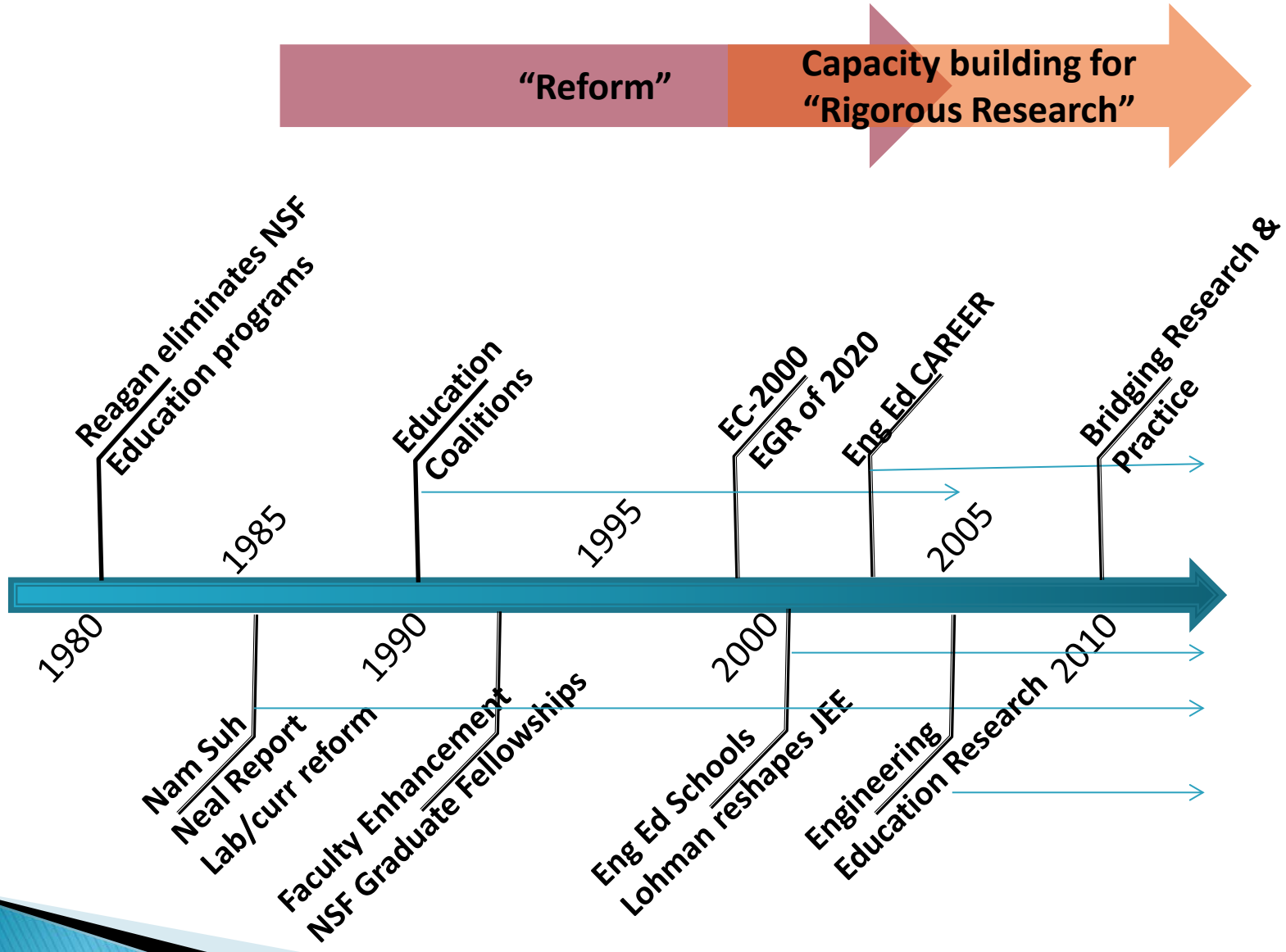
Update on Engineering Education Activities

Theresa A. Maldonado
Division Director
Engineering Education & Centers

Engineering Directorate Advisory Committee Meeting
April 17, 2013

Engineering Education at NSF



Coalitions (1990–2005)

Assessment (SRI, 1995):

- Local successes but not systemic reform
  - 10-25
  - GPA in
  - 95% re
- Reform
- Key role ent w/EER

Long Terr

- Produc searchers
- Role in
  - More active learning, better student performance in communications, teamwork, and lifelong learning
  - 2004 graduates better prepared than 1994 counterparts BUT need more work on ethics, social context, diversity (climate worse in 2004 than 1994)
  - Scholarship of teaching not always valued in faculty reward structure

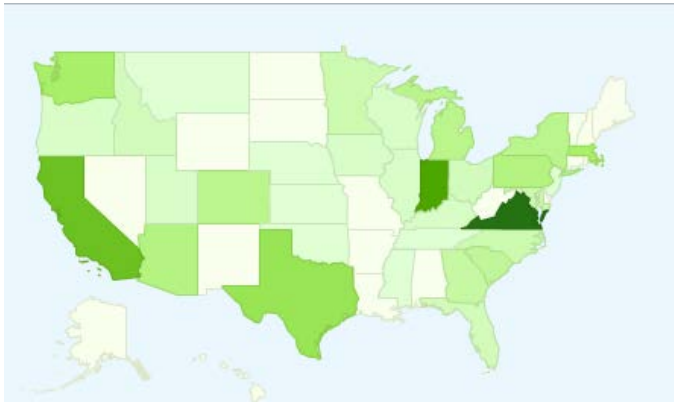
Purpose: Workforce needs and broadening participation

- $160M from ENG, teams of schools $2-3 M/yr for 10 yrs
- Together, schools enrolled 30% of US engineering students

Engineering Education Research (EER)

Research in Engineering Education (REE)
Program Description

- Pathways to and through engineering
- How credentials are earned and viewed
- Understanding the education innovation ecosystem
- Balance between technical and human
- How engineering is learned



