Engineering Education and Centers

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ASEE ERC
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A changing environment: The dynamic demographic trend is certainly reflected at the Ph.D. level.

*Engineering is affected more: Only ~38% PhDs are US citizen or permanent resident*
Targeted investment in Engineering Education is VERY SMALL (< 1%), and it is made only through ENG/EEC.

However on the Demand Side: What are our global grand challenges? We cannot do innovation without engineering.

**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

http://www.engineeringchallenges.org/
The Demand Side: What does industry want from B.S., M.S. and PhD Engineers?

Depth

Breadth

Threshold

Specialist

Generalist

“T-shaped”

Time

Breadth

Depth
And the technology and tools change rapidly over time, thus making the education of engineers a required ongoing process....
So we talk about developing our 21\textsuperscript{st} Century Skills. On the whole, Engineering is a \textit{mindset}. 

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure1.png}
\caption{P21 Framework for 21st Century Learning}
\end{figure}

\url{http://en.wikipedia.org/wiki/21st_Century_Skills}
How do we get the “T-shape?” And how do we ensure relevant careers over time? Challenges facing ENG Education...

• How to fit it all in?
  • “Then” ENG students: 144-152 credits for BS
  • “Today” ENG students: 120-136 credits for BS
• “Hard core tech” vs. “Soft skills” – curricula alignment and planning to achieve T-shaped engineer
• Retention and degree completion time
• Pathways and “quality” perspectives
• Opportunities for enhanced “learning experiences” and informal education? Project based learning models.
The rapid growth rate of underrepresented group demographics is undeniable.

- In Texas 70% of children under the age of one are minorities (2001).

- Nation-wide 50.4% of children under the age of 1 are minorities (2011).

Minority: Anyone who is not single race-white
Education funding is available throughout the NSF organization, primarily in EHR but also ENG...
The NSF ENG organization supports fundamental research to commercialization.

Office of the Assistant Director
Thomas Peterson, Assistant Director
Kesh Narayanan, Dep. Asst. Dir.

Emerging Frontiers in Research and Innovation (EFRI)
Rose Wesson

Program Director for Evaluation & Assessment
Alexandra Medina-Borja

Program Director for Strategic Operations
Cheryl Albus

Senior Advisor for Nanotechnology
Mihail Roco

Program Director for Diversity
Richard Smith

Engineering Education and Centers (EEC)
Theresa Maldonado

Chemical, Bioengineering, Environmental, and Transport Systems (CBET)
Sohi Rastegar (A)

Civil, Mechanical, and Manufacturing Innovation (CMMI)
Steven McKnight

Electrical, Communications, and Cyber Systems (ECCS)
Robert Trew

Industrial Innovation and Partnerships (IIP)
Grace Wang
The EEC programs portfolio supports primarily UGs, Grads, and faculty.

- **Engineering Education Research**
  - Research in Engineering Education (2 windows)
  - Research Initiation Grants in Engineering Education (2 windows)
  - Nanotechnology Undergraduate Education

- **Engineering Career Development**
  - Faculty Early Career Development (CAREER)
  - BRIGE: Broadening Participation Research Initiation Grants in Engineering
  - Research Experiences for Undergraduates
  - Research Experiences for Teachers

- **Centers**
  - Engineering Research Centers
  - Nanoscale Science and Engineering Centers
  - Network for Computational Nanotechnology
  - STEP Center on Engineering Innovation: EPICenter

What is Engineering Education Research?

The Innovation Cycle of Educational Practice and Research

- Educational Practice
  - identifies and motivates
  - improves and helps
  - that results in

- Educational Research
  - which lead to
  - Questions
    - Ideas
  - Answers
    - Insights

Adapted from Booth, Colomb, and Williams, 2008

“Creating a Culture for Scholarly and Systematic Innovation in Engineering Education,”
ASEE, 2009.
Fab Labs and the Maker Movement are engaging more and more students – and adults.
The Research Experiences for Undergraduates (REU) has inspired many students to continue their studies in Engineering and other STEM disciplines.

University of Alabama:
Engineering Solutions for Clean Energy Generation, Storage and Consumption
http://reu.eng.ua.edu/programs/energy/
Likewise, the Research Experiences for Teachers (RET) program has inspired many teachers to continue their professional development in STEM and make an impact in their classrooms.

http://www.retnetwork.org/
Established in 1985, the Engineering Research Centers program was launched with the GOAL:

“to further the development of fundamental knowledge in engineering fields that will

• Enhance the competitiveness of the U.S. and

• Prepare engineers to contribute through better engineering practice.”
The ERC Core Elements have been sustained over time.

- **Strategic vision** for transforming engineered systems
- **Research**
  - Systems-motivated, interdisciplinary, team-based
  - Societal-relevant, problem-focused
- **Education**
  - Interdisciplinary
  - Team-based
  - Global engagement
- **Technology/knowledge transfer**
  - Long-term university-industry-government *partnerships*
  - *Mechanisms* to accelerate innovation and technology transfer
- **People**
  - Community of scholar-educators
  - Diverse, globally competitive engineering *workforce*...
NSF’s FY 2013 Engineering Research Centers
Lead institutions

Note: All centers are multi-university partnerships; university shown is lead institution.
What is the Epicenter?

The Epicenter is dedicated to infusing entrepreneurship and innovation skills into undergraduate engineering in the United States.

Funded by the National Science Foundation and directed by the Stanford Technology Ventures Program, the Epicenter is an education, research and outreach hub for the creation and sharing

Epicenter:  http://epicenter.stanford.edu/
National Collegiate Inventors and Innovators Alliance:  http://nciia.org/
History of CAREER

Pre-1995
Two types of young investigator awards
Both focused on research

Prestige grants
PYI (1985-91)

Starter grants
RIA

Integration of Research and Education
CAREER (1995 – pres.)
PECASE (1996 – pres.)
The CAREER program continues to be an important approach to supporting junior faculty.
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The US employment decline in this recession was more than twice as large as in previous postwar recessions.

US employment decline from peak\(^1\)

\[\%\]

- July 1974–January 1976
- March–November 1980
- July 1981–October 1983
- June 1990–January 1993
- February 2001–January 2005
- January 2008–April 2011

Months since employment peak

- 9/11
- Today
- BP Oil Spill

1 Total nonfarm employment, seasonally adjusted.

US manufacturing employment has been shrinking since 1980, but the pace dramatically accelerated after 2000.

Manufacturing employment, 1942–2010, 5-year moving average
Millions of jobs

Manufacturing share of US employment

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Engineering enrollment in the US remains flat in numbers compared to general enrollment in higher education.