NSF
Directorate for Engineering

Theresa Maldonado, Ph.D., P.E.
Division Director
Engineering Education and Centers
National Science Foundation
tmaldona@nsf.gov

NSF Regional Grants Conference
Austin, TX
October 18, 2011

Agenda

- Engineering Directorate
- Interlaced topics
  - Funding Opportunities
  - Engineering Career Development
  - Innovation

Directorate for Engineering (ENG)

Office of the Assistant Director
Thomas Peterson, Assistant Director
Kesh Narayanan, Deputy Assistant Director

Emerging Frontiers in Research and Innovation (EFRI)
Sohi Rastegar
$29M

Senior Advisor for Nanotechnology
Mihail Roco

Program Director for Diversity
Omnia El-Hakim

Engineering Education and Centers (EEC)
Theresa Maldonado
$132M

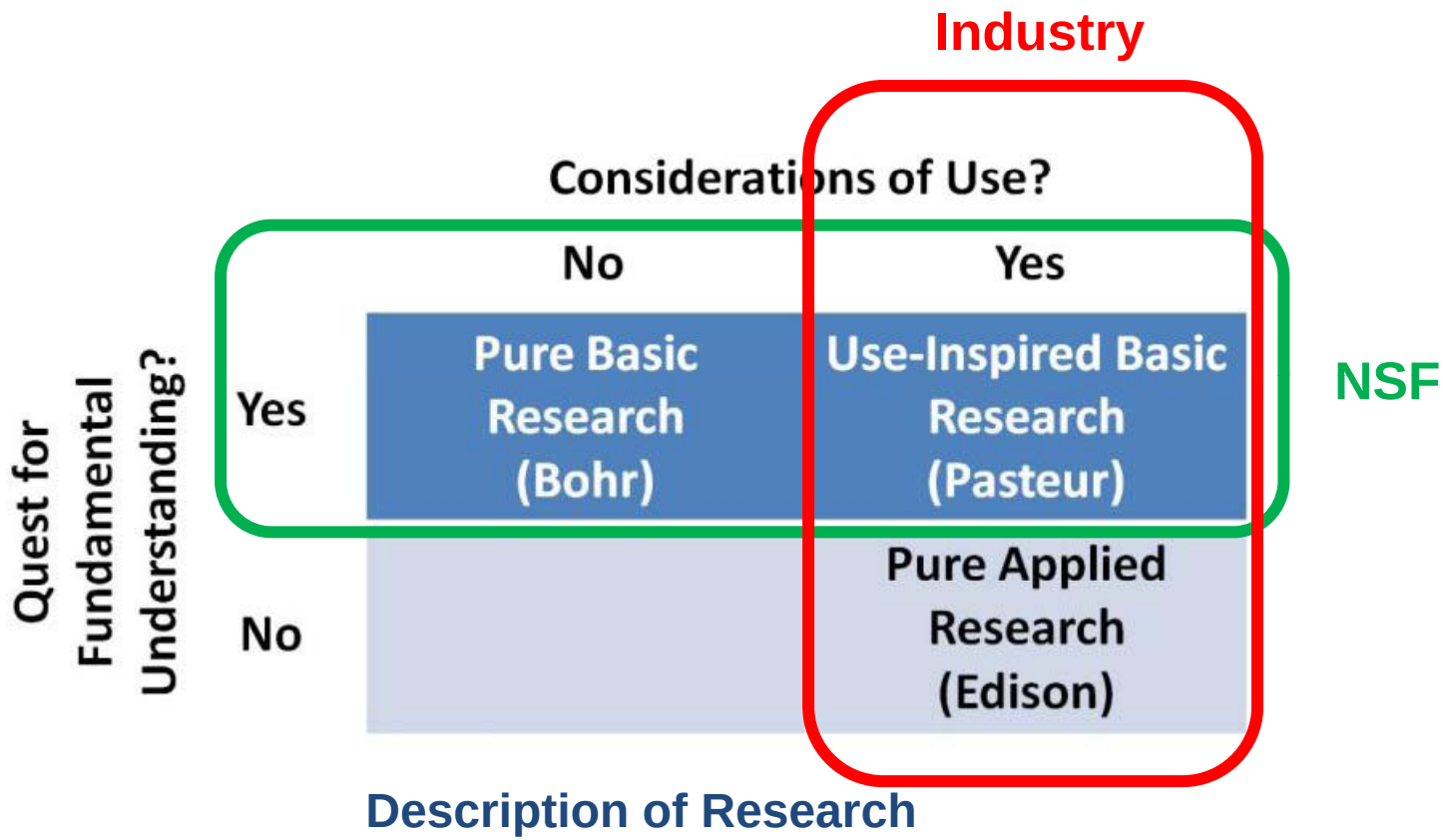
Chemical, Bioengineering, Environmental, and Transport Systems (CBET)
John McGrath
$160M

Civil, Mechanical, and Manufacturing Innovation (CMMI)
Steven McKnight
$192M

Electrical, Communications, and Cyber Systems (ECCS)
Robert Trew
$96M

Industrial Innovation and Partnerships (IIP)
Don Senich (Acting
$156M

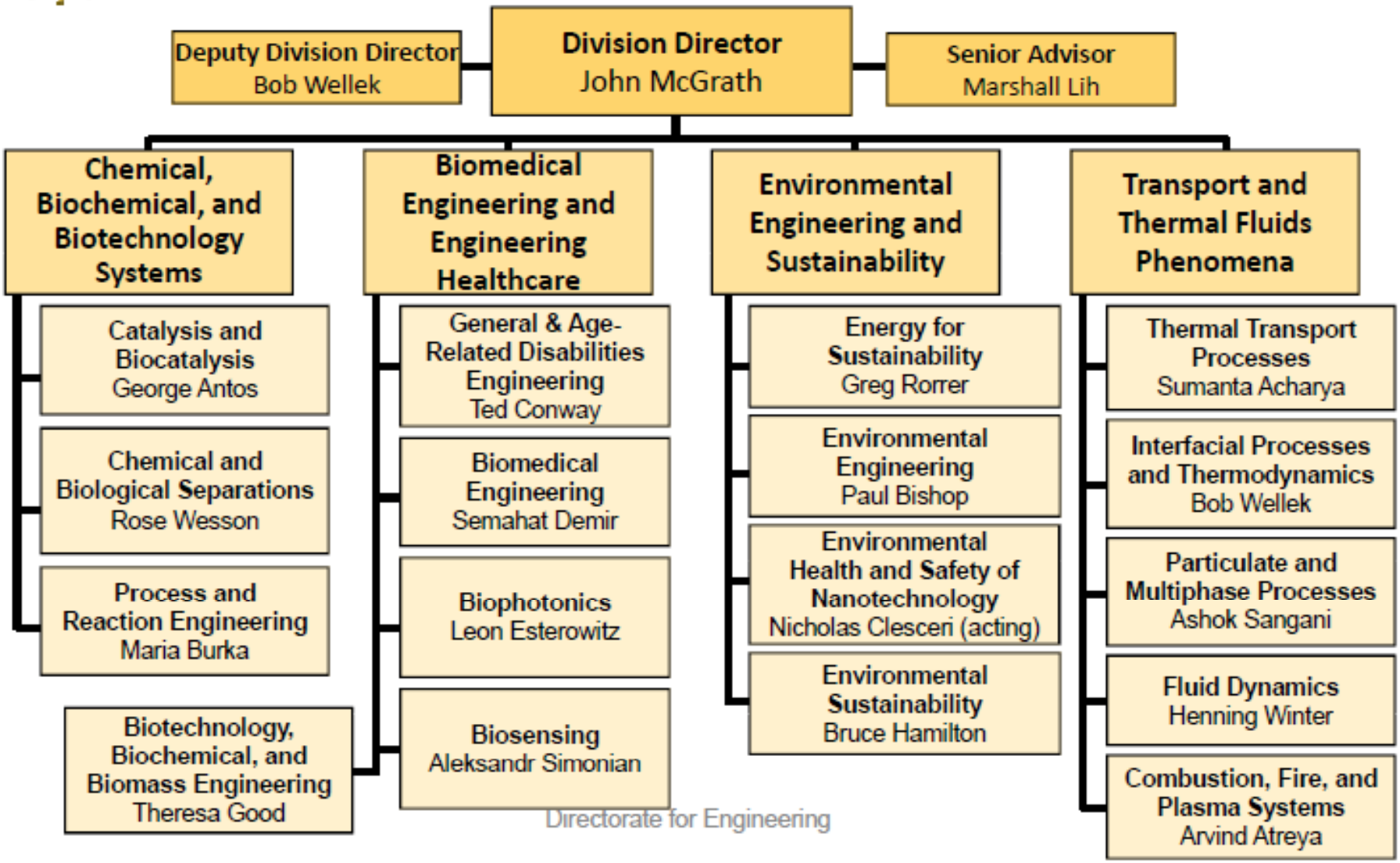
Pasteur's Quadrant



NSF support of Innovation Ecosystem: Translational research integrated with basic research and education

From: D. Stokes, "Pasteur's Quadrant," 1997.

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



One proposal submission window per year!

