

WELCOME

Spring 2014
Directorate for
Engineering
Advisory
Committee
Meeting



Welcome New Advisory Committee Members



- Karen Butler-Purry, Texas A&M University
- Curtis Carlson, SRI International
- Robert Chau, Intel Corp.
- Andres Clarens, University of Virginia



Agenda



April 23

- Directorate update
- Prior AdCom recommendations and outcomes
- Convergence
- Emerging areas in nanotechnology, infrastructure, and service systems research
- EEC overview and COV
- Collaborations and directions in engineering education

April 24

- Discussion with NSF Director and Deputy Director
- NSF strategic plan
- Transparency and accountability
- NSF support for statistical sciences
- IIP overview and COV
- AdCom member topics



Next Meeting

- October 22-23, 2014



Directorate for Engineering Update

Spring 2014
Advisory Committee
Meeting



Pramod Khargonekar
Assistant Director for
Directorate for Engineering
April 23, 2014

ENG welcomes Dr. France A. Córdoba



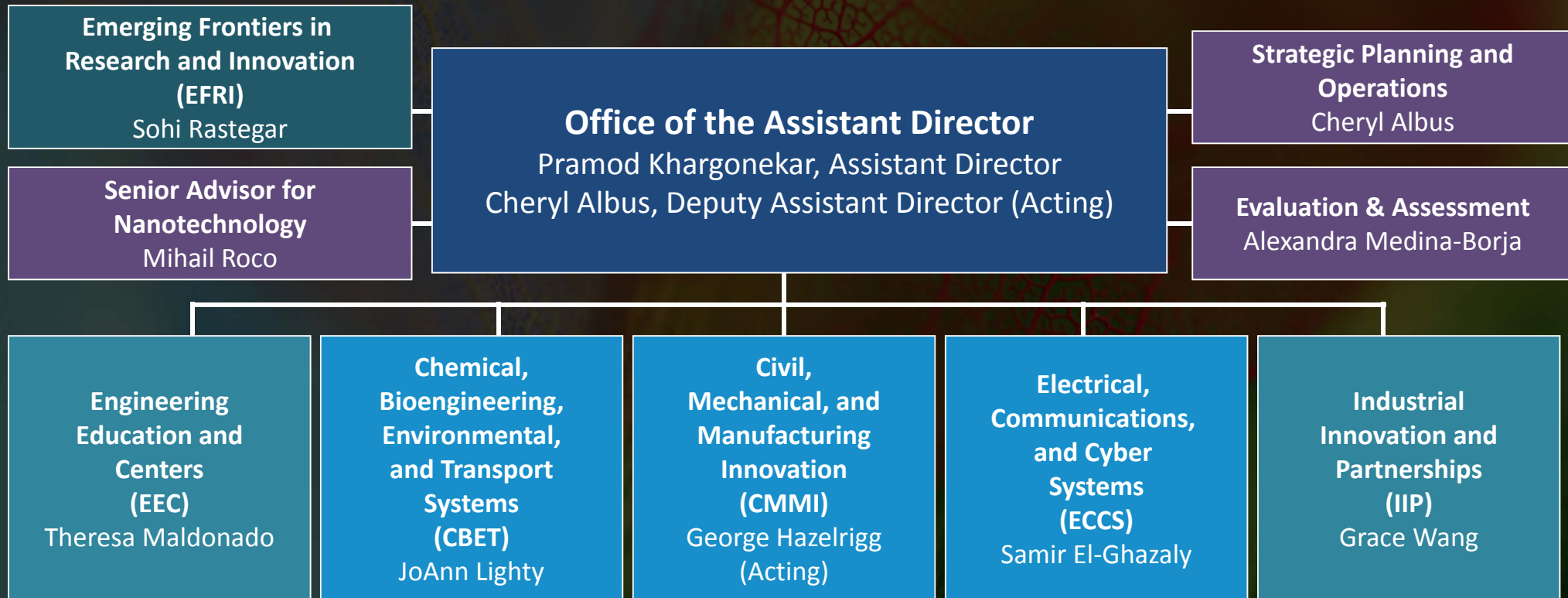
- March 31, 2014: sworn in as 14th director of NSF
- 2007-2012: served as president of Purdue University
- 2002-2007: served as chancellor of the University of California at Riverside and was a distinguished professor of physics and astronomy



Credit: photo by Sandy Schaeffer



NSF ENG Leadership



Thank you, Kesh Narayanan, Steve McKnight, Bob Trew,
Lynn Preston, and Bob Wellek!

