Engineering at NSF

National Science Foundation
Directorate for Engineering
Presentation Outline

• Directorate for Engineering (ENG) overview
• Funding opportunities
• Successful proposals
• Resources
ENG Mission and Vision

• Mission: To enable the engineering and scientific communities to advance the frontiers of engineering research, innovation and education, in service to society and the nation.

• Vision: ENG will be the global leader in advancing the frontiers of fundamental engineering research, stimulating innovation, and substantially strengthening engineering education.
ENG Research and Education Themes

• Cognitive engineering: Intersection of engineering and cognitive sciences
• Competitive manufacturing and service enterprises
• Complexity in engineered and natural systems
• Energy, water, and the environment
• Systems nanotechnology
Energy, Water, and the Environment

• Supports breakthroughs essential to the provision of energy and water in an environmentally sustainable and secure manner.

• Examples include:
  – Increasing the use of alternative energy sources through research in materials
  – Developing quantitative understanding of energy–environment interactions (including water)

Advanced water purification begins with understanding how ions in water interact with membranes. This dynamic computer simulation shows sodium (pink) and chlorine (green) ions inside a polyamide membrane. Shannon, 0120978.
Funding

• Proposals must address NSF goals
  – Discovery
  – Learning
  – Research infrastructure
  – Stewardship

• Funding may be found in ENG and crosscutting/interdisciplinary programs
Funding Opportunities

• Core programs
• Exploratory research
• Collaborative/interdisciplinary areas
• Crosscutting and NSF-wide programs
ENG Core Programs

• ENG divisions
• Faculty Early Career Development (CAREER)
• Broadening Participation
Proposals to ENG Divisions

• Proposals may be unsolicited or in response to a solicitations
• Submission windows and processes vary by division
• Awards are typically $240-300K for three years
CBET Areas of Interest

• **Chemical, biochemical, and biotechnology**: research on the processing and manufacture of products by effectively utilizing chemical and renewable resources, often with the aid of bioinformatics from genomic and proteomic information

• **Biomedical engineering and engineering healthcare**: research to develop novel projects that integrate engineering and life science to solve biomedical problems that serve humanity

• **Environmental engineering and sustainability**: research that aims to reduce adverse effects of solid, liquid, and gaseous discharges into land, water, and air that result from human activity and impair the ecological value of those resources

• **Transport and thermal fluids phenomena**: research on thermal, mass, and momentum transport that enable new technological solutions to understand pressing issues in energy, the environment, manufacturing, health care, and other fields

• Two submission deadlines per year: Sept. and Mar.
Water Sustainability and Climate

• Seeks to understand and predict the interactions between the water system and climate change, land use, the built environment, and ecosystem function and services through place-based research and integrative models.

• Letters of Intent due March 15; full proposals due April 15

• ~$16 M investment for 8–14 awards

ENG Contacts
Paul Bishop
Bruce Hamilton
CMMI Areas of Interest

• **Advanced manufacturing:** research leading to transformative advances in manufacturing and building technologies, with emphases on efficiency, economy, and sustainability

• **Mechanics and engineering materials:** research aimed at advances in the transformation and use of engineering materials efficiently, economically, and sustainably

• **Resilient and sustainable infrastructures:** research to advance fundamental knowledge and innovation for resilient and sustainable civil infrastructure and distributed infrastructure networks

• **Systems engineering and design:** research on the decision-making aspects of engineering, including design, control, and optimization

• Two submission deadlines each year: Oct. 1 and Feb. 15
George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) Research

• NEES is a network of 14 earthquake engineering experimental equipment sites available for experimentation on-site or in the field
• Advances knowledge discovery and innovation for:
  – Earthquake and tsunami loss reduction of our nation's civil infrastructure
  – New experimental simulation techniques and instrumentation for NEES
• Proposals due April 30, 2010
• ~$7M investment for 8–14 awards

Joy Pauschke

Directorate for Engineering
Electrical, Communications, and Cyber Systems (ECCS)