Civil, Mechanical, and Manufacturing Innovation (CMMI)

Division Director
Steven McKnight
Deputy Director
George Hazelrigg

- **Interdisciplinary and Cross-Divisional Activities**
  Bruce Kramer
- **Advanced Manufacturing**
  - **Manufacturing and Construction Machines and Equipment**
    George Hazelrigg
  - **Manufacturing Enterprise Systems**
    Russell Barton
  - **Material Processing and Manufacturing**
    Mary Toney
  - **Nano Manufacturing**
    Charalabos (Haris) Doumanidis
- **Mechanics and Engineering Materials**
  - **Geomechanics and Geotechnical Systems**
    Richard Fragaszy
  - **Materials and Surface Engineering**
    Clark Cooper
  - **Mechanics of Materials**
    Glaucio Paulino
  - **Nano/Bio Mechanics**
    Dennis Carter
  - **Structural Materials and Mechanics**
    Clark Cooper
- **Resilient and Sustainable Infrastructures**
  - **Civil Infrastructure Systems**
    Konstantinos Triantis
  - **NEES**
    Joy Pauschke
  - **Geotechnical Engineering**
    Richard Fragaszy
  - **Hazard Mitigation and Structural Engineering**
    Kishor Mehta
  - **Infrastructure Mgmt. and Extreme Events**
    Dennis Wenger
- **Systems Engineering and Design**
  - **Control Systems**
    Eduardo Misawa
  - **Dynamical Systems**
    Eduardo Misawa
  - **Engineering Design and Innovation**
    Christina Bloebaum
  - **Operations Research**
    Michael Fu
  - **Sensors and Sensing Systems**
    Shih Chi Liu
  - **Service Enterprise Systems**
    Russell Barton

Electrical, Communications, and Cyber Systems (ECCS)

Senior Engineering Advisor
Lawrence Goldberg

Division Director
Robert Trew

Electronics, Photonics, and Magnetic Devices

Micro/nanoelectronics; Advanced integrated circuits; Beyond silicon CMOS; Quantum-level devices; Electromagnetics/microwave/THz simulations and models
Samir El-Ghazaly

Molecular electronics; Organic and flexible electronics; Energy-efficient green electronics and photonics
Pradeep Fulay

Bioelectronics and biomagnetics; Spintronics and magnetics; Sensor technologies
Usha Varshney

Optoelectronics/photonics; Nanophotonics; Plasmonics and metamaterials; Large-scale photonic integration; Ultrafast phenomena
John Zavada

Communications, Circuits, and Sensing Systems

Cyber-physical systems; Next-generation cyber systems; Signal processing
Zygmunt Haas

MEMS/NEMS systems-on-a-chip; Diagnostic and implantable devices; Biological and medical devices; Environmental monitoring; Micro-power and energy
Rajinder Khosla

RF to optical communication systems; Inter- and intra-chip communication/networks; Mixed signal systems; Millimeter wave and terahertz systems
Andreas Weisshaar

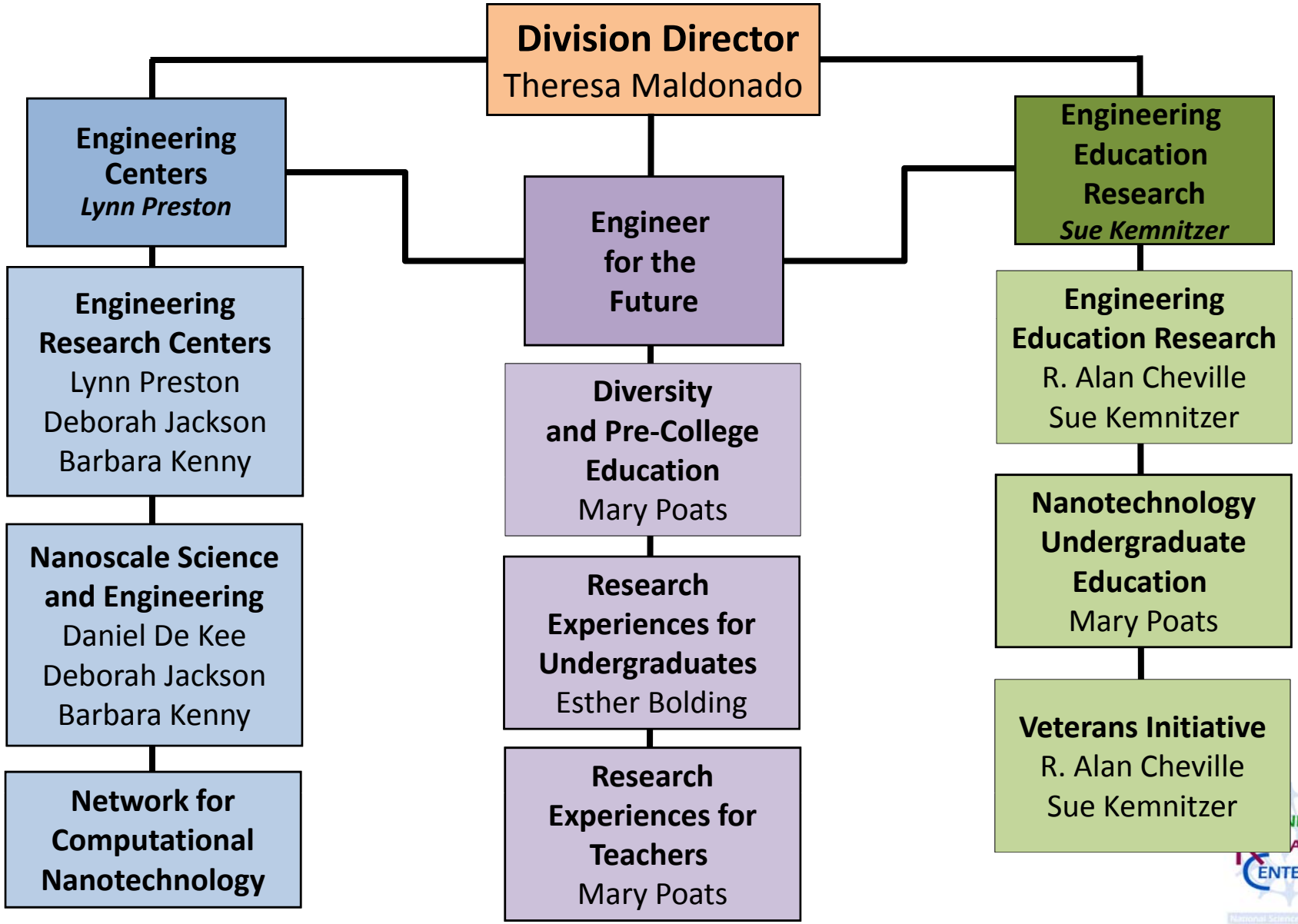
Energy, Power, and Adaptive Systems

Systems & control theory and hybrid dynamical systems; Energy systems reliability & control; Distributed & mobile networked control; Sensor & transportation networks; Estimation in sensing & imaging; Human-robot interaction; Stochastic modeling
Radhakisan Baheti

Energy collection, conversion, and storage; Renewable energy; Power conversion, generators, motors, & network interfacing; Energy and power sensing; High voltage, high power switching and conversion
George Maracas

Adaptive/intelligent systems; T&D systems; Intelligent power grid; High-performance & multi-scale modeling; Quantum systems & modeling; Neural networks; Cognitive optimization & prediction; Intelligent vehicles/robots
Paul Werbos

Engineering Education & Centers



Industrial Innovation and Partnerships

Serves the entire foundation by fostering partnerships to advance technological innovation and plays an important role in the public-private innovation partnership enterprise.

IIP Core Programs

- Industry/University Cooperative Research Centers (I/UCRC)
- Partnerships for Innovation (PFI)
- Small Business Innovation Research (SBIR)
- Small Business Technology Transfer (STTR)

Innovation Ecosystem

- Accelerating Innovation Research (AIR)
- I-Corps

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Emerging Frontiers in Research and Innovation

- Higher-risk, higher payoff opportunities:
  - Potentially transformative
  - Address a national need or grand challenge
- Comprehensive topic selection process
- PIs: Interdisciplinary team
- Funding: ≤ $2M for four years. Anticipate 12-15 awards
- Topical areas for FY12: NSF 11-571
  - Flexible Bioelectronics Systems (BioFlex): **Dr. Usha Varshney, ECCS**
  - Origami Design for the Integration of Self-Assembling Systems for Engineering Innovation (ODISSEI): **Dr. Christina Bloebaum, CMMI**
  - Photosynthesis Biorefineries: **Dr. Bruce Hamilton, CBET**

EFRI Director: Dr. Sohi Rastegar

EMERGING FRONTIERS IN RESEARCH AND INNOVATION 2012 (EFRI-2012)

1. Flexible Bioelectronics Systems (BioFlex)
2. Origami Design for Integration of Self-assembling Systems for Engineering Innovation (ODISSEI)
3. Photosynthetic Biorefineries (PSBR)

PROGRAM SOLICITATION
NSF 11-571

REPLACES DOCUMENT(S):
NSF 10-596

National Science Foundation

Directorate for Engineering
Emerging Frontiers in Research and Innovation

Directorate for Mathematical & Physical Sciences
Division of Mathematical Sciences
Division of Materials Research

Directorate for Biological Sciences
Division of Molecular and Cellular Biosciences

