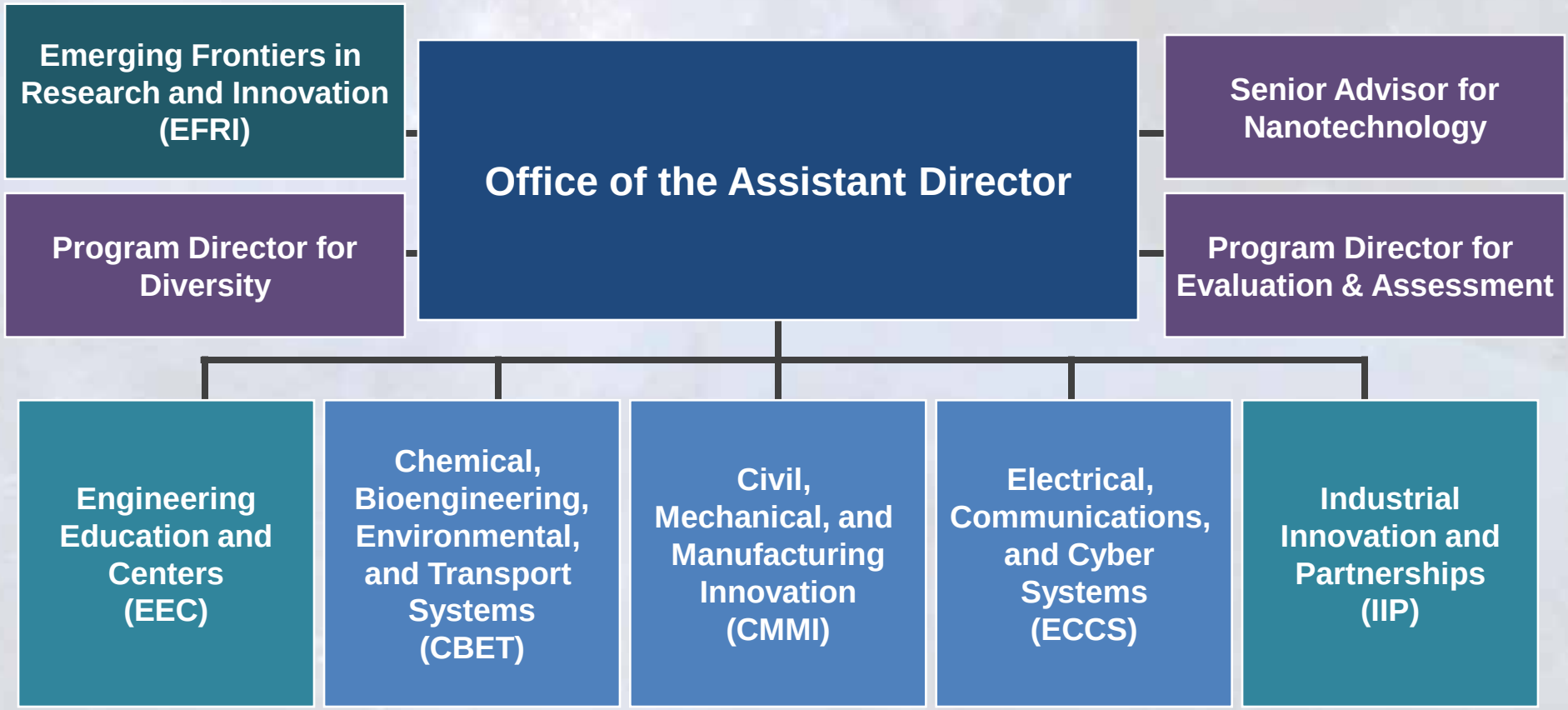
Investments in Innovation: Engineering At the National Science Foundation

Thomas Peterson
Assistant Director
Engineering Directorate

NSF Directorate for Engineering (ENG)



Engineering Prioritizes Research Critical to the Nation's Challenges

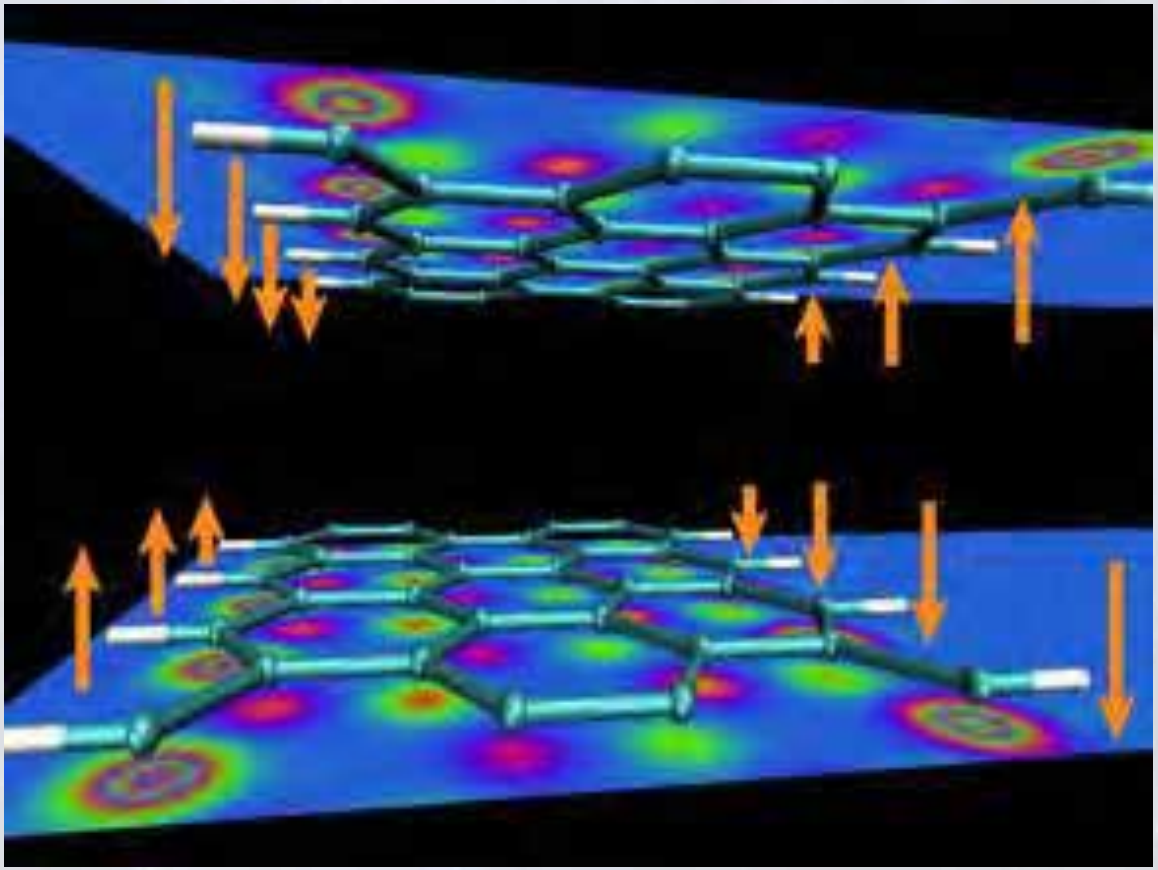
- National Priorities
  - National Nanotechnology Initiative
  - National Robotics Initiative
- OneNSF Initiatives
  - Advanced Manufacturing
  - Communications and Cyberinfrastructure
  - Education and Workforce
  - Interdisciplinary Research
  - Sustainability and Clean Energy
  - Innovation Ecosystem

