
Awards funded

2,000  
NSF-funded  
institutions

350,000  
NSF-supported  
Researchers

Fund research in  
all S&E  
disciplines

Fund STEM  
education &  
workforce

217  
Nobel Prize  
Winners
NSF FY 2018 Request: Total R&D

Budget Authority in Billions of Dollars

- Agriculture: $2.1
- Commerce (NI ST, NOA): $1.6
- NSF: $5.4
- Energy: $13.4
- NASA: $10.3
- HHS (NIH): $25.1
- Other: $13.4

Total R&D ~ $150 Billion
R&D is ~ 4% of Federal Budget
NSF Support of Academic Basic Research in Selected Fields (as a percentage of total federal support)

<table>
<thead>
<tr>
<th>Field</th>
<th>Support Percentage</th>
</tr>
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<tbody>
<tr>
<td>All Science and Engineering Fields</td>
<td>27%</td>
</tr>
<tr>
<td>Physical Sciences</td>
<td>45%</td>
</tr>
<tr>
<td>Engineering</td>
<td>46%</td>
</tr>
<tr>
<td>Environmental Sciences</td>
<td>63%</td>
</tr>
<tr>
<td>Mathematics</td>
<td>64%</td>
</tr>
<tr>
<td>Social and Psychological Sciences</td>
<td>68%</td>
</tr>
<tr>
<td>Biology</td>
<td>69%</td>
</tr>
<tr>
<td>Computer Science</td>
<td>83%</td>
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Notes: Biology includes Biological Sciences and Environmental Biology. Biology and Psychological Sciences exclude National Institutes of Health funding from the total amount of federal support.

Deadlines Removed for Core Programs

• New, unsolicited proposals may be submitted at any time.
• Change effective August 15th, 2018 for all ENG Divisions.
• 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.
• 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.
Deadlines Removed for Core Programs

Why is this change being made?

By accepting proposals at any time, ENG is affording more time to prepare proposals, build strong collaborations, and to think more creatively without the pressure of a deadline. Spreading proposal submissions more evenly over the year may also reduce the burden on principal investigators (PIs), reviewers, and proposing organizations.

Other programs (directorates?) in NSF have done this for multiple years. Typically, the quality increases and the number of submissions drops by half.
National Science Foundation Structure

- National Science Board (NSB)
  - Office of the Inspector General (OIG)
  - Biological Sciences (BIO)
    - Mathematical & Physical Sciences (MPS)
  - Computer & Information Science & Engineering (CISE)
  - Social, Behavioral, & Economic Sciences (SBE)
    - Education & Human Resources (EHR)
  - Engineering (ENG)
    - Office of International & Integrative Activities
    - Office of Legislative & Public Affairs
  - Geosciences (GEO)
    - Office of Diversity and Inclusion
    - Office of the General Counsel
  - Office of the General Counsel
  - Office of International & Integrative Activities
  - Office of Legislative & Public Affairs

- Director and Deputy Director

- Office of Diversity and Inclusion
- Office of the General Counsel
- Office of International & Integrative Activities
- Office of Legislative & Public Affairs

Office of Diversity and Inclusion
Office of the General Counsel
Office of International & Integrative Activities
Office of Legislative & Public Affairs

Information & Resource Management (IRM)
Budget, Finance, & Award Management (BFA)
Education & Human Resources (EHR)
Social, Behavioral, & Economic Sciences (SBE)
Mathematical & Physical Sciences (MPS)
Geosciences (GEO)
Computer & Information Science & Engineering (CISE)
Engineering (ENG)

Office of the Inspector General (OIG)
ENG Funding Rate FY 17

Overall FY 2017 ENG Funding Rate: 18%

<table>
<thead>
<tr>
<th>Program</th>
<th>Actions</th>
<th>Awards</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBET</td>
<td>14%</td>
<td></td>
</tr>
<tr>
<td>CMMI</td>
<td>14%</td>
<td></td>
</tr>
<tr>
<td>ECCS</td>
<td>19%</td>
<td></td>
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<tr>
<td>EEC</td>
<td>24%</td>
<td></td>
</tr>
<tr>
<td>EFMA</td>
<td>43%</td>
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<tr>
<td>IIP</td>
<td>50%</td>
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Dynamics, Control and Systems Diagnostics (DCSD) Mission

