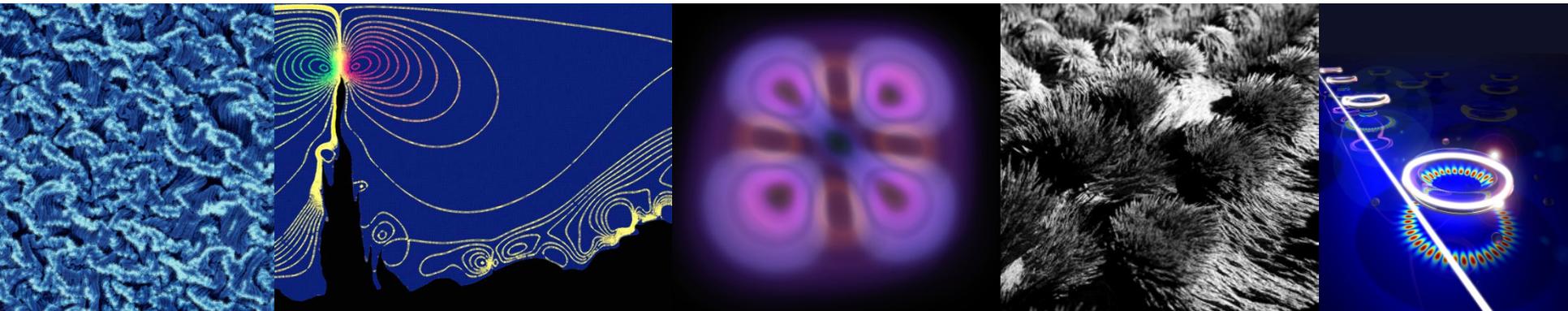
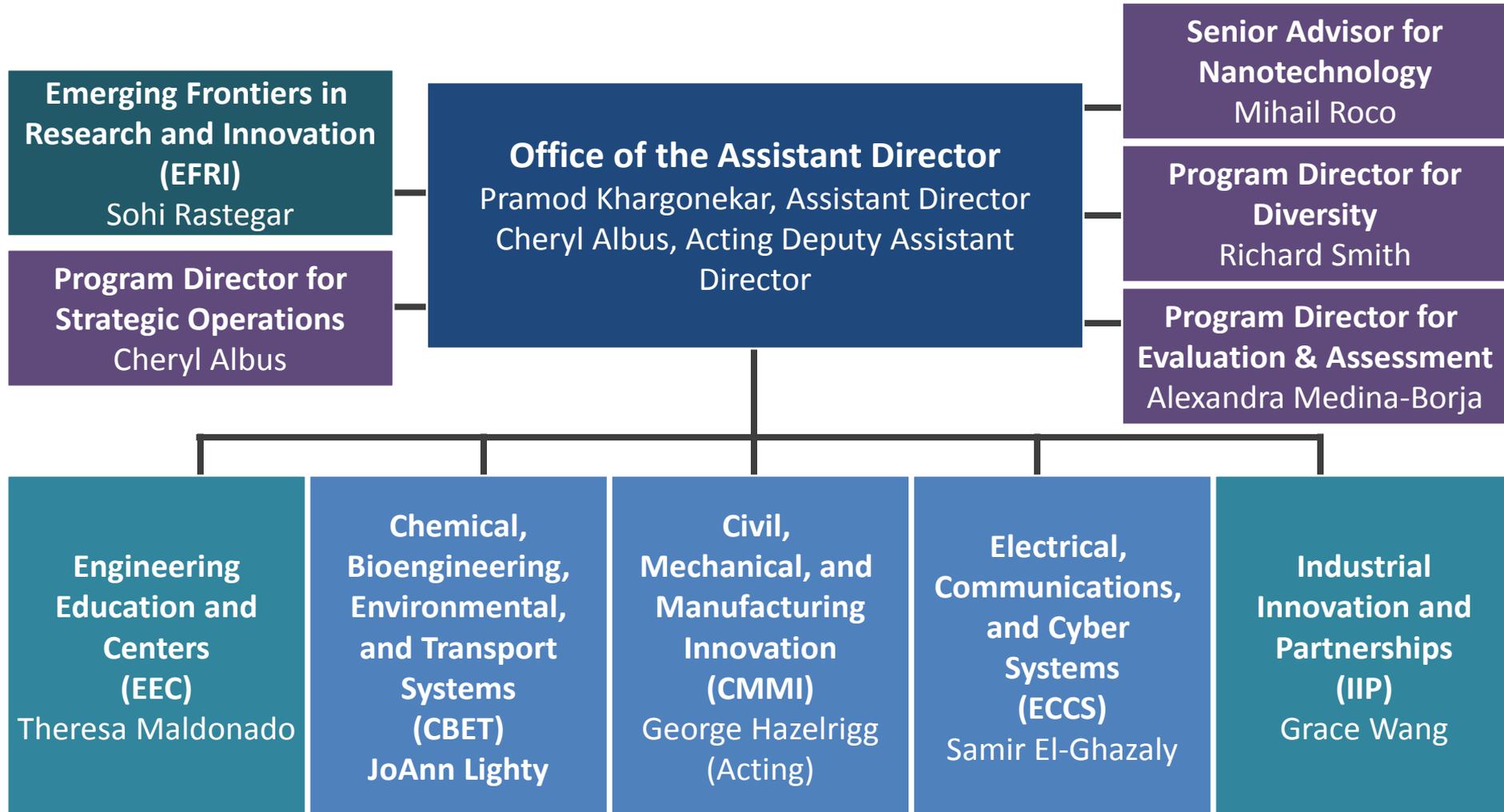