Open Recruitments



- ENG Deputy Assistant Director
- CMMI Division Director
- EEC Division Director
- CBET Deputy Division Director
- EEC Deputy Division Director
- IIP Deputy Division Director
- CBET Program Directors
 - Catalysis and Biocatalysis
 - Environmental Health and Safety of Nanotechnology
 - General and Age Related Disabilities Engineering
 - Thermal Transport Processes
- ECCS Program Directors
 - Communications, Circuits, and Sensing Systems
 - Electronic, Photonic and Magnetic Devices
- IIP Program Director
 - Industry/University Cooperative Research Centers Program
- Others to be announced





New Staff, OAD and EFRI

- **Byron Atkinson**, Pathways Student
- **Ophelia Barizo**, Einstein Fellow
- **TJ Donahue**, Program Director Expert for EFRI
(Cherry Creek Schools)
- **Matt Realff**, Program Director Expert for EFRI
(Georgia Tech)





New Staff, CBET

- **JoAnn Lighty**, Division Director (University of Utah)
- **William Cooper**, Program Director for Environmental Engineering (University of California, Irvine)
- **Christine Grant**, Program Director Expert (North Carolina State University)
- **Felita Jackson**, Program Support Manager



New Staff, CBET (continued)



- **William Olbricht**, Program Director (Cornell University)
- **Greg Rorrer**, Program Director for Energy for Sustainability (Oregon State University)
- **Athanassios Sambanis**, Program Director for Biomedical Engineering (Georgia Tech)
- **William Weigand**, Program Director Expert (University of Maryland)





New Staff, CMMI

- **Kaye Ebelt**, Einstein Fellow
- **Kathleen Feldman**,
Science/Engineering Analyst
- **Clifford Henderson**, Program Director
Expert (Georgia Tech)



New Staff, CMMI (continued)



- **Alexis Lewis**, Program Director for Materials Engineering and Processing (Naval Research Lab)
- **Mohammad Noori**, Program Director Expert (consultant)
- **Chris Paredis**, Program Director for Engineering and Systems Design (Georgia Tech)





New Staff, ECCS

- **Samir El-Ghazaly**, Division Director (University of Arkansas)
- **Eyad Abed**, Program Director for Energy, Power, and Adaptive Systems (University of Maryland)
- **Kerstin Mukerji**, Science Analyst
- **Mona Zaghloul**, Program Director for Communications, Circuits, and Sensing Systems (George Washington University)





New Staff, EEC

- **Brooke Coley**, Science Assistant
- **Kathy Hoppe**, Einstein Fellow
- **Bevlee Watford**, Program Director for Broadening Participation in Engineering (Virginia Tech)



New Staff, IIP



- **Peter Atherton**, Program Director for SBIR/STTR
- **Steven Griffin**, Einstein Fellow
- **Barbara Kenney**, Program Director for PFI
Accelerating Innovation Research





Operational Innovation

- PRIM (Panel Reviewer Information Management) system for efficient reviewer identification and communication
 - Begun by IIP in 2011
 - Significantly reduced IIP staff time spent on panels
 - Expansion to divisions in ENG, CISE, and MPS
 - Discussions underway with BIO and GEO





Operational Resilience

- Shut down in October 2013
 - 51 ENG panels impacted
 - Funding windows impacted
 - Staff appointments and start dates delayed
 - Staff attendance at meetings and conferences cancelled
- Caught up on most activities by Winter 2014