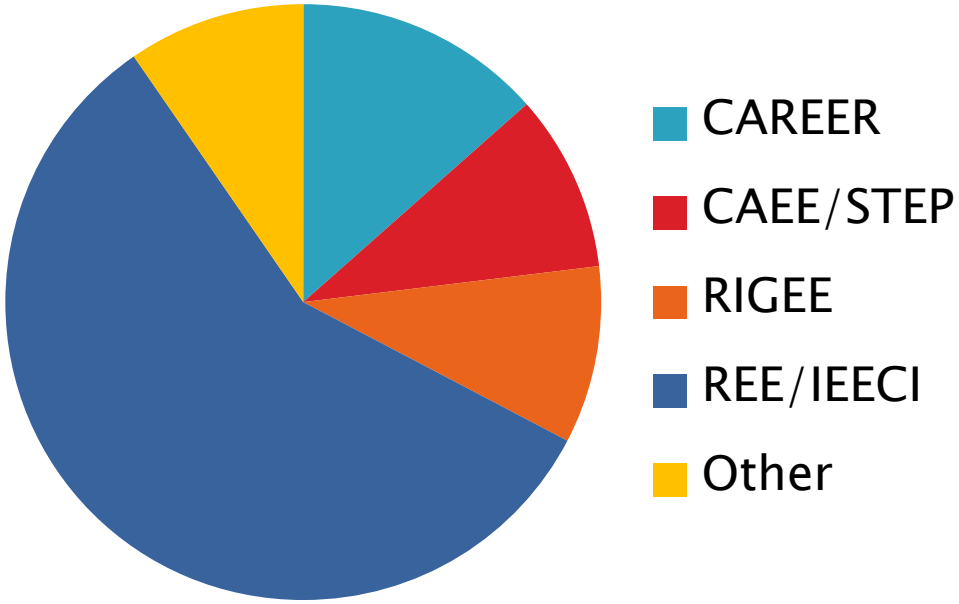
Research Initiation Grants in Engineering Education (RIGEE)
Solicitation

- Small, short term grants to build partnerships between engineering faculty and learning scientists
- Partnership focuses on a research project
- Anticipated outcome is continuation in REE program or other

Also: CAREER, STEP Epicenter (with EHR), workshops, INSPIRE, SAVI, etc.

Funding Allocations in EEC

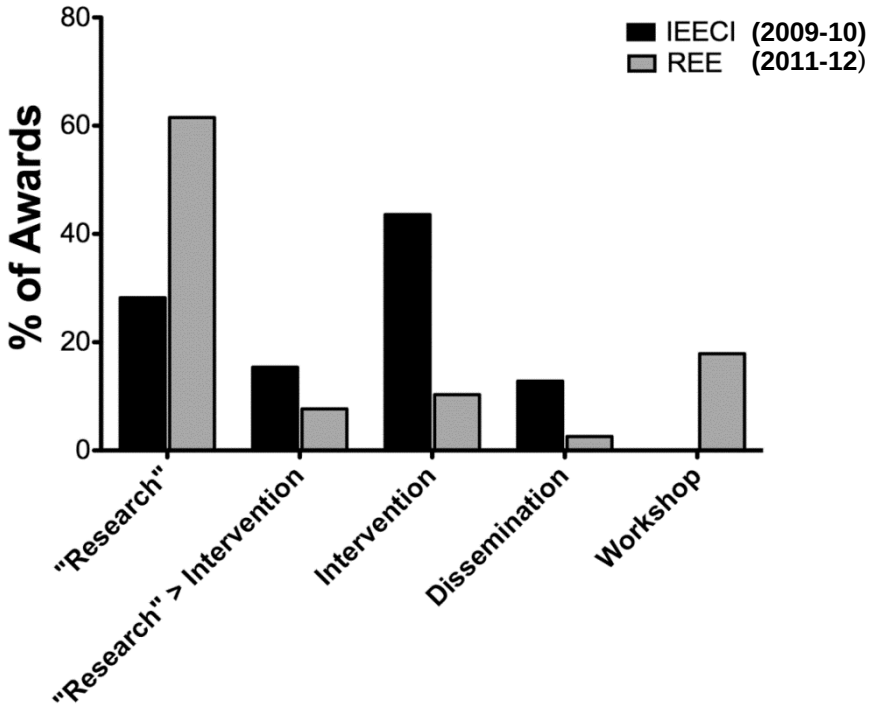
$10 million/year



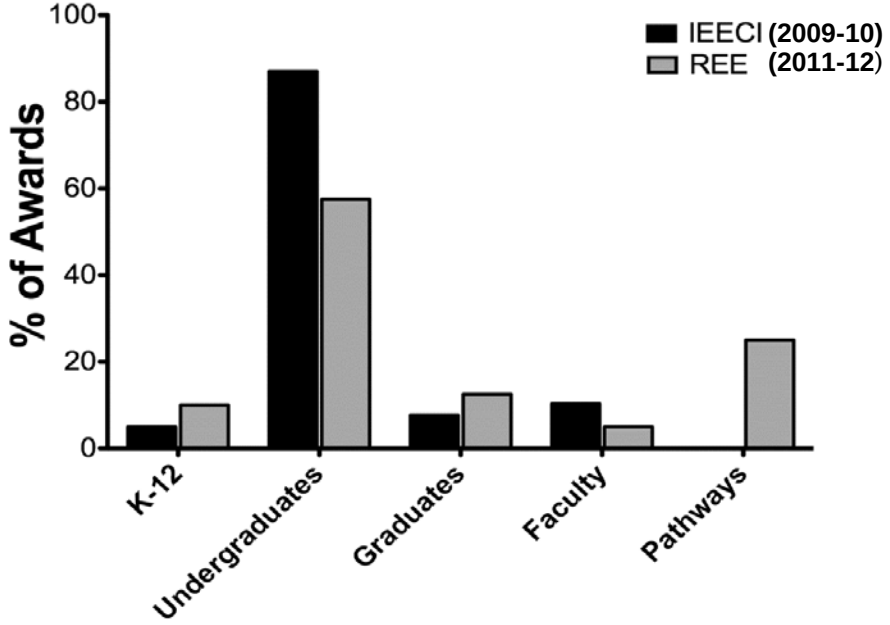
- Capacity Building (1/3-1/2)
  - CAEE, Midfield, iKNEER
  - 25 CAREER, 4 PECASE
  - Workshops
  - Bridging research to practice
- How Students Learn & How learning is measured (1/2-2/3)
  - Problem Solving
  - Design Thinking
  - Global Competencies
  - Creativity and Innovation
- Broadening Participation (1/3)
  - Design Squad
  - Veterans
  - STEP EpiCenter

