



National Science Foundation

Research Priorities in the Electrical and Communications Systems Division (ECS)

2005 ASEE Engineering Research Council
Workshop and Forum
February 27- March 1, 2005

Dr. Usha Varshney

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Electrical and Communications Systems Division
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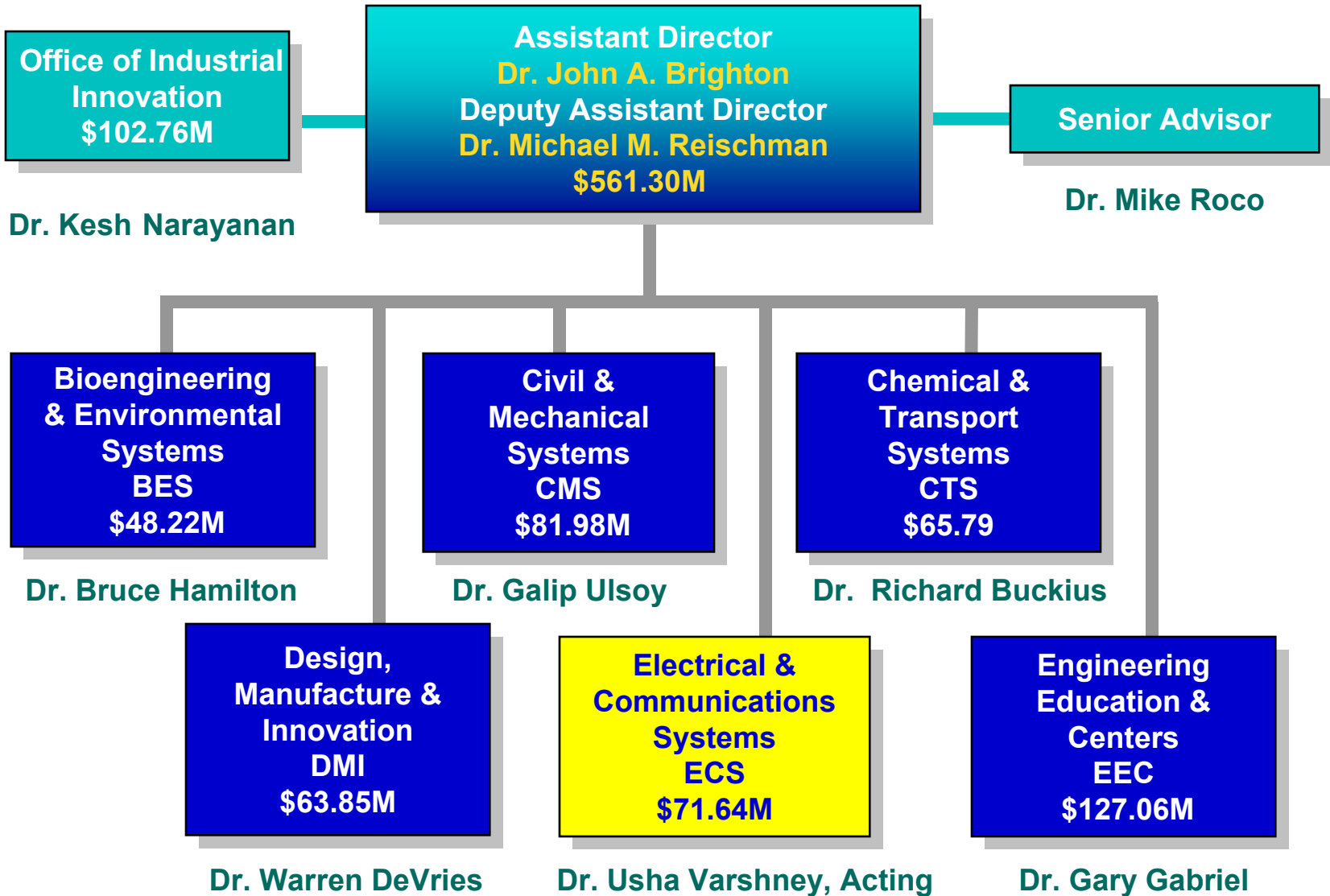


Outline

- **ECS Division**
- **Vision**
- **Mission**
- **Programs**
- **Future Technologies**
- **Program Management**
- **Investments in Initiatives**
- **Infrastructure Network**
- **Graduate Research Supplements**
- **Workshops**



Directorate for Engineering





Vision

ECS envisions a research community...