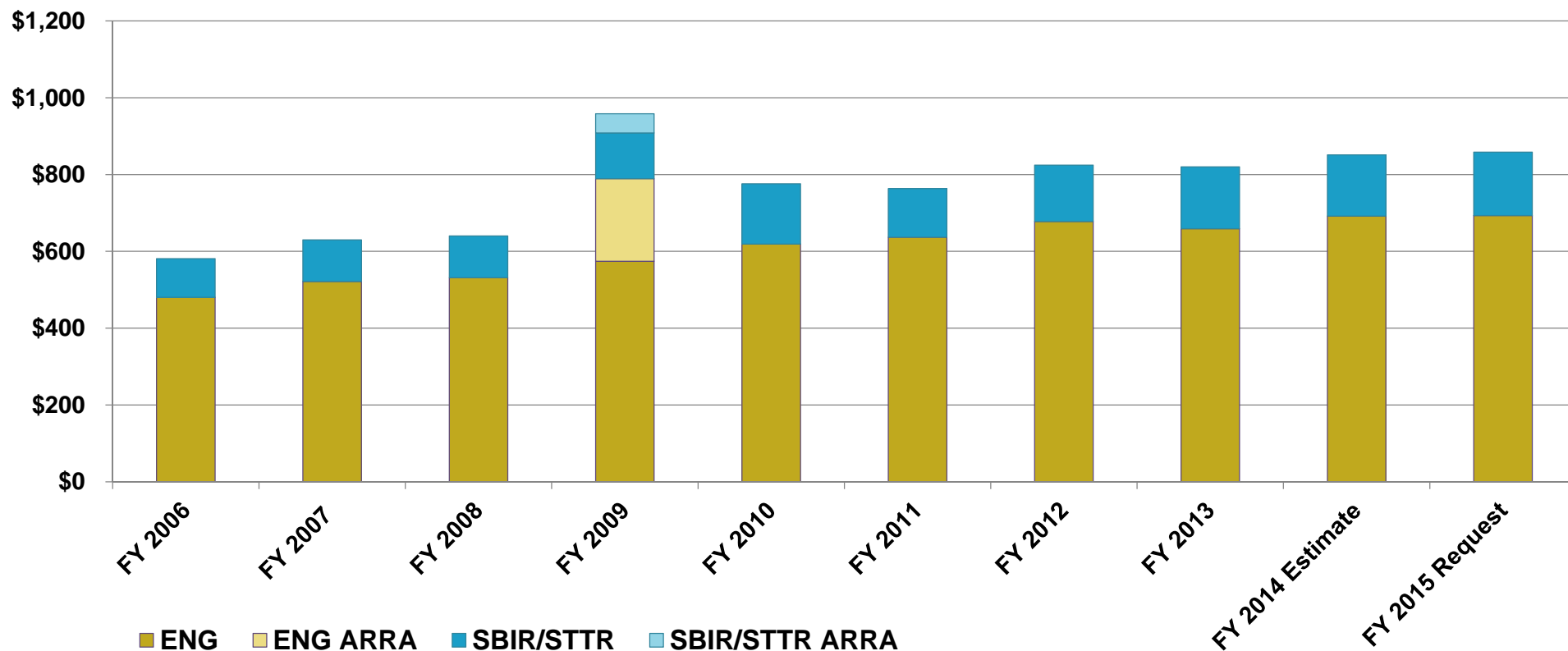




ENG FY 2015 BUDGET REQUEST



ENG and SBIR/STTR R&RA Budgets (\$M)



ENG R&RA Budget (\$M)



	FY 2013 Actual	FY 2014 Estimate	FY 2015 Request	Change over FY 2014 Estimate	
				Amount	Percent
CBET	\$167.01	\$173.00	\$174.99	\$1.99	1.2%
CMMI	200.81	209.20	210.40	1.20	0.6%
ECCS	104.58	110.06	110.41	0.35	0.3%
EEC	115.21	122.24	117.38	-4.86	-4.0%
IIP	202.41	205.97	213.69	7.72	3.8%
<i>SBIR/STTR</i>	<i>161.34</i>	<i>159.39</i>	<i>164.99</i>	<i>5.61</i>	<i>3.5%</i>
EFRI	30.16	30.60	31.30	0.70	2.3%
ENG TOTAL	\$820.18	\$851.07	\$858.17	\$7.10	0.8%

Engineering prioritizes research critical to the Nation's challenges



- National Initiatives

- Advanced Manufacturing
- Clean Energy
- National Nanotechnology Initiative
- BRAIN

Core programs in various divisions play a critical role in addressing these priorities.

- NSF Cross-cutting Priorities

- Cognitive Science and Neuroscience
- Communications and Cyberinfrastructure (security, wireless spectrum)
- Cyber-Enabled Materials, Manufacturing, and Smart Systems (CEMMSS)
- Science, Engineering, and Education for Sustainability (SEES)
- Education and Career Development
- Interdisciplinary Research
- Research Centers
- Innovation Corps

