The Future of EducatingEngineers

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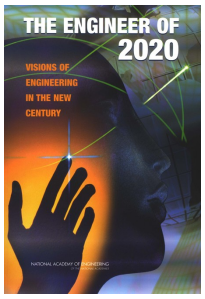
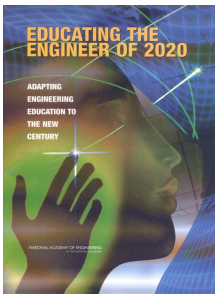
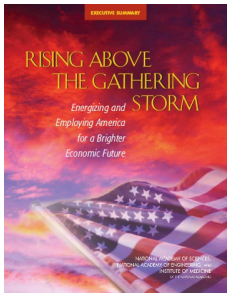
ASEE Reports

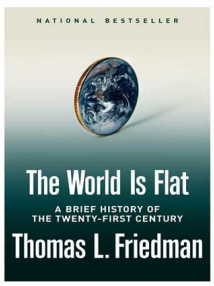
- The Mann Report (1918)
  - The first evaluation of U.S. engineering education, focusing on common curricula and values.
- The Wickenden Study (1923)
  - Examined humanities, accreditation, and curriculum and inspired SPEE-sponsored faculty summerschools.
- The Hammond Report (1940)
  - Considered sequences of science-tech and humanities courses, stressing the need for more scientific fundamentals in engineering
  - training.
- Engineering Education After the War (1944)
  - Emphasized liberal arts and graduate work and helped shape the nation's postwar engineering curricula.
- Grinter Report (1955)
- Goals of Engineering Education (1968)
- The Boyer Commission Reinventing Undergraduate Education: A Blueprint for America's Research Universities (1998)

National Reports, Books & Transition









Engineer of 2020 Attributes

Ingenuity of	Lillian Gilbreth
Problem Solving of.....	Gordon Moore
Scientific Insight of.....	Albert Einstein Pablo
Creativity of	Picasso Wright
Determination of.....	Brothers Bill Gates
Leadership of	Eleanor Roosevelt
Conscience of	Martin Luther King, Jr.
Vision of.....	Our Grandchildren

Priority Research Areas established by the Engineering Education Colloquies

- Engineering Epistemologies:
  - Research on what constitutes engineering thinking and knowledge within social contexts now and into the future.
- Engineering Learning Mechanisms:
  - Research on engineering learners' developing knowledge and competencies in context.
- Engineering Learning Systems:
  - Research on the instructional culture, institutional infrastructure, and epistemology of engineering educators.
- Engineering Diversity and Inclusiveness:
  - Research on how diverse human talents contribute solutions to the social and global challenges and relevance of ourprofession.
- Engineering Assessment:
  - Research on, and the development of, assessment methods, instruments, and metrics to inform engineering educationpractice
  - and learning.

Concerns about Engineering Education

- Curriculum still stresses analytical skills to solve well-defined problems rather than engineering design, innovation, and systems integration.
- Continue to pretend that an undergraduate education is sufficient, despite fact that curriculum has become bloated and overloaded, pushing aside liberal education.
- Failed to take more formal approach to lifelong learning like other professions(medicine, law).
- Need to broaden education to include topics such as innovation, entrepreneurial skills, globalization, and knowledge integration.
- Make it all exciting and attractive to young people.

Recommendations: Building Strong Engineering Foundation

- Value and expect career-long professional development programs in teaching, learning, and education innovation for engineering faculty and administrators.
- Expand collaborations and partnerships between engineering programs and (a) other disciplinary programs germane to the education of engineers (b) other parts of the educational systemthat support the pre-professional, professional, and continuing education of engineers.
- Continue current efforts to make engineering programs more engaging and relevant and especially expand efforts to makethem more welcoming.
- Increase, leverage, and diversify resources in support of engineering teaching, leaning, and educational innovation.
- Raise awareness of the proven principles and effective practices of teaching, learning, and educational innovation, and raise awareness of the scholarship of engineering