Research in Engineering Education Portfolio Analysis

Types of projects funded

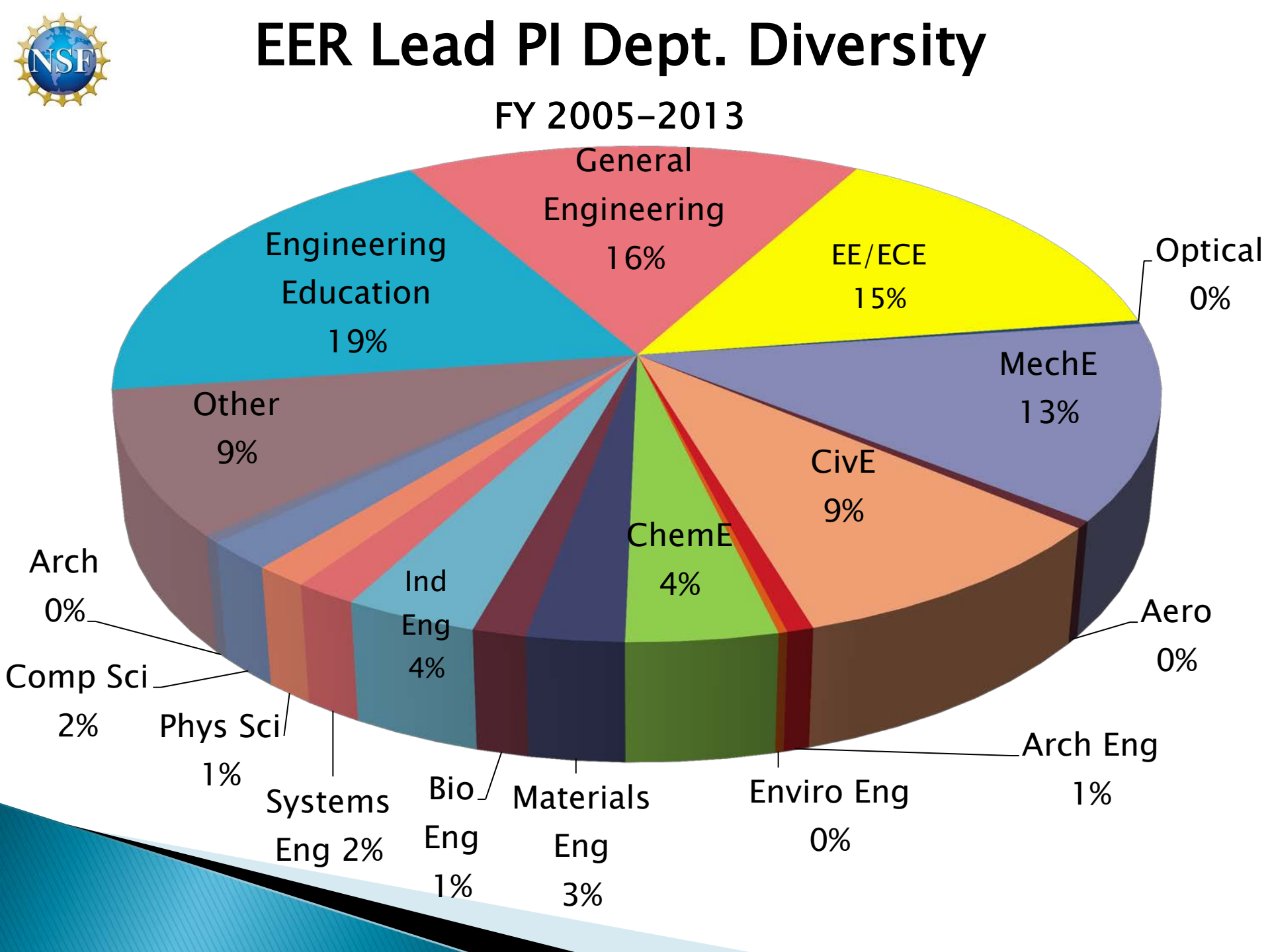


Populations targeted



EER Lead PI Dept. Diversity

FY 2005-2013

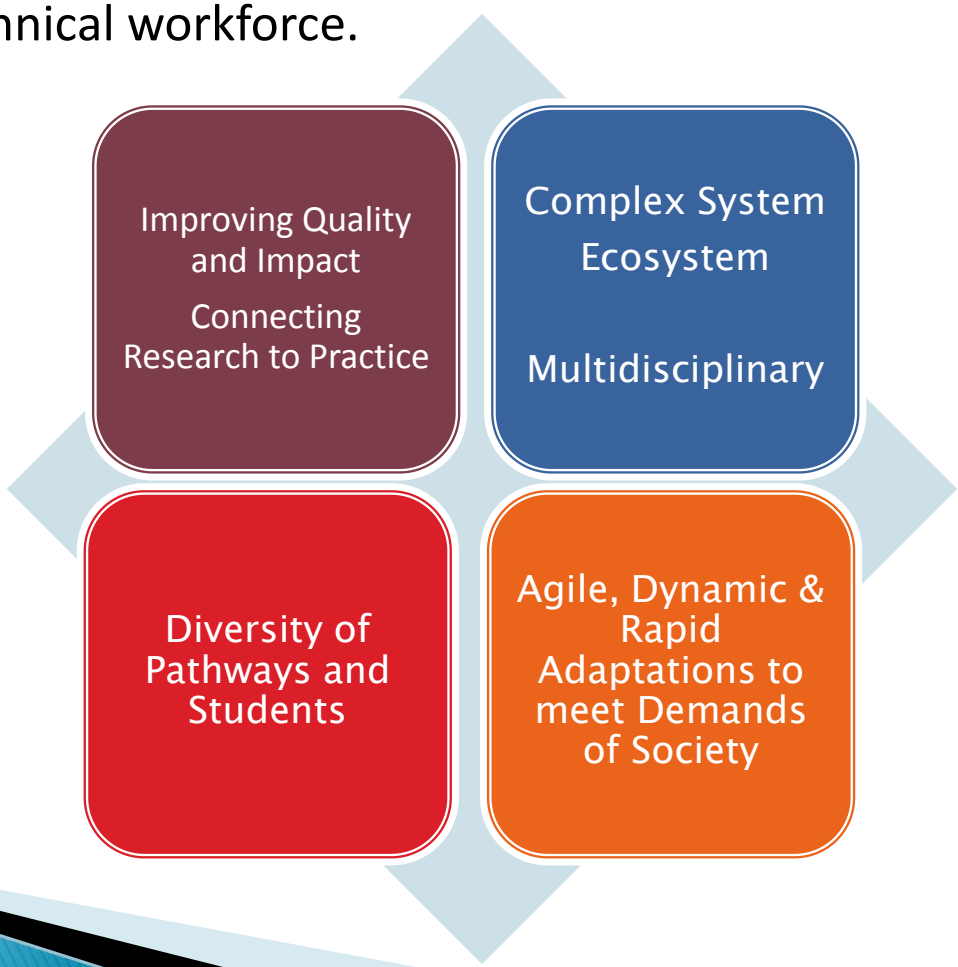


So throughout the past year…

- AdCom Meeting, Spring 2012: Facilitated outside-the-box discussions w/ Dr. Roger Burton
- August 2012: small (intense) meeting to explore future directions for the ENG Education discipline
- AdComm Meeting, Fall 2012: Panel discussion – Alan Cheville (ENG), Don Millard (EHR), and Daniel Hastings (edX, MIT)
- Cheville: Comprehensive strategy for the future
- New hire: Dr. Donna Riley

Vision

Initiate and nurture discoveries and innovations that inform an engineering education system that can dynamically and rapidly adapt to meet the changing needs of society and the nation's economy, is equally accessible to all members of society, and constantly improves the quality and diversity of graduates ready to enter the technical workforce.