- that will address major technological challenges in devices and systems due to the **convergence of** micro/nano/info/cogno/bio-electronics, controls, networks, computation, and communications
- that will **prepare a future workforce** to meet the emerging technological challenges of the 21st Century



Mission

- **Address** fundamental research issues underlying component and device technologies, computation, networking, controls, and systems principles at the nano, micro, and macro scales
- **Support** the integration and networking of intelligent systems for a variety of application domains
- **Ensure** the education of a diverse workforce prepared to continue the rapid development of emerging technologies as drivers of the global economy



ECS Programs

Electronics, Photonics, and Device Technologies

- ✓ Microelectronics
- ✓ Nanoelectronics
- ✓ Molecular Electronics
- ✓ Silicon Nanoelectronics and Beyond
- ✓ Organic Electronics
- ✓ Spin Electronics
- ✓ Bioelectronics
- ✓ Micromagnetics
- ✓ Photonics and Optoelectronics
- ✓ Quantum Optics
- ✓ Ultrafast Sources
- ✓ Sensors and Actuators
- ✓ MEMS/NEMS
- ✓ Power Electronics
- ✓ Nonsilicon Electronics
- ✓ RF/Microwave and Mixed Signals
- ✓ Electromagnetics

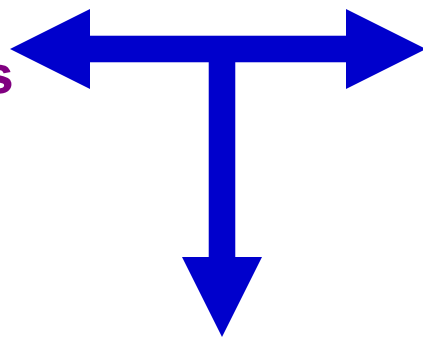
Control, Networks, and Computational Intelligence

- ✓ Hybrid and Distributed Control
- ✓ Power and Energy Networks
- ✓ Computational Intelligence
- ✓ Sensor Networks
- ✓ Multi-scale Modeling
- ✓ Biologically Inspired Computation
- ✓ Computational Video and Imaging

Integrative Systems

Nanosystems, Microsystems, Microsystems, Hybrid and Complex Systems

- ✓ Lab-on-a-chip
- ✓ Organic and Silicon- based Hybrid Systems
- ✓ Optical and Wireless Communications Systems
- ✓ Robotics and Machine Intelligent Systems
- ✓ Quantum Information Systems





ECS Future Technologies

Key Technologies

- Integrative and Complex Systems
- Communications and Network Systems

Priority Technologies

- ✓ Nanoelectronics, Nanomagnetism, and Nanophotonics
- ✓ Cyberengineering and Cybersecurity Systems
- ✓ Critical Infrastructure Systems
- ✓ Flexible Electronics

Other Focus Areas

- Quantum Engineering
- Diagnostic and Implantable Devices
- Hydrogen Economy
- Adaptive Dynamic Programming
- Neuro-dynamic Control and Learning for Complexity



Unsolicited Proposals

- **Submission Windows**
 - » September 7 - October 7
 - » January 7 - February 7
- **Success Rates**
 - » Unsolicited: 12%
- **Award Size for Unsolicited**
 - » \$240,000 for three years
- **Reviewers**
 - » Encourages reviewers from university , industry and government



Program Management

Dr. Usha Varshney, Acting Division Director

Dr. Lawrence Goldberg, Senior Engineering Advisor

lgoldber@nsf.gov

Dr. Filbert Bartoli

fbartoli@nsf.gov

Optoelectronics; Photonics; Ultrafast Technologies; EUV; Nanophotonics

Dr. Rajinder Khosla

rkhosla@nsf.gov

Micro/Nanoelectronics; NEMS/MEMS based on silicon and non-silicon materials; Sensors; Imaging; Bioelectronics

Dr. James Mink

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Micro/Nanoelectronics; Molecular Electronics; Spin Electronics; Organic Electronics; Power Electronics; Micromagnetics

Vacant

Optical and Wireless Communications; Mixed Signals Technologies

Dr. Radhakishan Baheti

rbaheti@nsf.gov

Embedded Control, Control Theory and Methods for Communications Networks, Internet, Biomedical Systems; Robotics