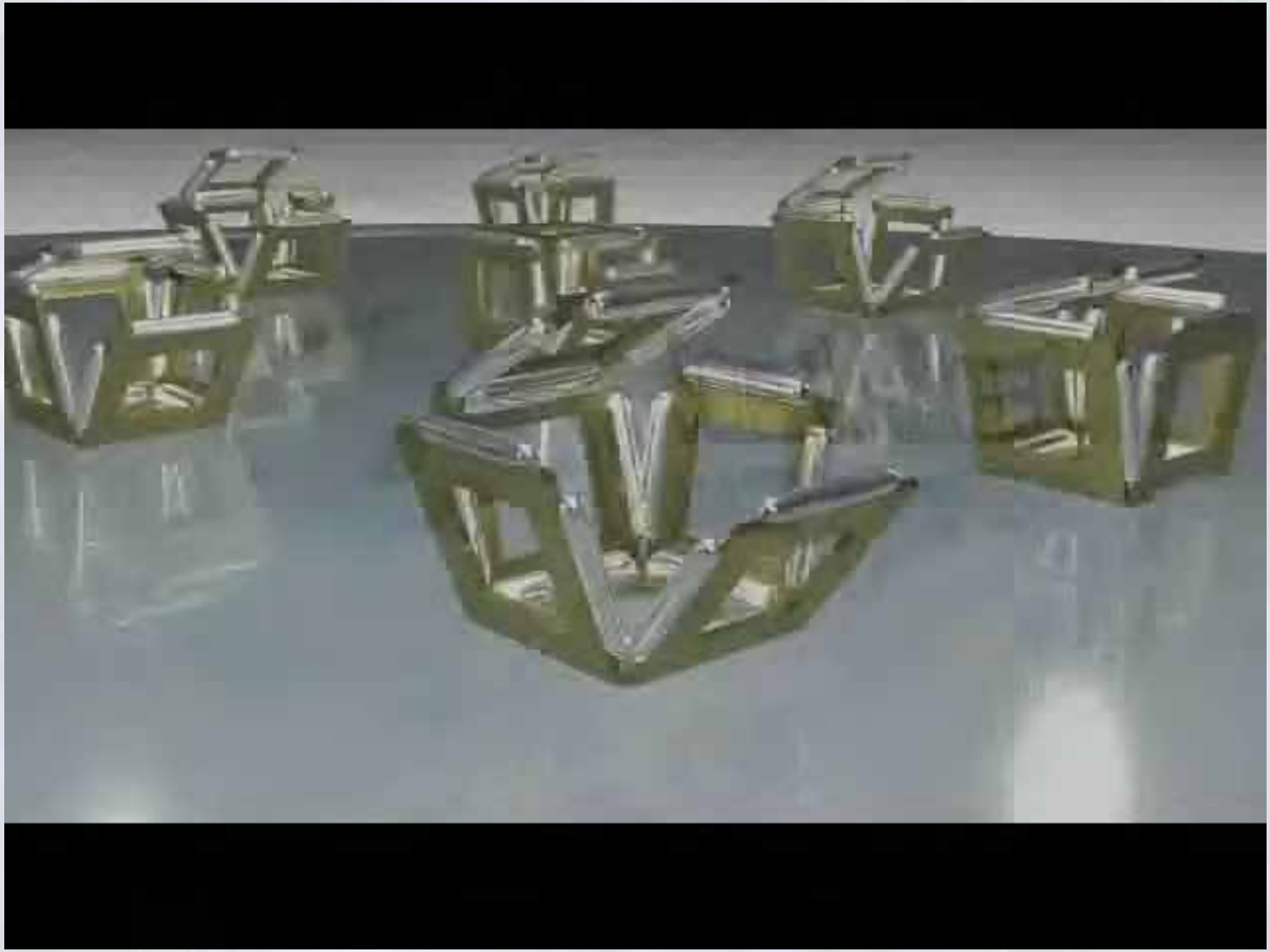
National Nanotechnology Initiative

$174 M

- The directorate will continue support for
  - nanomaterials and nanodevices
  - nanosystems
  - nanomanufacturing
  - environment, health, and safety
- ENG will direct additional funds towards three Signature Initiatives
  - Nanoelectronics for 2020 and Beyond
  - Sustainable Nanomanufacturing
  - Nanotechnology for Solar Energy Collection and Conversion

Nanoelectronics for 2020 and Beyond





CMMI CAREER and EFRI Building Engineered Complex Systems awards

Credit: *Science Nation, NSF*

National Robotics Initiative

$10 M

- ENG will support
  - Assistive mechanisms for those with physical disabilities and/or cognitive impairments
  - Systems integration that enables ubiquitous, advanced robotics to be realized
  - Next-generation robotics for manufacturing, healthcare and rehabilitation, surveillance and security, education and training, and transportation

Advanced Robotics

ENG collaborates through OneNSF

ENG will be a major contributor to Advanced Manufacturing

- **Advanced Manufacturing**
  ENG will support multi-scale modeling, nanomanufacturing, and complex engineering systems design

$68 M for Adv. Manu.

- **Cyber-Enabled Materials, Manufacturing, and Smart-Systems (CEMMSS)**
  ENG with invest in breakthrough materials and design, advanced techniques and processes, and smart systems

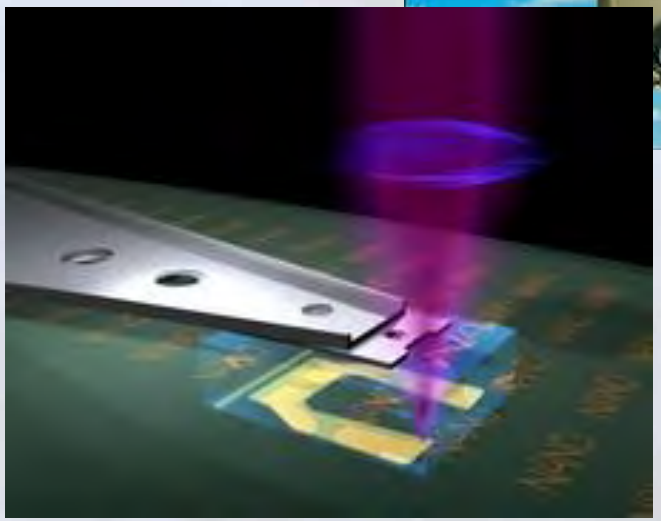
$110 M for CEMMSS

- **Research at the Interface of the Biological, Mathematical, and Physical Sciences, and Engineering (BioMaPS)**
  ENG will focus on nanoscale biosensing, neuro-engineering, cellular biomechanics, metabolic engineering, and engineering aspects of synthetic biology

$5 M for BioMaPS

Advanced Manufacturing

- Complex systems design and engineering
- Cyber Based Approaches
- Materials Design
- Scalable Manufacturing



National AM Initiatives

- Advanced Manufacturing Partnership
  - National Robotics Initiative
  - Materials Genome Initiative
- National Manufacturing Institutes

CMU

Rolls Royce

ENG will strategically support better Communications and Cyberinfrastructure

- **Enhancing Access to the Radio Spectrum (EARS)**
  ENG will prioritize research on more efficient radio spectrum use and energy-conserving device technologies

$14 M for EARS

- **Cyberinfrastructure for the 21st Century (CIF21)**
  The ENG investment will focus on cyber–physical systems, engineering modeling and simulation, smart networks, and sensors

$11 M for CIF21

- **Secure and Trustworthy Cyberspace (SaTC)**
  ENG support will focus on the engineering aspects of the Networking and Information Technology Research and Development (NITRD) strategic plan

$4 M for SaTC

Networking and Communications

- **Secure and Trustworthy Cyberspace (SaTC)**
  ENG support is focusing on the engineering aspects of the Networking and Information Technology Research and Development (NITRD) strategic plan

Credit: ThinkStock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Education and Workforce

- The directorate emphasizes support for
  - Expeditions in Education (E^2)
  - CAREER awards
  - Activities that promote the entry and retention of veterans and other non-traditional students in engineering programs

$1 M for E^2

$53 M for CAREER

NSF Investments in Workforce

Primary focus: Enhancements to Flow (*all levels*)

- K12 Pre-college programs – EHR, EEC, RET
- Recruitment of undergraduate Engineers
  - GI Bill, PEEC
- Encouragement to pursue Graduate degrees
  - REU
- Support during graduate studies
  - GRF, IGERT
- Support for transition to Academia and Industry
  - Innovation Fellows, BRIGE, CAREER

