Evolving Accreditation Standards around the World: The Need to Embrace Global Standards while Retaining What Works in India

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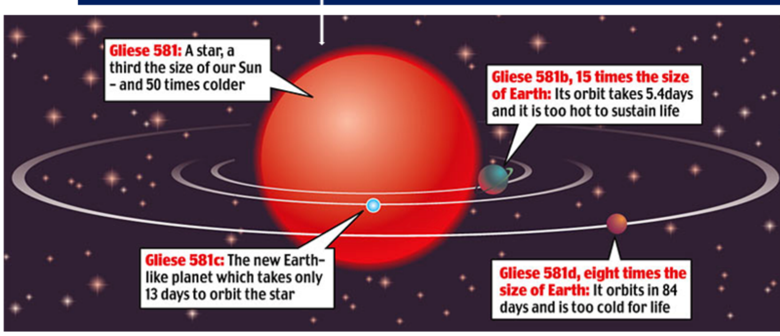
OUTLINE OF THE TALK

- Engineers are problem solvers; engineering education prepares problem solvers
- Engineering education and quality assurance- a look at early thoughts
- Evolution of engineering education and quality assurance reflecting the needs of the constituencies (the view from the US)
- Concluding remarks: thoughts on how India can adopt and adapt.

Engineering and Science, Theodor von Karman (1902)

"Science is about understanding nature, understanding what 'is.'



By contrast, engineering is synthetic; it is about creating what has never been."

Humanity's Top Ten Problems for the Next 50 Years *(the same as the last 50 years)*

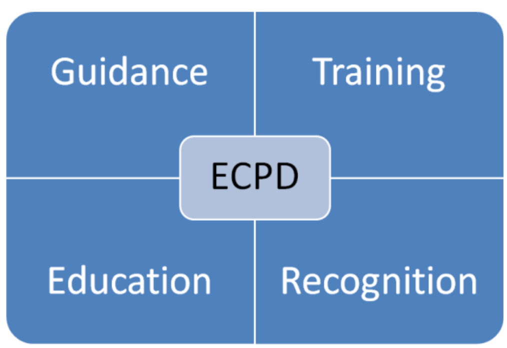
1. Energy
2. Water
3. Food
4. Environment
5. Poverty
6. Terrorism & War
7. Disease
8. Education
9. Democracy
10. Population

2003	6.3	Billion People
2050	8-10	Billion People

Engineering Education Produces Problem Solvers

- How do we know the quality of the products?
- How do we measure quality?
- Accreditation ensures compliance at an acceptable level.

84 Years AGO (1932) in the US…
Engineers' Council for Professional Development

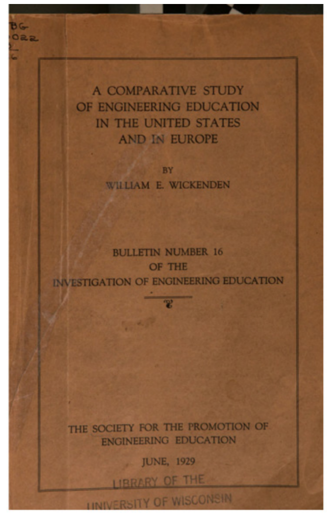


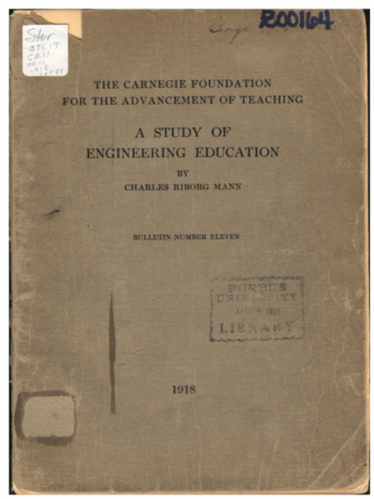
Guidance: Supplying information to engineering students and Potential students

Training: Developing plans for personal and professional development.

Education: Appraising engineering curricula and maintaining a list of engineering programs.

Recognition: Developing methods whereby individuals could achieve recognition by the profession and by the general public.