Transform Frontiers

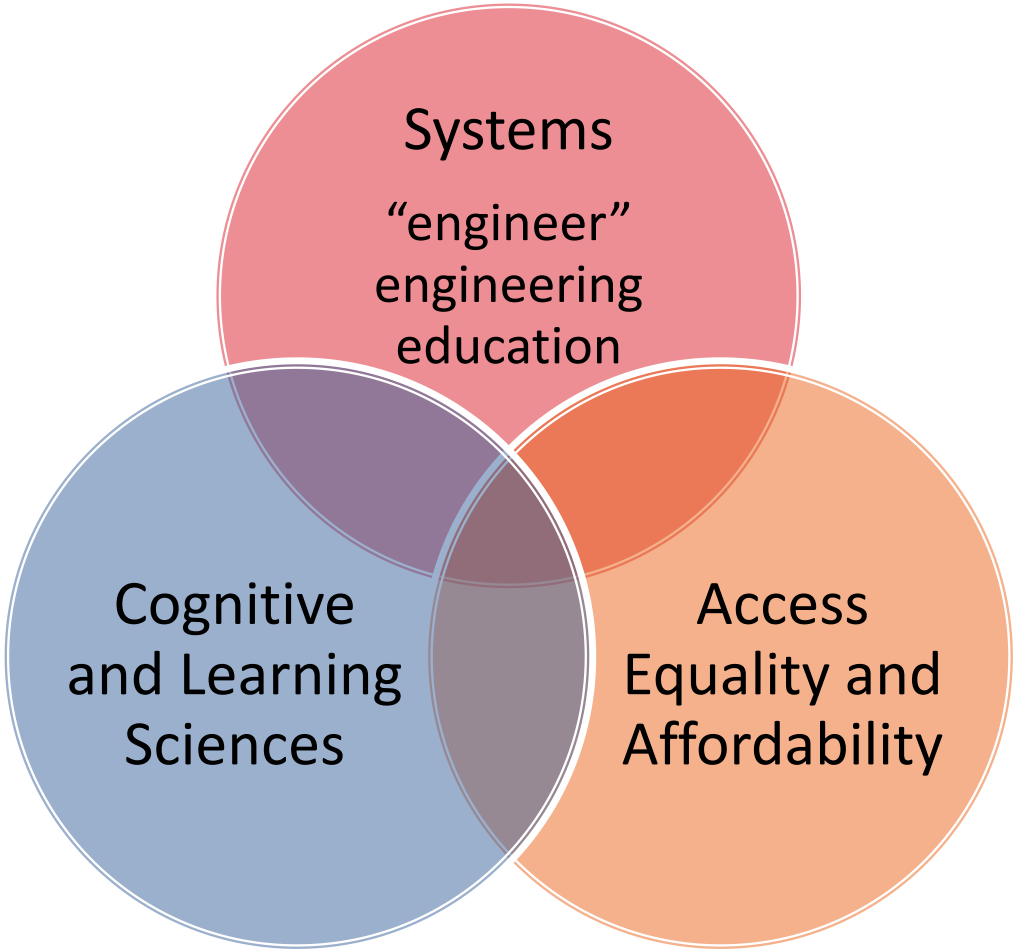
Innovate for Society

Perform as a Model Organization

Future Directions and Challenges

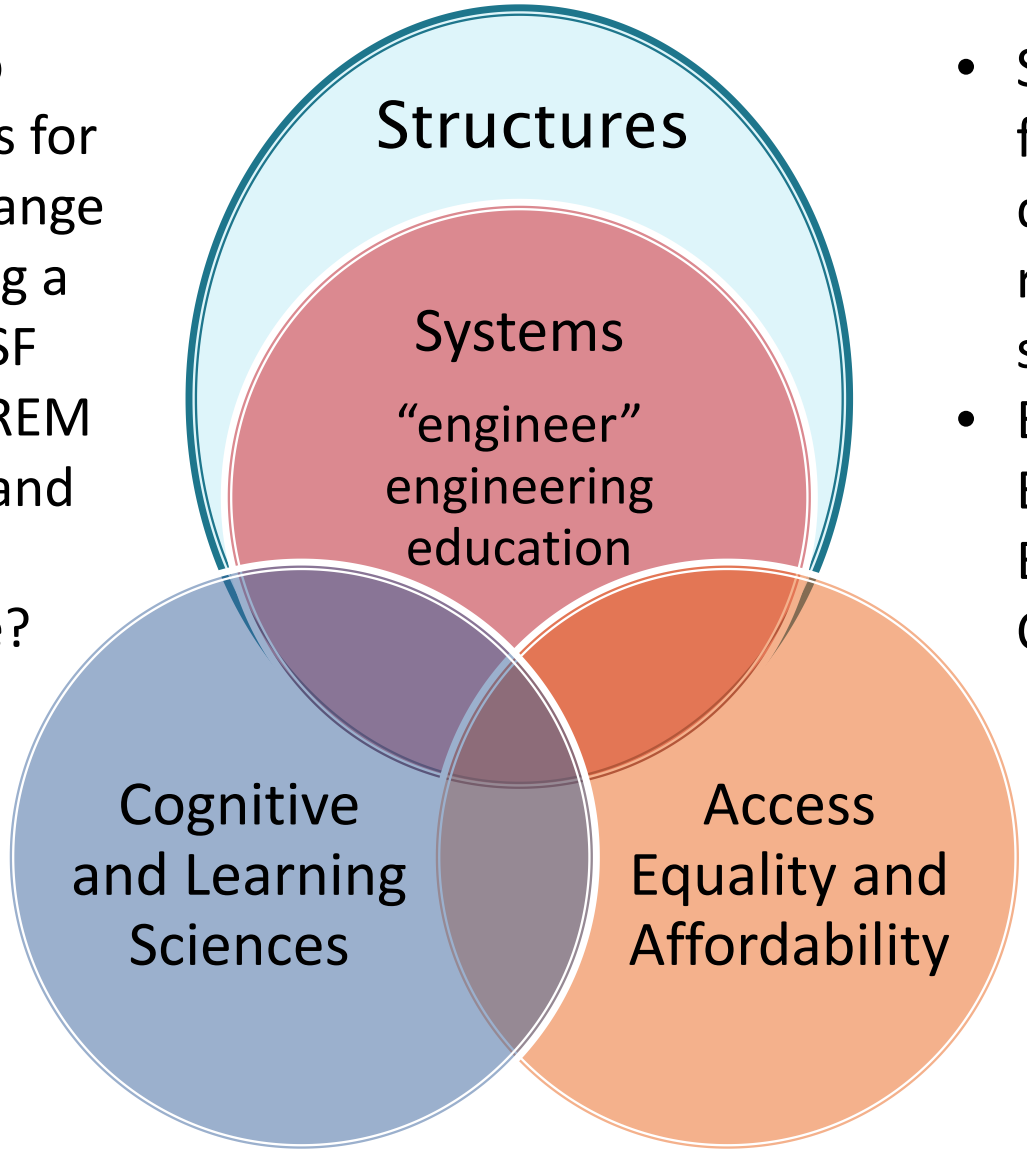
National policy context: emphasize the "E" in STEM