ENG FY 2015 Budget Request

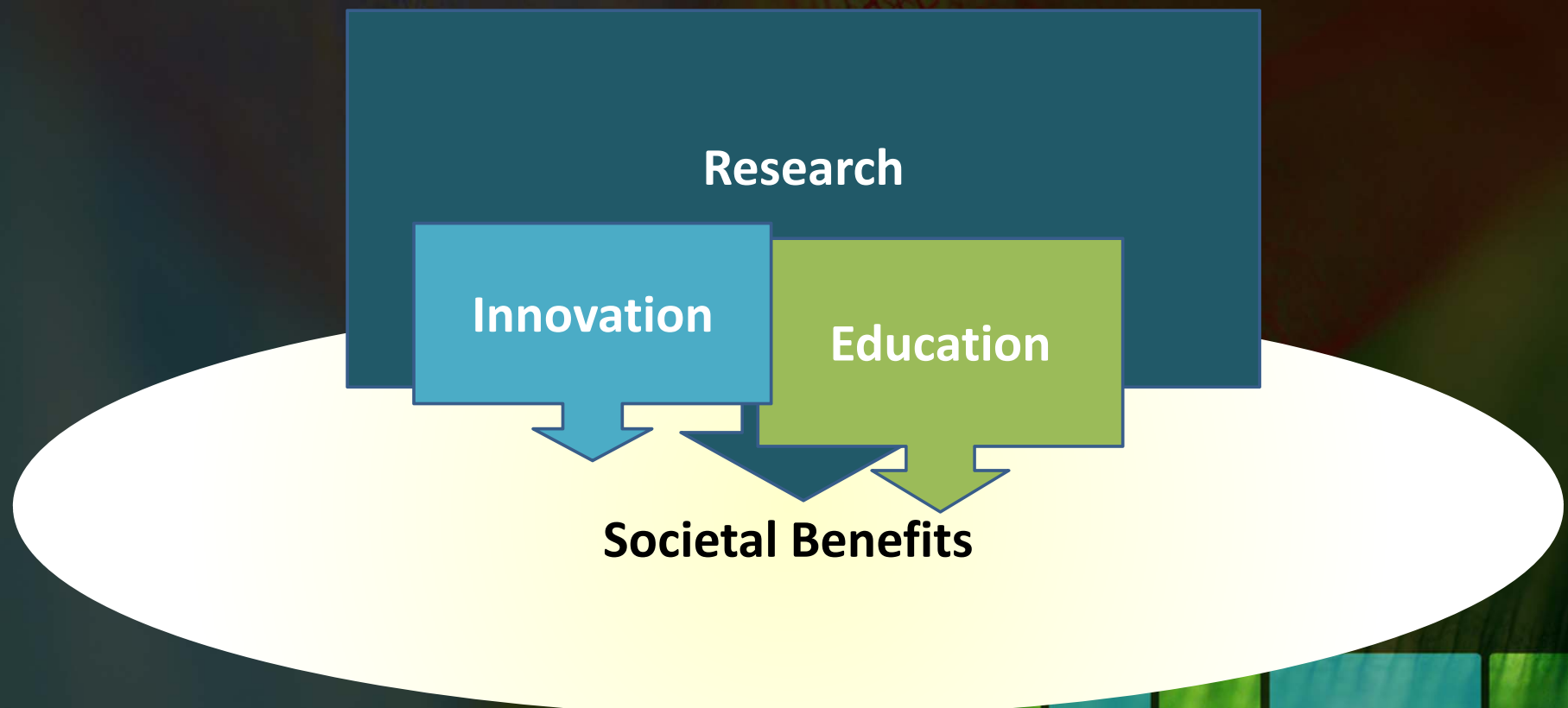




CONTEXT FOR ENG INVESTMENT



NSF ENG: Investing in transformative research and education to foster innovations benefiting society



Major Trends and Forces

- **Ubiquitous computing and communications**
 - Computational modeling, data, simulation, optimization pervasive in all fields of engineering
 - Networks and computation deeply integrated into engineered systems
 - Machine intelligence
- **Systems science and engineering**
 - Multi-scale analysis, design, and optimization
 - Integration of physical and cyber components
 - Range: nano- to micro- to macro-scale
 - Scale and complexity: large numbers of components
 - Safety, robustness, resilience, ...

Major Trends and Forces

- **Nanoscale science and technologies**
 - Improving understanding and new tools at the atomic and molecular scales
 - Progressing from passive components to active systems and design
- **Biological/Medical**
 - Interaction of engineered systems and biology at all scales – DNA to cells to organs to organisms to eco-systems
 - Advanced biomanufacturing
 - Synthetic biology
 - Engineering for neuroscience and brain
 - Biologically inspired engineering
 - Plants, food, and agriculture

Major Trends and Forces

- **Behavioral/economic/cognitive sciences**
 - Human behavior and game theory in engineered systems and technology design
 - Prominent role in infrastructure systems such as electric grid, transportation, water, gas
 - Economic, regulatory, policy issues
- **Design, *creativity, aesthetics*, ...**





Societal Context

- Economic growth, competitiveness, employment, and sustainability imperatives
- Mega problems: food, energy, water, health, security, education, infrastructure, ...
- Stubborn long-standing issues in STEM talent, diversity, and education
- Globalized flows of components, products, services, knowledge, capital, and people