ENG will continue its long-standing support for Interdisciplinary Research

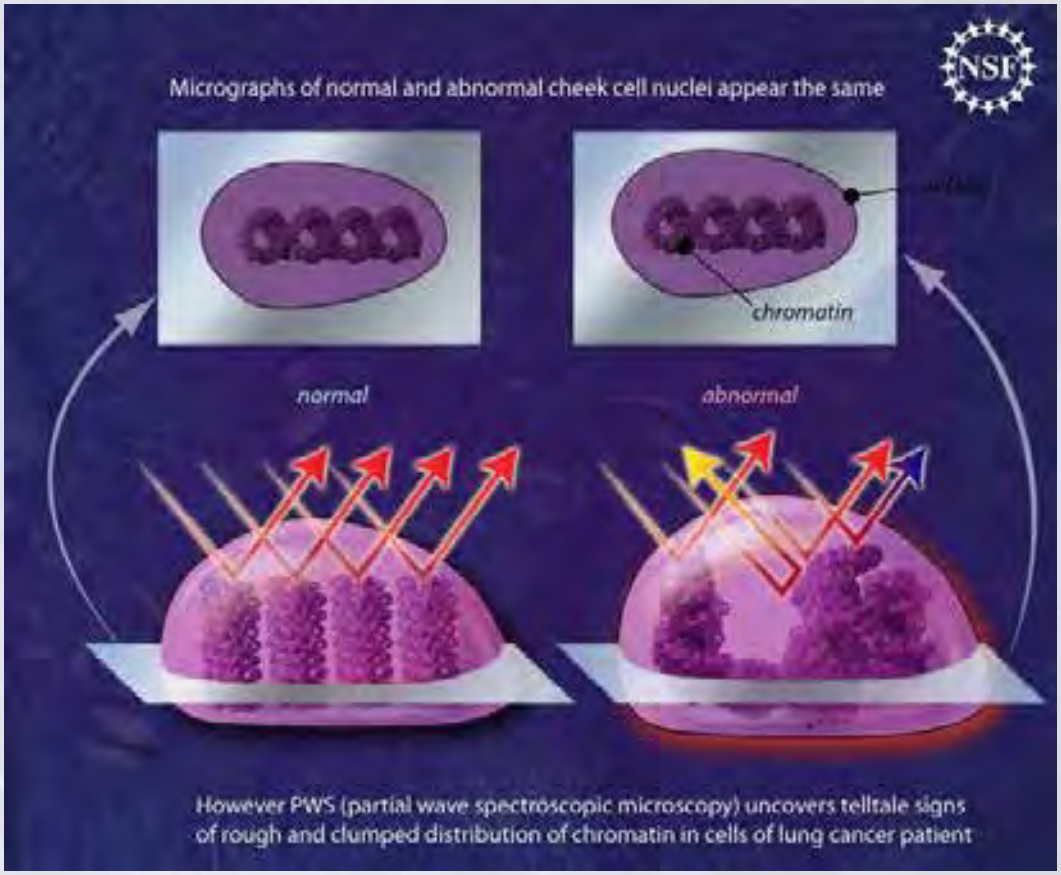
- **INSPIRE (Integrated NSF Support Promoting Interdisciplinary Research and Education)**
  ENG will support creative, important research collaborations between disciplines that may lead to new opportunities

$6 M for INSPIRE

- **Emerging Frontiers of Research and Innovation (EFRI)**
  ENG will provide strategic support for fundamental research that may overcome scientific and/or national challenges and lead to breakthrough technologies

$32 M for EFRI

Biophotonics for Cancer Detection



CBET CAREER and EFRI BioSensing and BioActuation

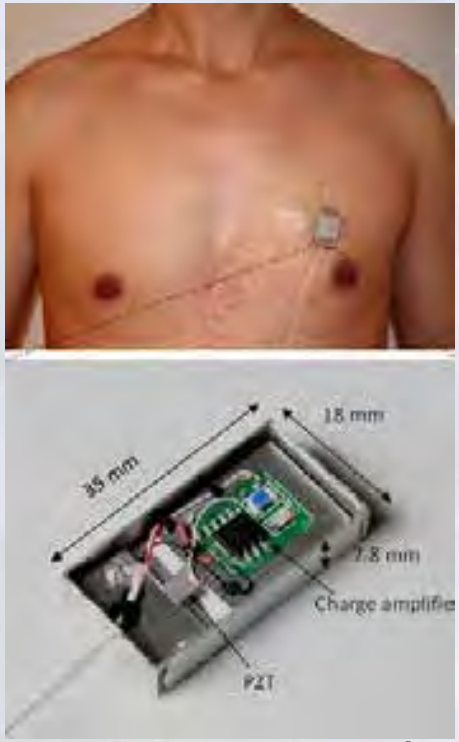
Credit: *Zina Deretsky, National Science Foundation*

Flexible Electronics for Healthcare

CMMI NSEC and ECCS Awards

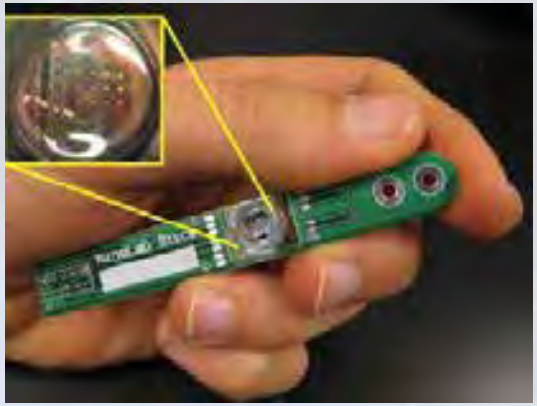
Credit: *J. Rogers, University of Illinois*

Biological Applications for Electronic Systems & Devices



Wearable accelerometers for continuous respiratory sound monitoring (Xu, Wayne State University)

Self-Assembly of Functional Systems Within Live Cells – building the first contact lens with an integrated lactate sensor. (Parviz, University of Washington)



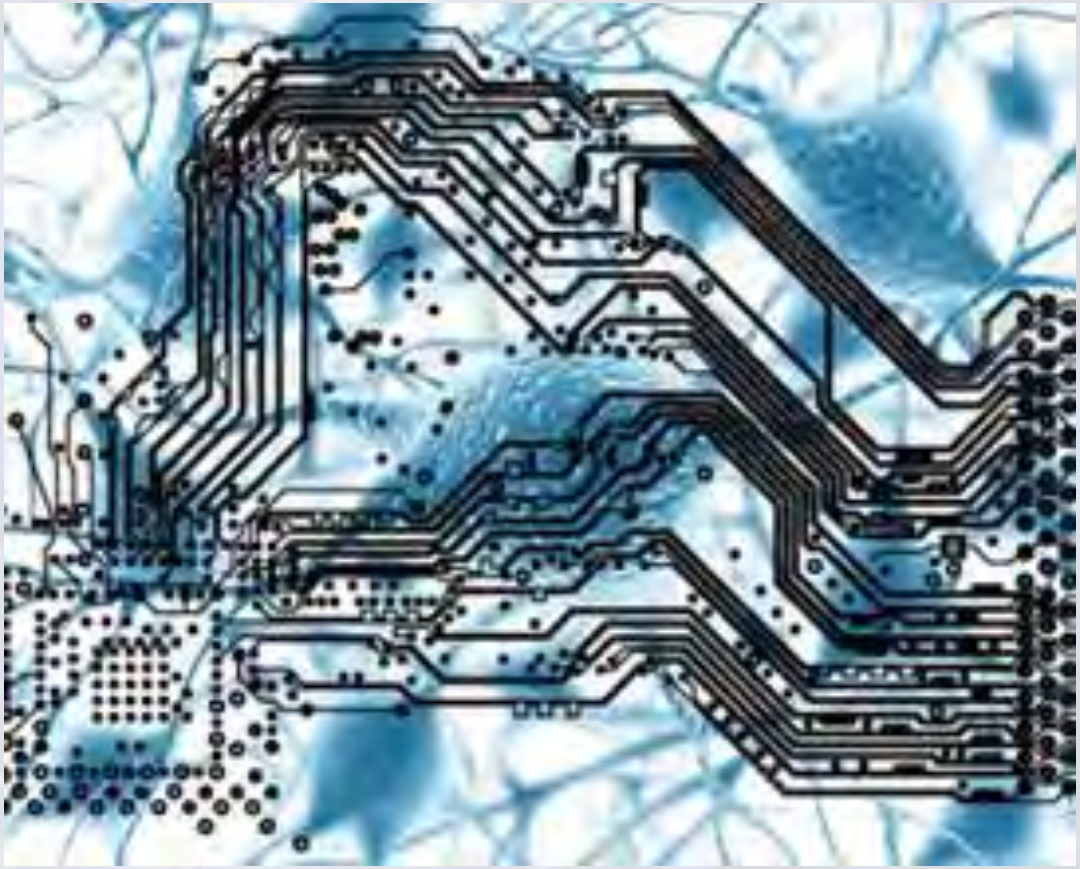
Rapid Magnetic DNA and Protein Chip for Point of Care Molecular Diagnostics (Wang, Stanford)