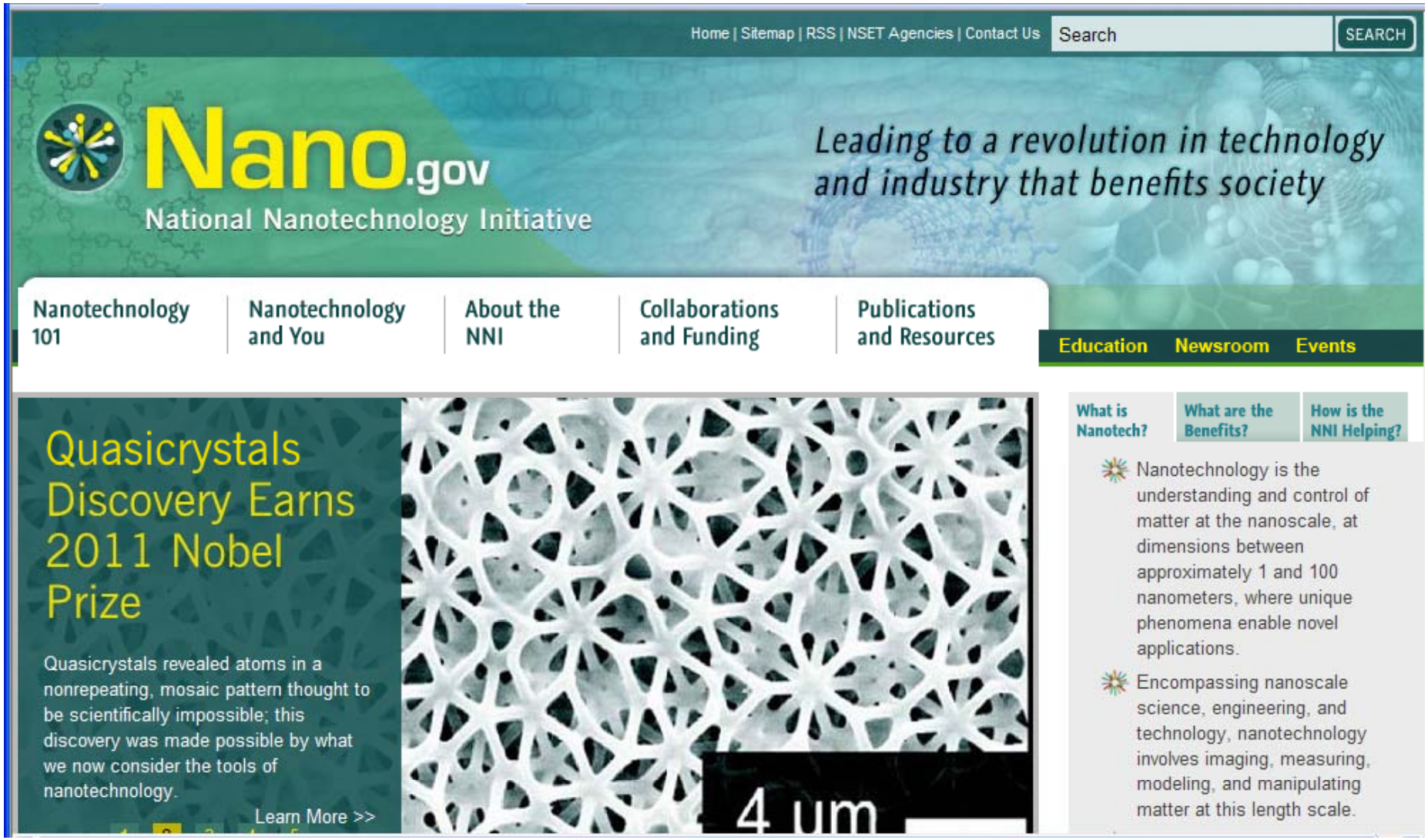
Air Force Office of Scientific Research

LOI: Sept. 30, 2011
Preliminary Proposal: Nov. 9, 2011
Full Proposal: March 30, 2012

http://www.nsf.gov/div/index.jsp?div=EFRI

EFRI Director: Dr. Sohi Rastegar

National Nanotechnology Initiative



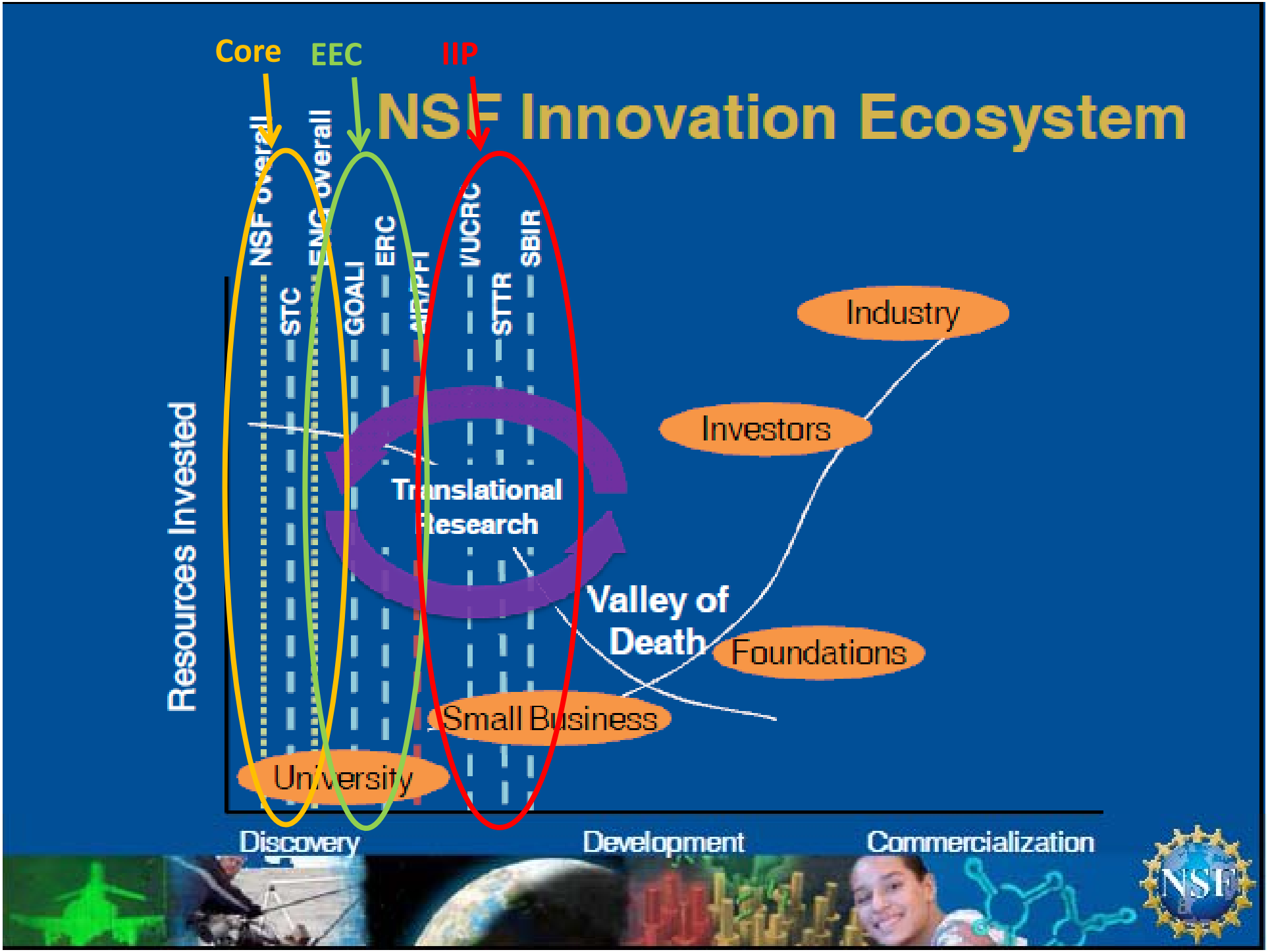
NSF Support for Nano: FY11

- Existing core programs across NSF
- Nano Environmental Health and Safety (CBET)
- Nanosystems Engineering Research Centers (NERC): NSF 11-527
- Nanotechnology Undergraduate Education in Engineering (NUE): NSF 11-524
- Nanoelectronics for 2020 and Beyond (NEB): NSF 10-614
- Scalable Nanomanufacturing: NSF 10-618
- The Small Business Innovative Research (SBIR) and Small Business Technology Transfer (STTR) programs
- International supplements

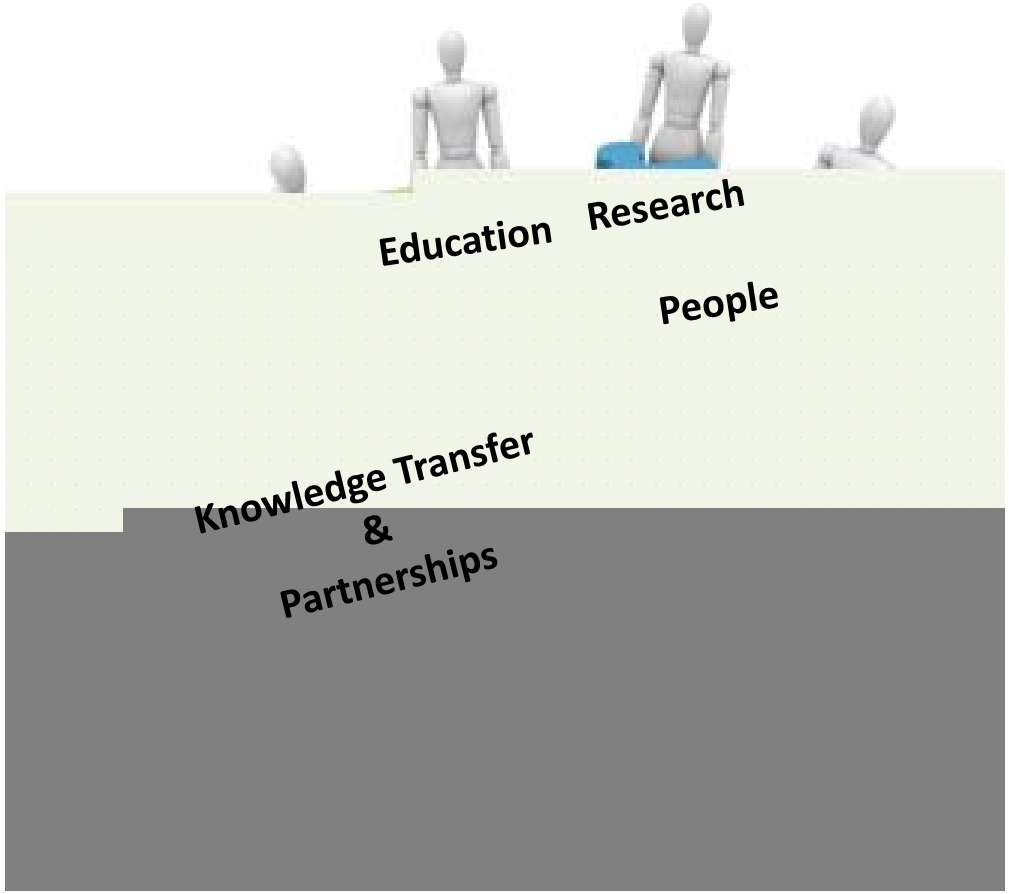
Diversity Office

- Objective: Encourage broader participation in science and engineering, especially from underrepresented groups
- Programs
  - Broadening Participation Research Initiation Grants in Engineering
  - Graduate Research Diversity Supplements
  - Graduate Research Fellowships for Women
  - NSF-wide programs (ADVANCE, etc.)
- Workshops

POC: Dr. Omnia El-Hakim


NSF Innovation Ecosystem
Core
EEC
IIP
NSF Overall
STC
ENG Overall
GOALI
ERC
I/UCRC
STTR
SBIR
Translational Research
Valley of Death
Industry
Investors
Foundations
Small Business
University
Resources Invested
Discovery
Development
Commercialization

EEC = The Integrator
A Critical Function



EEC

- Centers
- Infrastructure
- Engineering Education Research
- Engineering Career Development

Engineering Centers

- Engineering Research Centers (ERC)
  - 25th Anniversary
  - Three generations since 1985
  - 50 ERCs since 1985
  - FY10 Competition Gen-3 ERCs
    - Open topic
    - Energy: Partnership with DOE
    - Infrastructure
    - Four new centers announced Summer 2011
  - Current competition
    - Nano-Systems ERC: **NSF 11-537 (No pre-proposals)**
    - Open topic