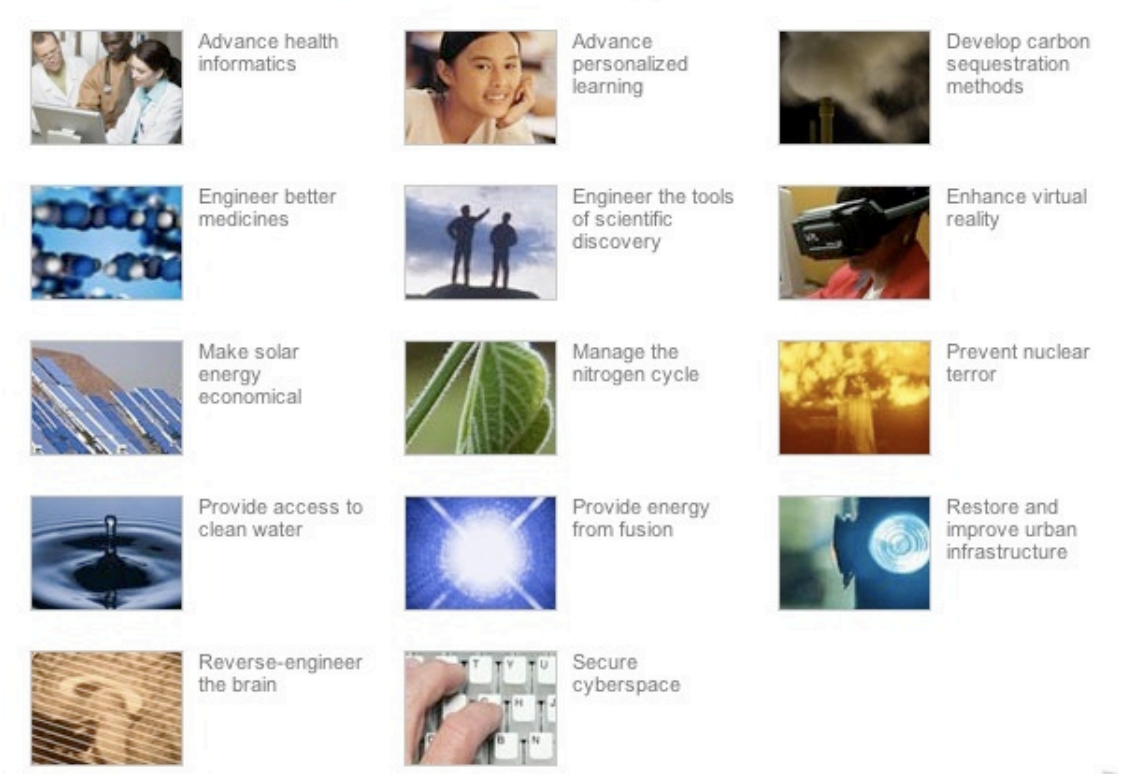
education.

- Conduct periodic self-assessments within our individual institutions to measure progress in implementing policies, practices, and infrastructure in support of scholarly and systematic innovation.
- Conduct periodic engineering community-wide self-assessments to measure progress in implementing policies, practices, and infrastructure in support of scholarly and systemicinnovation.

Challenges Facing Engineering

- Engineering education at the high school level, let alone lower grades, is virtually non-existent.
- Girls and young women don't see engineering as a pathway to multiple career choices.
- Dropout rates are much higher in engineering than in other areas of college study.
- The proportion of US College graduates in engineering is low and dropping.
- Engineering educational approaches are stale and need updating.

NAE Grand Challenges



Types of Problems

"Wicked" (Rittel & Webber)