Impact on CMMI Areas

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 and related to the proposal.
M3X: Mind, Machine and Motor Nexus
Emerging Frontiers in Research and Innovation FY 2018 (EFRI-2018)

Program Solicitation: **NSF 17-578**

**TOPICS**

- Chromatin & Epigenetic Engineering (CEE)
- **Continuum, Compliant, and Configurable Soft Robotics Engineering (C3 SoRo)**

**Partners**

- ENG, CISE
- Air Force Office of Scientific Research
FY 2020 EFRI Topic Selection

• Two new EFRI topics for FY 2020 competition (next chance 2022)
• Topic suggestions are sought from the research community
• Candidate topic ideas, including a 500-word description submitted to https://www.surveymonkey.com/r/efritopicideasFY2020
• Deadline: October 31, 2018

• More Info: Louise R. Howe; lhowe@nsf.gov
Continuum, Compliant, and Configurable Soft Robotics Engineering (EFRI C3 SoRo)

- **Continuum** structures possess a high number of degrees of freedom, and may attain a wide variety of different shapes.
- **Compliant** structures are readily deformed by external forces.
- **Configurable** systems display a significant degree of functionality over a wide range of configurations.

**C3 SoRo FY18 Research Thrusts:**

1. Dynamic Modeling of C3 Robots
2. Distributed Sensing, Actuation, and Computation
3. Validation & Testing

- Soft robots fully utilizing the configurability offered by compliant, continuously deformable structures would be capable of unprecedented functionality, both for stand-alone operation, and for close physical integration with humans.
C3 SoRo: Objectives & Outcomes

• Show how a large space of accessible configurations may be used to provide robustness, adaptability, and versatility under uncertain and unexpected conditions.

• Provide a progressive vision for future breakthroughs.

• Autonomous robots capable of accomplishing unstructured tasks in variable and uncertain environments.

• Wearable robots capable of enhancing human strength and endurance, providing new modes of locomotion and manipulation, or remediating musculoskeletal dysfunction.
**Looking Ahead: Ten Big Ideas**

**Research Ideas**
- Navigating the New Arctic
- Harnessing Data for 21st Century Science and Engineering
- Work at the Human-Technology Frontier: Shaping the Future
- 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
Ten Big Ideas: The Future of Work at the Human-Technology Frontier (FW-HTF)

Understanding how constantly evolving technologies are actively shaping the lives of workers and how people in turn can shape those technologies, especially in the world of work.

The future of work at the human-technology frontier will bring together NSF research communities to conduct basic scientific research on the interaction of humans, society, and technology that will help shape the future of work to increase opportunities for workers and productivity for the American economy.

Four research themes:
• Building the human-technology partnership
• Augmenting human performance
• Illuminating the socio-technological landscape
• Fostering lifelong learning.
Ten Big Ideas: Navigating the New Arctic (NNA)

Arctic change will fundamentally alter climate, weather and ecosystems globally in ways that we do not yet understand but that will have profound impacts on the world's economy and security. Rapid loss of Arctic sea ice and other changes will also bring new access to the Arctic's natural resources such as fossil fuels, minerals, and new fisheries, and this new access is already attracting international attention from industry and nations seeking new resources.

Image Credit: mosaicobservatory.org
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
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
CMMI Open Positions

**Program Director** - *Engineering for Civil Infrastructure*
- IPA or Visiting Scientist Appointment

**Program Director** – *Advanced Manufacturing*
- Federal, IPA, or Visiting Scientist Appointment
- Expertise in materials processing

**Program Director** – *Engineering Design and Systems Engineering*
- IPA Appointment only

Check: [https://nsf.gov/careers/openings/](https://nsf.gov/careers/openings/) for more details
Supplemental Programs

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.
NSF Research Traineeship

Encouraging the development of innovative models for interdisciplinary STEM graduate training

Key Traineeship Goals
• Interdisciplinary Research
• Institutional Change
• Workforce Development

Solicitation NSF 18-507 - up to $3M over 5 years
GRFP Goals

• To select, recognize, and financially support individuals who have demonstrated the potential to be high achieving scientists and engineers, early in their careers.

