NSF Directorate for Engineering

Athanassios Sambanis
Grants Conference
June 1-2, 2015
ENG Mission and Vision

- **Mission:** To enable the engineering and scientific communities to advance the frontiers of engineering research, innovation, and education, in partnership with the engineering community, and in service to society and the nation.

- **Vision:** ENG will be a global leader in identifying and catalyzing fundamental engineering research, innovation, and education.
NSF ENG Strategy

- Attract, stimulate, catalyze and challenge research communities to think big, enable transformational advances, and expand national innovation capacity
- Portfolio balance between fundamental, applied and translational as well as small, medium and large projects
- New approaches to address engineering education challenges
- Collaborate and partner within and outside NSF to maximize opportunity for the engineering research and education community to address major national priorities
Disciplines in a Multidisciplinary World

- NSF ENG has a strong commitment to fundamental engineering research
- How should we think about discipline based fundamental research in the contemporary research environment?
- Think of disciplines as super-nodes in the knowledge network
- Major opportunity: robust, effective linkages among nodes to solve tomorrow’s problems

Role of Grand Challenges

- Grand challenges can be very useful in catalyzing major breakthroughs and advances
  - NAE Grand Challenges in Engineering
- Key characteristics:
  - Big impact
  - Ambitious yet achievable
  - Compelling vision
  - Right level of specificity
- How can the engineering research community use the grand challenge vehicle for big research achievements?
Funding Opportunities

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

Funding

- Proposals must address NSF goals
  - Transform the frontiers of science and engineering
  - Stimulate innovation and address societal needs through research and education
- NSF Merit Review criteria
  - Intellectual Merit
  - Broader Impacts
Leaf sensor alerts when plants are thirsty

- The biotech and agriculture company, AgriHouse, developed a sensor that measures the water deficit stress in a plant.
- When a plant starts drying out, its leaves contract, which is reflected in a change electrical voltage.
- The sensor transmits those voltage changes to a cell phone, or computer, so a farmer can use the data to turn irrigation equipment on or off.
- In tests at the USDA research farm, beans attached to leaf sensors used 25 percent less water with the sensors than they did when watered using standard irrigation practices.
- The technology was first created by aerospace engineers and the doctoral research work of Hans-Dieter Seelig of the University of Colorado.

Images courtesy: NSF

Generating energy from wastewater

- The Cambrian Innovation system, called EcoVolt, generates methane gas from the wastewater.
- The system sends wastewater through a bio-electrochemical reactor.
- As water filters through it, special bacteria in the reactor eat the organic waste in the water and release electrons as a byproduct.
- Those electrons travel through a circuit to generate methane, which is then burned to generate heat and energy.
- In a pilot at the Clos du Bois winery in Calif., it is saving the winery more than $200K per year.

Images courtesy: Cambrian Innovation
Wireless power transfer for vehicles

- Researchers at the FREEDM Systems ERC at North Carolina State University have developed new technology and techniques for transmitting power wirelessly from a stationary source to a mobile receiver.
- Srdjan Lukic and team developed a small, functional prototype of their system and are now working to both scale it up and increase the power of the system.
- This proof of concept brings them closer to their goal of creating highway "stations" that can recharge electric vehicles wirelessly as the vehicles drive by.

Image Credit: NCSU

Sensitive electrode locates areas for treatment

- Walt Besio, a biomedical engineer at the University of Rhode Island, has developed a more sensitive electrode that can conduct electricity into and out of specific brain areas.
- He has already used it to pinpoint areas to treat epilepsy, a brain disorder associated with abnormal electrical activity.
- With support from I-Corps and SBIR, Besio aims to make the electrodes commercially available.

Image Credit: Joe Giblin, URI
Simultaneous functional imaging of all neurons

- Researchers led by Ed Boyden of MIT achieved simultaneous functional imaging of all the neurons of the transparent roundworm *C. elegans*.
- This technique is the first that can generate 3-D movies of activity across entire brains at the millisecond timescale.