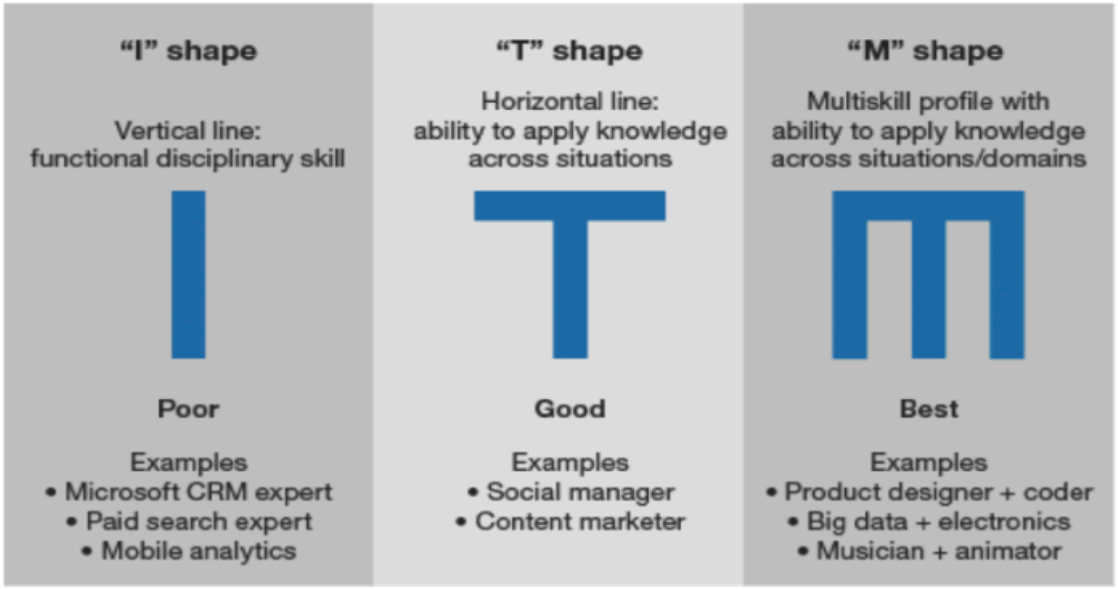
- Each problem unique and part of web of problems
- Enumerable potential solutions

- No end state
- No right or wrong answer

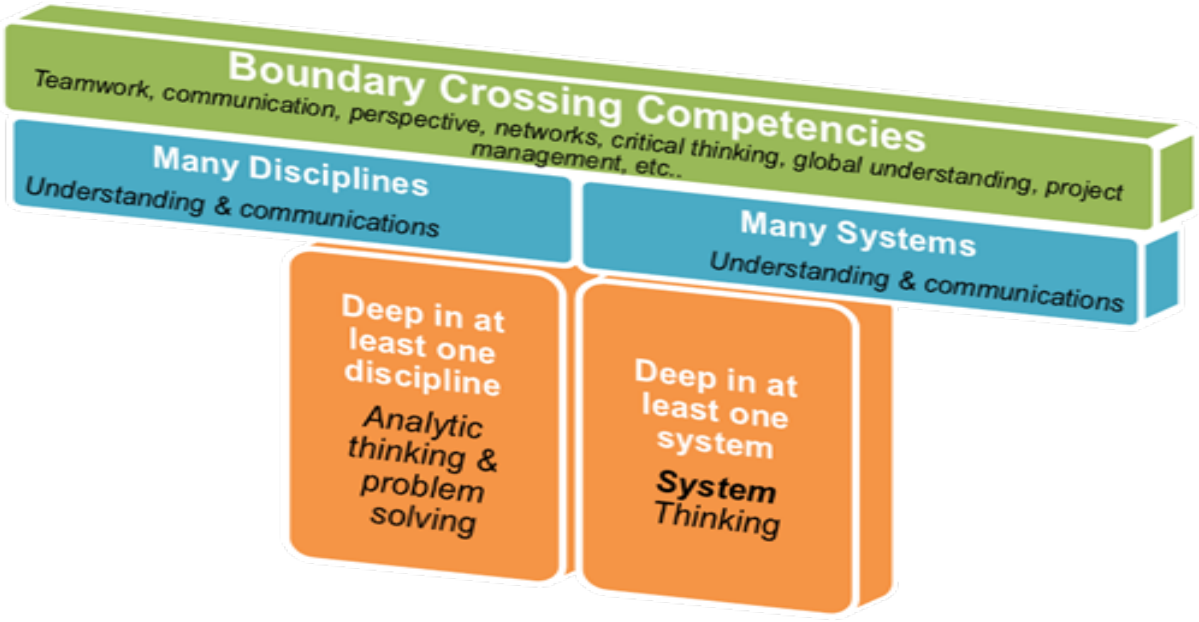
Systems Thinking

- Useful for complex, ill-defined, dynamic or recurring problems involving engineering, social, ethical, cultural, environmental, business, and political issues.
- Recognizes that “you can’t just do one thing” and that “everything is connected to everythingelse.”
- Views "problems" as parts of an overall system, rather than reacting to specific parts, outcomes or events.
- Explains relationships with feedback loops.
- Focuses on traditional scientific approach which involves separating the individual pieces of what is beingstudied.
- Issues where an action affects (or is affected by) the environment surrounding the issue, either the natural environment or the competitive environment.
- Problems whose solutions are not obvious.