Dr. Vittal Rao

vr Rao@nsf.gov

Integrated Sensor Networks; Autonomic Communications and Networks; Computational Video and Imaging Networks; Cyberinfrastructure and Cybersecurity

Dr. Kevin Tomsovic

ktomsovi@nsf.gov

Power and Energy Networks; Distributed Networks; Economics of Power Grids; Security and Reliability of Critical Infrastructures

Dr. Paul Werbos

pwerbos@nsf.gov

Neural Network Computation and Control; Learning and Self-organizing Computations; Biologically Inspired Computation



ECS Investments for FY 2005

NSF Priority Areas

(Millions of Dollars)

	NSF	ENG	ECS
● Biocomplexity in the Environment	\$99	\$6	\$1.2
● Human and Social Dynamics	\$38	\$2	\$0.5
● Mathematical Sciences	\$89	\$2.9	\$0.55
● Nanoscale Science and Engineering	\$297	\$127.77	\$36

NSF Programs

- ✓ ADVANCE: Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers
- ✓ CAREER: Faculty Early Career Development Program
- ✓ RET: Research Experiences for Teachers
- ✓ REU: Research Experiences for Undergraduates
- ✓ SGER: Small Grants for Exploratory Research
- ✓ MRI: Major Research Instrumentation Program

ENG Initiatives

- Collaborative Large-scale Engineering Analysis Network for Environmental Research (CLEANER)
- Grants for the Department-Level Reform of Undergraduate Engineering Education (DLR)
- Sensors and Sensor Networks



Nanoscale Science and Engineering (NSE)

Research Themes:

- Biosystems at the Nanoscale
- Nanoscale Structures, Novel Phenomena, and Quantum Control
- **Nanoscale Device and System Architecture**
- **Silicon Nanoelectronics and Beyond**
- Nanoscale Processes in the Environment
- Multi-Scale, Multi-Phenomena Theory, Modeling and Simulation at the Nanoscale
- Manufacturing Processes at the Nanoscale
- Societal and Educational Implications of Nanotechnology

Modes of support:

- » **Nanoscale Interdisciplinary Research Teams (NIRT)**, \$1-2 M/Year for 4 Years
- » **Nanoscale Exploratory Research (NER)**, < \$130K, 1 Year, 11-18-2004
- » **Nanoscale Science and Engineering Centers (NSEC)**, 11-10-2004, **3-01-2005**
 - ✓ **Center on Hierarchical Manufacturing (CHM)**, \$4.0 M/Year for 5 Years
 - ✓ **Center for Nanotechnology in Society (CNS)**, \$2.6 M/Year for 5 Years



Nanoscale Science and Engineering Education (NSEE)

To produce systemic changes in Nanoscale Science and Engineering Education

- **Nanoscale Informal Science Education (NISE):**

Foster public awareness and understanding of nanoscale science and engineering through establishment of a Network, a national infrastructure that links science museums and other informal science education organizations with nanoscale science and engineering research organizations

Up to \$4.5 M/Year for 5 Years, 1 Award

- **Nanotechnology Undergraduate Education (NUE):**

Introduce nanoscale science and technology into undergraduate education through a variety of interdisciplinary approaches, particularly in the first two collegiate years

Up to \$200.000 total for up to 2 Years, 15 Awards

NSF 05-543 (\$7.5M)

Proposal Deadline: April 6, 2005



Sensors and Sensor Networks

Program	Sensors and Sensor Networks I FY 2003	Sensors and Sensor Networks II FY 2004	Sensors and Sensor Networks III FY 2005
Solicitation Number	NSF 03-512	NSF 04-522	NSF 05-526
Participating Directorates	MPS, CISE, ENG	ENG, GEO, BIO, OPP	ENG, GEO, OPP
Funding Amount	\$46.0M	\$38.9M	\$23.0M
Awards	900 / 94	600 / 100	40
Success Rate	10%	14%	-

Topical Areas:

- » Engineering of materials, concepts, and designs for new sensors and sensing systems
- » Engineering applications of networked sensors, interpretation of data, responsive action
- » Environmental sensors and sensing systems

Emphasis on Integration of Sensor Research and Education

Researcher can participate in no more than one proposal for submission to this solicitation