• To broaden participation in science and engineering of underrepresented groups, including women, minorities, persons with disabilities and veterans.
Engineering Research Centers

- Complex engineering research challenges
- ERCs focus cutting-edge researchers from multiple fields to discover and launch ubiquitous future technologies
- Translate discoveries into innovations
- Prepare next generation of diverse technological leaders
- 10-year, $40M per center
ERC: Use-Inspired System Driven Center Vision, Mission and Goals

- **Quest for Fundamental Understanding**
  - Pure Basic Research
  - Use-Inspired Basic Research
  - Pure Applied Research

- **Consideration of Use**
  - Low
  - High

- **Bohr**
- **Curie**
- **Johnson**
- **Pasteur**
- **Carver**
- **Edison**

ERC: Use-Inspired Basic Research
14 Generation-3 ERCs in FY 2018

4 new ERCs awarded in FY17

- Innovative and Strategic Transformation of Alkane Resources, Purdue University
- Cell Manufacturing Technologies, Georgia Tech
- Cellular Metamaterials, Boston University
- Precise Advanced Technologies and Health Systems for Underserved Populations, Texas A&M University
New ERC Program Model

4 interconnected **foundational components**
- Research
- Workforce Development
- Culture of Inclusion
- Innovation Ecosystem

Three layers of **impact**
- Engineering Community
- Scientific Enterprise
- Society
A New Vision for Center-Based Engineering Research
ERC Planning Grant

Seed quality ERC teams/ proposals; support: $100K/award

Societal impact
Convergence

Team formation
Effective leadership/management
stakeholder communities

Summer 2018: 60 ERC Planning Grant Awards
Convergence Accelerators: A New Model for Research to Innovation

New organizational structure intended to:

- Leverage external partnerships,
- Accelerate convergent, translational activities
- Focus on areas of national importance
  - Application-driven basic research
  - Cohorts, integrated teams
  - Proactively and intentionally managed

A few “tracks” will define the focus areas

New Dimensions:
- Selection by pitch instead of 15-page proposal
- Competition for monetary prizes
NSF 2026 Idea Machine

• Competition to identify the next set of Big Ideas
• Suggest pressing research questions
• Help set the U.S. agenda for fundamental research in science and engineering
• Participants can earn prizes and receive public recognition
• Open to researchers, the public, other stakeholders
• Launches late August 2018
Thank you!
Merit Review Process

TIMELINE & RUBRICS
Merit Review Timeline

-1 months
PI communicates with Program Director to determine program fit
0 months
Proposal is Submitted
1 month
Program Director reads proposals, identifies reviewers, assembles panels
2 months
Reviewers perform 6-8 proposal reviews
3 months
Panels convene to discuss and rank proposals
4 months
Program director recommends proposals for funding
5 months
Recommendation goes through the approval process
6 months
PIs are notified

NATIONAL SCIENCE FOUNDATION
Merit Review Criteria

**Intellectual Merit:** How important is the proposed activity to *advancing knowledge and understanding* within its own field or across different fields?

**Broader Impacts:** What is the potential for the proposed activity to *benefit society* or advance desired societal outcomes?
The Five Elements of Merit Review

1. What is the potential for the proposed activity to:
   ◦ advance knowledge and understanding within its own field or across different fields (Intellectual Merit); and
   ◦ benefit society or advance desired societal outcomes (Broader Impacts)?

2. To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts?
The Five Elements of Merit Review (2)

3. Is the plan for carrying out the proposed activities well-reasoned, well-organized, and based on a sound rationale? Does the plan incorporate a mechanism to assess success?

4. How well qualified is the individual, team, or institution to conduct the proposed activities?

5. Are there adequate resources available to the PI (either internally or through collaborations) to carry out the proposed activities?
How to Achieve Broader Impact?