Directorate for Engineering

George A. Hazelrigg
Acting Division Director, CMMI



NSF Directorate for Engineering (ENG)



ENG 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

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 an hypothesis), it's probably research

Chemical, Bioengineering, Environmental, and Transport Systems (CBET)

Deputy Division
Director
Susan Kemnitzer (Acting)

Division Director
JoAnn Lighty

Chemical,
Biochemical, and
Biotechnology
Systems

Catalysis and
Biocatalysis
George Antos

Chemical and
Biological Separations
Rose Wesson

Process and
Reaction Engineering
Maria Burka

Biomedical
Engineering and
Engineering
Healthcare

Biotechnology and
Biochemical
Engineering
Friedrich Srienc

Biomedical
Engineering
Thanassis Sambanis

Biophotonics
Leon Esterowitz

Nano-Biosensing
Alex Revzin

General and Age-
Related Disabilities
Engineering
Ted Conway

Environmental
Engineering and
Sustainability

Energy for
Sustainability
Greg Rorrer

Environmental
Engineering
William Cooper

Environmental
Health and Safety
of Nanotechnology
Eddie Chang (Acting)

Environmental
Sustainability
Bruce Hamilton

Transport, Thermal,
and Fluid
Phenomena

Combustion and Fire
Systems
Ruey Chen

Fluid Dynamics
Dimitrios Papavassilou

Interfacial Processes
and Thermodynamics
Eddie Chang

Particulate and
Multiphase Processes
William Olbricht

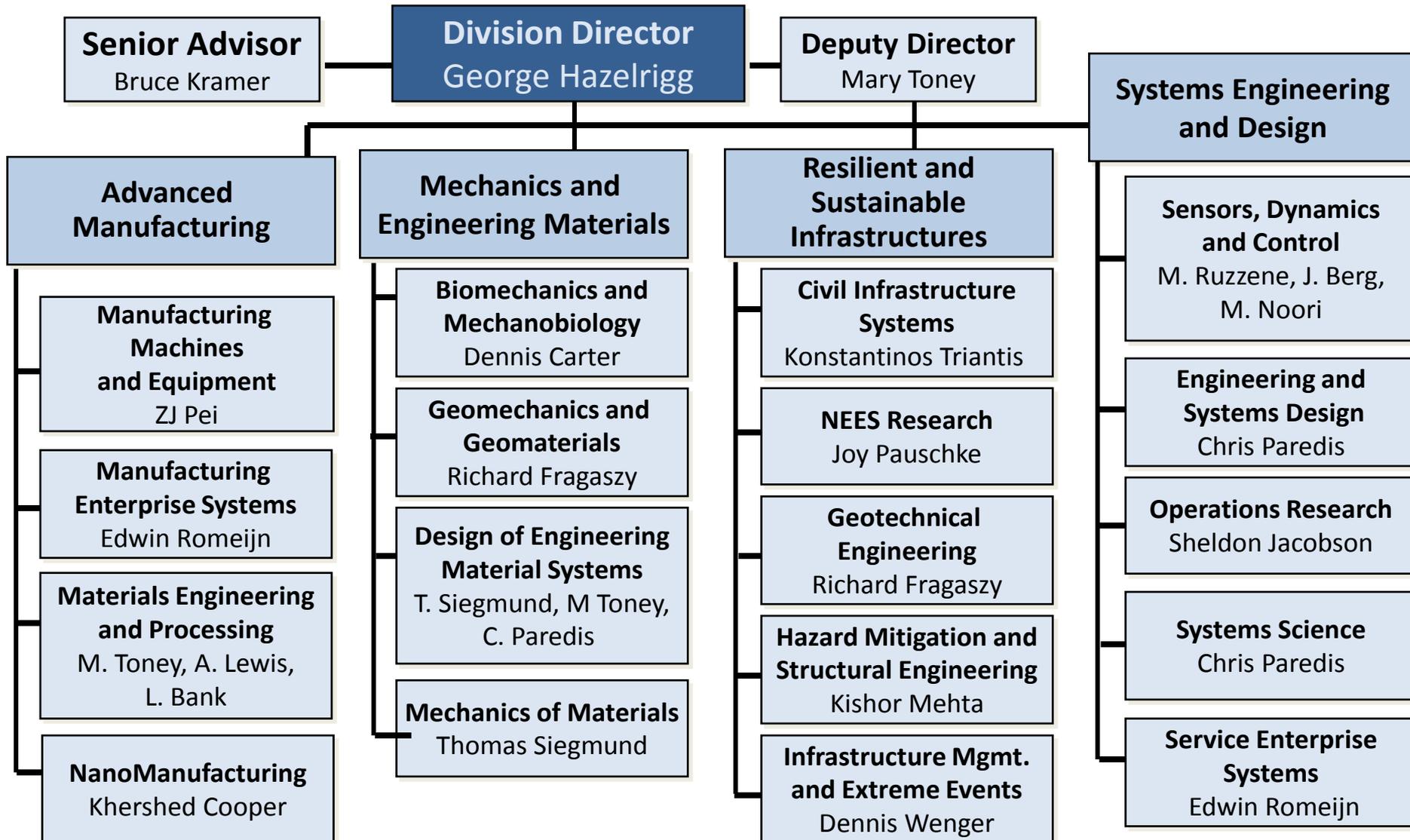
Thermal Transport
Processes
Sumanta Acharya