Engineering Biological Signals

EFRI Multicellular and Inter-kingdom Signaling

Credit: *Gary Alpert, Harvard University, Bugwood.org*

Engineering Biological Machines



EFRI Cellular and Biomolecular Engineering

Credit: *Roger Kamm, MIT*

ENG will invest heavily in Sustainability and Clean Energy

- **Science, Engineering, and Education for Sustainability (SEES)**
  ENG's investment will focus on sustainable research networks, sustainable chemistry, and human dimensions

$20 M for SEES

- **Clean Energy Technologies**
  ENG will support novel research for smart grid technologies, solar energy technologies, biofuels and bioenergy, wind energy generation, and renewable energy storage

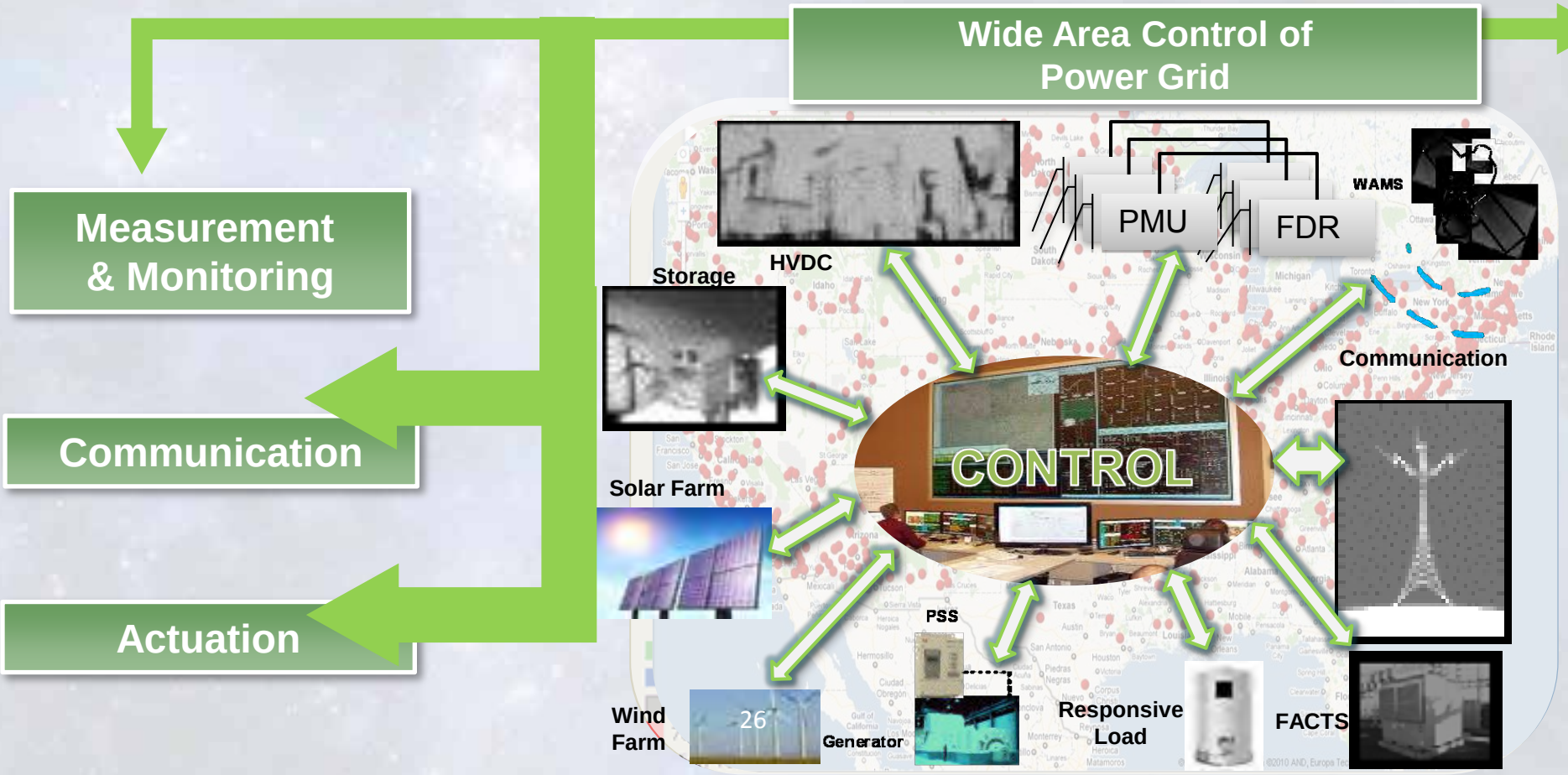
$128 M for Clean Energy

Converting Biomass into Biofuel

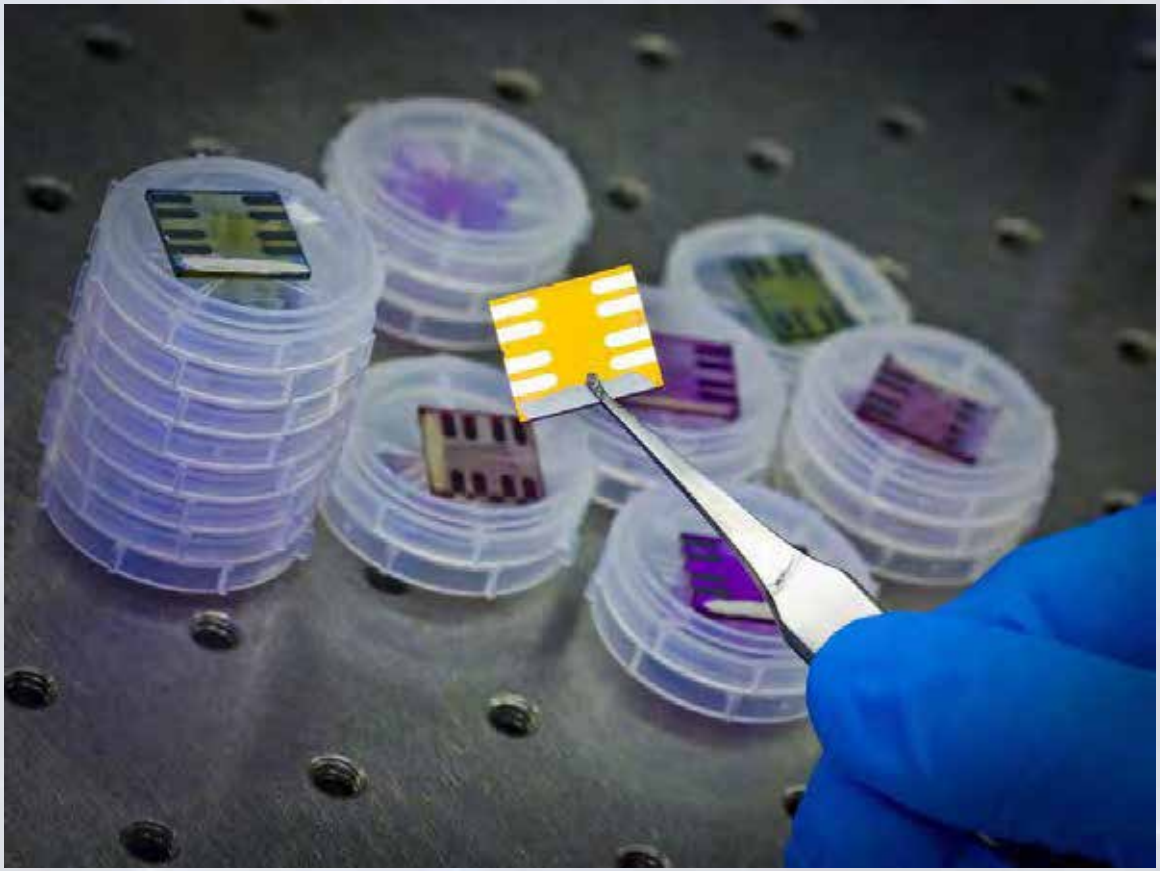
CBET CAREER and EFRI Hydrocarbons from Biomass Award

