Inspiring Change Agents to Transform Engineering Education:
An Emergent Engineering Curriculum

June 18, 2014
ASEE Distinguished Lecture Series
Gary R. Bertoline, Dean & Distinguished Professor

Engineering

• The Behavior vs. the Discipline
  ◦ Engineering (from Latin ingenium, meaning "cleverness" and ingeniare, meaning "to contrive, devise") is the application of scientific, economic, social, and practical knowledge in order to invent, design, build, maintain, and improve structures, machines, devices, systems, materials and processes.
Historical Context

  - Move to a scientifically oriented engineering curricula
  - Abandoned practical engineering curriculum
  - Development of Engineering Technology programs in the early 1960’s
- Industry views engineering education as too theoretical
  - Integration of design and lab experiences into engineering education
  - Constraints as to how much can be done
- Higher Education in the nation is being questioned

Emergence of “Boutique” Engineering Programs

- Fills a void but not the one left by the original Grinter Report
- Smaller programs not at large public research intensive universities where there are the most engineering graduates
- Examples include: Rose Hulman, Harvey Mudd, WPI, Olin, etc.
The German Model for Engineering Higher Education

- Technical Universities
  - Scientifically prepared engineering
- Universities of Applied Science (Fachhochschulen)
  - Applied engineers
    - Required internships
    - Year-long senior thesis-based, industry-sponsored projects
- Germany graduates twice as many Applied Engineers as Theoretical Engineers
  - PBS interview with BMW’s head of Workforce Development for the Americas
  - WSJ- Behind Germany’s Success Story in Manufacturing

Can Americans compete with quality-driven Germans?

BY PAUL SOLMAN  June 4, 2014 at 4:10 PM EDT
Engineering Education is a Continuum Based on Behaviors

Very Applied → Very Theoretical

Technical Career Education → Engineering Technicians (AS and AAS) → Applied Engineer → Engineering Science
Today 3-types of Engineering Programs

- Engineering at Research Intensive Universities that are slanted towards the theoretical and scientific approach
- Engineering at the Boutiques that are more applied and design oriented.
- Engineering that is applied that are primarily at the Engineering Technology programs that are AS and BS and mostly not at the Research Intensive Universities.

A Fourth-type of Engineering Program

- Similar to the German Fachhochschule (university of applied science) but for the 21st century needs of industry and society.
  - Blends theory with practice
  - Integration of the humanities, science and math
  - Application oriented at the system/enterprise level (Product design & production, construction management, transportation & logistics, computing & informatics, etc.)
  - The T-shaped professional
The Purdue Polytechnic Institute

- Original definition of a Polytechnic from the first create in France in 1794.
  - Relating to or devoted to instruction in many technical arts or applied sciences.
  - A blend of scientific theory and engineering practice.
- Purdue Polytechnic adds the blending of liberal arts and industry needs to scientific theory and engineering practice

The world has changed
WHAT THE ECONOMY OF TODAY AND TOMORROW DEMANDS

- Ability to ask good questions,
- Thinking and analytical skills to seek answers
- Information
- Literacy
- Collaboration & Communication
- Civil duty and sense of community
- Lifelong curiosity and learning
College of Technology

The world has changed
The students have changed

• Connected, multi-taskers, digital natives
• Used to creating and sharing;
• Learning with and from others
• Informal interest-based exploration and learning
• Learning through exploration and discovery

Are They Really Ready To Work: (Employer’s Perspectives on the Basic Knowledge and Applied Skills of New Entrants to the 21st Century U.S. Workforce.)

Top 5 Needs of Employers

Critical Thinking and Problem Solving
Information Technology Application
Teamwork/Collaboration
Creativity/Innovation
Diversity

Education Technology Expert Alan November has included Empathy as Number One In His Surveys

21st century tech website provides total ranking
New culture for students

- Students are mentored into discovering and creating a purposeful path rather than given a one size fit all plan.
- Students work in classroom with multi-disciplinary teams of faculty (mostly) rather than through fragmented mono-disciplinary courses.
- Students learn just in time following their passion and purpose rather than just in case it comes up in the test.
- Students receive credit for demonstrating mastery rather than for seat-time served.
- Students receive credit for everything they learn however they learn it rather than only through our lectures.
- Students are trusted and respected rather than tested and suspected.

New culture for faculty

- Working with students is our highest form of scholarship rather than a routine different from scholarship.
- Faculty trust the students, nurture their passion, and follow their lead rather than be the sage on the stage.
- Faculty model openness, growth mindset, risk-taking, and lifelong learning, the same values and skills we expect from students.
- Faculty are collaborative, cooperative and reflective in their working with students.
- Faculty expect the highest standards from themselves, from each others, and from the students.
**Curriculum Transformation**

- Common core curricula may include
  - Common Core & First-year Experience
  - Learn by Doing
  - Real-world Immersive Capstone Experience
  - Global Perspectives Program
  - Polytechnic Field Experience
  - Applied Innovation Certificate Program
  - Humanities, science and math integration
Challenges

• Challenges the status quo in engineering education.
• Culture change for faculty and the current higher education model.
• Industry expected to actively engage with higher education.