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:** to
 - reduction of adverse effects of solid, liquid, and gaseous discharges into land, fresh and ocean waters, and air that result from human activity
 - the long-term availability of these resources and energy
- **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: Fall (Nov.) 2014

Civil, Mechanical, and Manufacturing Innovation (CMMI)

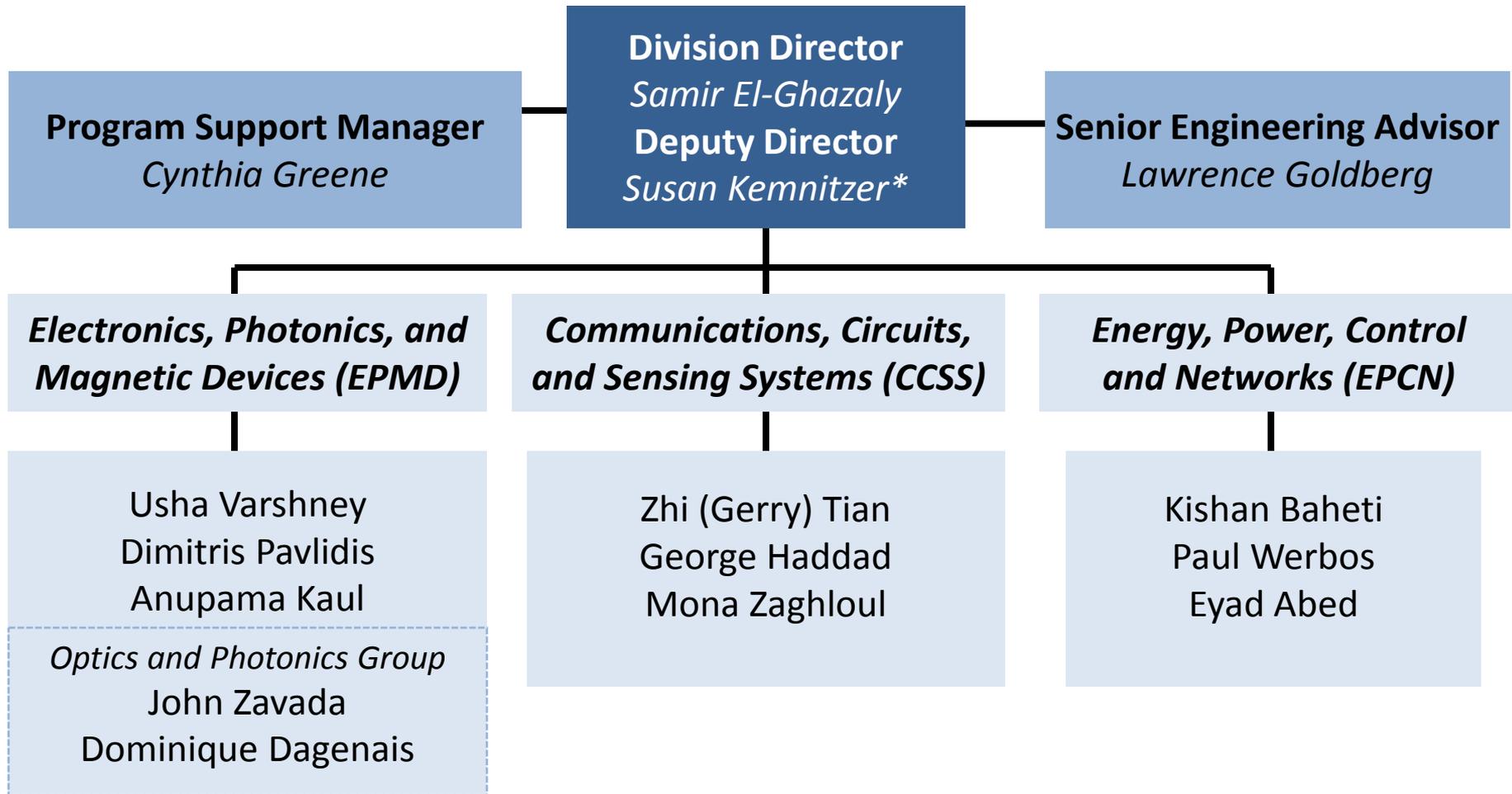


CMMI Areas of Interest

- **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 each year: Sept. 15 and Feb. 15

Electrical, Communications, and Cyber Systems (ECCS)



* Currently serving as Acting Deputy Division Director for CBET

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 a variety of application domains in healthcare, homeland security, disaster mitigation, energy, telecommunications, environment, transportation, manufacturing, and other systems-related areas.