Shape of Future Engineers



Source: Upcity website



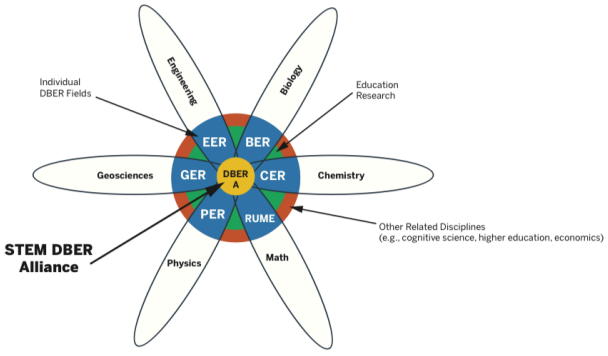
Jim Spohrer, IBM Labs

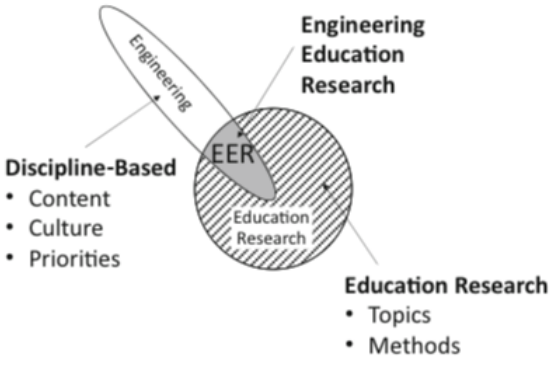
Future Jobs: 2025 - 2050

- Space Pilot
- Data Detective
- Ethical Sourcing Manager
- Extinct Species Revivalist
- Companion for the Angel
- IT Service Builder
- AI Specialist
- UX Designer
- 3D Printing Engineer
- Digital Rehabilitation Counselor

Current Approach to Problem Solving

- Focuses on traditional scientific approach which involves separating the individual pieces of what is being studied.





Sample Engineering Education Projects from Virginia Tech

Design Education Make a Difference?

- Questions:
  - What changes during design education? How do you measure it?
  - What is the effect of design education on students' design cognition?
  - How does students' design thinking and practice evolve over time?
- Methods:
  - Longitudinal study
    - Control: Engineering Mechanics
    - Experimental: Mechanical Engineering
  - Record, transcribe, and code design sessions
  - Measure amount of time spent thinking in different design domains

  Preliminary Conclusions:
  - ME students show increase in focus in problem solving after design course.

Motivation and Identity Development

- Relationships between student motivation and:
  - classroom pedagogies (such as problem-based learning)
  - classroom practices (such as offering reward-based extra challenges)
  - student's learning strategies (particularly for learning difficult thermodynamics concepts)
- Identity development
  - Pathways to engineering careers including factors that influence:
  - high school student's intentions to pursue engineering degrees college student's intentions to continue enrollment in engineering programs
  - early career choices of people who have graduated with
  - engineering degrees
- Faculty motivation:
  - beliefs about teaching teamwork and communication skills in undergraduate classes
  - beliefs about how they teach and how students learn traditionally complex and difficult concepts

Quotes

"We have studied engineering reform to death. While there are differences among the REPORTS, the differences are not great. Let's get on with it! It is urgent that we do!!" William Wulf, President National Academy of Engineering, 2003

"Most of our universities are attempting to produce 21st century engineers with a 20th century curriculum in 19th century intuitions." James J. Duderstadt, Former Engineering Dean & President University of Michigan

“We may not be able to prepare the future for our children, but we can at least prepare our children for the “We must prepare students for jobs that don’t yet exist; using technologies that haven’t yet been invented; in order to solve problems we don’t yet know are problems.” future.” Former Secretary of Education Richard Riley

“We must prepare students for jobs that don’t yet exist; using technologies that haven’t yet been invented; in order to solve problems we don’t yet know are problems.” President Franklin D. Roosevelt

“We can't solve problems by using the same kind of thinking we used when we created them.” Albert Einstein