Senior Engineering Advisor
Lawrence Goldberg

Division Director
Robert Trew

Power, Controls, and Adaptive Networks
- Control theory and applications; Networked control systems; Sensing and imaging networks; Robotic and embedded systems; Modeling/control of electric power grids
  - Radhakisan Baheti
- Photovoltaics and novel energy conversion devices; Alternate energy devices/systems; Power and energy systems; Renewable/alternative energy conversion and storage; Interdependencies of critical infrastructures
  - George Maracas
- Neuromorphic engineering; Bio-inspired complex systems; Quantum systems engineering; Multi-scale modeling/simulation of devices and systems
  - Paul Werbos

Electronics, Photonics, and Device Technologies
- Optoelectronics/photonics; Nanophotonics; Plasmonics and metamaterials; Large-scale photonic integration; Ultrafast phenomena (Vacant)
- Micro/nanoelectronics; Advanced integrated circuits; Beyond silicon CMOS; Quantum-level devices; Electromagnetics/microwave/THz simulations and models
  - Samir El-Ghazaly
- Molecular electronics; Organic and flexible electronics; Energy-efficient green electronics and photonics
  - Pradeep Fulay
- Bioelectronics and biomagnetics; Spintronics and magnetics; Sensor technologies
  - Usha Varshney

Integrative, Hybrid, and Complex Systems
- MEMS/NEMS systems-on-a-chip; Diagnostic and implantable devices; Biological and medical devices; Environmental monitoring; Micro-power and energy
  - Rajinder Khosla
- RF to optical communication systems; Inter- and intra-chip communication/networks; Mixed signal systems; Millimeter wave and terahertz systems
  - Andreas Weisshaar
- Cyber-physical systems; Next-generation cyber systems; Signal processing (Vacant)

Division Director
Robert Trew

Optoelectronics/photonics; Nanophotonics; Plasmonics and metamaterials; Large-scale photonic integration; Ultrafast phenomena (Vacant)

Micro/nanoelectronics; Advanced integrated circuits; Beyond silicon CMOS; Quantum-level devices; Electromagnetics/microwave/THz simulations and models

Molecular electronics; Organic and flexible electronics; Energy-efficient green electronics and photonics

Bioelectronics and biomagnetics; Spintronics and magnetics; Sensor technologies

Electronics, Photonics, and Device Technologies

Integrative, Hybrid, and Complex Systems
Faculty Early Career Development (CAREER) Program

• Supports junior faculty who exemplify the role of teacher-scholars through
  – outstanding research
  – excellent education
  – integration of education and research
• Encourages women, members of under-represented minority groups, and persons with disabilities to apply
• $80M invested each year for 425 new awards
• ENG awards are ≤$400K for 5 years
• Deadlines vary by directorate;
ENG proposals due July 21, 2010

ENG Contact
Sharon Middledorf
ENG CAREER
Proposals and Awards
Broadening Participation

• Broadening Participation Research Initiation Grants in Engineering (BRIGE)
• ADVANCE: Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers
• Graduate Research Fellowships for Women
• Graduate Research Supplements
Broadening Participation Research Initiation Grants in Engineering (BRIGE)

- Funding opportunity intended to increase the diversity of researchers through research program support early in their careers
- Encourages support of under-represented groups, engineers at minority serving institutions, and persons with disabilities
- Up to $175,000 over two years
- New solicitation in late 2010
ADVANCE: Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers

- **Partnerships for Adaptation, Implementation, and Dissemination (PAID):** the adaptation, implementation, dissemination, and diffusion of effective materials and practices; and to advance understanding of gender in the STEM academic workforce (PAID-Research)
- **Institutional Transformation (IT):** systemic organizational approaches for institution-wide change
- **Institutional Transformation Catalyst (IT-Catalyst):** institutional self-assessment activities to identify specific issues in the recruitment, retention, and promotion of women faculty in STEM academics
- Next solicitation is expected in the first half of 2010
Funding Opportunities

• Core programs
• **Exploratory and urgent research**
• Collaborative/interdisciplinary areas
• Crosscutting and NSF-wide programs
Exploratory and Urgent Research

• Early-Concept Grants for Exploratory Research (EAGER)
• Grants for Rapid Response Research (RAPID)
• Emerging Frontiers in Research and Innovation (EFRI)
Early-Concept Grants for Exploratory Research (EAGER)