POC: Lynn Preston

- Nanoscale Science and Engineering Centers (NSEC)
  - 19 NSECs since 2001
  - 3 graduated NSECs from FY01 class

- Science and Technology Centers (STC)

- Science of Learning Centers (SLC)

Class of 2011 ERCs

NSF/DOE Co-Fund

ReNUWIt: The Urban Water ERC

Re-inventing the Nation's Urban Water Infrastructure

NSF/DOE Co-Fund

Class of 2011 ERCs

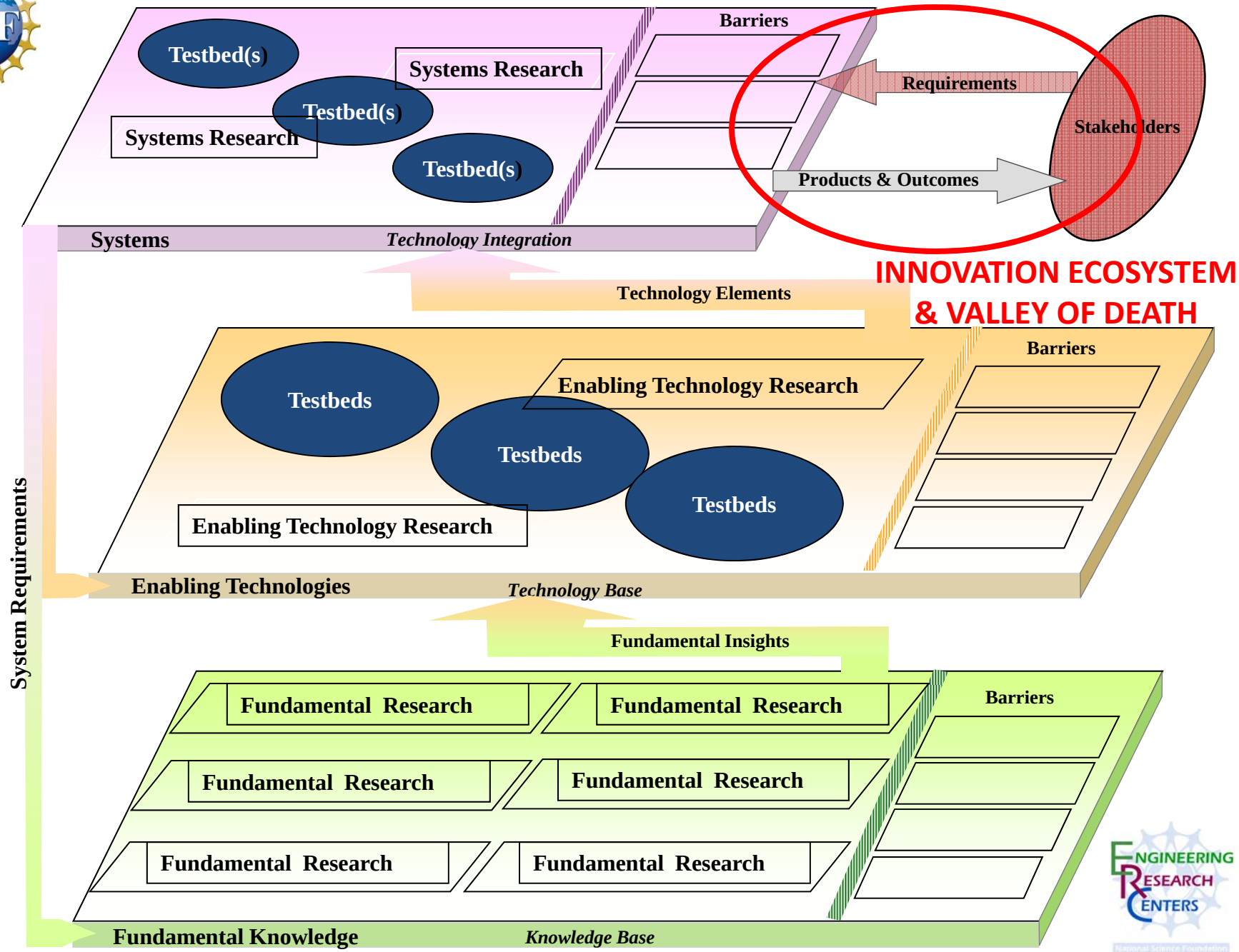
The **NSF ERC for Re-inventing America's Urban Water Infrastructure**, led by Stanford University, will seek sustainable urban water systems to supply, treat, and reuse water.

The **NSF ERC for Sensorimotor Neural Engineering**, led by the University of Washington, will pursue the ideal mind-machine interface and other devices to restore and augment health.

The **NSF-DOE ERC for Quantum Energy and Sustainable Solar Technologies (QESST)**, led by Arizona State University, will aim to make solar energy technologies sustainable, ubiquitous, and multifunctional.

The **NSF-DOE ERC for Ultra-wide-area Resilient Electric Energy Transmission Networks (CURENT)**, led by the University of Tennessee, Knoxville, will create transforming technologies to allow reliable, secure, and efficient operation of the electricity transmission infrastructure across vast distances.

ERC (Research) Strategic Framework:

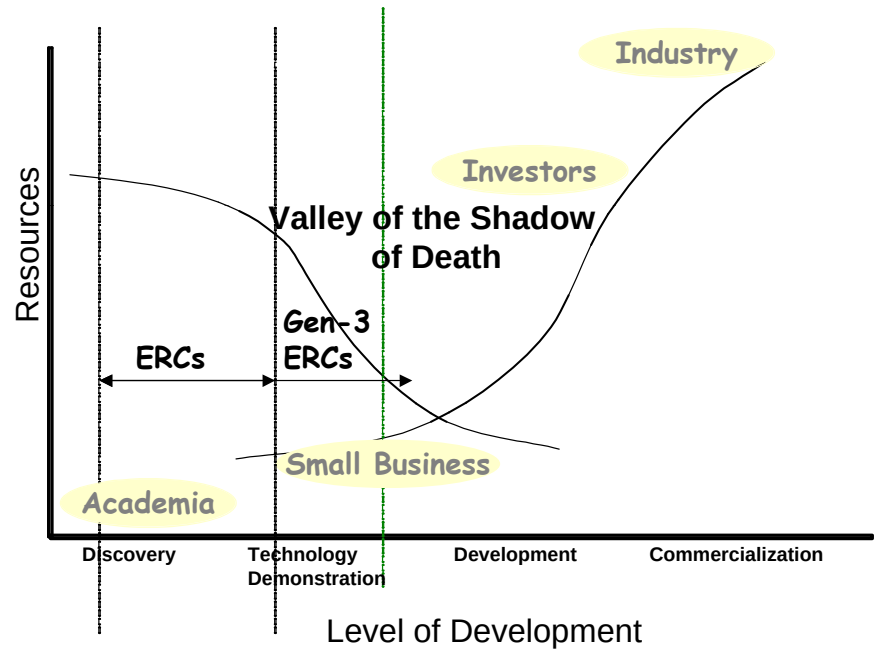


Additional Gen-3 ERC Key Features

Gen-3 ERCs bridge discovery to innovation by expanding the research culture to:

- Support translational research with small firms
- Develop more creative & innovative engineers
- Partner with economic development organizations
- Reward mentoring
- Partner with 1-3 foreign universities to provide cross-cultural, global research and education experiences
- Long-term pre-college partnerships