Long-term plan: to guide agile responses to changing needs



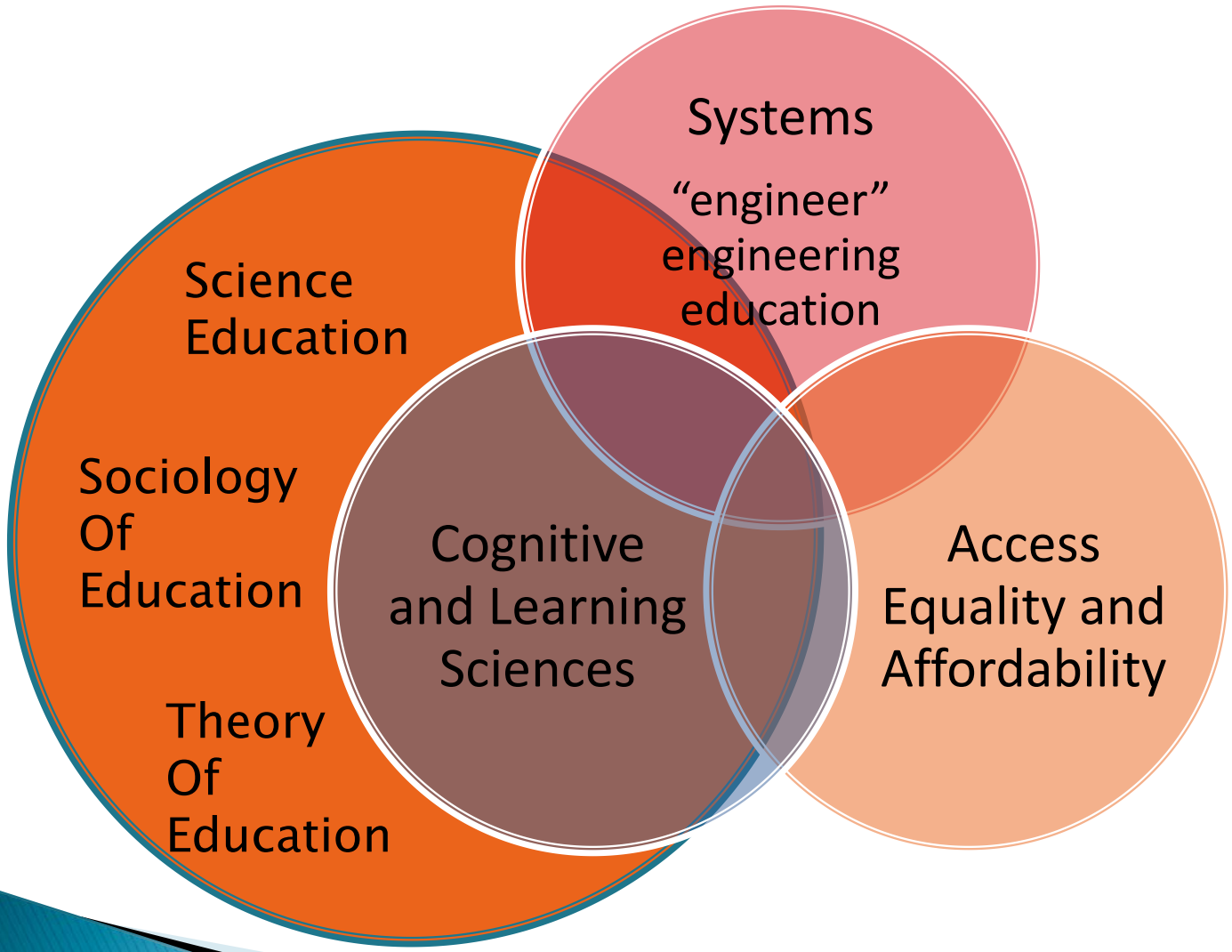
Future Directions and Challenges

- Shift focus to opportunities for structural change
- Scale up using a successful NSF model like PREM
- Better tools and products
- Demand side?