Electrical, Communications and Cyber Systems (ECCS)

Susan Kemnitzer, Division Deputy Director • Samir El-Ghazaly, Division Director • Lawrence Goldberg, Senior Engineering Advisor

Electronics, Photonics, and Magnetic Devices (EPMD)

Dimitris Pavlidis

- Microwave/mm-Wave/THz Devices & Components, Electromagnetic Effects and Components based on them
- Nanoelectronics & Next Generation Devices, Semiconductor Material - Device Interaction and Reliability
- Wideband gap Semiconductors and Devices, Circuits, Device/Circuit Simulation & Modeling
- Metamaterial and Plasmonic-Based Devices & Components

Anupama Kaul

- Flexible, Printed and Organic Electronics & Photonics
- Carbon-based Electronics
- "Beyond" graphene 2D materials and devices
- Nano-electronics and Energy-Efficient electronics

Usha Varshney

- Bioelectronic and Biomagnetic Devices
- Magnetics, Spin Electronics and Quantum Devices
- Sensor Device Technologies
- Next Generation Memories

Optics & Photonics Group

(John Zavada & Dominique Dagenais)

- Nanophotonics, Metamaterials & Plamonics
- Advanced Optical Sources & Photo-detectors
- Nonlinear & Ultrafast Photonics
- Photonics Integrated Circuits
- Optical Communication Components
- Single-photon and Quantum Devices
- Optical Imaging & Sensing
- Solar Cells & Photovoltaic Components

Communications, Circuits, and Sensing-Systems (CCSS)

Zhi (Gerry) Tian

- RF/Wireless, Optical, and Hybrid Communications and Networking
- Integrated Sensing, Communication, and Computational Systems
- Spectrum Access and Spectrum Sharing, Cognitive Radio
- Signal Processing and Compressive Sampling
- Cyber Physical Systems and Security.

George Haddad

- Low Power, Low Noise, High Efficiency Communications
- Inter- and Intra-Chip Communications and Networking including THz and optical guided and wireless interconnects.
- Wireless Communications and Sensing circuits and systems.
- Integrated Circuit Design (Mixed-Signal, Fault-Tolerant, Self -Test and Repair, Stochastic Design)
- Real-Time Monitoring and Stimulation of the Brain and other Body functions in natural environments

Mona Zaghloul

- Micro, Nano, and Bio Systems (MEMS/NEMS)
- Chemical, Biological and Physical Diagnostics
- Sensors, Actuators and Electronic Interfaces (Brain and other Body functions, Health, Infrastructure and Environment)
- Ultra-Low power wearable and implantable sensing and imaging systems.

Energy, Power, Control and Networks (EPCN)

EPCN Group

(Eyad Abed, Kishan Baheti, & Paul Werbos)

- Control Theory and Hybrid Dynamical Systems
- Distributed and Mobile Networked Control
- Cyber Physical Systems Modeling and Control
- Control and Optimization in Healthcare, Transportation and Robotics
- Adaptive and Intelligent Systems/Neural Networks
- Energy Harvesting and Storage Devices and Systems
- Solar, and Wind Energy and Integration of Renewables with Grid
- Monitoring, Protection and Cyber Security of Power Grid
- Advanced Power Electronics and Electric Machines
- Design and Operation of Microgrids
- Electric and Hybrid Vehicles Integration with Grid
- Policy, Economics and Engineering of Power Grid
- Quantum theory and modelling for systems and devices - QMHP (Paul Werbos)



Emerging Frontiers in Research and Innovation (EFRI)