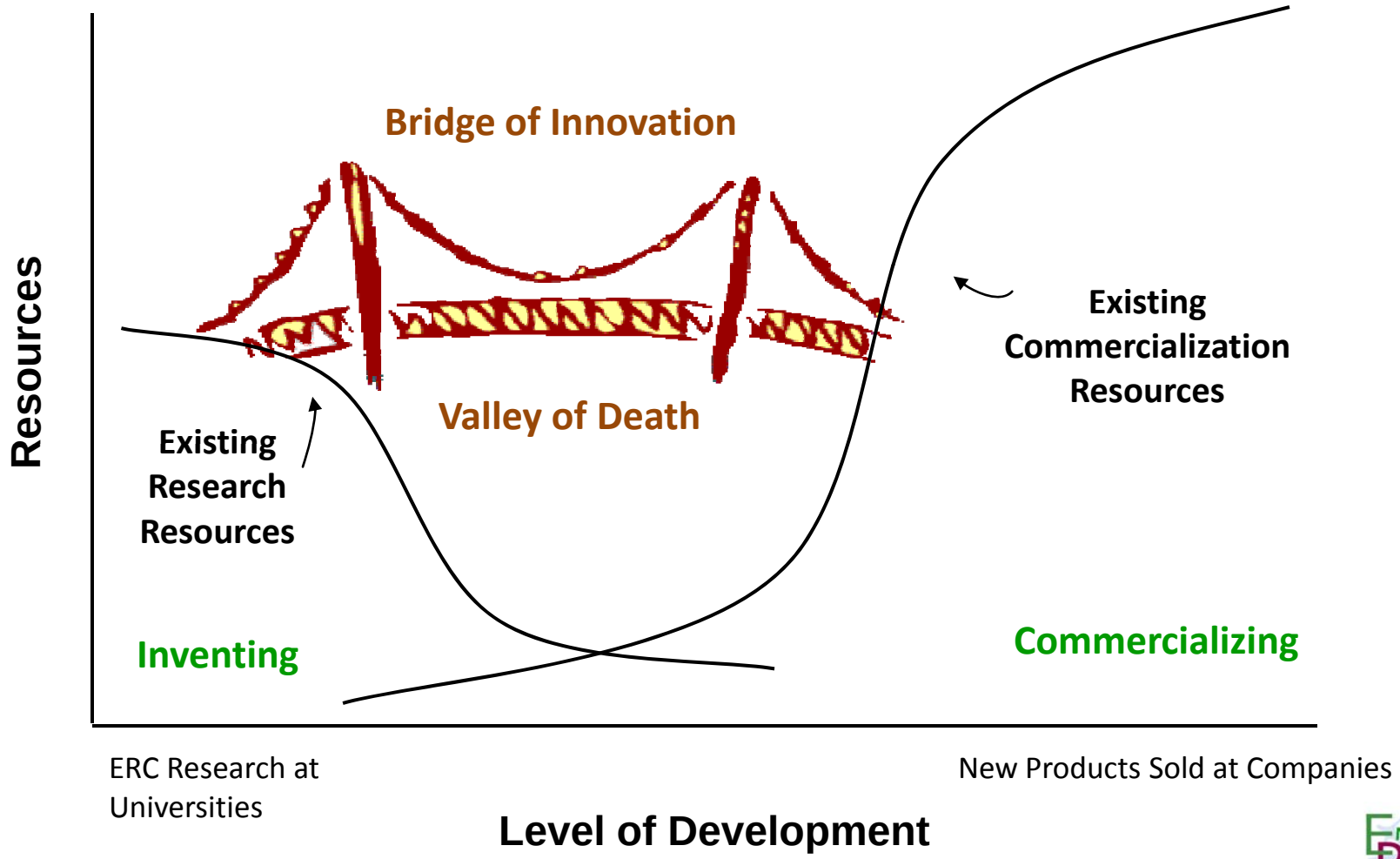
ERCs on the Innovation Spectrum



Adapted from slide created by Angus Kingon, Brown University

Between Invention and Commercialization

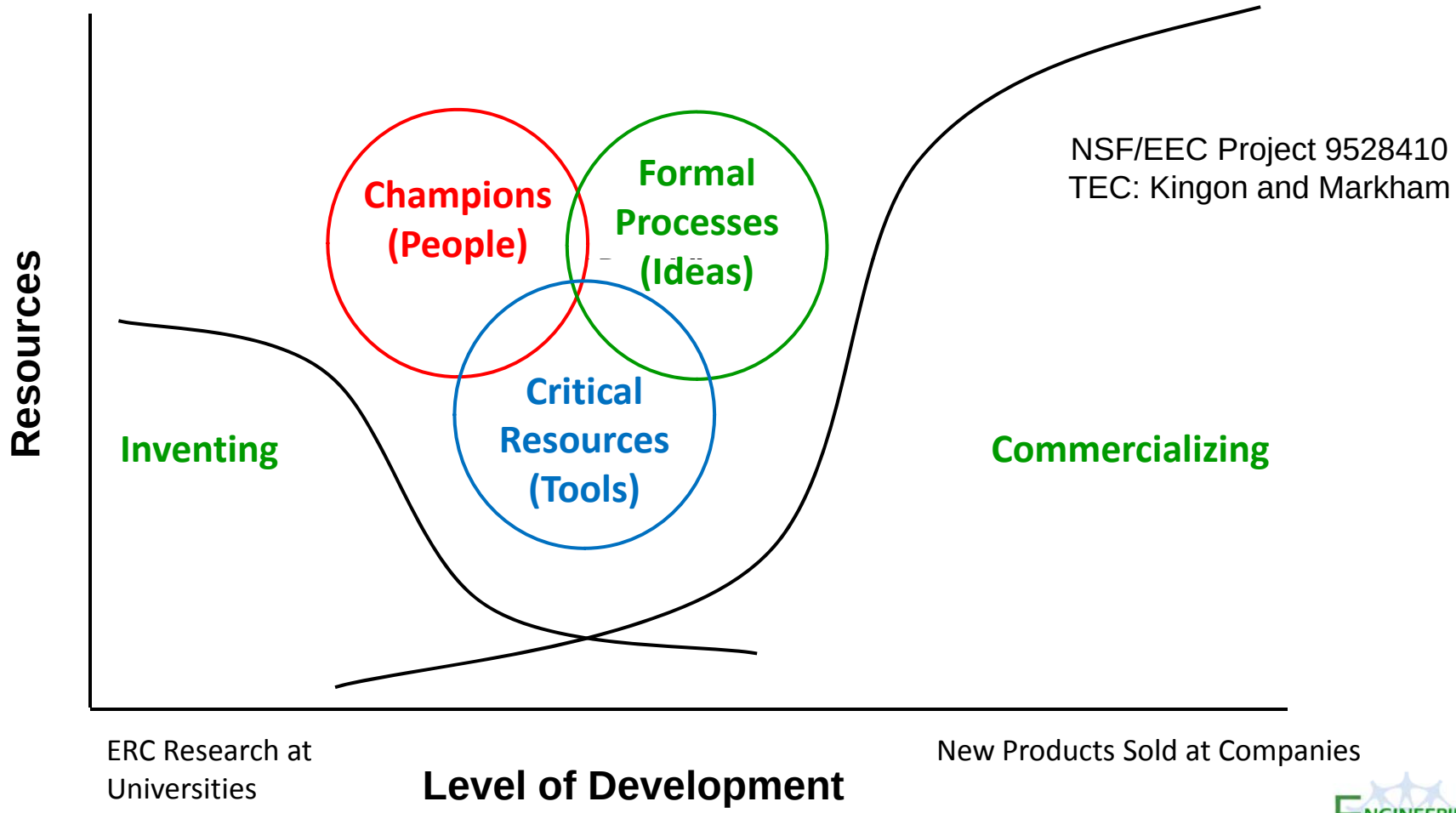
Innovation Program to Bridge the Valley of Death



Credit: Dr. Deborah Jackson, 2011

Closer Look at the Valley of Death

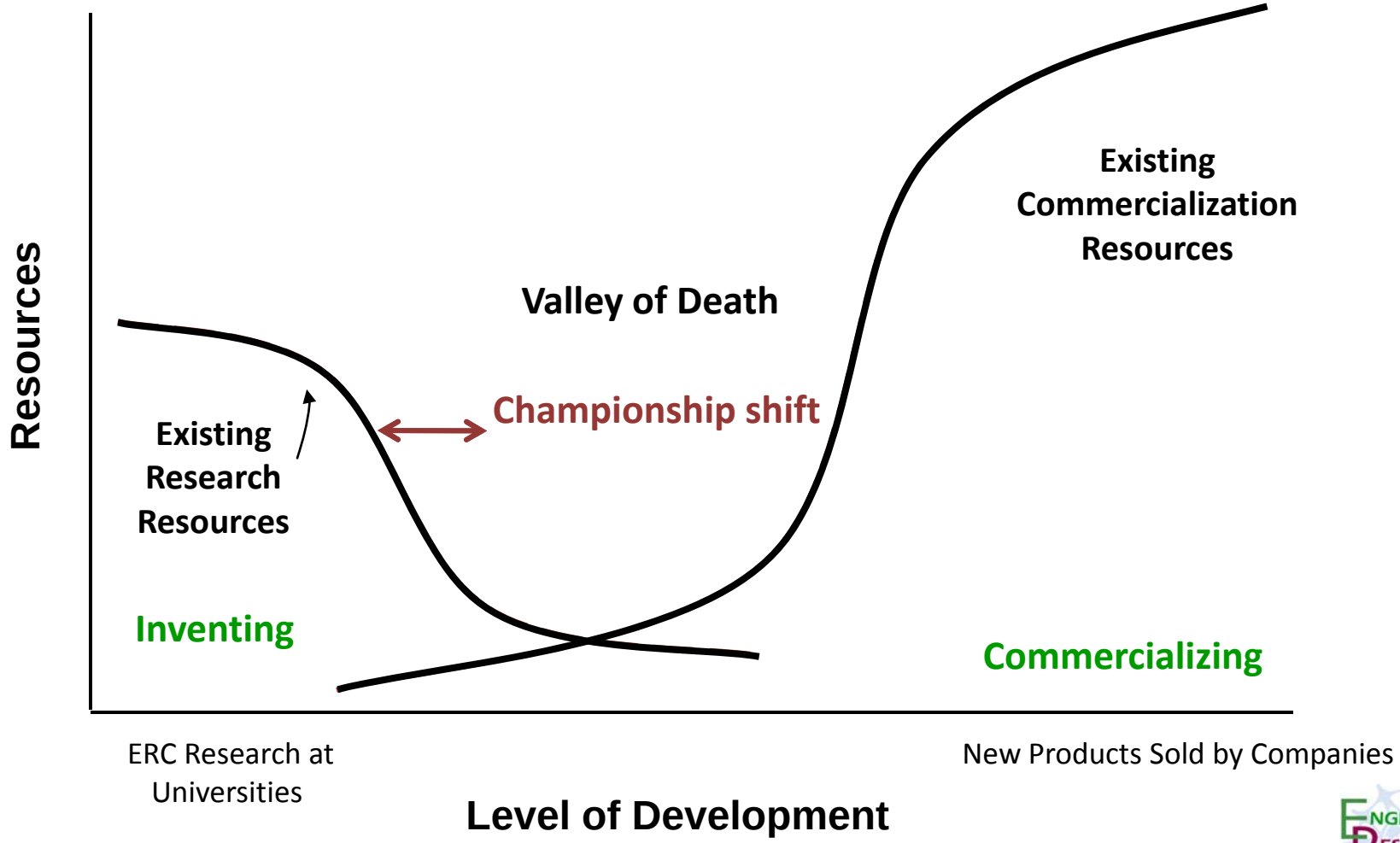
Overlapping Structural Resources and Activities



NSF/EEC Project 9528410
TEC: Kingon and Markham

Credit: Dr. Deborah Jackson, 2011

Innovation Bridge Structures Turn "Valley of Death" into "Challenge Basin"