Credit: *George Huber, UMass*

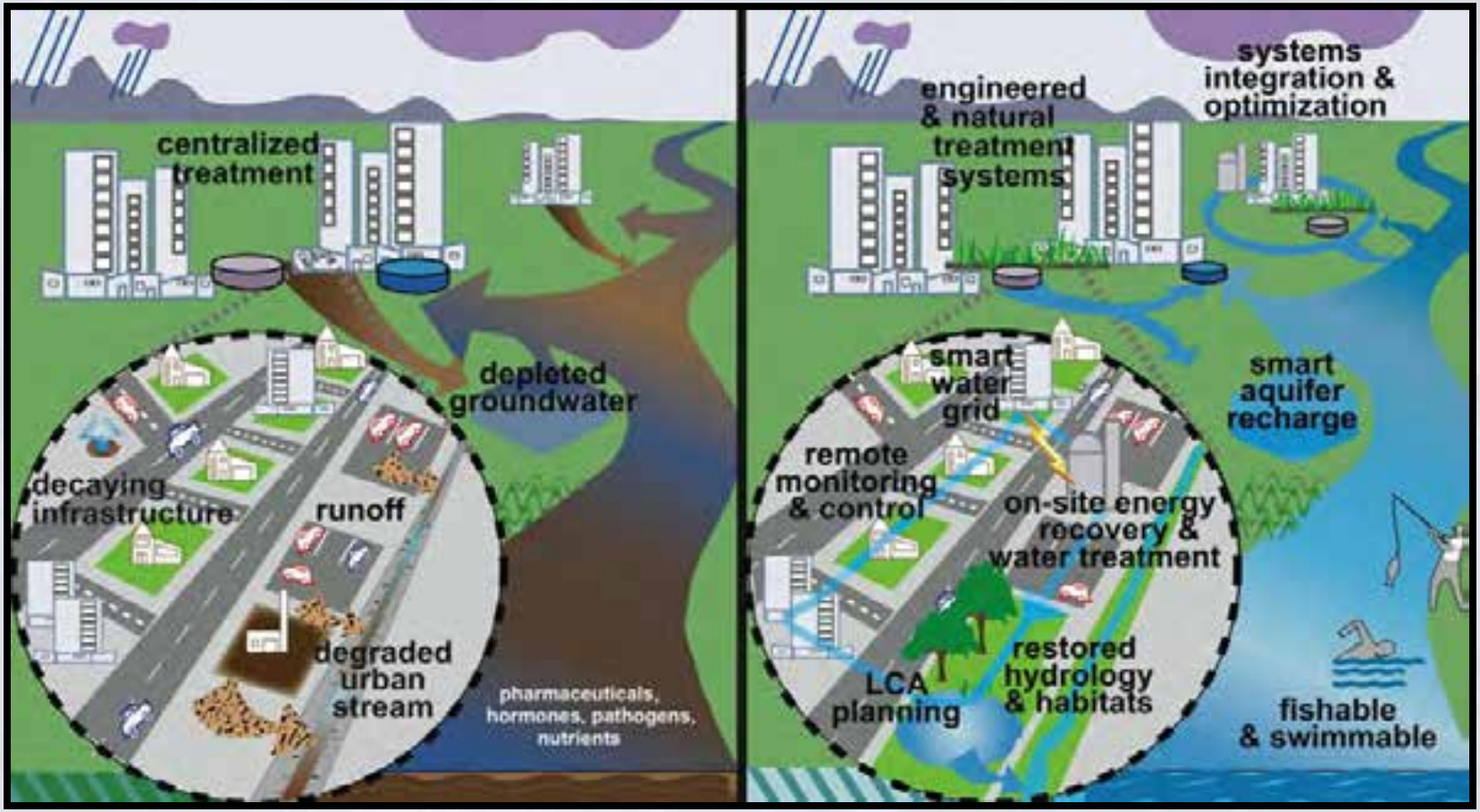
ERC for Ultra-wide-area Resilient Electric Energy Transmission Network – CURENT



Foundational Program to Advance Cell Efficiency (F-PACE)