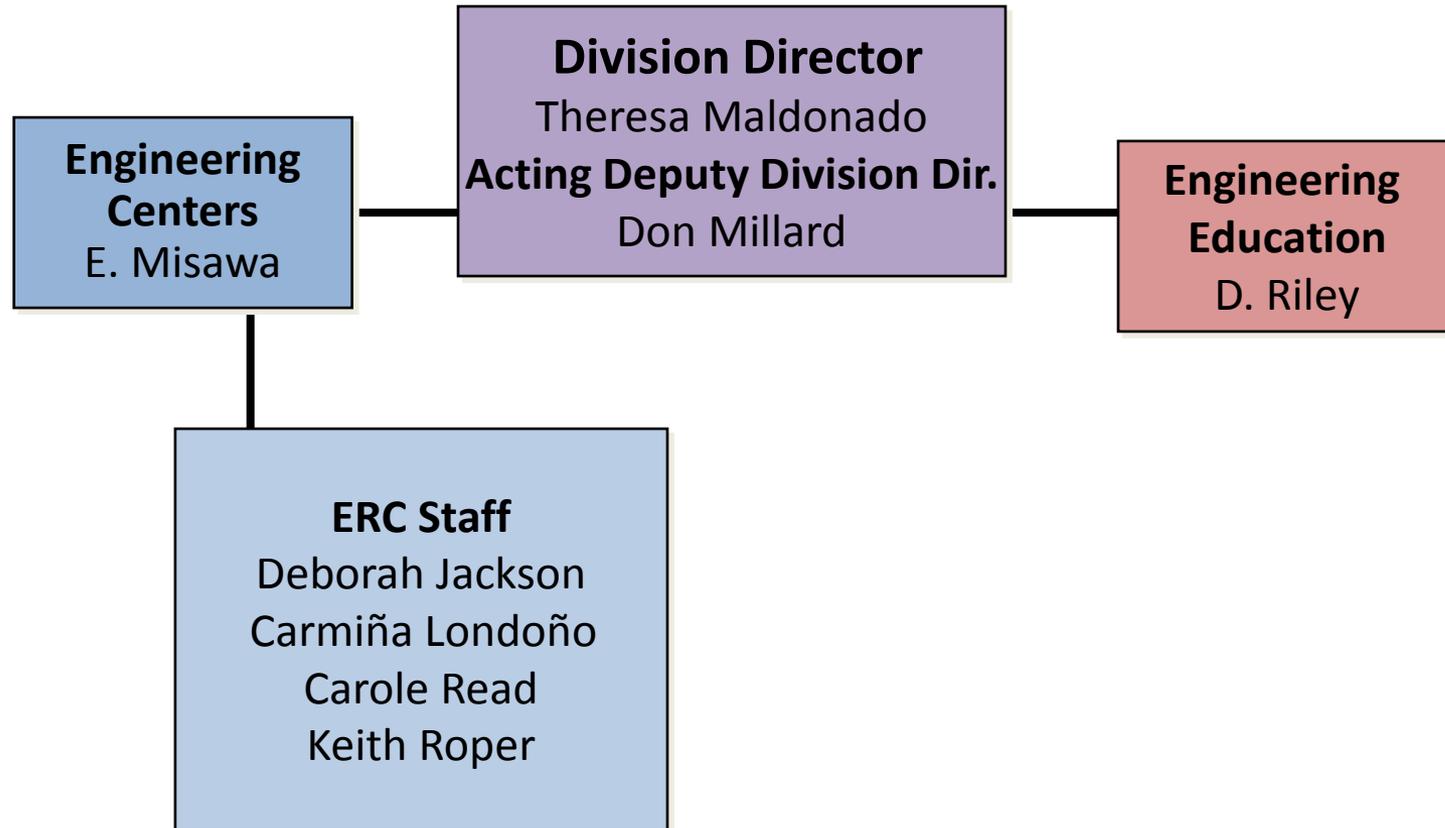
Exploratory Research

- Supports higher-risk, higher-payoff opportunities that:
 - Are potentially transformative
 - Address a national need or grand challenge
- Topic area for FY 2014:
 - 2-Dimensional Atomic-Layer Research and Engineering (2-DARE)
- \$31M investment for 4-year awards at ~\$500K per year
 - More information -- <http://nsf.gov/eng/efri> and <http://efri.org>

EFRI in FY 2013

- FY 2013 Topics
 - Flexible Bioelectronics Systems (BioFlex)
 - Origami Design for Integration of Self-assembling Systems for Engineering Innovation (ODISSEI)
 - Photosynthetic Biorefineries (PSBR)
- FY 2014 Topics
 - 2-DARE chosen from ~150 topic ideas

Engineering Education and Centers (EEC)



Engineering Research Centers

- Support collaboration with industry to promote innovative research and education
- Engineering Research Centers
 - 17 in operation
 - Funding for 10 years
 - 2-year process from solicitation to funding
 - FY 2012 up to 3 Nanosystems ERCs to be established
- Nanoscale Science & Engineering Centers
 - First NSECs graduated in 2011
 - 2007 solicitation established two Centers for the Environmental Implications of Nanotechnology

17 Active ERCs



Note: All centers are multi-university partnerships, university shown is lead institution.