Credit: Dr. Deborah Jackson, 2011

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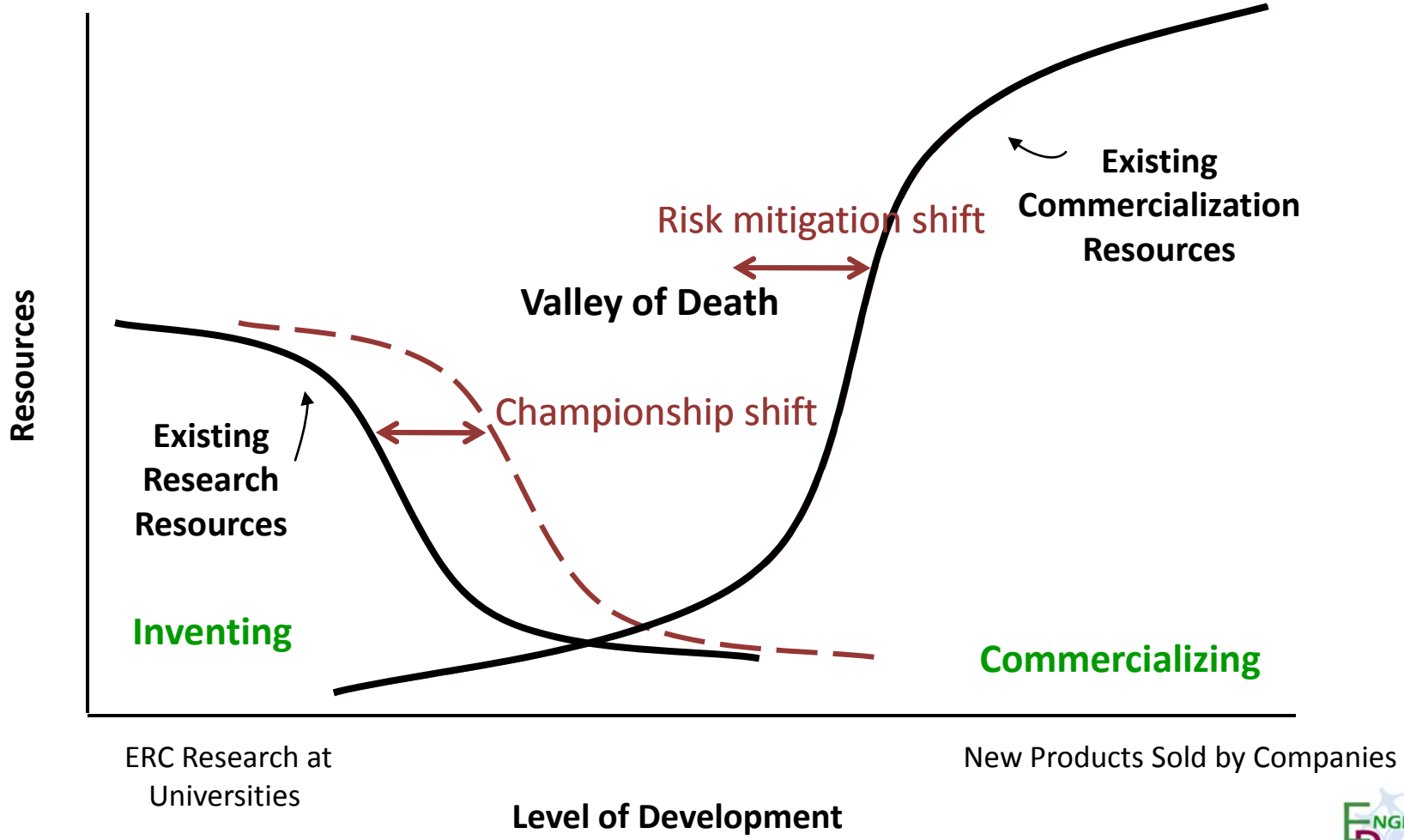

Credit: Dr. Deborah Jackson, 2011

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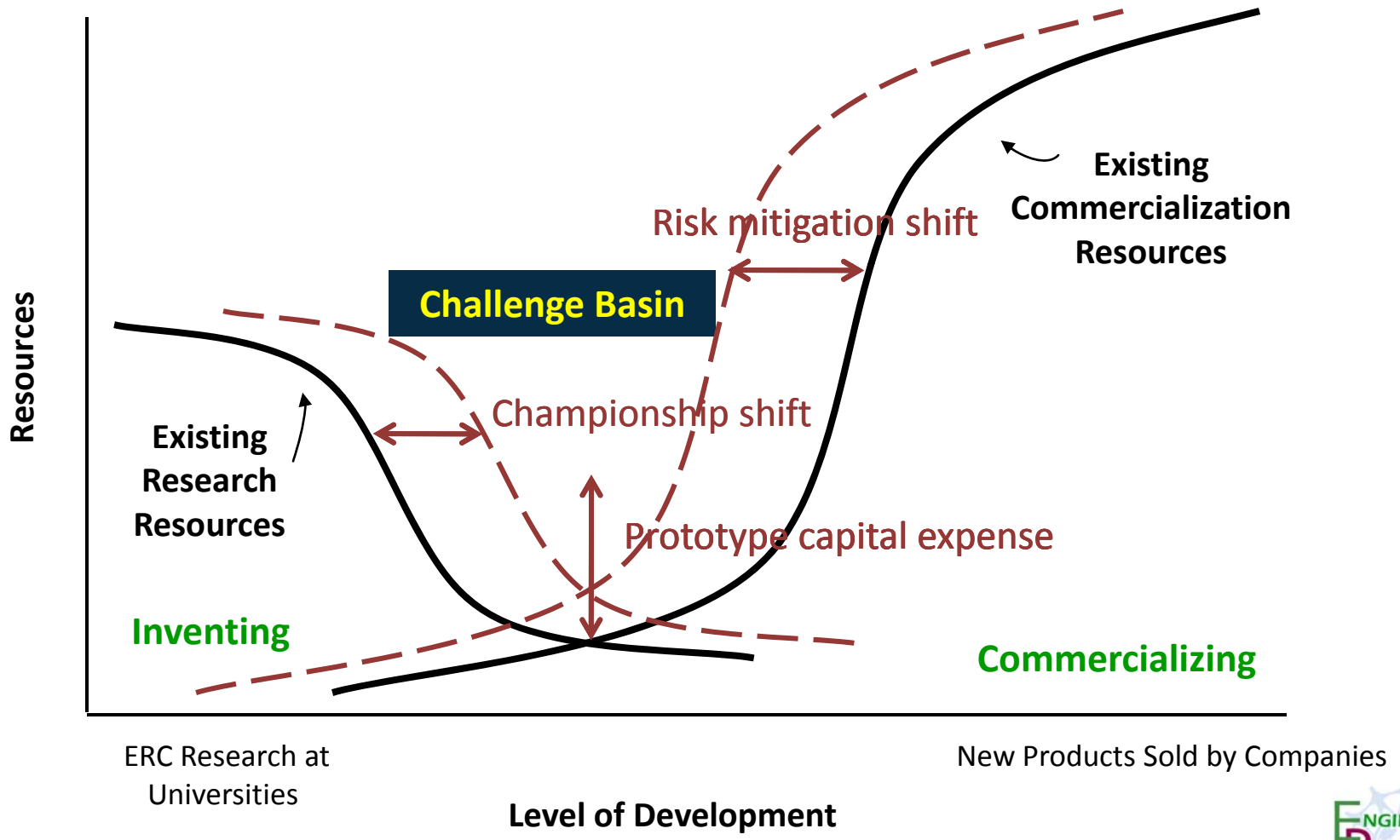
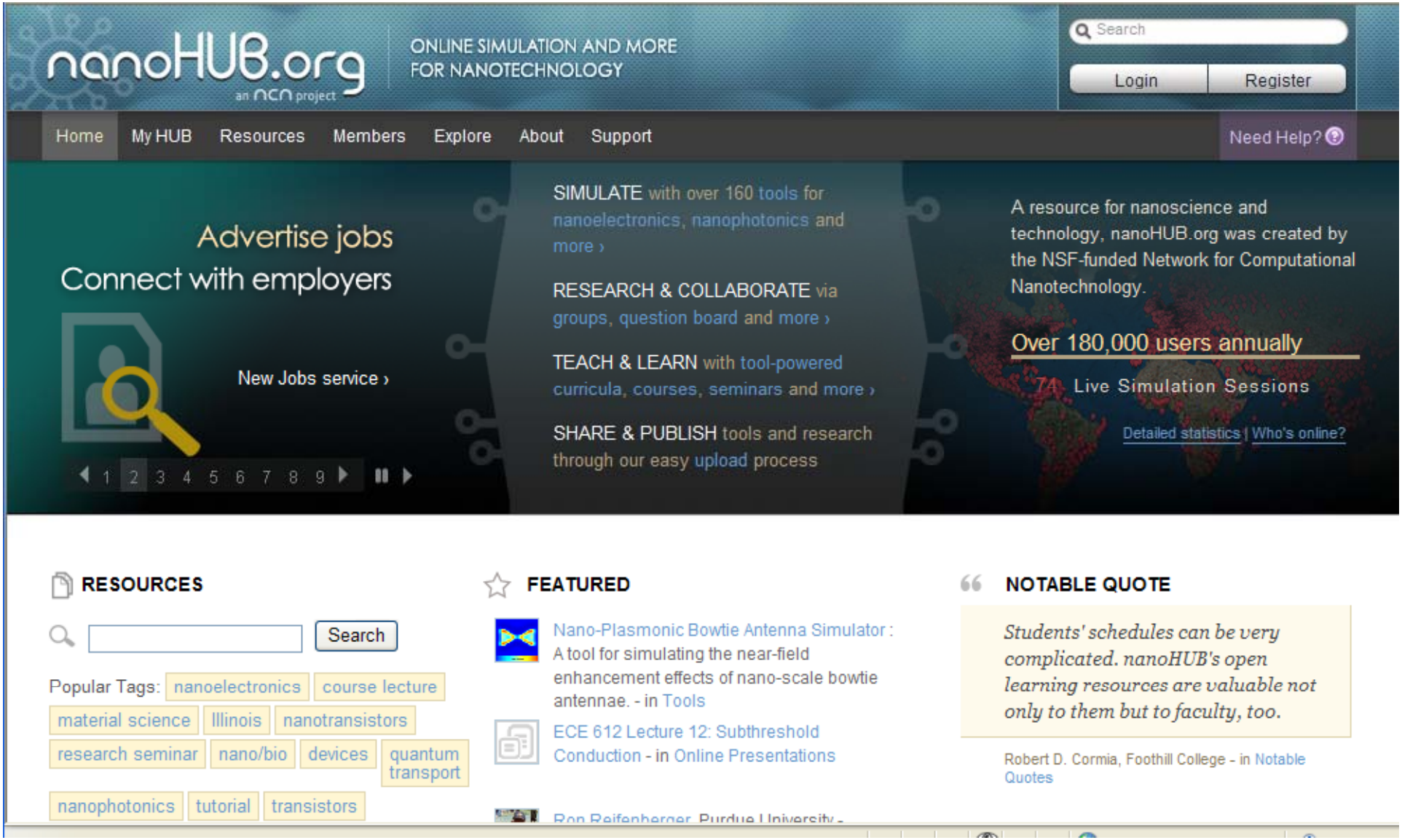


Network for Computational Nanotechnology



Network for Computational Nanotechnology (NCN)