**NSF Mission:** To promote the progress of science; advance the national health, prosperity, and welfare; and to secure the national defense

**Broader Impact:** Advancement of scientific knowledge and activities that contribute to the achievement of societally relevant outcomes

Can be accomplished through:

- the research itself,
- the activities that are directly related to specific research projects,
- through activities that are supported by, but are complementary to, the project.

Broadening Participation is one Broader Impact goal
Proposal
Foundations
Proposal Basics

- Write to the reviewers (not to the program director and not to yourself)
- Your proposal will be judged by the reviewers
- Reviewers want to know four things:
  - What is it about (the research objective)?
  - How will you do it (the technical approach)?
  - Can you do it (you and your facilities)?
  - Is it worth doing (intellectual merit and broader impacts)?
- This is, basically, all the proposal needs to convey – but it needs to convey this
12 Steps to a Better Proposal

1. Know yourself - strengths/weaknesses
2. Know the program (director) from which (whom) you seek support
3. Read the program announcement and PAPPG
4. Formulate clear and appropriate research and education objectives
5. Develop a viable plan to accomplish your stated objectives
6. State your objectives up front in your proposal
7. Frame (contextualize) your project around the work of others
12 Steps to a Better Proposal

8. Grammar and spelling count
9. Format and brevity are important
10. Know the review process
11. Proof read the proposal before you submit it
12. Submit your proposal early and proofread it after you submit it

Writing a good proposal takes common sense and effort—it’s not magic!
CAREER Awards

SPECIAL CONSIDERATIONS
Introduction

- Foundation-wide activity that offers NSF’s most prestigious awards for faculty members beginning their 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 award size is $500,000, period.
Beware!

The CAREER award is NOT a research award

The CAREER award is a career development award

Your proposal must reflect this focus
You

- **Who are you?**
  - Your expertise/interests
  - Your career/life goals
  - Your position/resources

- **Your proposal should fit into your life plan**

What is your life plan?
Do you need to develop a strategic plan?
Your Strategic Plan

- A strategic plan has three parts:
  - Where are you today?
  - Where do you want to be in the future (5, 10, 20 years from now)?
  - How do you get from here to there?

- Questions: What do you want to leave as your career legacy? Do you need to work on important problems?

A strategic plan is a roadmap for your life!
Your Proposal

- Should advance you toward your life goals
  - Should be a stepping stone to the next thing
- Should be compatible with your institution’s goals
- Should represent a contribution to society at large

Test: If you accomplish your objectives, are you better off for the effort?
Do’s & Don’ts

PLUS ETHICS
DOs

- Have a strategic plan
- Build on your strengths
- Differentiate this proposal from your Ph.D. thesis work and other sponsored work
- Perform a thorough literature search and exploratory research before writing the proposal
DON’Ts

- Rush
- Wait until last minute (1 month) to contact program directors
- Make the proposed work (research and education) too broad
- Make the proposed work too narrow
- Ask for too much (or too little) money
- Ignore rules (PAPPG) and misc. items – violation of the PAPPG requirements will result in return without review
Talking to Program Officers: Pre-Submission

**DO:**
- Discuss the objectives of the program
- Relate your research idea to the program objectives
- Ask about Broader Impact activities
- Ask about budgets
- Volunteer to serve on review panels

**DON’T:**
- Argue that your proposal fits the program
- Try to convince the PD to fund your proposal
- Count on the PD remembering anything you talked about
Talking to Program Officers: Post-Decisions

**DO:**
- Ask for feedback on the panel discussion
- Respond to technical issues from the reviews
- Discuss a possible revision
- Volunteer to serve on review panels

**DON’T:**
- Get mad
- Insult the reviewers and/or the PD
- Try to convince the PD to change the decision
Ethics!!!

- Persons submitting proposals to the Federal government are held to high standards of conduct
- Misbehavior can be dealt with quite severely
  - PI barred from submission to NSF for up to 2 years
  - Permanently barred from proposal review
  - At least two cases of jail time (Grimes case, 42 months in Federal prison)
  - Maximum $250,000 fine, 5 years in prison
- Institutions must train and verify