- Strong need for faculty development -> reward structures
- EFRI finalist: Engineering Education as a Complex System

Future Directions and Challenges

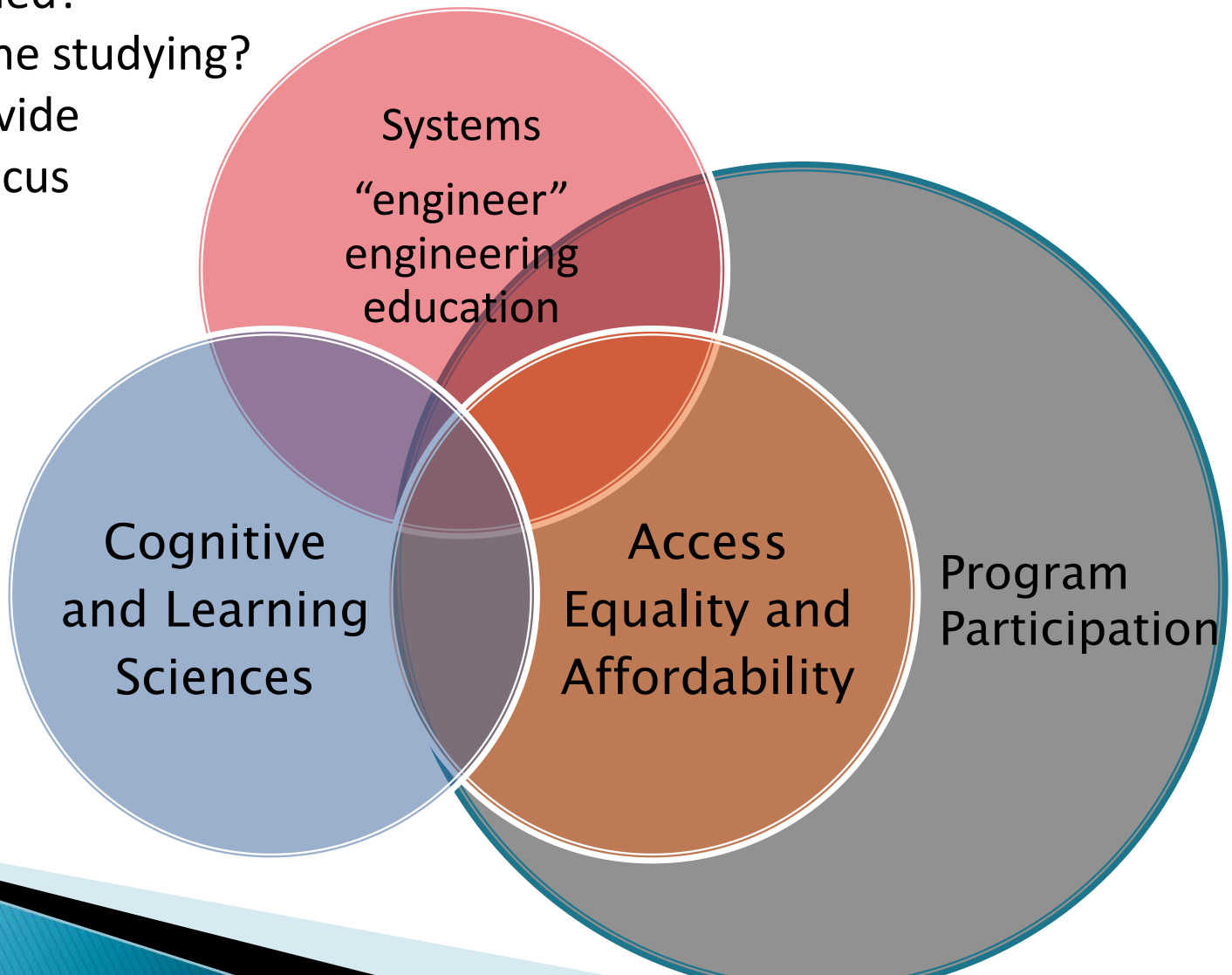


- How do engineering students learn and integrate social context?
- How do we assess student learning in/of context?
- NSF gap in funding Undergraduate ethics education