• Supports high-risk, exploratory, and potentially transformative research
• Began Jan. 1, 2009
• Up to $300K over two years
• May be submitted any time; contact program officer prior to proposal submission
Grants for Rapid Response Research (RAPID)

- Supports research of great urgency with regard to data, facilities, or equipment, such as research on disasters
- Up to $200K over one year
- May be submitted any time; contact program officer prior to proposal submission
RAPID Proposals: Effects of the January 2010 Haitian Earthquake

• Research on the effects of the earthquake that struck Haiti on January 12, 2010

• Topics include:
  – Geotechnical systems performance
  – Structural and nonstructural systems performance
  – Critical infrastructure systems performance
  – Collection of perishable field data
  – Emergency response and relief

• Awards up to $40K; proposals due March 5, 2010
Emerging Frontiers in Research and Innovation (EFRI)

• Supports higher-risk, higher-payoff opportunities that:
  – Are potentially transformative
  – Address a national need or grand challenge

• Topic areas for FY 2010 are:
  – Science in Energy and Environmental Design (SEED): Engineering Sustainable Buildings
  – Renewable Energy Storage (RESTOR)

• $29M investment for 4-year awards at ~$500K per year
• Letters of Intent due in Oct.; preliminary proposals due in Nov.; invited full proposals due in March
• EFRI Web site: www.nsf.gov/eng/efri
Funding Opportunities

• Core programs
• Exploratory research
• **Collaborative/interdisciplinary areas**
• Crosscutting and NSF-wide programs
Engineering Education and Centers (EEC)

Division Director
Allen Soyster

Engineering Centers
Lynn Preston

Senior Staff Associate
Win Aung

Expert
John Lamancusa

Engineering Education
Sue Kemnitzer

Diversity and Pre-College Education
Mary Poats

Biotechnology and Health Care
Lynn Preston

Energy, Sustainability, and Infrastructure
Barbara Kenny

Microelectronics, Sensing, and IT
Deborah Jackson

Nanoscale Science and Engineering
Daniel De Kee
Deborah Jackson
Barbara Kenny

Nanotechnology Undergraduate Education
Mary Poats

International Research and Education in Engineering
Win Aung

Engineering Education
Sue Kemnitzer
Sally Wood

Research Experiences for Teachers
Mary Poats

Research Experiences for Undergraduates
Esther Bolding

Directorate for Engineering
Engineering Centers

• Supports collaboration with industry to promote innovative research and education

• Engineering Research Centers
  – 15 in operation, including 5 new for 2008
    • Funding for 10 years
  – 2-year process from solicitation to funding
  – FY 2010 competition is underway

• Nanoscale Science and Engineering Centers
  – 6 of 10 are engineering
  – 2007 solicitation to establish a Center for the Environmental Implications of Nanotechnology
Engineering Research Centers

• FY 2010 awards will be made in the following topic areas:
  – Complex, coupled physical civil infrastructure systems under stress
  – Energy systems for a sustainable future
  – Transformational engineered systems — open category with topic chosen by the proposing ERC team

• ~$13M to fund 2–4 awards

• Letters of Intent due May 15, 2009; preliminary proposals due July 15, 2009; invited full proposals due May 5, 2010

ENG Contact
Lynn Preston
Engineering Education Research

• Addresses educational goals of the engineering community

• Supports focused efforts that integrate research into advances in undergraduate and PhD engineering education, and partner with K–12 pipeline innovators
Innovations in Engineering Education, Curriculum, and Infrastructure

• FY 2010 awards will be made in the following topic areas:
  – Innovations in Teaching and Learning
  – Translation of Engineering Education Research into our Classrooms
  – Implementation of Programs for Students Supported by the GI Bill

• ~$8.5M for 35–40 awards

• Full proposals due Jan. 20, 2010, in area 1, and March 31, 2010, in areas 2 and 3

ENG Contact
Sue Kemnitzer
Tribal Colleges and Universities Program (TCUP)

- To enhance the quality of STEM instructional and outreach programs at Tribal Colleges and Universities, Alaska Native-serving Institutions and Native Hawaiian-serving Institutions.