**Image Credit:** MIT and University of Vienna

3-D printed implants for complex injuries

- Researchers adapt technology for 3-D printing metals, ceramics and other materials to create custom medical implants designed to fix complicated injuries.
- Materials scientist Susmita Bose and materials engineer Amit Bandyopadhyay of Washington State University are creating implants that more closely mimic the properties and shape of human bone, such as the skull.

**Image Credit:** Robert Hubner, WSU Photo Services
New component design for cognitive radio

- Cognitive radio allows temporarily unallocated frequencies to be loaned to secondary users.
- For it to work, front-end microwave components must support cognitive radio operation over a wide frequency range (spectrum sensing).
- A team led by Vijaya Kumar Devabhaktuni at the University of Toledo designed and fabricated an effective low-cost, low-complexity power divider component that enables cognitive radio for ultra-wideband spectrum.

Image Credit: University of Toledo

Proposal Submission

- The right program for a proposal depends on the research objective
- The research goal is to obtain a fundamental understanding of...
- The research objective is to test the hypothesis...
- Winning proposals need both a research objective and a plan to accomplish the objective
NSF Supports Research

• Winning proposals focus on research, not development
• If the focus of the proposal is an artifact (a device, system, product, process,...), it’s probably development
• If the focus of the proposal is knowledge (the truth of a hypothesis), it’s probably research

Steps towards Successful Proposals

• Begin with
  • White paper
  • Dialog with Program Officer
  • Short biography
• Get involved with NSF reviews
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

Major Forms of Misbehavior

- Plagiarism—uncited reproduction of the work of others
- Falsification—intentional misrepresentation of data or results (progress reports)
- Fabrication—making up data
- Double charges—billing the government twice for the same work
CBET Areas of Interest

Chemical, biochemical, and biotechnology
- processing and manufacturing of products with chemical and renewable resources

Biomedical engineering and engineering healthcare
- integration of engineering and life science to solve biomedical problems

Environmental engineering and sustainability
- reduction of adverse effects of solid, liquid, and gaseous discharges into land, waters, and air that result from human activity

Transport and thermal fluids phenomena
- thermal, mass, and momentum transport that enable new technological solutions (energy, environment, manufacturing, health care, ...)

ONE submission deadline per year: October 1 - 20, 2015; October 1 - 20, Thereafter
Civil, Mechanical, and Manufacturing Innovation (CMMI)

CMMI Areas of Interest

**Advanced Manufacturing**
- transformative advances in manufacturing and materials processing, with emphases on efficiency, economy, sustainability and scalability

**Mechanics and Engineering Materials**
- understanding the properties and use of materials in engineered and natural systems

**Resilient and Sustainable Infrastructures**
- innovation to advance resilience and sustainability of civil infrastructure and distributed infrastructure networks

**Systems Engineering and Design**
- decision-making aspects of engineering, including design, control, optimization and systems science

TWO submission deadlines: September 1-15, February 1-17
**Electrical, Communications, and Cyber Systems (ECCS)**

- **Deputy Division Director**
  - Dominique Dagenais (acting)

- **Division Director**
  - Samir El-Ghazaly

- **Senior Engineering Advisor**
  - Larry Goldberg

**Communications, Circuits, and Sensing Systems (CCSS)**
- George Haddad
- Zhi (Gerry) Tian
- Mona Zaghloul

**Electronics, Photonics, and Magnetic Devices (EPMD)**
- Mahmoud Fallahi
- Dimitris Pavlidis
- Usha Varshney

**Energy, Power, Control and Networks (EPCN)**
- Eyad Abed
- Kishan Baheti
- Paul Werbos

**Optics and Photonics Group**
- Dominique Dagenais
- Mahmoud Fallahi

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**ECCS Areas of Interest**

- Fundamental research issues underlying device and component technologies, power, controls, computation, networking, communications and cyber technologies

- The integration and networking of intelligent systems at the nano, micro and macro scales
  - for healthcare, homeland security, disaster mitigation, energy, telecommunications, environment, transportation, manufacturing, and other systems-related areas