- ✓ Individual Investigator, up to \$125,000/year for three years
- ✓ Small Teams, up to \$250,000/year for three years
- ✓ Interdisciplinary Research Groups, up to \$500,000/year for five years

Proposal Deadline: March 3, 2005



Electric Power Network Efficiency and Security (EPNES) I and II

Goals:

- Address fundamental issues underlying survivability, efficiency, sustainability and behavior of large electric power systems under different disruptive or catastrophic events
- Build interdisciplinary partnerships which allow more unified coherent research to ensure reliable, secure, and efficient electric power networks
- Address socio-economic issues, environmental issues, new pedagogy and curricula to prepare a future workforce,

NSF 02-041 and NSF 02-188 (\$9M)



Ultra-High-Capacity Optical Communications I and II

Goal: Enable continued growth in data capacity, increase bandwidth, achieve higher spectral efficiency, and facilitate low-cost processing and manufacturing for optical communication systems

Topical Areas: Materials, Devices and Systems that will promote

- Advanced optical switching networks
- Integration of microwave wireless with the optical backbone
- Increased capacity and functionality of Communication Networks
- Optical fiber communications beyond 300-nm spectral bandwidths
- Spectrally efficient 50-100 terabit/s single-fiber capability
- Optical-electronic interfaces to achieve greater than 40-Gbit/s per channel systems
- New mathematical models and tools for accurate simulation to identify fundamental limitations

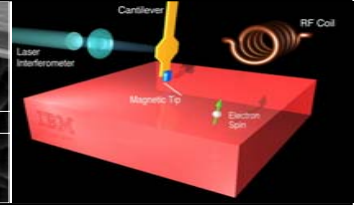
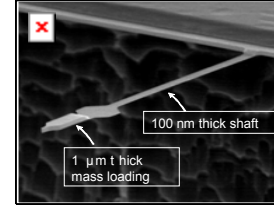
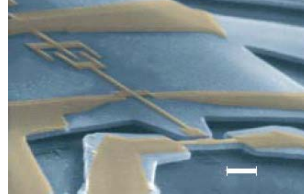
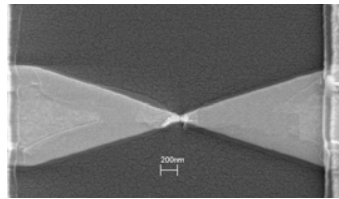
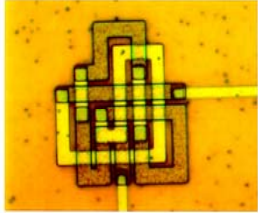