Imagining the Future of Engineering

- **Vital and essential role for engineering** to enable a prosperous, secure, healthy and sustainable society
- **Ambitious, specific, but achievable grand challenges** to stimulate the imagination, creativity, and ingenuity of the engineering community leading to major technological advances
- **Seamless transitions and feedback loops** between research and practical realizations leading to great innovations
- **Engineering education innovations** to overcome stubborn, long-standing problems in retention, diversity, and K-12 and attract highly talented people to the profession





ENG STRATEGY



Directorate for Engineering



Fundamental

EFRI

CBET

- Chemical, Biochemical, and Biotechnology Systems
- Biomedical Engineering and Engineering Healthcare
- Environmental Engineering and Sustainability
- Transport and Thermal Fluids Phenomena

CMMI

- Advanced Manufacturing
- Mechanics and Engineering Materials
- Resilient and Sustainable Infrastructure
- Systems Engineering and Design

EECS

- Electronics, Photonics, and Magnetic Devices
- Communications, Circuits, and Sensing Systems
- Energy, Power, and Adaptive Systems

EEC

- Engineering Research Centers
- Engineering Education
- Engineering Workforce

Translational

IIP

- Academic Partnerships
- Small Business Partnerships



NSF ENG Strategy

- Enable, stimulate and catalyze research communities to think big, foster transformational research, and expand innovation capacity
- Maximize synergies between fundamental and translational as well as core programs, centers and initiatives
- New approaches to address engineering talent challenges
- Collaborate within and outside NSF to maximize opportunity for the engineering community to address national priorities

Objective: *Maximize long-term societal benefit*



Core Programs: Strategically Reformulated to Catalyze New Frontiers



Previous Biomedical Engineering Themes

- Neural engineering
- Cellular biomechanics

Current Context

- BRAIN Initiative and the neural engineering theme
- Cellular biomechanics is a maturing area and could be better served in the setting of advanced biological engineering and manufacturing

New Biomedical Engineering Themes

- Neural engineering and human brain mapping
- Molecular, cellular and tissue approaches for advanced biomanufacturing

ENG in Cognitive Science and Neuroscience:

Understanding the Brain

www.NSF.gov/BRAIN



- ENG investments are critical to success of the BRAIN Initiative
 - ENG will drive integration across scales and across disciplines
 - ENG will accelerate the development of new experimental and analytical approaches, including computational and data-enabled modeling, and new neural engineering and technology research
 - ENG focus areas will include optogenetic mapping and stimulation of the brain, noninvasive or minimally invasive imaging technologies, and advanced neuroprosthetics for neuron repair or regeneration
- FY 2014 focus on preparatory and exploratory investments, e.g. **BRAIN EAGERs**
- FY 2015 opportunities will be announced later this year



Major Investments: Strategically Designed to Create Future Capabilities – Advanced Manufacturing



Previous Manufacturing Research

- Led to transformational advances in manufacturing
 - Additive manufacturing grew out, in part, from basic research investments in the 1970s and 1980s
 - MEMS were enabled by fundamental research in late 1980s (NSF and DARPA)

Current Manufacturing Research

- Extends traditional advances and builds upon convergence of trans-disciplinary advances
 - National Robotics Initiative
 - Cyber-Physical Systems
 - Digital design and manufacturing methods
 - Scalable Nanomanufacturing
 - Bio-manufacturing
 - Novel semiconductor design and manufacturing

Future Manufacturing Research

- Will create advanced manufacturing with new characteristics and capabilities
 - Internet-enabled, distributed, personalized, dynamic, digital...
 - Energy- and materials-efficient sustainable manufacturing
 - Integration of services into manufacturing and servitization of products

Major Investments: Strategically Designed to Create Future Capabilities – NNI



Previous Research

- National initiative since FY 2001
- Investments in fundamental science, engineering, centers, education and translational projects
- Collaborative research with 26 NNI agencies

Current Investments

- Nanomaterials and devices; nanosystems; nanoinformatics and design methods; nanomanufacturing; environmental health and safety; nano-bio sensors.
- Progression from passive nanostructures to active nanostructures to nanosystems and new technology convergence platforms

Signature Directions

- Nanoelectronics for 2020 and Beyond
 - Nanosystems and new technology convergence platforms
 - Metamaterials, plasmonics
- Solar Energy Collection and Conversion
- Knowledge Infrastructure
- Nanotechnology Sensors and Sensors for Nanotechnology
- Two-dimensional materials

Major Investments: Strategically Designed to Create Future Capabilities – Clean Energy and Sustainability



Previous Investments

- Renewable technologies such as solar, wind, wave, geothermal, chemical, and biofuels.
- Electric power systems
- Civil infrastructure
- All parts of ENG involved