A Competition to Reconfigure the NCN

PROGRAM SOLICITATION
NSF 12-504

National Science Foundation

Directorate for Engineering
Division of Chemical, Bioengineering, Environmental, and Transport Systems
Division of Civil, Mechanical and Manufacturing Innovation
Division of Engineering Education and Centers
Division of Electrical, Communications and Cyber Systems

Directorate for Computer & Information Science & Engineering
Division of Computing and Communication Foundations

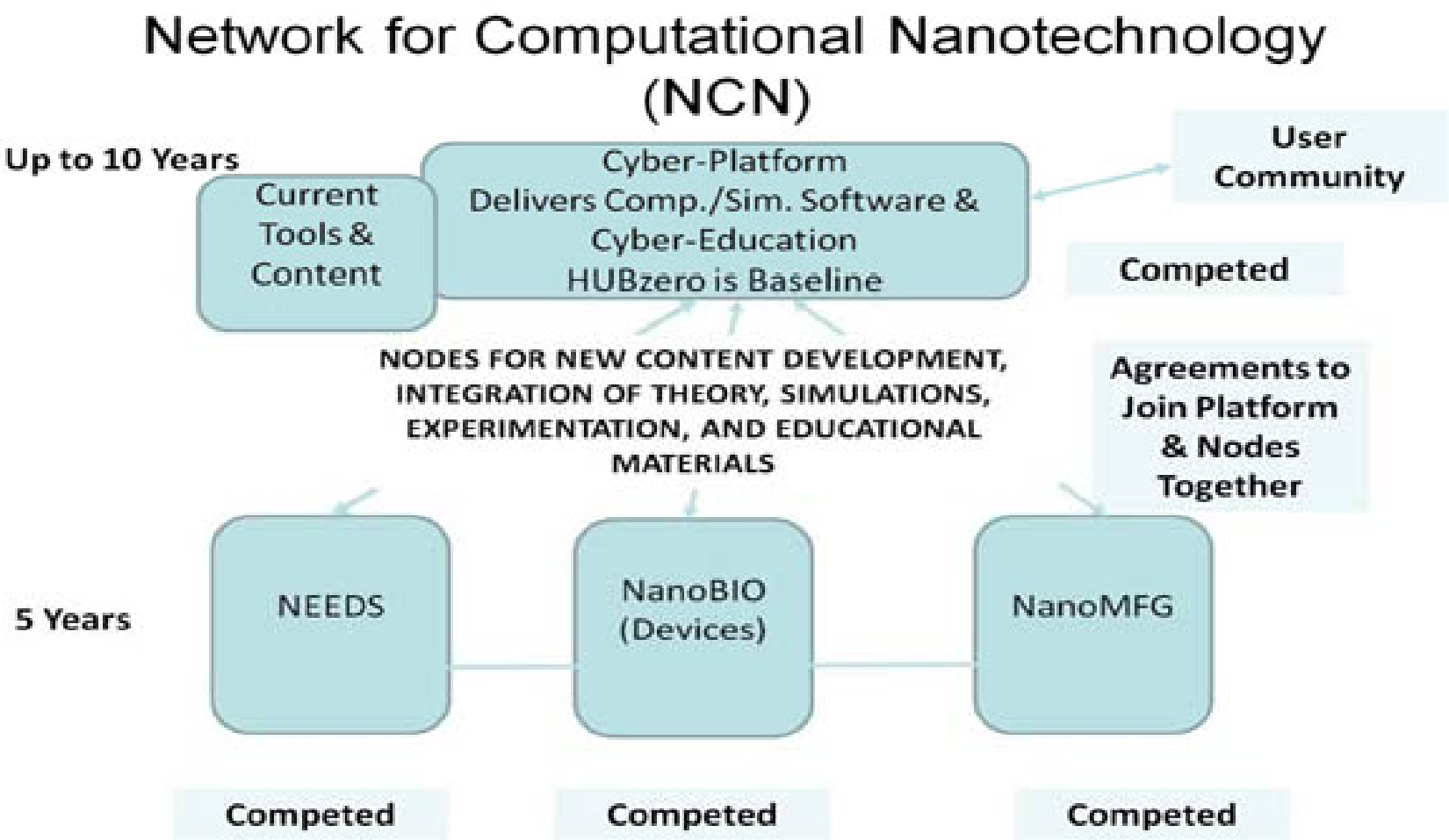
Office of Cyberinfrastructure

Letter of Intent Due Date(s) ***(required)*** (due by 5 p.m. proposer's local time)***:***

December 16, 2011

Full Proposal Deadline(s) (due by 5 p.m. proposer's local time):

January 17, 2012



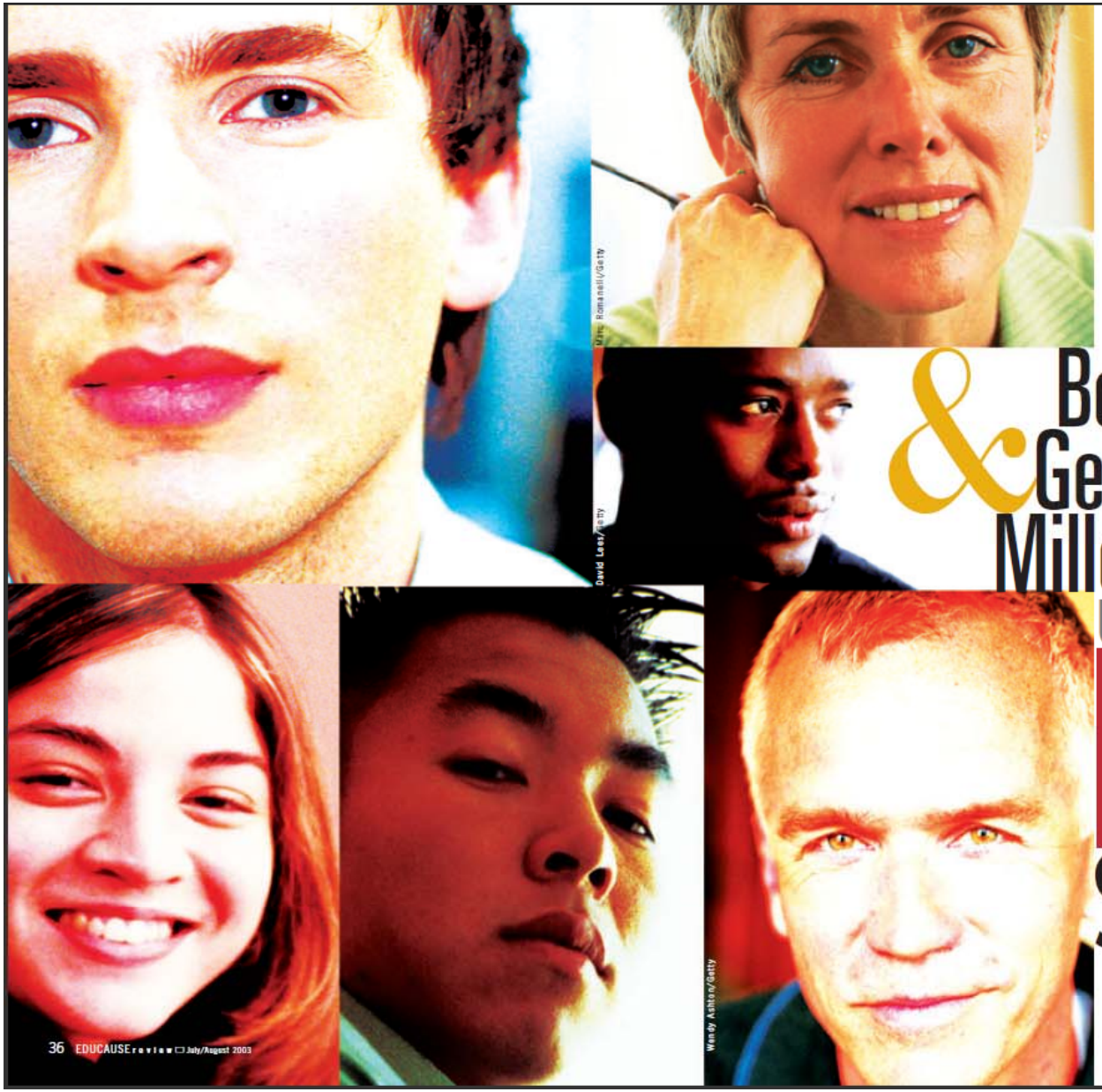
Cyber Platform: $2.9M/yr for five years; renewal possible after five years
Nodes: $700K/yr for five years

Engineering Education
EEC Strategic Plan 2007-2011

- Retention and throughput in our engineering schools remain a critical problem.
- Retention: 98% of the students who left STEM degree programs cited *poor teaching* by the faculty. (1997 study by Seymour and Hewitt)
- Retention: Of those students who began studies in an Engineering UG program, only 56% completed the degree by age 30.
- Throughput: Engineering graduation rate is in the low 60's%.
- Missing links: Between teaching effectiveness and retention/graduation.
- How does quality in the classroom impact the revenue streams of an engineering college?

By Al Soyster, former Division Director, EEC

Who and how are we teaching?



Boomers & Gen-Xers & Millennials

UNDERSTANDING THE NEW STUDENTS

By Diana Oblinger

An essential component of facilitating learning is understanding learners. The learning styles, attitudes, and approaches of high school students differ from those of eighteen- to twenty-two-year-old college students. The styles, attitudes, and approaches of adult learners differ yet again. How well do college and university faculty, administrators, and staff understand these differences? How often do they take the differences into account when designing programs or courses?

Diana Oblinger is the Executive Director of Higher Education for Microsoft Corporation. She has served as a Senior Fellow for the EDUCAUSE Center for Applied Research (ECAR) as well as Vice-President and Chief Information Officer for the University of North Carolina.

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Engineers of the Future

"…for much of its recent history, engineering education seems driven more by external "threats" than by internal reflection and visions of how best to design a better future."