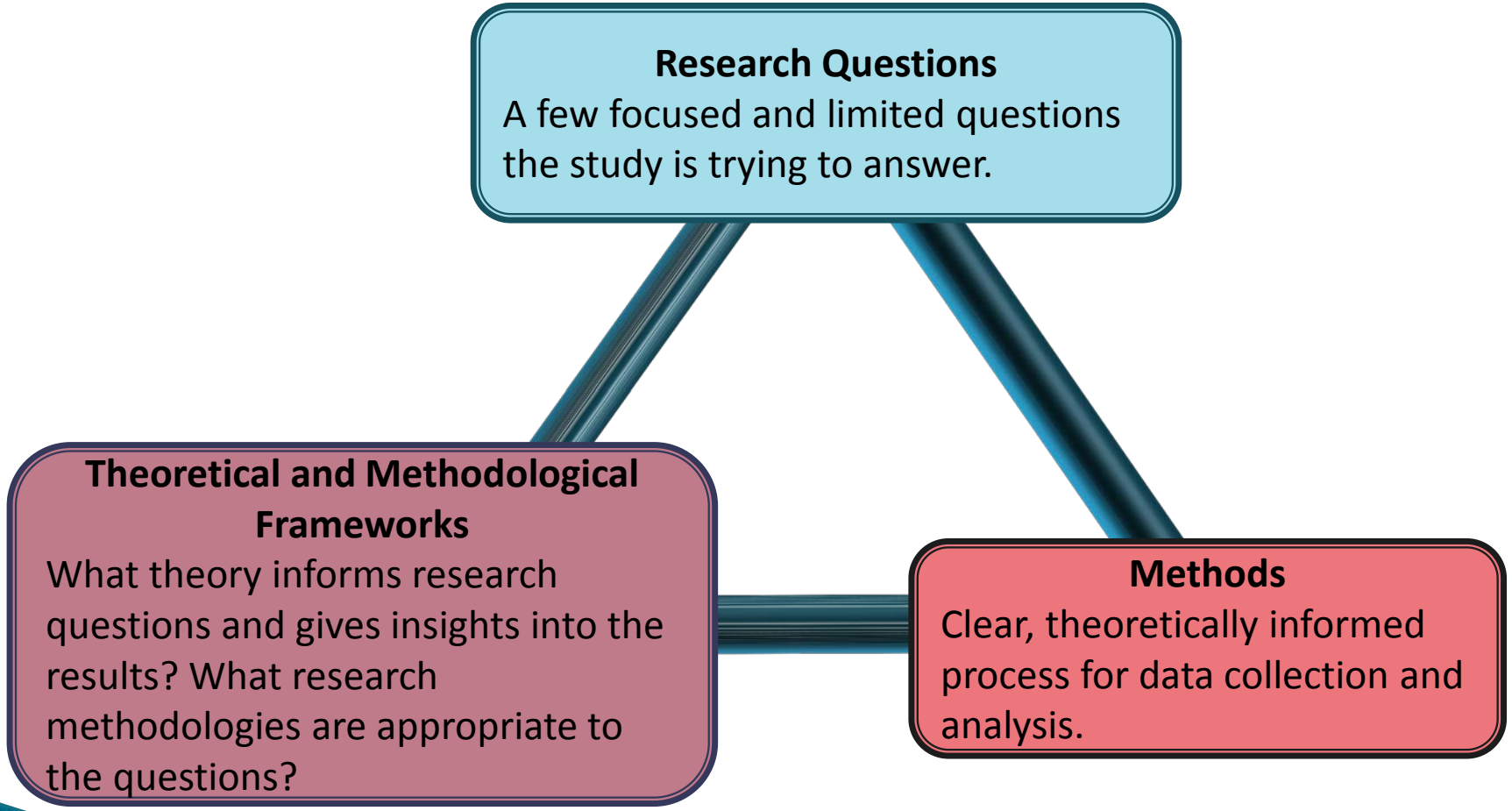
Future Directions and Challenges

Broaden Participation

- Who is studied?
- Who does the studying?
- EER can provide structural focus



What is research in engineering education?



Engineering Education and ERCs

Gisele Ragusa
University of Southern California
BMES ERC

How

Impact: Improving Student Learning

- Gamechanger: Pedagogical practices can nurture creativity
- Valid instrument for measuring creativity and propensity to innovate, propagated in ERCs
- Index for global competencies used at 17 universities (includes ethics, engineering efficacy, connectedness of engineering communities)

Theory and

Theories of creativity a

s

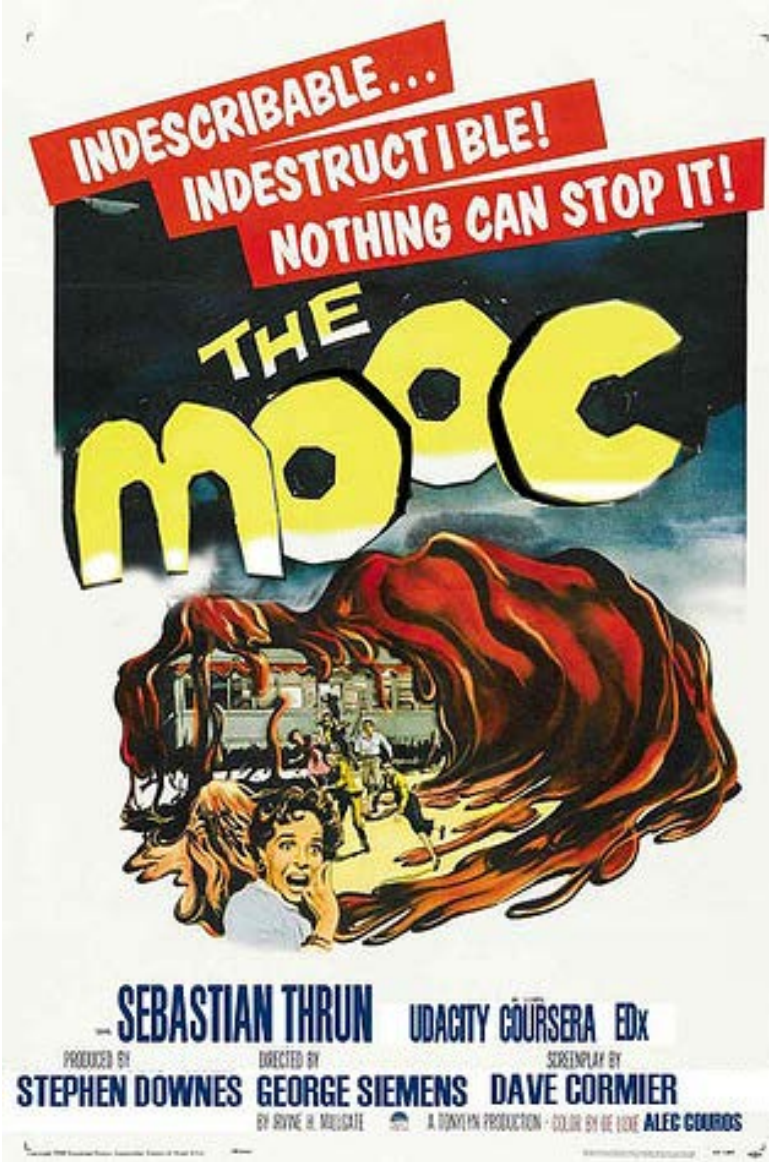
d Engineering

nsity for Innovation

Massive Open Online Courses (MOOCs)

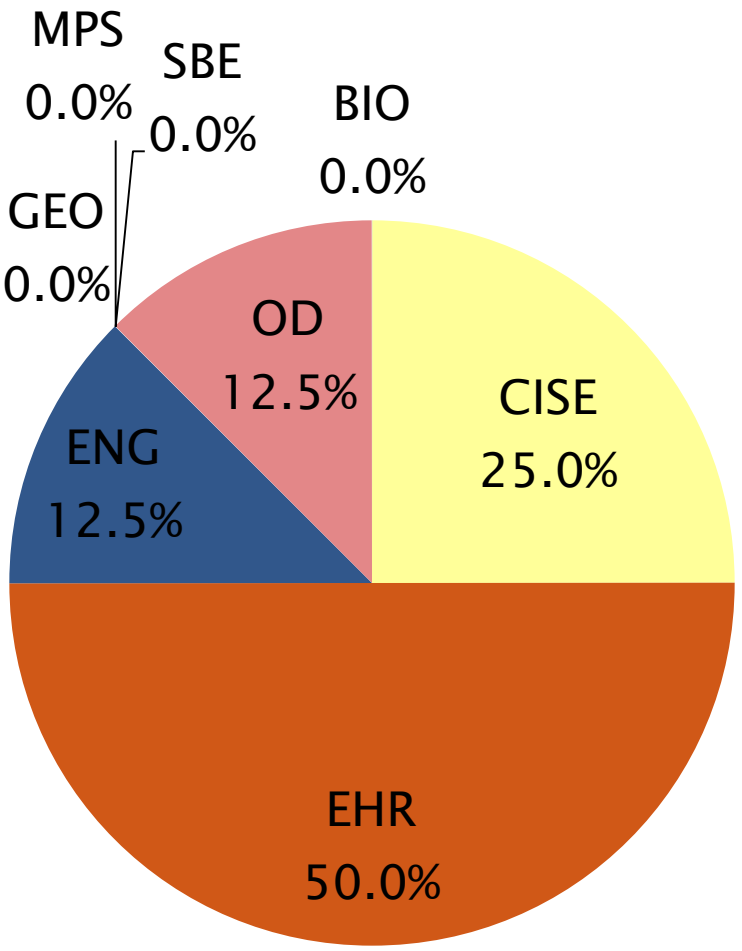
Dorothy Jones-Davis, AAAS S&T Policy Fellow