Current Investments

- SEES investments
 - Sustainable Energy Pathways
 - Sustainable Research Networks
- Core programs
- ERCs
 - Electric Energy Delivery and Management Systems (with DOE)
 - Electric Energy Transmission Networks (with DOE)
 - Quantum Energy and Sustainable Solar
 - Smart Lighting
- Water–Energy Nexus, such as reducing power plant use of water for cooling (with EPRI)

New Directions

- SEES transitioning to core programs
- Core programs
- RIPS
- Materials, use, and efficiency
- Conversion, storage and distribution of diverse renewable power sources
- Water–Energy–Food Nexus
- Potential new ERCs

SEES = Science, Engineering, and Education for Sustainability

Resilient and Interdependent Infrastructure Systems

- Historical approaches and successes
 - Earthquake-resistant structures (e.g., base isolation, novel materials, improved building codes)
 - NEES: unique national facilities “at scale”
 - RAPIDs: learning from real-world examples
 - Integration of engineering and social sciences for infrastructure management and hazard mitigation
- Looking forward
 - Protection from multi-hazard threats and evolving trends (e.g., extreme events and climate change, demographics)
 - Design of infrastructure systems as processes and services vs. discrete “things”
 - Interdependency of existing and emerging infrastructure
 - Ubiquity and availability of real-time data via cyber-physical systems and Internet of Things

The Service Economy



Last updated: January 24, 2013 6:27 pm

Xerox says shift to services is paying off

By Anjli Raval in New York

Medtronic's Ishrak outlines health services expansion plans

August 21, 2013 | By Mark Hollmer

- The U.S. service sector is responsible for:
 - Employing approximately 85% of workers
 - Creating approximately 80% of GDP
- The boundary between manufacturing and services is blurring
- Great need for high-quality, low-cost, and highly personalized solutions in education, healthcare, manufacturing, transportation, and agriculture
- What is the opportunity for ENG in this direction?

Service Systems Presentation





Engineering Education Observations

- Engineering enrollments are growing across the nation
 - Mechanical engineering growing rapidly to become the largest major
- Engineering continues to have major issues with attracting women and URMs
 - Trailing certain other fields of science
 - Significant differences among engineering disciplines
- Greater progress with respect to women doctoral students and junior faculty levels

Can engineering as a field and profession have a great future if we do not address broadening participation issues?