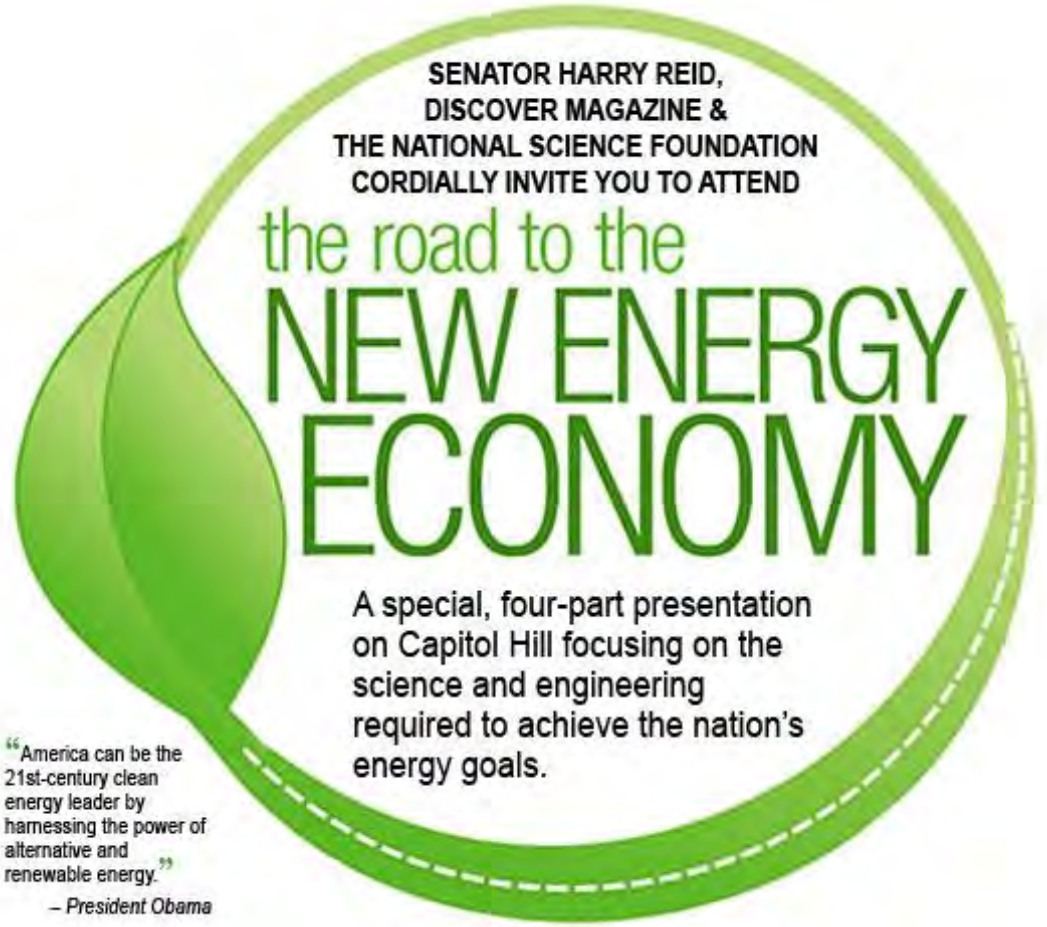


ERC for Re-inventing America's Urban Water Infrastructure



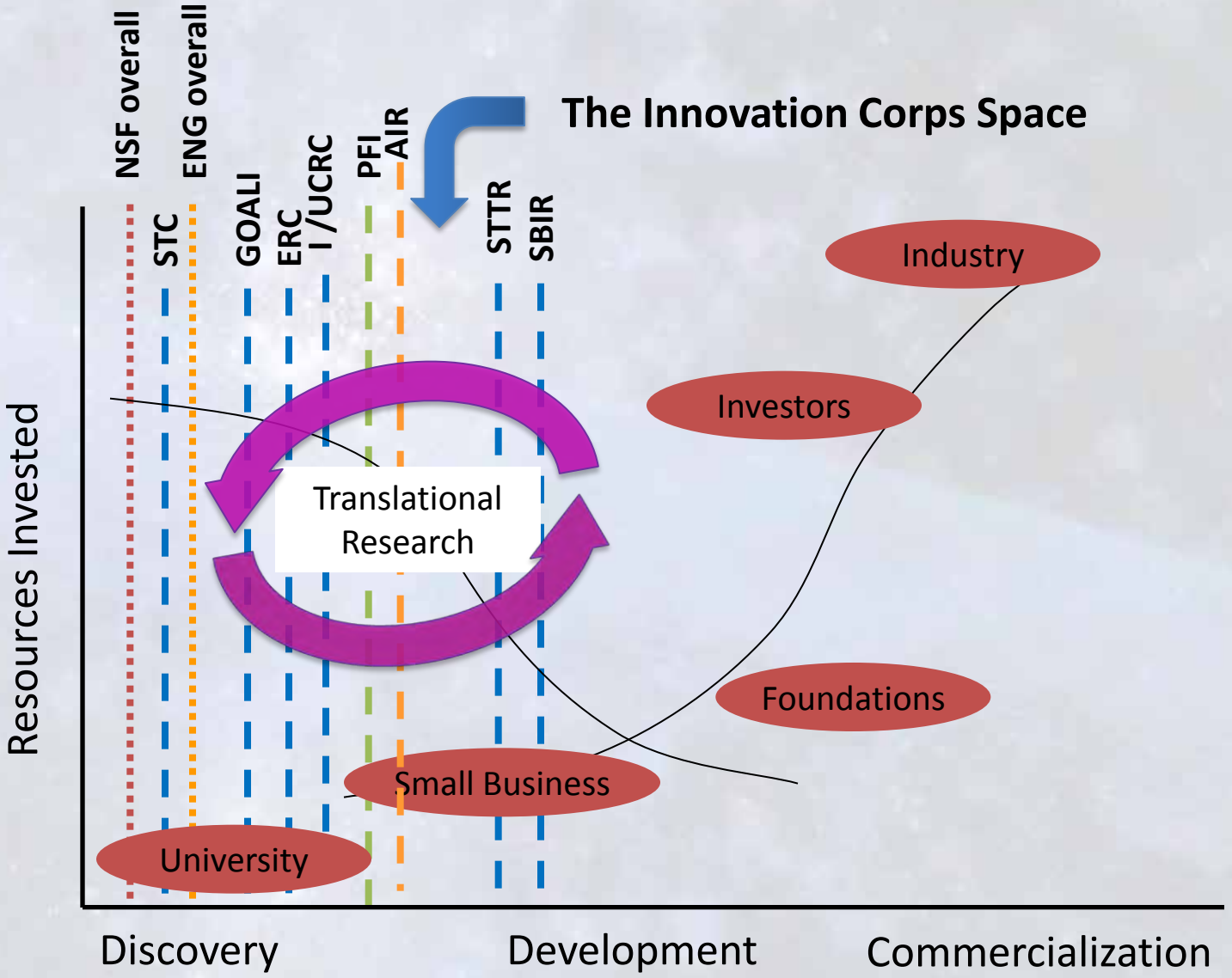
The current (left) and re-invented (right) urban water infrastructure paradigm.