Recent Emphasis in ENG /ECS Initiatives

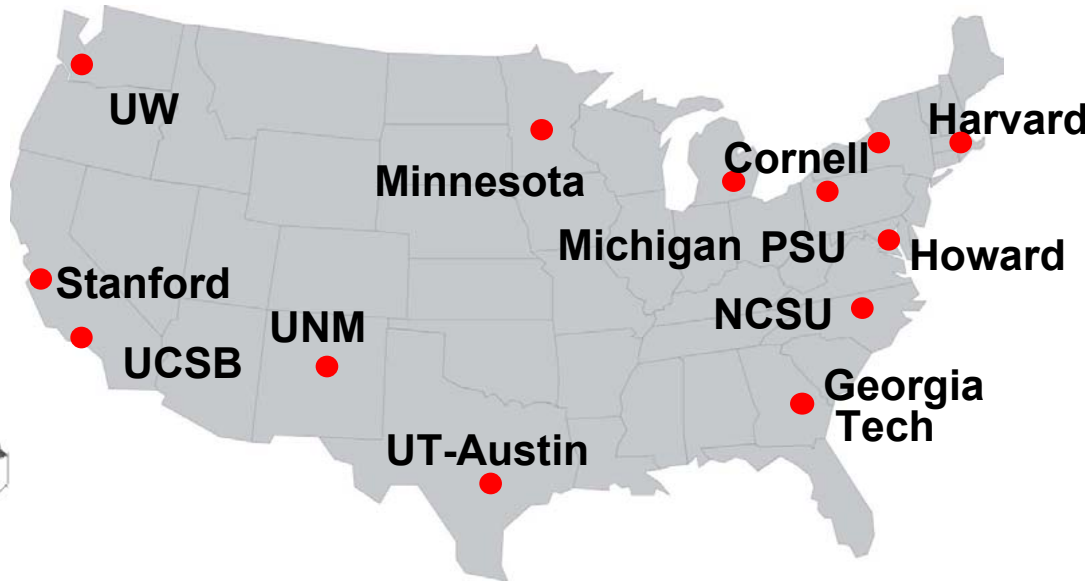
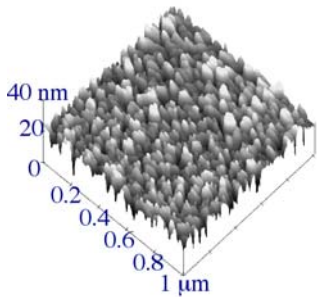
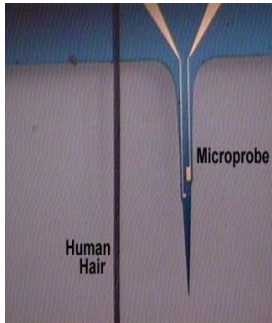
- **Spin Electronics for the 21st Century**
(NSF 02-036), with **ENG (CMS, CTS, BES)** and **ONR**
- **Joint Investigation of Enabling Technologies for Space Solar Power**
(NSF 02-098), with **ENG (BES, DMII)**, **CISE (DIIS)**, **EPRI** and **NASA**
- **Partnership in Electric Power Network Efficiency and Security I and II**
(NSF 02-041, NSF 02-188), with **ENG (BES)**, **SBE (INT)**, **HER (DUE)**, **ONR** and **EPRI**
- **Ultra-High Capacity Optical Communications and Networking I and II**
(NSF 01-065, NSF 03-537), with **ENG (BES)**, **NSF(CISE)** and **DARPA**, and **ENG (CTS, DMII)**, **MPS (DMS)** and **DARPA**
- **Silicon Nanoelectronics and Challenges to Current CMOS Technology**
(NSF 03-043), with **SRC**
- **Technological Challenges in Organic Electronics, Photonics and Magnetics**
(NSF 04-554), with **ENG (CMS, CTS, BES, DMII)**, **DARPA** and **AFOSR**
- **Sensors and Sensor Networks I, II and III** (NSF 03-512, NSF 04-522, NSF 05-526),
with other **ENG Divisions**, **NSF(OPP)** and **NSF(GEO)**
- **Nanoscale Science and Engineering**, **NSF-wide** Yearly Solicitation, Centers,
Interdisciplinary teams, Exploratory Research, Undergraduate Education



National Nanofabrication Infrastructure Network (NNIN)



Single Electron Spin detection using Magnetic Resonance force Microscopy, Rugar et al., *Nature* 430, July (2004)



- Cornell U.*
- Stanford U.*
- U. of Michigan*
- Georgia Institute of Technology*
- U. of Washington*
- Pennsylvania State U.*
- U. of California-Santa Barbara*
- U. of Minnesota*
- U. of New Mexico*
- U. of Texas –Austin*
- Harvard U.*
- Howard U.*
- North Carolina State U.*

An integrated national network of user facilities, providing researchers open access to resources, instrumentation, and expertise in all domains of nanoscale science, engineering, and technology





Graduate Research Supplements

Graduate Research Supplements (GRS) for Women and Underrepresented Minority Ph.D. Students Majoring in Electrical Engineering or Biomedical/Biochemical/Environmental Engineering Disciplines

- To increase numbers in academic/professional careers
- Supplements to existing NSF grants
 - » Graduate student stipend and tuition consistent with university practices
 - » 25% Administrative Cost
 - » 12 months, renewable for two additional years during the grant period
 - » Nontransferable
 - » US Citizens or Nationals or Permanent Residents

Expected Deadline: May 30, 2005



Workshops

- **Macro to Nano: Challenges and Opportunities in Integrative Complex Systems Engineering**

March 7- 8, 2005, Arlington, Virginia

- **Impact of the Changing Global Environment on Electrical Engineering Education**

June 2005 (In-Planning)

Organized by the Electrical and Computer Engineering Department Heads Association (ECEDHA) and the International Engineering Consortium (IEC)



Thank you

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<http://www.nsf.gov/eng/ecs/about.jsp>**