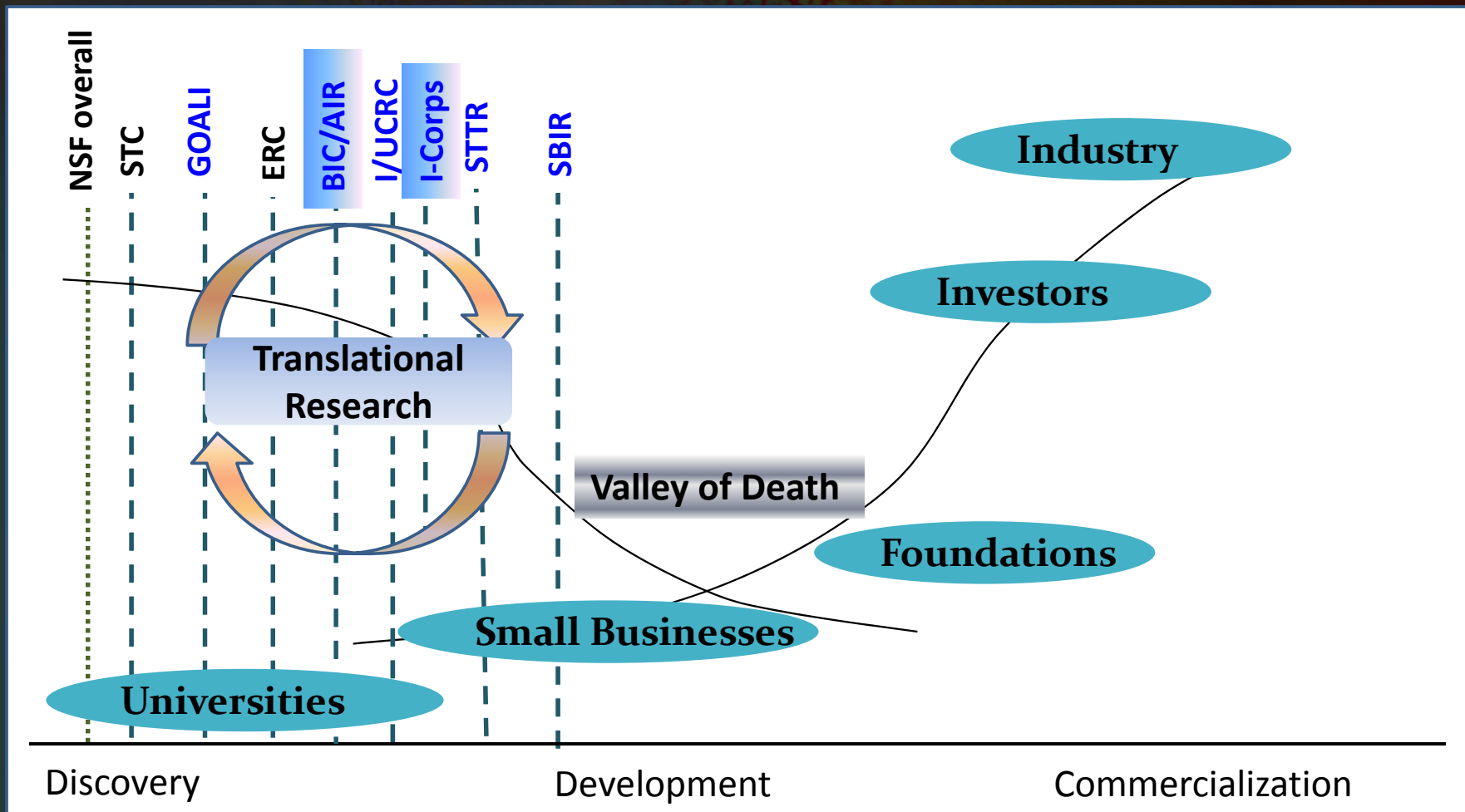




Questions and Directions

- Models: What are the most successful models for change?
- Transferability: How can success at one institution be used to achieve success at another?
- Culture: What is the role of culture – societal, academic, engineering, institutional – in rate of change?
- What is the proper role for NSF (ENG) in engineering education?
- Can the Broader Impacts criterion encourage opportunities in broadening participation?

Providing Technology Translation Pathways





Innovation Corps, a Runaway Success

- Goal: national scaling of I-Corps activities
- Tremendous and growing enthusiasm for the program
- Collaborations with other Federal agencies
- Expansion of capacity throughout the U.S.

“NSF is making a permanent change in how science is commercialized.”
Steve Blank



Building the Nation's I-Corps "Fabric"