ECPD

SPEE (now ASEE), **ASCE, AIME** (now Mining, Metallurgical and Petroleum Engineers), **ASME, AIEE** (now IEEE), **AIChE, NCSBEE** (now NCEES)

"A conference of engineering bodies organized to enhance the professional status of the engineer through cooperative support of those organizations."

ECPD Allowed Flexibility

- "(ECPD) has no authority to impose restrictions or standardizations upon engineering colleges, no does it desire to do so." (1930's)
- "To avoid rigid standards as a basis for accreditation in order to prevent stand and ossification of engineering education and to encourage well-planned experimentation" (ABET 2000's).

Engineering Evolution during 1940–1960

- US emerges as the leading industrialized/engineering centered nation in the world.
- Engineering education evolved from a hands-on, practical enterprise to science and mathematics based profession.

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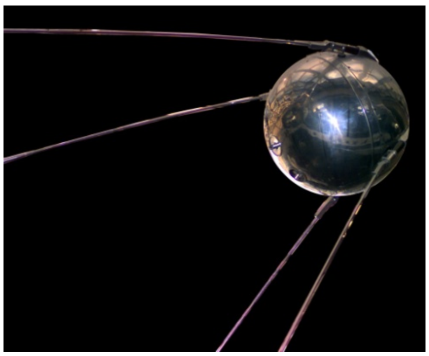

- USSR launched Sputnik 1 it into an elliptical low Earth orbit.
- It was a 58 cm diameter polished metal sphere, with four external radio antennae to broadcast radio pulses.

"Crisis in Engineering Education"
J. L. Stewart, IRE Transactions on Education, Vol. 1, No. 1, March 1958

- …engineering education in the US is and has always been backward and of low quality…compared to…Russia
- Average graduate from a 4-year school in Russia is equivalent to an American MS level…
- Serious questions regarding ability to compete with the Communist world.

Evaluation of Engineering Education Grinter Report (1955)

- More science and mathematics
- Engineering sciences as a common core
- Analysis, design and systems approach
- Electives for specialization
- Humanities and social sciences
- Oral, written and graphical communications
- Experimental work
- Strengthening of graduate programs
- Faculty development.

1956
ECPD and Accreditation Criteria Adapt

- One year of mathematics and basic science
- One year of engineering science

- One semester of humanities and social sciences
- Engineering design and engineering systems

1960's and 70's
Theory vs. Practice

- **Engineering** is the profession in which a knowledge of the mathematical and natural sciences gained by study, experience and practice is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind.

1960's and 70's
Theory vs. Practice

- **Engineering Technology** is that part of the technological field which requires the application of scientific and engineering knowledge and methods combined with technical skills in support of engineering activities; it lies between the craftsman and engineer at the end of the spectrum closer to the engineer.

Science base versus Practice Emergence of ABET in 1979

Engineering

Why?	What?	When?	Why not?	What else?	
		How to?	Standards	Ethics	$$

Engineering Technology

Why?	What?	When?	Why not?	What else?	
		How to?	Standards	Ethics	$$

Accrediting Engineering and Technology

- ECPD is renamed ABET to reflect the accreditation of engineering and technology programs (July 1, 1980)
- Two commissions governed the details of the accreditation activities.
- Today, ABET has four commissions.

1990's

- Unprecedented technological changes
- New graduates were technically well prepared but lacked the professional skills for success in a competitive, innovative, global marketplace.
- Employers complained that new hires had poor communication and teamwork skills
- Need to appreciate the social and nontechnical factors on engineering solutions and quality processes

- National reports recommending changes galore education appeared *(e.g., ASEE 1987; NRC, 1985; NSB, 1986; NSF, 1989).*

Shifting Focus from Teaching to Learning

- Outcomes bases education
- Accountability for graduating engineers who meet what was expected
- Criteria 2000.

15 years of Experience with Criteria 2000

- Minor tweaking removed the worries with Criterion 2.
- Assessment was moved to Criterion 4 and so, Criterion 3 became simply a set of statements.
- The familiar (a)-(k) student outcomes, assessment data and Continuous Improvement continue to dominate the accreditation process but now as part of Criterion 4.