- Educational Disruption
  - Challenges traditional models of knowledge dissemination, and the role of the instructor
  - Provides an opportunity for gaining a deeper knowledge of the process of learning, for engagement of student populations traditionally underrepresented in Engineering
  - Massive Open Online Courses (MOOCs) are an example of a recent educational disruption that has started a revolution, and for some, a revolt



History of MOOCs at NSF

- MOOC "precursors" in ENG
  - Network for Computational Nanotechnology (NCN)/NanoHUB
  - Ethics Education in Science in Engineering (EESE)/Ethics Core
- October 2012: MOOCs and Disruptive Technologies in Education AAAS Fellow Working Group (MaDTECHEd)
- December 2012: NSF Internal Workshop on MOOCs (EHR/ENG/CISE/SBE MaDTECHEd AAAS Fellows)
- Approximately 100 participants, representing all directorates, and a majority of divisions within NSF
- January 2013: PD-level agency-wide "working group" formed by EHR



Funded MOOC-related Grants as of 4/1/13 (n = 8)

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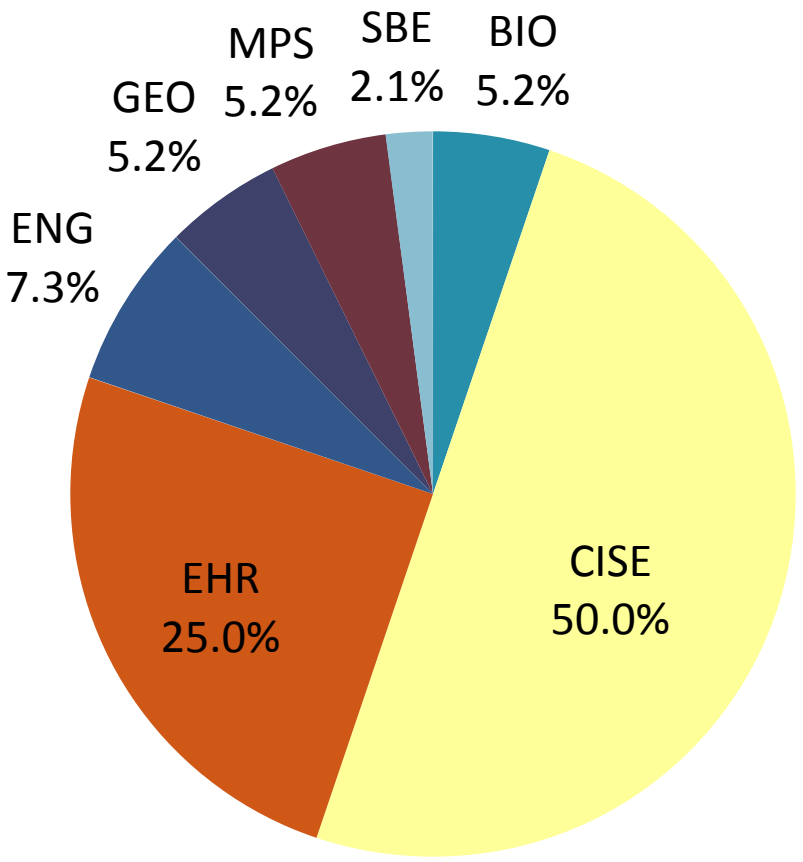

Pending MOOC-related Grants as of 4/1/13 (n = 96)

Preparing the Engineer for the Future

National need: *To stimulate and accelerate U.S. economic growth and global competitiveness by preparing more engineering undergraduate and graduate students for practice in the private and/or public sectors.*

- **Strengths**
  - Growing body of knowledge in ENG education research
  - Growing community of ENG education researchers
  - Growing interest by industry
- **Weaknesses / Challenges**
  - Gap between research & practice
  - Skills gap between ENG preparation of students and industry expectations
  - (Very weak) transition points
  - Interactions between scales
  - (Serious lack of) diversity of engineering students, faculty, and the workforce
  - (Relatively poor) level of Funding for ENG education research and practice
- **Opportunities**
  - (Internal) Joint strategies specific to ENG education with EHR, SBE, & others
  - (Internal) Joint strategies specific to broadening participation in ENG with EHR, SBE, & others
  - (Internal) NSF centers as platforms for demonstrating ENG education research outcomes and research training of students
  - (External) Partnership with Dept. of Education specific to ENG
  - (External) Public – private partnerships with industry and non-profits
- **Threats**
  - (Accelerated) Waning of U.S. global competitiveness
  - Regional economic decline

Opportunities for EER in ENG

- **Why ENG?**
  - Connected to the discipline and its specific needs
  - Adjacent to research
  - Lends important credibility, supporting change efforts
  - Guards against risk of "losing the E in STeM"
  - Nam Suh: responsibility of ENG to do education
- **What can ENG do?**
  - Nurture a Directorate wide working group
  - Strategy for messaging within ENG divisions and engineering disciplines
- **Whither EHR?**
  - History of collaboration, esp. on large projects
  - Programs are different (disciplinary tradition and OMB requirements affect scope and scale)
  - We need to align differences & our messaging about them with our strategic goals

Looking Forward
Opportunities and Challenges

- MOOCs & online coursework represent an **OPPORTUNITY**
  - To ease entry into Engineering fields, particularly for key groups (Veterans, LIFG, URM, persons with disabilities)
  - To address workforce needs (e.g. Power, Energy, Nuclear, Aerospace)
  - To ask Engineering-specific research questions surrounding learning in online environments
    - How do engineering students learn in the context of MOOCs?
    - How can we leverage online learning to enhance project-based learning?
    - How can we design online learning to work with engineering needs (design components, team-based learning)?
- Challenges
  - Adaptation to discipline-specific course needs
  - Validation of learning outcomes
  - Accreditation

What questions should we be asking?