Re-engineering Water for Power

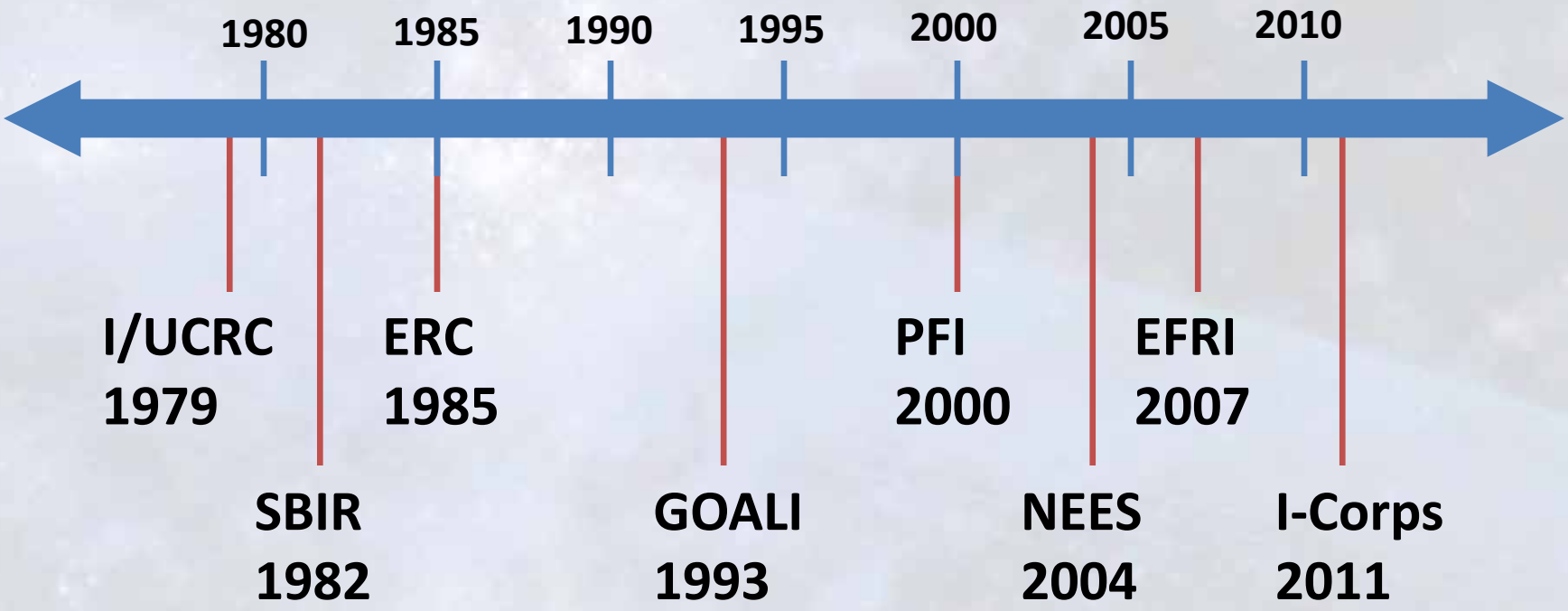


ENGINEERING ROLE IN THE INNOVATION ECOSYSTEM

NSF Innovation Investments



Programmatic Innovation



Research Centers

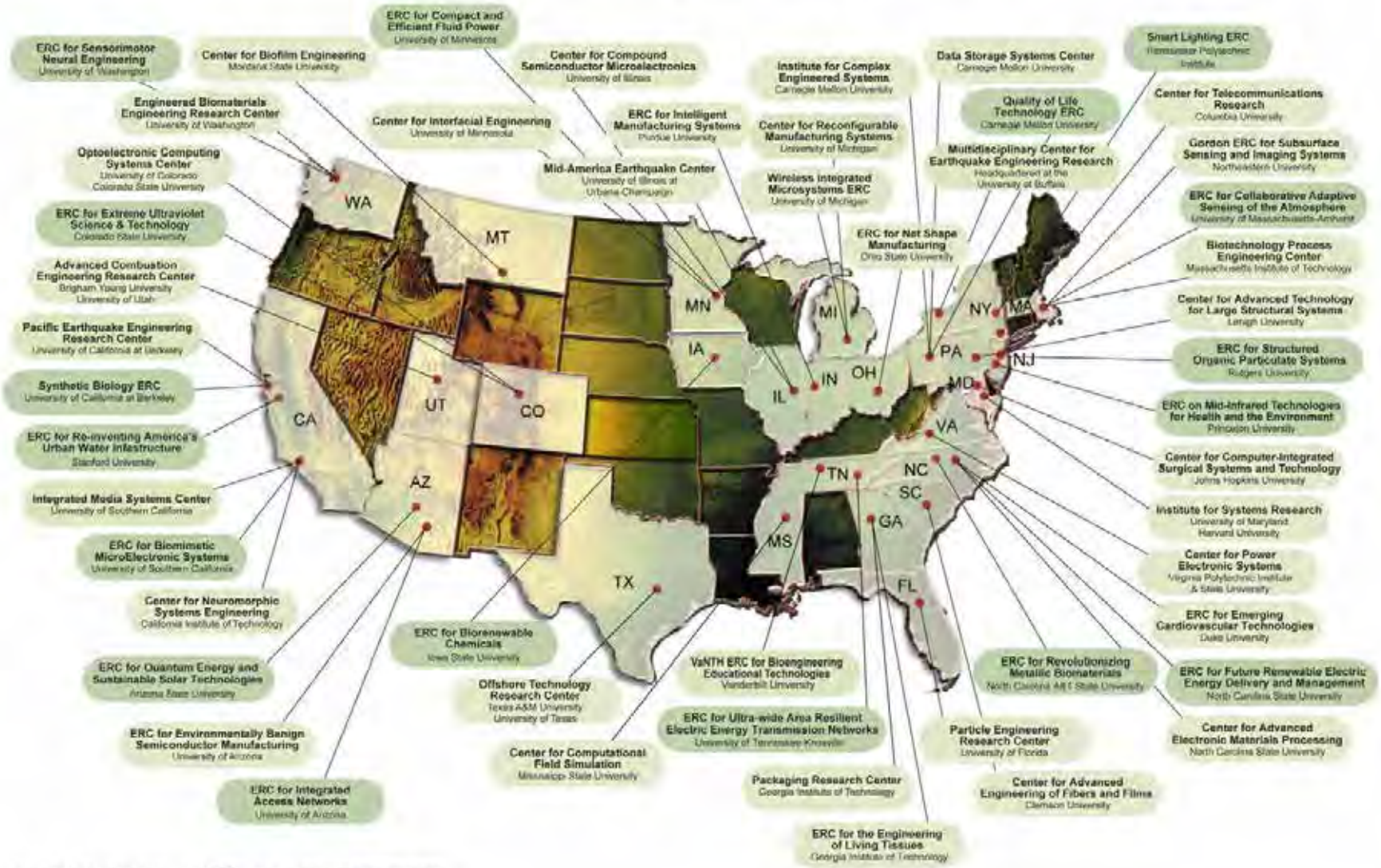
$69 M for ERCs

- Engineering Research Centers (ERCs)
  - EEC will continue support for the first class of Nanosystems ERCs from FY 2012 and 17 others
- Science and Technology Centers (STCs)
  - CBET will continue supporting the Center on Emergent Behaviors of Integrated Cellular Systems
  - ECCS will continue supporting the Center for Energy Efficient Electronics Science

$10 M for STCs

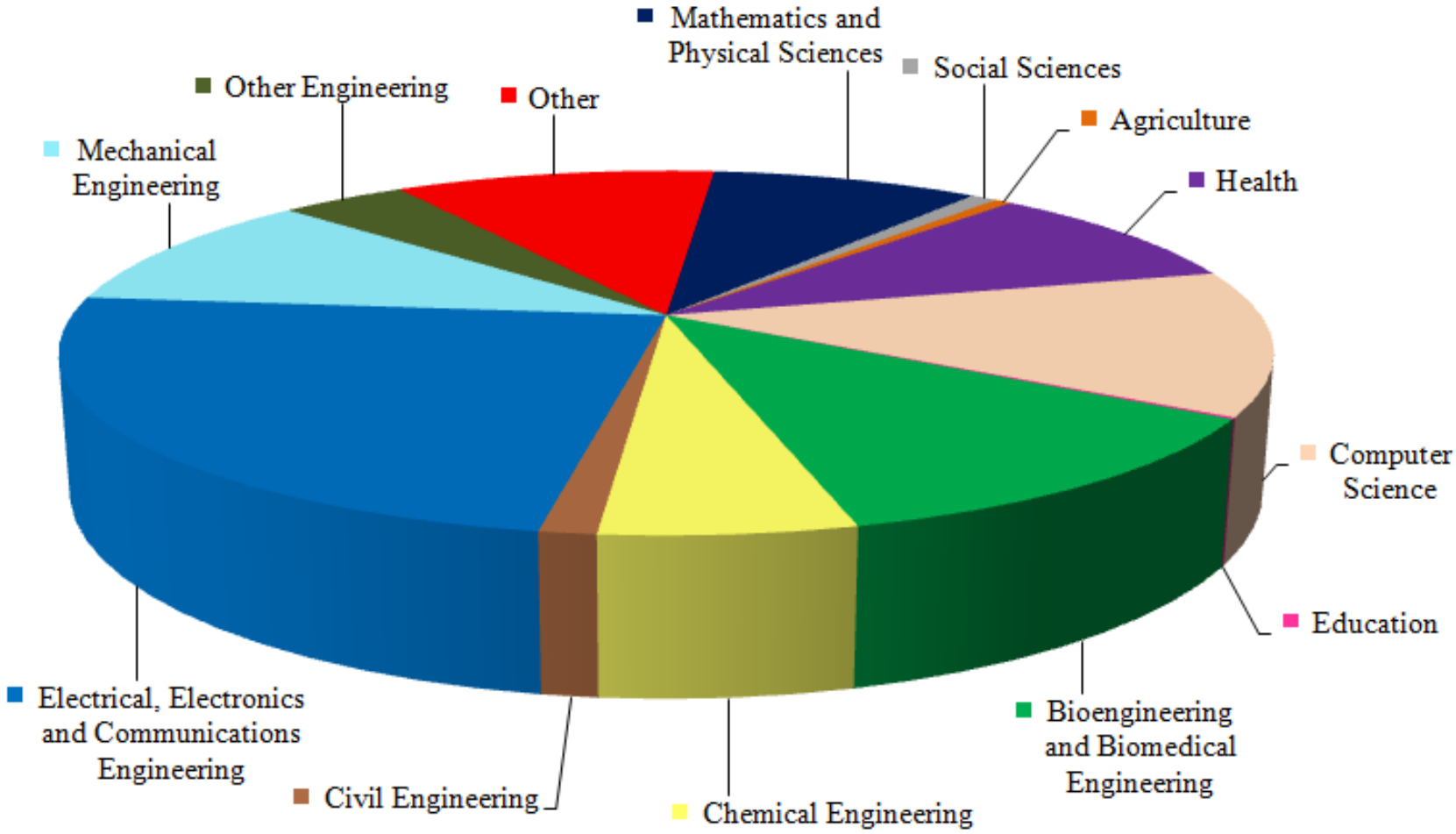
Industry/University Cooperative Research Centers (I/UCRCs)

NSF Engineering Research Centers



Notes: (1) Darker labels denote current ERCs. Lighter labels denote graduated centers.
(2) Most centers are multi-university partnerships. University shown is lead institution.

All ERC Disciplines



ENG will invest strategically in the Innovation Ecosystem

- **Innovation Corps (I-Corps)**
  The ENG investment will provide mentoring and resources to help determine the commercial readiness of technology built on NSF-funded basic research

$6 M for I-Corps

- **Partnerships for Innovation**
  - ENG support for Accelerating Innovation Research (AIR) will foster connections with an existing NSF innovation research alliance
  - ENG support for Building Innovation Capacity (BIC) will enable collaboration between academia and business to advance basic research for market-accepted innovations

$23 M for PFI

I-Corps in A Nutshell

- **A Public/Private Partnership**: to support the translation of NSF research into the development of technologies, products and processes

- **Increasing Network Opportunities**: aims to help create a national network scientists, engineers, innovators, business leaders and entrepreneurs building on existing NSF grantee events

- **Supporting NSF Strategy**: I-Corps will enhance our nation's economic competitiveness by "reaching out to a range of communities that play complementary roles in the innovation process and are essential to ensuring the impact of NSF Investments." *

**From "Empowering the Nation through Discovery and Innovation" NSF Strategic Plan, April 2011*

I-Corps Projects are Team-Based

- Team Composition:
  - Entrepreneurial Lead: Post-doc or Student to move it forward
  - I-Corps Mentor: Domain-relevant volunteer guide
  - PI: Researcher with current or previous award
- Program Outcomes
  - Functioning network of Mentors/Advisors
  - Scientist and Engineers trained as Entrepreneurs
  - Increased impact of NSF-funded basic research

Credit: © 2011 JupiterImages Corp.