Lessons Learned

- Criteria 2000 replaced the so called "bean counting" format for curriculum.
- Emphasis shifted (not by design but by practice) to soft skills.
- Program Criteria became less important.
- Engineering Science courses became secondary.
- Some of the (a)-(k) outcomes became difficult to track and assess.

Lessons Learned – Problem Areas

- Align ABET criteria more closely with *Washington Accord* graduate attributes referencing project management and finance.
- 3(d) ability to function on multidisciplinary teams.
- 3(f) understanding of professional and ethical responsibility.
- 3(h) a broad education to understand engineering solutions in global, economic, environmental, and societal context
- 3(i) recognition of the need for and ability to engage in life-long learning
- 3(j) knowledge of contemporary issues.

Proposals for Reform in Criterion 3: Student Outcomes

	Area	*New Criterion*
1.	Engineering problem solving	An ability to identify, formulate and solve engineering problems by applying principles of engineering, science, and mathematics.
2.	Engineering design	An ability to apply both analysis and synthesis in the engineering design process, resulting in designs that meet desired needs.

	Area	*New Criterion*
3.	Measurement, testing, and quality assurance	An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
4.	Communication skills	An ability to communicate effectively with a range of audiences.
5.	Professional responsibility	An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
6.	Professional growth	An ability to recognize the ongoing need for additional knowledge and locate, evaluate, integrate, and apply this knowledge appropriately.
7.	Teamwork and project management	An ability to function effectively on teams that establish goals, plan tasks, meet deadlines, and analyze risk and uncertainty.

Feedback
https://www.surveymonkey.com/r/CRIT35R2

Changes to Criterion 5

- Definitions and explanations currently placed in Criterion 5 were moved to a revised introductory section to the *Criteria for Accrediting Engineering Programs*

Proposals for reform in Criterion 5: Curriculum

Changes are mostly minor except for one important item that may cause problems for many programs.

- (c) a broad education component **that includes humanities and social sciences**, complements the technical content of the curriculum, and is consistent with the program educational objectives.

Feedback
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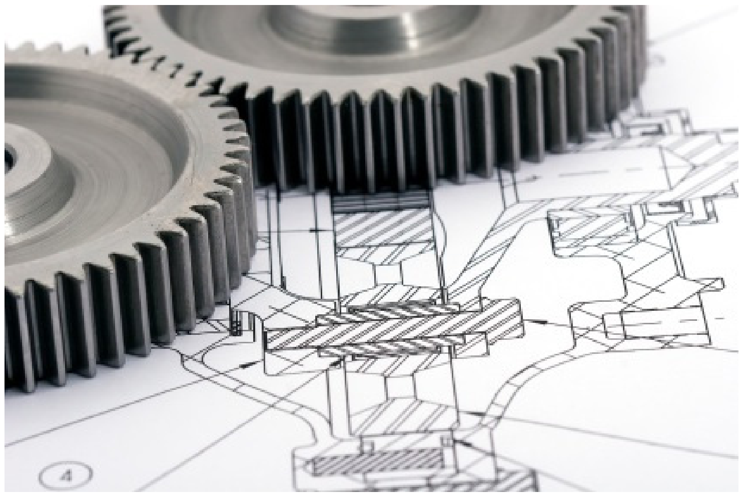
Continuing issues in the US

- Engineering fundamentals are the foundations of a solid engineering education.
- The US curricula contained these since the release of Grinter Report in the 1950's.
- Engineering fundamentals are not always taught any more.

What are Engineering Fundamentals?

The interface of science and the analytical and operational principles behind engineering.



Disappearing Foundations

Engineering graphics/CAD	Dynamics	Thermodynamics
Statics	Materials	Electrical Circuits I
Chemistry I w/Lab	Chemistry II w/Lab	Engineering Chemistry
Modern Physics	Chemistry Labs	Physics Labs
Electrical Circuits II	ME Labs	Programming

Why?

Discipline based pressures:

There is tremendous pressure to pack more and more discipline specific information into a BS degree curriculum. Example- Civil engineers have to have four areas represented for the BS degree as part of the program criteria of ABET.