- Awards in three tracks:
  - Planning
  - Implementation
    - TCUP Initiation
    - STEM Teachers of Excellence Education Projects (STEEP)
    - Pre-engineering Education Collaboratives (PEEC)
  - Innovation through Institutional Integration (I3)

- Various deadlines, beginning Jan. 14 - April 7, 2010

NSF-wide Education Programs

• Integrative Graduate Education and Research Traineeship (IGERT)
  – ~20 awards each year
  – Pre-proposals due in March, full proposals due in Sept.

• Graduate Teaching Fellows in K-12 Education (GK-12)
  – ~20 awards each year
  – Letters of Intent due in May, full proposals due in June

• Graduate Research Fellowships (GRF)
  – ~1000 fellowships awarded each year
  – Engineering and interdisciplinary proposals due in Nov. each year
Ethics Education for Science and Engineering

• Invests in research and education projects to improve ethics education in all of the fields of science and engineering that NSF supports, especially in interdisciplinary or inter-institutional contexts

• Focuses on improving ethics education for graduate students, although proposed programs may benefit undergraduates as well

• ~$2.4M for 6–12 awards

• Full proposals due March 1, 2010
Human Resource Development

• Nanotechnology Undergraduate Education
  – Introduces nanotechnology into undergraduate engineering education.
  – Focuses on devices and systems and/or on the societal, ethical, economic and/or environmental issues relevant to nanotechnology
  – ~$19M for 10 awards; proposals due May 7, 2010

• Research Experiences for Undergraduates (REU)
  – Supports the involvement undergraduates in ongoing research
  – $10M/year available for engineering; deadline for site proposals in Aug. each year

• Research Experiences for Teachers (RET) in Engineering
  – Supports the active involvement of K-12 teachers and community college faculty in engineering research to bring knowledge of engineering and technological innovation into their classrooms
  – $4M/year available; deadline in Nov. each year
Grant Opportunities for Academic Liaison with Industry (GOALI)

• Effectively promotes the transfer of knowledge between academe and industry, student education, and the exchange of culture

• Supports:
  – Faculty and students in industry (≤ 1 year)
  – Industry engineers/scientists in academe (≤ 1 year)
  – Industry-university collaborative projects (≤ 3 years)

• $5M available for co-funding with all NSF Directorates

• Proposals accepted anytime; ~70 awards each year
Industry/University Cooperative Research Center (I/UCRC) Program

• Promotes long-term partnerships among industry, academe, and government

• Centers are catalyzed by a small investment from NSF and are primarily supported by industry center members during their development and evolution

• \(\sim\$9M\) for 2-8 full center awards (\(\$55\text{-}80K/\text{year}\) for up to 5 years) and 4-12 planning grant awards (\(\$10K\) for 1 year)

• Two windows per year: Letters of Intent due in Jan. and June; full proposals due in March and Sept.
Partnerships for Innovation (PFI)

• Catalyzes partnerships among colleges and universities, the private sector, and governments
• Supports one or more of the following activities:
  – research, knowledge transfer, and/or commercialization
  – workforce education and training
  – establishing the infrastructure for innovation
• $9.5M to fund 12–15 awards each year; grants are up to $600,000 for 2–3 years
• New solicitation in 2010
Small Business Innovation Research (SBIR) Programs

• Encourages small firms to undertake cutting-edge research with the potential for significant economic and public benefits

• Supports
  – Biotechnologies and chemical technologies
  – Education applications
  – Information and communication technologies
  – Nanotechnology, advanced materials, and manufacturing

• $45M for 200–300 awards

• Full proposals due in June and Dec.
Small Business Technology Transfer (STTR) Programs

• Encourages small firms to undertake cutting-edge research with the potential for significant economic and public benefits

• Enables university researchers to spin off commercially promising ideas while remaining employed primarily at the research institution

• Supports multi-functional materials

• $5M for ~35 awards

• New solicitation in late summer 2010
Funding Opportunities

• Core programs
• Exploratory research
• Collaborative/interdisciplinary areas
• Crosscutting and NSF-wide programs
Crosscutting and NSF-wide Opportunities