- 1960's – Soviet threat (Sputnik): **Scientific Engineer**
- 1970's – Economic threat (Japanese manufacturing prowess): **Transactional Engineer**
- 1980's – Demographic threat (retirements & sagging ENG enrollments): **Managerial Engineer**
- 1990's – Global threat (relative decline of U.S. competitiveness in global context & ubiquitous IT): **Global Engineer**
- 2000's – Environmental threat (imperative global sustainability): **Holistic Engineer**

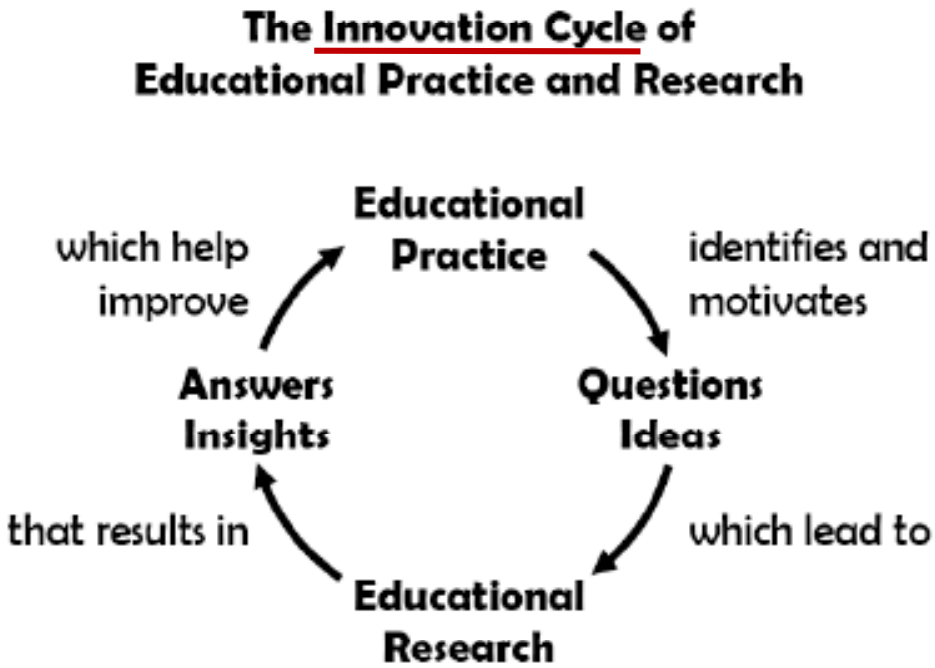
"**Creating a Culture for Scholarly and Systematic Innovation in Engineering Education,**" ASEE, 2009.

Engineering Education Research and Practice

- Develop the rich scholarly activity that is growing rapidly
- Support practitioner activities
- Bridge the education researcher and practitioner communities
- Develop alternative pathways for engineering education
  - Most pipeline issues are local (Rec. 3B, ENG Strategic Plan)
  - Re-entry of students (AS, BS, etc.)
  - Veterans
  - Broadening participation

What is Engineering Education Research?

Think ERC 3-Tier Chart



Adapted from Booth, Colomb, and Williams, 2008

"**Creating a Culture for Scholarly and Systematic Innovation in Engineering Education ,"**
ASEE, 2009.

Engineering Education Research Programs

- Research Initiation Grants in Engineering Education (RIGEE)
- Research in Engineering Education (REE)
- Nanotechnology Undergraduate Education in Engineering (NUE)
- Ethics Education in Science and Engineering (EESE)
- Broadening Participation Research Initiation Grants in Engineering (BRIGE)
- CAREER

POC: Sue Kemnitzer

Research Initiation Grants in Engineering Education (RIGEE)

PROGRAM SOLICITATION
NSF 11-507

REPLACES DOCUMENT(S):
NSF 10-502

National Science Foundation

Directorate for Engineering
Engineering Education and Centers

Full Proposal Deadline(s) (due by 5 p.m. proposer's local time):

March 31, 2011

Last Thursday in March, Annually Thereafter

- Objectives:
  - To broaden participation of Engineering faculty new to Engineering Education Research
  - To address major challenges in developing the career preparation of engineers
- Concept: Engineering Education = Loosely coupled complex system
- NOT curriculum development

POC: Dr. Alan Cheville

Research in Engineering Education

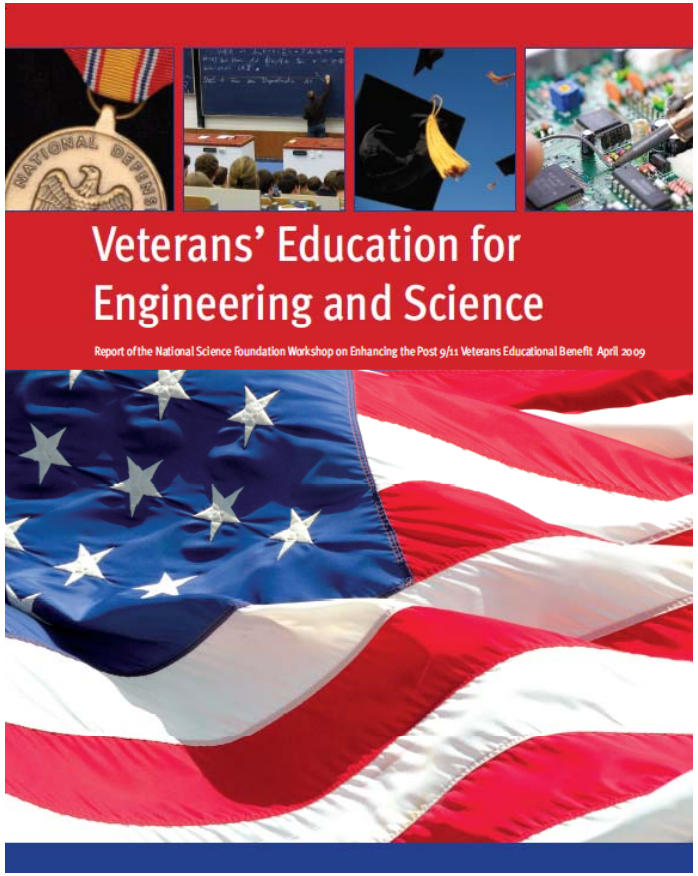
- Program Description: NSF 10-1340
- Proposal preparation per GPG
- Two full proposal windows in 2012
  - Jan. 23 – Feb. 10, 2012
  - Aug. 20 – Sept. 14, 2012
- Objectives:
  - Diversify pathways to and through engineering programs
  - Understand how to increase diffusion and impact of engineering education research outcomes
  - Understand engineering education in broader, organizing frameworks (innovation, globalization, sustainability, etc.)
  - Increase understanding of how engineering students learn and the capacity that supports such discovery

POC: Dr. Alan Cheville

Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP) Centers: **National Center for Innovation Education**

- NSF 10-569
- EHR DUE/ENG EEC
- A comprehensive and coordinated set of activities to address the challenge of educating engineers to be innovators
- $10-million over 5 years
- Co-funded 50-50 between ENG and EHR
- Expected outcomes
  - Create engineers who are more innovative
  - Build new knowledge about how to educate engineers to be innovative
  - Develop new tools to measure innovativeness
- **Award: Stanford University**

Innovations in Engineering Education, Curriculum, and Infrastructure (IEECI)



- 2008 Act significantly expands benefits to veterans
  - *36 months of tuition limited to maximum in state tuition for state university.*
  - Monthly Housing Allowance
  - $1000 for Books and Supplies
- 2.1 M veterans are eligible (est.)
- 46% of veterans use benefits for four year college
- Veterans are *nontraditional*
- 98% US citizens

Replaced by RIGEE NSF 11-507
Due date: March 31, 2011

Engineering Career Development

- Faculty
  - CAREER
  - BRIGE

- Graduate Students
  - Graduate Research Fellowships (GRFP)
  - GRFP Engineering Innovation Fellows
  - Integrative Graduate Education and Research Traineeships (IGERT)
  - Graduate Research Development Supplements

Engineering Career Development

- Research Experiences for Undergraduates (REU)
  - Supports the involvement undergraduates in ongoing research
  - $8M/year available for engineering; deadline for site proposals in Aug. each year
  - MOU with DOD AFOSR and DOE Geothermal Program
- Research Experiences for Teachers (RET) in Engineering
  - Supports the active involvement of K-12 teachers and community college faculty in engineering research to bring knowledge of engineering and technological innovation into their classrooms
  - $3M/year available
  - CISE now engaged - $1.2M FY11
  - $2M for FY12
  - Solicitation is NSF11-509

Junior Faculty

- Core programs
- CAREER
- BRIGE
- RIGEE

CAREER: Teacher-Scholar
NSF 11-690

- "Successful applicants will propose creative, effective, **integrated** research and education plans, and indicate how they will assess these components."

CAREER Project Description:

- a description of the **proposed research project**;
- a description of the **proposed educational activities**, including evaluation
- **a description of how the research and educational activities are integrated with one another**; and
- results of prior NSF support, if applicable

ENG Funding Levels: ≤ $400K for five years

BRIGE: Mentor-Scholar
NSF 11-576

- BRIGE: "a vehicle to promote the participation of engineers from all segments of the engineering community, especially from under-represented groups"
- BRIGE supports
  - Innovative research
  - **Broadening Participation (Diversity) plan**: recruiting and retaining a broad representation of engineering researchers
- **Integrate** excellent research and research training of diverse groups
- Funding Level: ≤ $175K for two years
- Contact: Dr. Omnia El-Hakim and division program director

CORPS
NSF Innovation Corps

i6 Challenge

E·D·A

U.S. ECONOMIC DEVELOPMENT ADMINISTRATION

SEARCH

ABOUT EDA | NEWS ROOM | PROGRAM & FUNDING OPPORTUNITIES | RESOURCES | RESEARCH & TOOLS | CONTACT US

IN THIS SECTION:

- News Room
- Press Releases
- Monthly Newsletter
- New Investments
- Photo Gallery
- Speeches
- Congressional Testimony

Press Releases

September 29, 2011
Contact: John Atwood, (202) 482-4085

OBAMA ADMINISTRATION ANNOUNCES $12 MILLION I6 GREEN INVESTMENT TO PROMOTE CLEAN ENERGY INNOVATION AND JOB CREATION

National initiative leverages resources of five federal agencies to advance clean technology commercialization

WASHINGTON – The Obama Administration today announced the six winners of the i6 Green Challenge, an initiative to drive technology commercialization and entrepreneurship in support of a green innovation economy, increased U.S. competitiveness and new jobs.

Projects in Florida, Iowa, Louisiana, Michigan, New England and Washington will each receive up to $1 million from the U.S. Commerce Department's Economic Development Administration (EDA) and up to $6 million in additional funding and technical assistance from the U.S.