Program Criteria for Civil Engineering Programs

- The program must prepare graduates to apply knowledge of mathematics through differential equations, calculus-based physics, chemistry, and at least one additional area of basic science, consistent with the program educational objectives; apply knowledge of **four technical areas appropriate to civil engineering**; conduct civil engineering experiments and analyze and interpret the resulting data; design a system, component, or process in more than one civil engineering context; explain basic concepts in management, business, public policy, and leadership; and explain the importance of professional licensure.

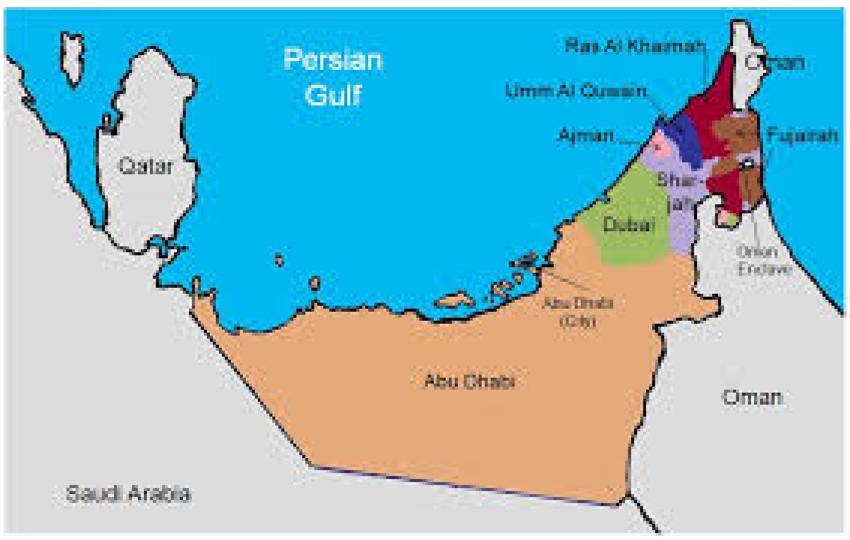
Why?

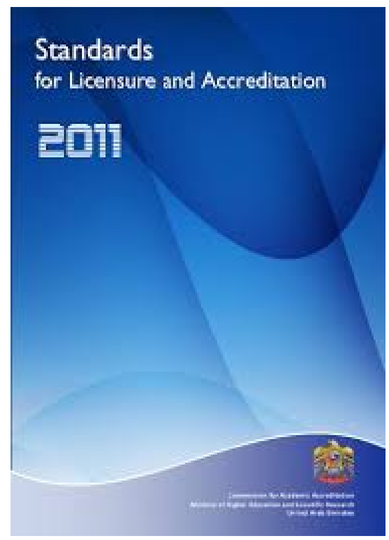
Pressure to Reduce the Credit Hour Requirement for a Degree:

Engineering programs have traditionally been high unit majors which sometimes are as high as 15 or even 140. At the same time, legislatures, governors, university administration, etc. are putting pressure to bring the total units down to 120.

Examples of Accreditation Criteria Outside the US

UAE





Examples of Accreditation Criteria outside the US

Excellent in Enforcing Quality across the UAE but Not Outcomes Based

1. Mission, Organization and Governance
2. Quality Assurance
3. The Educational Program
4. Faculty and Professional Staff
5. Students
6. Learning Resources
7. Physical Resources
8. Fiscal Resources
9. Public Disclosure and Integrity
10. Research and Scholarly Activities
11. Community Engagement.

Examples of Accreditation Criteria outside the US: *UAE*

The Educational Program

1. Credit bearing programs
2. The Curricula
3. Academic Courses
4. General Education
5. Internship
6. Undergraduate Preparatory or Remedial Courses and Programs
7. Graduate Programs
8. Course Delivery
9. Program Effectiveness
10. Substantive Change for Programs.

Local Issues Stressed

Engineering degree programs are required to ensure that all undergraduate students complete the equivalent of one or more university level courses in **Islamic studies, history, or culture**.

Programs taught in English (all engineering programs) are required to use a minimum **TOEFL score of 500** or 5.0 IELTS, or for admission.

Calibration with International Standards

Use of international panels in conducting accreditation visits

Local Flavor is in the US Too

Texas History is required.

Missouri Constitution is required.