- ONE submission deadline per year: Nov. 3, 2014, and Nov. 1 annually thereafter
Emerging Frontiers in Research and Innovation (EFRI)

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

- Recent topic areas:
  - Flexible Bioelectronics Systems (BioFlex)
  - Origami Design for the Integration of Self-assembling Systems for Engineering Innovation (ODISSEI)
  - Photosynthetic Biorefineries (PSBR)

- New topic announced in April 2013: 2-DARE
  - 2-D Atomic-layer Research and Engineering

- 4-year awards at ~$500K per year

Engineering Education and Centers

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Engineering Centers and Networks

- Large-scale research investments in ENG
- Supports collaboration with industry and other stakeholders to promote innovative research and education
- Engineering Research Centers (ERC)
  - Three generations (50 centers total) since 1985
  - New Nano-Systems ERCs (NERCs) in FY12
- Nanoscale Science and Engineering Centers (NSEC)
  - 19 NSECs since 2001
  - 3 graduated NSECs from FY01 class
- Network for Computational Nanotechnology
  - Cyber-resource for nanotechnology theory, modeling and simulation
  - nanoHUB.org gateway for nanotechnology research and education
  - > 180k users globally

Industrial Innovation and Partnerships (IIP)

- Senior Advisor
  - Donald Senich
- Division Director
  - Cheryl Albus (acting)
- SBIR/STTR Program
  - Joe Hennessey

- Grant Opportunities for Academic Liaison with Industry (GOALI)
  - Donald Senich
- Industry/University Cooperative Research Centers (I/UCRC)
  - Raffaella Montelli
  - Shashank Priya
- Partnerships for Innovation: Accelerating Innovation Research (PFI-AIR)
  - Barbara Kenny
- Partnerships for Innovation: Building Innovation Capacity (PFI-BIC)
  - Sara Nerlove

- Advanced Material & Instrumentation (MI)
  - Ben Schrag
- Advanced Material & Nanotechnology (MN)
  - Rajesh Mehta
- Biological Technologies (BC)
  - Ruth Shuman
- Chemical and Environmental Technologies (CT)
  - Prakash Balan
- Education Applications and Technologies (EA)
  - Glenn Larsen

- Electronic Hardware, Robotics and Wireless Technologies (EW)
  - Murali Nair
- Information and Communication Technologies (IC)
  - Peter Atherton
- Semiconductors (S) and Photonic (PH) Devices and Materials
  - Steven Konsek
- Smart Health (SH) and Biomedical (BM) Technologies
  - Jesus Soriano
- Experts/Special Topics
  - George Vermont
Research to Commercialization: Filling the Gap

ENG Investments and Crosscutting Programs
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 award size increased to $500,000
- Note: the CAREER award is not just a research award, it is a career development award

Crosscutting and NSF-wide Opportunities

- Collaborative Research in Computational Neuroscience (CRCNS)
- Critical Techniques and Technologies for Advancing Big Data Science & Engineering (BIGDATA)
- Cyber-enabled Sustainability Science and Engineering (CyberSEES)
- Cyber-Physical Systems (CPS)
- Innovation Corps (I-Corps)
- Integrative Strategies for Understanding Neural and Cognitive Systems (NSF-NCS)
- Interdisciplinary Research in Hazards and Disasters (Hazards SEES)
- National Robotics Initiative (NRI)
- Pan-American Advanced Studies Institutes (PASI)
- Partnerships for International Research and Education (PIRE)
- Research Coordination Networks
- Scalable Nanomanufacturing (SNM)
- Sustainability Research Networks (SRN)
- Sustainable Chemistry, Engineering, and Materials (SusChEM)
Closing Thoughts

- NSF ENG is deeply committed to fundamental engineering research, education and people, and innovation for benefit to the nation.

- We invite the engineering community to help us in embracing current opportunities and lay the foundations for a prosperous future for engineering.

- This will require all of us to be creative, bold, collaborative, inclusive, and persistent.

Stay in Touch

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ENG Homepage, www.nsf.gov/eng

Email updates
• Funding opportunities
• Due dates

Questions?

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