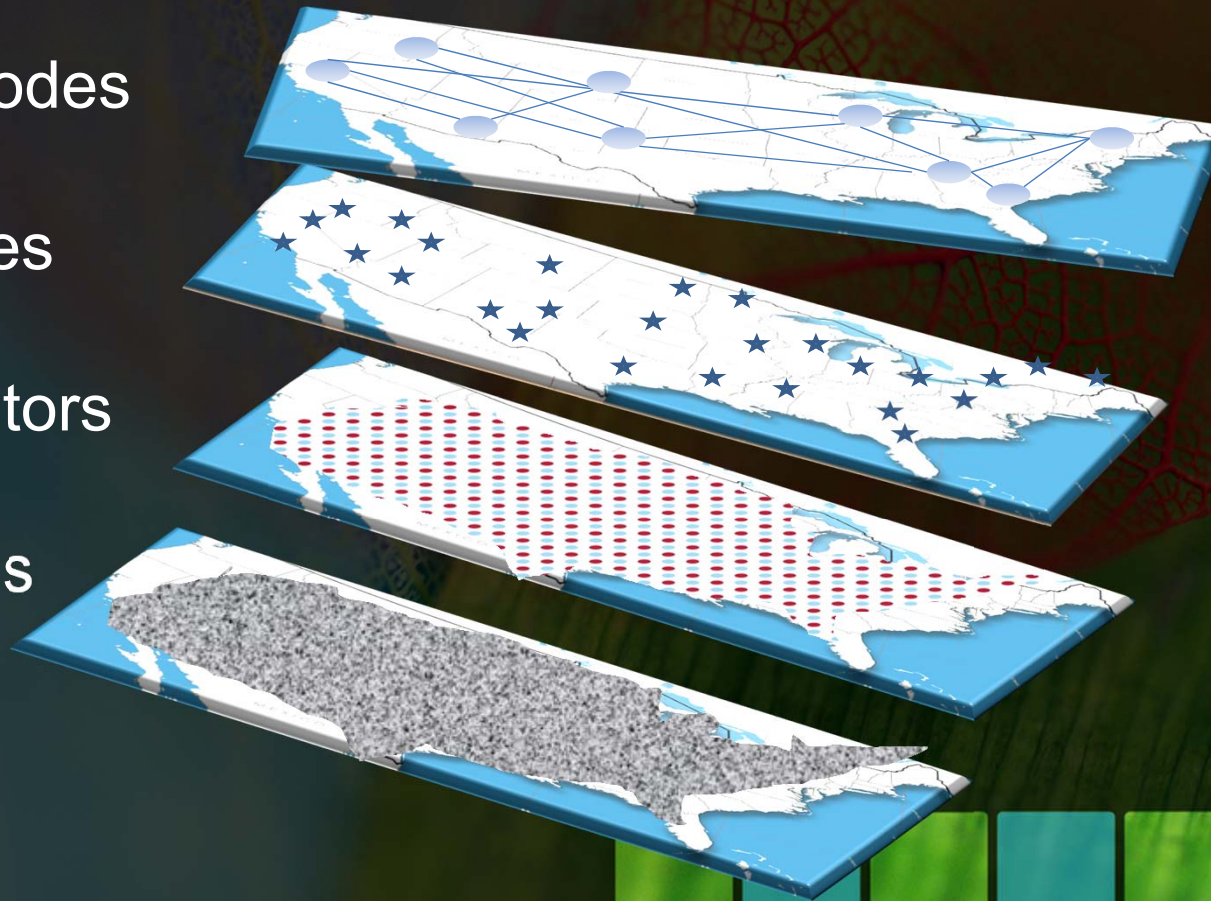


Nodes

Sites

Mentors

Teams





Disciplines in a World without Disciplines

- NSF ENG continues to have a strong commitment to fundamental engineering research
- How should we think about discipline-based fundamental research in the contemporary multi-disciplinary research environment (centers, initiatives)?
- How can our investments in multi-disciplinary initiatives also advance knowledge in core disciplines?

Convergence Panel Discussion



Merit Review Criterion: Broader Impacts



- The Broader Impacts criterion encompasses the potential to benefit society and contribute to achieving specific, desired societal outcomes, including:
 - increased participation of women, persons with disabilities, and underrepresented minorities in science, technology, engineering, and mathematics (STEM);
 - improved STEM education at all levels;
 - increased public scientific literacy and public engagement with science and technology;
 - improved well-being of individuals in society;
 - development of a globally competitive STEM workforce;
 - increased partnerships between academia, industry, and others;
 - increased national security;
 - increased economic competitiveness of the United States; and
 - enhanced infrastructure for research and education.





NSB Recommendation

- “Just as institutions play an important role in facilitating research-related activities of their investigators, often in ways that align with strategic departmental and institutional ... priorities and investments, **such a role can extend to activities directed toward the broader impacts of the project as well.**”
- “... such efforts might be more effective if **coordinated appropriately in ways that leverage particular institutional assets or strategic directions** and even link investigators from multiple projects.”
- “NSF should encourage institutions to pursue such cooperative possibilities, which have the dual benefit of retaining the contributions of individual investigators while addressing national goals and yielding benefits broader than those within a given project.”





Broader Impacts Opportunity

How do we leverage research for larger societal benefits?

Broader Impacts Infrastructure

New Broader Impacts RCN



<http://www.broaderimpacts.net/>



Role of Grand Challenges

- Grand challenges can be very useful in catalyzing major breakthroughs and advances
 - NAE Grand Challenges for Engineering
- Key characteristics:
 - Big impact
 - Ambitious yet achievable
 - Compelling vision
 - Right level of specificity



Grand Challenges

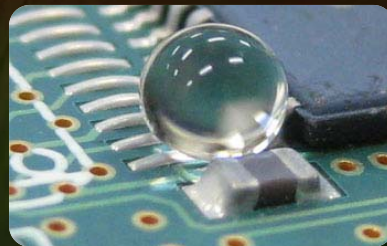
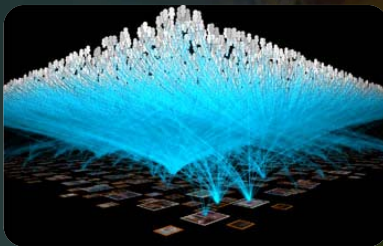


How can the engineering research community use the grand challenge vehicle for big research achievements?



The Directorate for Engineering

- Empowers research in frontiers of engineering
- Builds an innovation economy
- Prepares today's students for tomorrow's challenges and opportunities



Credits, from left: Electronic Visualization Laboratory, University of Illinois at Chicago; Philip DeCamp and Deb Roy; Integrated Surface Technologies, Menlo Park, CA; NSF; Erik Demaine and Martin Demaine, MIT



QUESTIONS?

IDEAS, THOUGHTS!

pkhargon@nsf.gov