New ERC competition is underway

- 188 pre-proposals received
- 18 invited for full proposals
- Deadline: June 2014
- Awards in FY15

Research Initiation Grants in Engineering Education

- Enables engineering faculty who are renowned for teaching, mentoring, or leading educational reform efforts to initiate collaborations with colleagues in the learning and cognitive sciences to address difficult, boundary-spanning problems in engineering education
- ~\$3M for 20 awards
- Proposals due the last Thursday in March

Engineering Education Research

- Seeks to enable a system of engineering education, equally open to all members of society, that dynamically and rapidly adapts to meet changing needs. Research areas include:
 - Increasing our understanding of how engineering students learn and the capacity that supports such discovery
 - Understanding how to increase the diffusion and impact of engineering education research
 - Understanding engineering education in broader frameworks such as sustainability
 - Diversifying pathways to and through engineering degree programs

Industrial Innovation and Partnerships(IIP)

Division Director
Grace Wang

Senior Advisor, OSDBU
Donald Senich

SBIR/STTR Program
Joe Hennessey

Grant Opportunities for Academic Liaison with Industry (GOALI)
Donald Senich

Industry/University Cooperative Research Centers (I/UCRC)
Larry Hornak

Industry/University Cooperative Research Centers (I/UCRC)
Shashank Priya

Partnerships for Innovation: Accelerating Innovation Research (PFI-AIR)
Barbara Kenny

Partnerships for Innovation: Building Innovation Capacity (PFI-BIC) Sara Nerlove

Assessment, Diversity, & Program Support
Gracie Narcho

Operations Specialist
Greg Misiorek

Program Analyst
Mary Konjevoda

Science Assistant
Lindsay D'Ambrosio

Einstein Fellow
Steve Griffin

Program Specialist
Alexander Hale

Program Specialist
Caroline Hayer

Program Specialist
Willis Phan

Contract Staff

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) & Photonic (PH) Devices and Materials
Steven Konsek

Smart Health (SH) and Biomedical (BM) Technologies
Jesus Soriano

Special Projects
Juan Figueroa

Experts/Special Topics
George Vermont

Grant Opportunities for Academic Liaison with Industry (GOALI)

Synergize university-industry partnerships and fund transformative research that lies beyond that which industry would normally fund



**Industrial scientists
and engineers to
universities**

**Faculty, postdoctoral
fellows, and students
to industry**

**University-
industry teams to
conduct joint
research projects**

Accelerating Innovation Research (AIR)

NSF funding lineage required

- **AIR choice 1: TECHNOLOGY TRANSLATION (TT)**
 - Proofs-of-concept and/or pre-commercial prototypes
 - Promote entrepreneurial thinking among faculty and students
 - Up to \$200k for 18 months

- **AIR choice 2: RESEARCH ALLIANCE (RA)**
 - Develop innovation ecosystem
 - Stimulate entrepreneurial & innovation activities
 - Up to \$800k for 3 years
 - Third party investment required

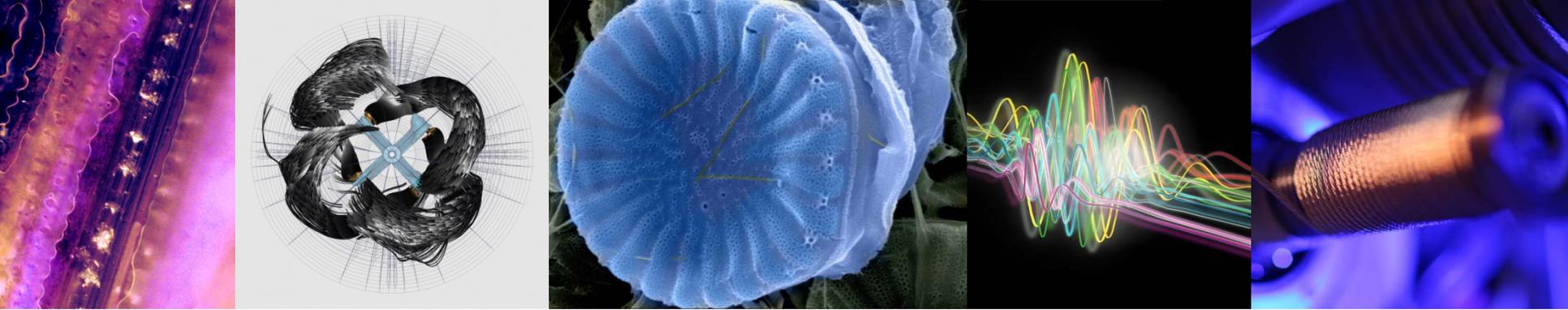
Building Innovation Capacity (BIC)

- ***Platform technologies* to enable customer-centered and market-driven "smart" service systems**
 - Potential to achieve transformational change
- **Academe-industry partnerships required**
 - Industry contribution of customer feedback and market knowledge to ensure relevance
- **Social behavioral and/or cognitive science component required** to understand the potential interaction of the technology with customers/users
- Up to \$800k for 3 years