- 30 Hours of Curriculum
- $50,000 per award
- F&A $5,000 maximum
- 25 awards in FY2011
- 100 awards in FY2012

SAVI: Science Across Virtual Institutes

Launched October 5, 2011

Science Across Virtual Institutes (SAVI)

- Create a uniform platform for International Collaborations between NSF funded US researchers and other institutions around the world.
- Facilitate collaboration among scientists, engineers and educators across the globe to help solve society's most vexing problems.
- Early pilots VIs:
  - Mathematical and Statistical Sciences (VI-MSS) with India
  - Physics of Living Systems Student Research Network (PoLS SRN) with Israel and others
  - Wireless Innovation (WiFiUS) with Finland

ENG Budget ($M)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change over FY 2012 Estimate	
				Amount	Percent
CBET	$158.82	$171.45	$179.40	$7.95	4.6%
CMMI	189.62	203.58	217.06	13.48	6.6%
ECCS	97.54	106.73	114.30	7.57	7.1%
EEC	125.76	120.00	123.27	3.27	2.7%
IIP	162.65	193.41	210.30	16.89	8.7%
SBIR/STTR	*126.47*	*152.76*	*165.20*	*12.44*	*8.1%*
EFRI	28.95	31.00	32.00	1.00	3.2%
ENG TOTAL	$763.33	$826.17	$876.33	$50.16	6.1%

ENGINEERING ROLE IN SOLVING GRAND CHALLENGE ISSUES

WHAT DO YOU THINK?

Click on the engineering challenge you think is the most important:


Make solar energy economical


Provide energy from fusion


Develop carbon sequestration methods


Manage the nitrogen cycle


Provide access to clean water


Restore and improve urban infrastructure


Advance health informatics


Engineer better medicines


Reverse-engineer the brain


Prevent nuclear terror


Secure cyberspace

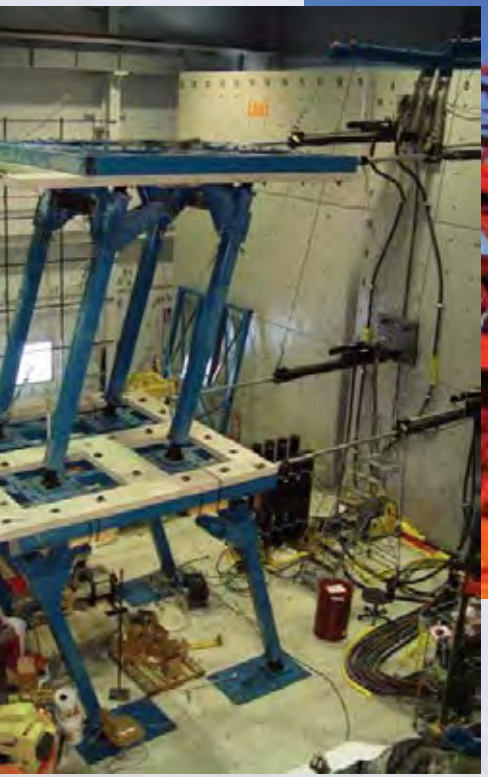

Enhance virtual reality

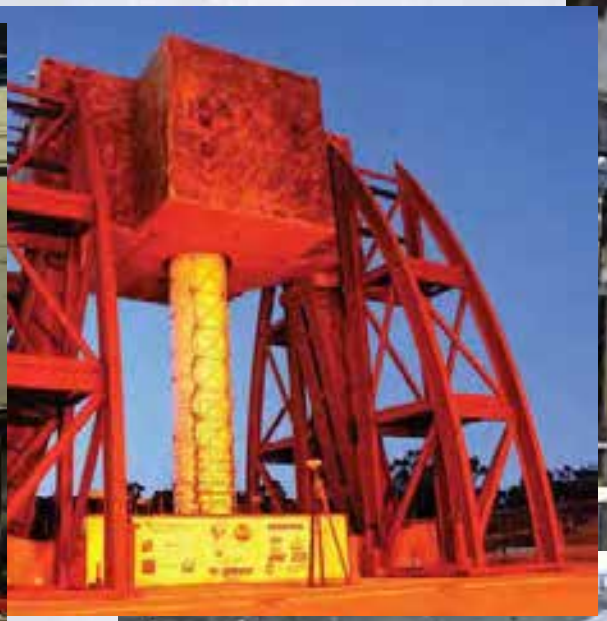

Advance personalized learning


Engineer the tools of scientific discovery


WHAT DO YOU THINK?
Click on the engineering challenge you think is the most important:
Develop carbon sequestration methods
Manage the nitrogen cycle
Restore and improve urban infrastructure
Advance health informatics
Engineer better medicines
Reverse-engineer the brain
Prevent nuclear terror
Enhance virtual reality
Sustainability
Health
Security
Joy of Living

Network for Earthquake Engineering Simulation, est. 2004

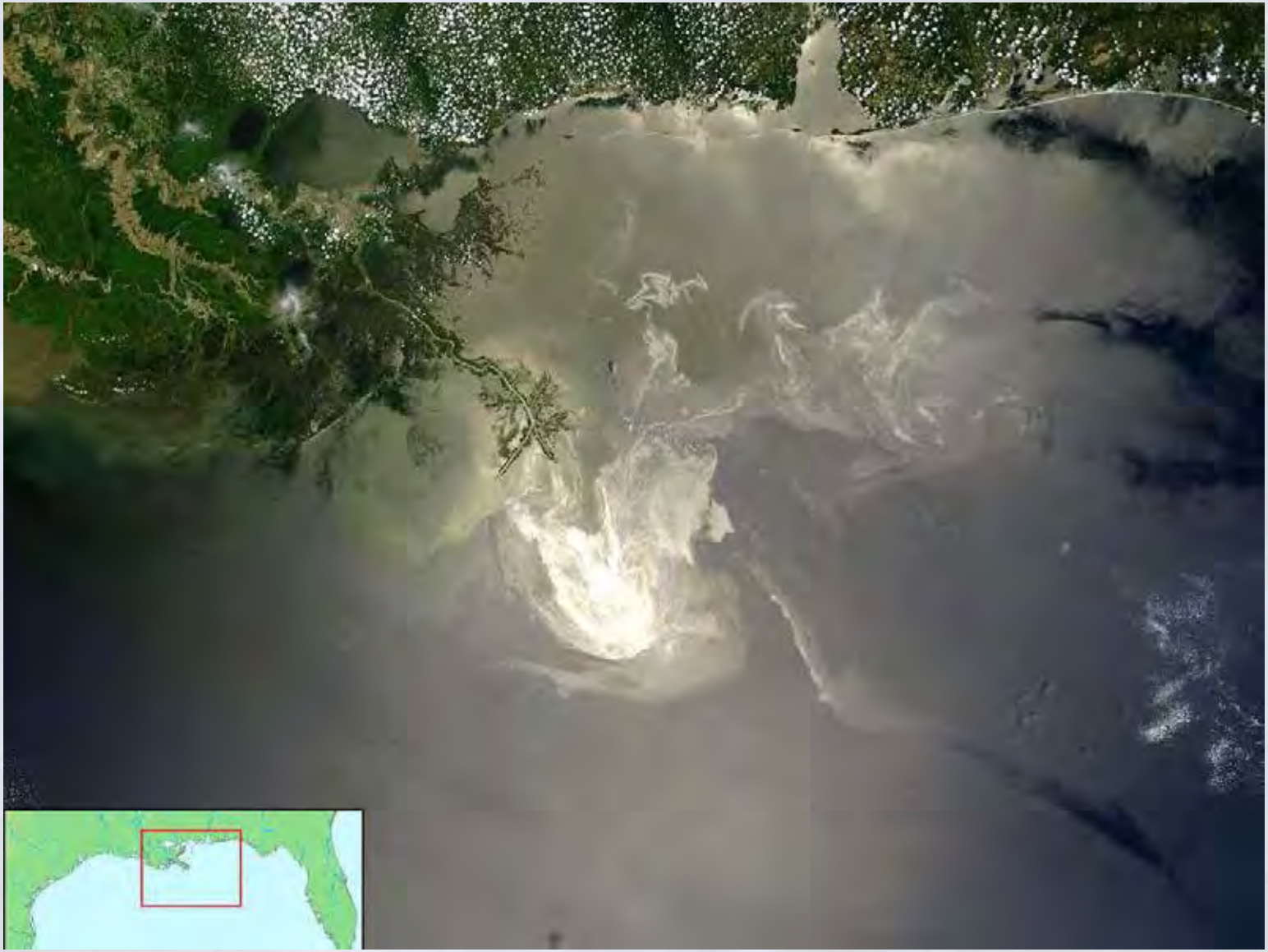





UC San Diego

Japan Earthquake and Tsunami, March 11, 2011

Hurricane Katrina Makes Landfall, August, 2005



Gulf of Mexico Oil Spill, May 24, 2010


One NSF


One NSF