Humanity's Top Ten Problems for the next 50 years (the same as the last 50 years)

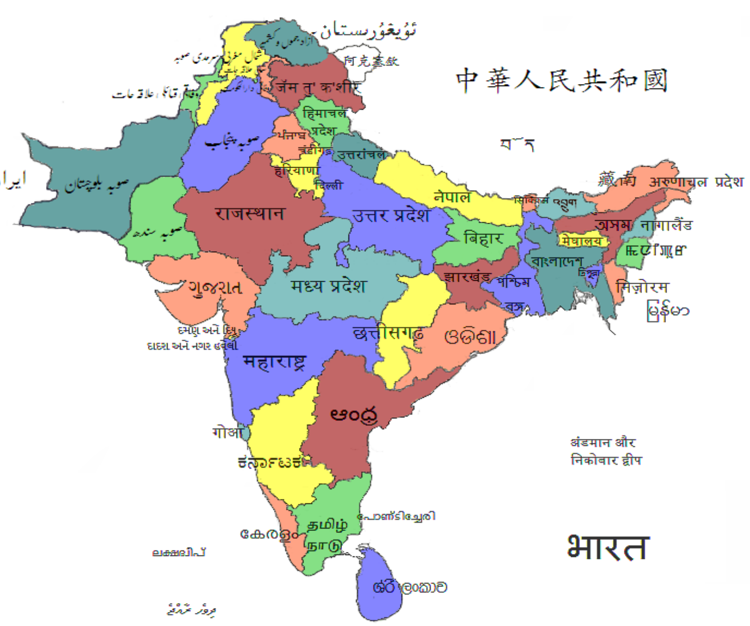
- Energy
- Water
- Food
- Environment
- Poverty
- Terrorism & War
- Disease
- Education
- Democracy
- Population

Some Emerging Trends in Engineering

1. Pervasive existence of software and sensors
2. Ethical challenges in software
3. IoT
4. Additive manufacturing
5. Increasing sophistication of terrorism
6. Cybersecurity and evolution of modern warfare
7. The last frontier- engineering and the human body
8. Delivery of education

Special Challenges in India

- Infrastructure
- Pollution
- Sanitation
- Power generation and distribution
- Ethics



Washington Accord

- Australia
- Canada
- Chinese Taipei
- Hong Kong China
- India
- Ireland
- Japan
- Korea
- Malaysia
- New Zealand
- Russia
- Singapore
- South Africa
- Sri Lanka
- Turkey
- United Kingdom
- United States

Continuous Improvement for NBA

- How does engineering education address local needs?
- How are periodic changes in accreditation criteria made by NBA?
- Is there a mechanism for continuous improvement for quality assurance?
- Is India ready for its own "Grinter Report" to define the future of engineering education?

Thank You

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Dr. Raman Menon Unnikrishnan is the Dean of Engineering and Computer Science at California State University, Fullerton. Prior to joining CSUF, Dr. Unnikrishnan served as the Head of the Electrical Engineering Department at RIT, Rochester, New York for 10 years. He is credited with placing the EE Department as the 3rd best among similar departments (2002) within comprehensive universities. During 1988–91 he was the Associate Dean for Graduate Studies and Research for the College of Engineering at RIT.

Dr. Unnikrishnan is active nationally and internationally in the field of engineering education and accreditation and served as an ABET/EAC Commissioner during 2008–2013. He is serving this role again during the 2015-16 accreditation cycle. During 2009–2014 he served as a Mentor to India as it sought full membership in the *Washington Accord*. Dr. Unnikrishnan received his BS degree from the University of Kerala, India, MS from South Dakota State University, and the Ph.D. degree from the University of Missouri, all in electrical engineering. The Fullerton Chamber of Commerce honored him as *"Educator of the Year"* in April 2015. He is the recipient of the "*Eisenhart Award for Excellence in Teaching"* at RIT. In 2000, he received the IEEE "*Third Millennium Award"* for Outstanding Achievements and Contributions. In 2006 he was given the *"Missouri Honor Award,"* one of the highest honors given by the University of Missouri to an alumnus. Dr. Unnikrishnan is a Fellow of IEEE.