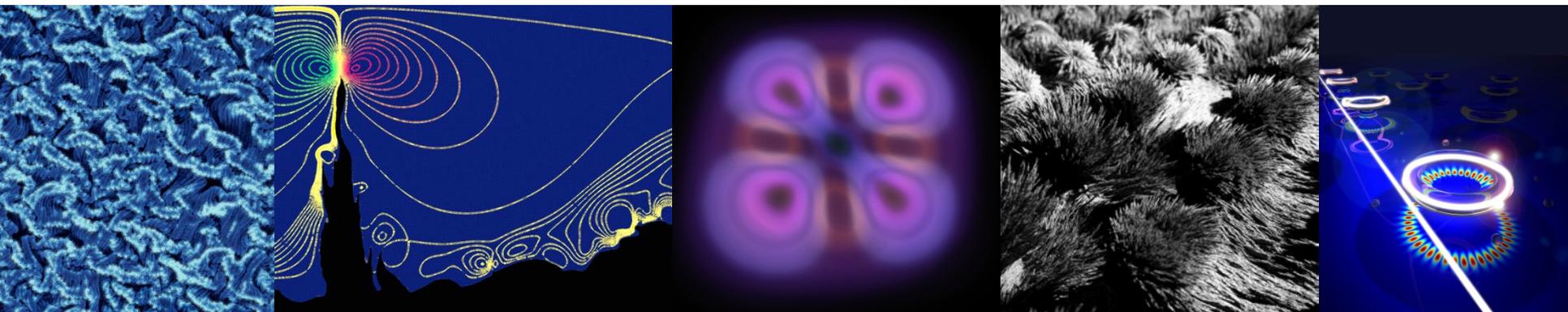
Industry/University Cooperative Research Centers (I/UCRC)

➤ Mission:

- To contribute to the nation's research infrastructure base by **developing long-term partnerships among industry, academe and government**
- To leverage NSF funds with industry to **support graduate students performing industrially relevant research**



ENG Investments and Crosscutting Programs



Advanced Manufacturing

National initiatives

CMU

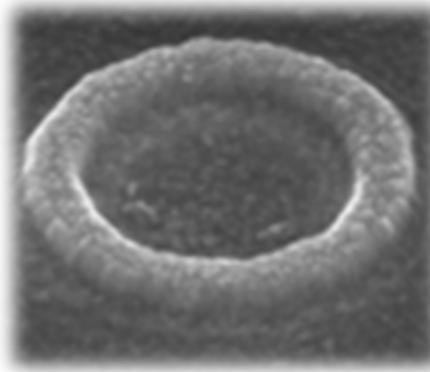
- Advanced Manufacturing Partnership
 - National Robotics Initiative
 - Materials Genome Initiative
- National Manufacturing Institutes
 - Pilot institute for the National Network for Manufacturing Innovation (NNMI)



Rolls Royce

Nanosystems Engineering Research Centers

- Three NSF awards of \$55.5 million (2012-2017)
- **Advanced Self-Powered Systems of Integrated Sensors and Technology**
 - North Carolina State University: self-powered wearable systems that simultaneously monitor a person's environment and health; links exposure to pollutants and chronic diseases.
- **Nanomanufacturing Systems for Mobile Computing and Mobile Energy Technologies**
 - UT-Austin: high-throughput, reliable, and versatile nanomanufacturing process systems and will demonstrate them through the manufacture of mobile nanodevices.
- **Transformational Applications of Nanoscale Multiferroic Systems**
 - UCLA: exploit nanoscale phenomena to reduce the size and increase the efficiency of components and systems whose functions rely on the manipulation of either magnetic or electromagnetic fields.



Credits, L to R: Marc Hall, NCSU; Joshua Leon Hockel, Mechanical and Aerospace Engineering, UCLA; Cockrell School of Engineering, University of Texas at Austin

Nanotechnology Infrastructure

- Network for Computational Nanotechnology (NCN)
 - Cyber Platform
 - NanoBIO Node
 - Nano-Engineered Electronic Device Simulation (NEEDS) Node
- National Nanotechnology Infrastructure Network (NNIN)
 - FY 2013 was year ten of this planned ten-year investment, re-competing this year

Earthquake Engineering Research and Research Infrastructure FY 2015-FY 2019



Award 0936505 (Hutchinson)

- National Science Board (NSB-08-16) requires large, multi-user facilities re compete
- NEES completes planned ten years of research and operations on September 30, 2014; current NEES operations awardee is Purdue University
- FY 2013: After two years of planning with community, NSF re competed NEES through NSF 13-537; anticipated outcome was one award; no award made
- FY 2014: NSF 14-054 Dear Colleague Letter informing community of revised plans
 - NSF 14-557, Decision Frameworks for Multi-hazard Resilient and Sustainable Buildings (RSB), broadening research into multi-hazards
 - New solicitation to be released summer 2014 (Natural Hazards Engineering Research Infrastructure (NHERI) FY 2015-FY 2019) to re compete NEES with added wind engineering component; outcome will be up to ten individual awards for coordination office, cyberinfrastructure, simulation center, and 7 experimental facilities
- FY 2015: Level support with better balance between NHERI and research support
 - NHERI awards to be made in FY 2015
 - Earthquake engineering components form the successor NEES as a subset of NHERI
 - NSF will support Purdue University to operate the NEES cyberinfrastructure during NHERI competition period until new cyberinfrastructure awardee made
 - Several CMMI research programs will reorganize to better realign with NHERI and multi-hazards research direction