- Cyber-Enabled Discovery and Innovation (CDI)
- Cyber-Physical Systems (CPS)
- Domestic Nuclear Detection Office/NSF Academic Research Initiative (ARI)
- Major Research Instrumentation (MRI) Program
- Pan-American Advanced Studies Institutes Program (PASI)
- Partnerships for International Research and Education (PIRE)
Cyber-Enabled Discovery and Innovation (CDI)

• CDI is a five-year initiative to create revolutionary science and engineering research outcomes made possible by innovations and advances in computational thinking
• Seeks proposals within or across the following three thematic areas:
  – From Data to Knowledge
  – Understanding Complexity in Natural, Built, and Social Systems
  – Virtual Organizations
• ~$36M investment in FY 2010 for 30 grants
• Type I proposals due Feb. 4, Type II proposals due Feb. 5
Cyber-Physical Systems (CPS)

• Refers to the tight conjoining of and coordination between computational and physical resources

• Seeks proposals that address a CPA research theme:
  – **Foundations** research to develop new principles, algorithms, models, and theories
  – **Methods and Tools** research to bridge gaps between approaches to the cyber and physical elements of systems through innovations
  – **Components, Run-time Substrates, and Systems** research motivated by grand challenge applications

• ~$30M investment for 30–40 grants for small, medium, and large projects

• Full proposals due March 11, 2010
Domestic Nuclear Detection Office/NSF Academic Research Initiative (ARI)

• Focused on detection systems, individual sensors or other research for the detection of nuclear weapons or material, radiation dispersal devices, and related threats

• Possible topics include:
  – Detector materials, concepts and designs for new sensors and sensing systems
  – Non-intrusive active interrogation systems; particle generators and accelerators, associated detectors, and algorithms for improved data analysis
  – Nuclear forensics and attribution

• 7–8 awards for up to $400K annually per award for up to five years

• Full proposals due April 26, 2010

ENG Contact
Geoff Prentice
Major Research Instrumentation (MRI) Program

• Goals of the program are to:
  – Support the acquisition or development of major state-of-the-art instrumentation
  – Improve access to and increase use of modern research and research training instrumentation
  – Enable the creation of well-equipped learning environments that integrate research with education
  – Foster the development of the next generation of instrumentation
  – Promote partnerships

• Typically ~$110M investment for approximately 225 awards

• Letters of Intent due in Dec.; full proposals due Jan. 28, 2010
Pan-American Advanced Studies Institutes (PASI) Program

• Aims to disseminate advanced scientific and engineering knowledge and stimulate training and cooperation among researchers of the Americas

• Supports courses that
  – Ranging in length from ten days to one month duration,
  – Involve lectures, demonstrations, research seminars and discussions
  – Are taught at the advanced graduate and post-doctoral level

• ~$500K annual investment for 6–8 grants

• Full proposals due March 19, 2010
Partnerships for International Research and Education (PIRE)

- Seeks to catalyze a cultural change in U.S. institutions by establishing innovative models for international collaborative research and education

- Other objectives include to:
  - Provide international research experiences for U.S. students and faculty
  - Build strong international partnerships
  - Develop new replicable models for international collaborative research and education
  - Raise the profile and increase the importance of international collaborative research and education

- New solicitation in fall 2010
Steps towards Successful Proposals

• Begin with
  – Dialog with program officer
  – White paper
  – Short biography

• Get involved with NSF reviews
What Do Reviewers Look For?

• Proposals that address one or more NSF goals:
  – Discovery
  – Learning
  – Research infrastructure
  – Stewardship
• Intellectual merit
• Broader impact
ENG Research Grant Proposals and Awards

Directorate for Engineering
ENG Awards and Funding Rates for Prior and New PIs
Proposal Submissions to ENG by Women

* Source: ASEE, 2009, Engineering By the Numbers
Proposal Submissions to ENG by Under-Represented Minorities

* Source: ASEE, 2009, *Engineering By the Numbers*
Research Proposal Funding Rates for All ENG, Women, and Under-Represented Minorities
Resources

• Directorate for Engineering:
  – Rosemarie D. Wesson, Program Director, Chemical and Biological Separations, CBET
  – rwesson@nsf.gov and 703-292-7070

• Funding Opportunities:
  http://www.nsf.gov/funding/

• NSF Email Updates: www.nsf.gov