New Sustainability Research Networks (SRNs)

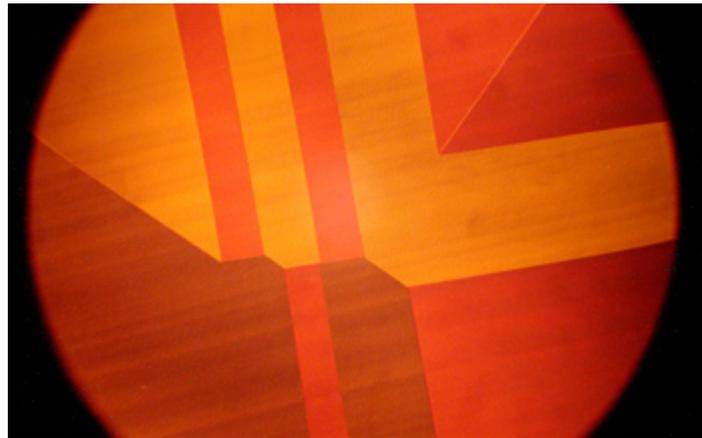
- NSF SEES SRN: Natural Gas Development and its Effects on Air and Water Resources
 - Led by the University of Colorado, Boulder
- NSF SEES SRN: Sustainable Climate Risk Management Strategies
 - Led by Pennsylvania State University



Credit: Alfred Eustes, Colorado School of Mines

Optics and Photonics

- 2012 – NRC issued **Optics and Photonics: Essential Technologies for Our Nation**
- 2010 – ECCS award to National Academies
- 1998 – NRC issued **Harnessing Light: Optical Science and Engineering for the 21st Century**



Credit: *Integrated Photonics Inc.*

CAREER

- Forward-looking program review is led by Pat Farrell, ENG Advisory Committee member
- NSF CAREER Coordinating Committee chair is Theresa Maldonado, ENG/EEC Division Director
- ENG award size increased to \$500,000
- Note: the CAREER award is not a research award, it is a career development award

Ethics

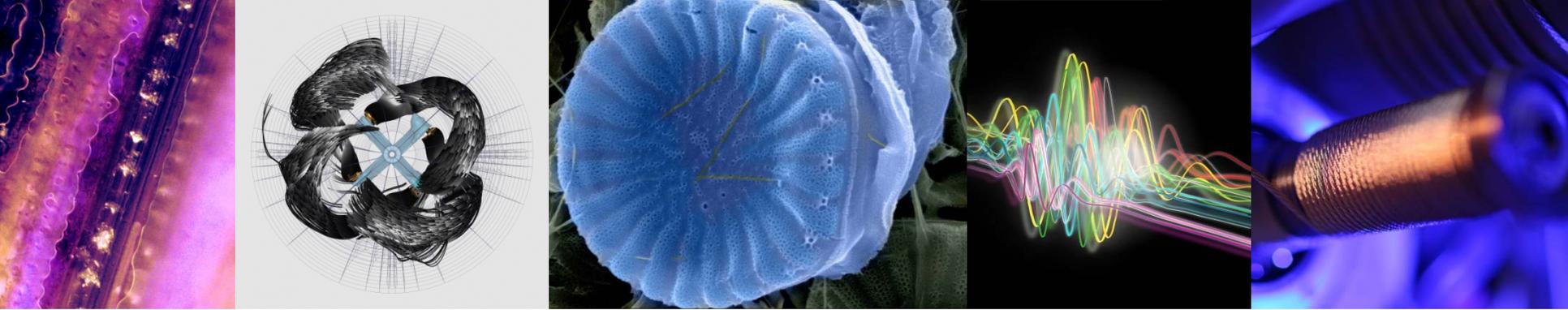
- Persons submitting proposals to the Federal government are held to high standards of conduct
- Misbehavior can be dealt with quite severely
 - PI barred from submission to NSF up to 2 years
 - Permanently barred from proposal review
 - At least two cases of jail time (Grimes case, 42 months in Federal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

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

Train and Verify

- Faculty and students should be trained annually—consequences should be made explicit
- Institutions need to perform oversight
- Institutions themselves need to operate in a culture of compliance



Questions

Image Credits (top, from left): Sijie Lin, Pu-Chun Ke, Clemson Univ.; Sumanta Acharya, Louisiana State Univ.; Gregory L. Rorrer, School of Chemical, Biological, and Environmental Engineering, Oregon State Univ.; Tenio Popmintchev, JILA and Univ. of Colorado at Boulder; Barrett Technology, Inc. www.barrett.com

Image Credits (bottom, from left): Mark D. Huntington and Teri W. Odom, Northwestern Univ.; Tyler Andrew House and Daniel T. Schwartz (advisor), Univ. of Washington; Gerhard Klimeck, David Ebert, and Wei Qiao, Network for Computational Nanotechnology, Purdue Univ.; David Durlach, TechnoFrolics; Nano/Micro Photonics Laboratory, Electrical and Systems Engineering Dept., Washington Univ. in Saint Louis

