

Proposed revisions to ABET Criterion 3 (Student outcomes [a-k]) and Criterion 5 (Curriculum)

What are Student outcomes [a-k]?

- a) an ability to apply knowledge of mathematics, science, and engineering
- b) an ability to design and conduct experiments, as well as to analyze and interpret data
- c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- d) an ability to function on multidisciplinary teams
- e) an ability to identify, formulate, and solve engineering problems
- f) an understanding of professional and ethical responsibility

What are Student outcomes [a-k]?

- g) an ability to communicate effectively
- h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- i) a recognition of the need for, and an ability to engage in life-long learning
- j) a knowledge of contemporary issues
- k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Each of these must be assessed.

Reasons to consider changes

- [a-k] have been relatively unchanged since ABET 2000. Do they still represent contemporary practice?
- Data show many shortcomings continue in the assessment of (a few) outcomes
- Balance between specificity (conformity) and generalization (differentiation) appears inconsistent among [a-k]
- Goal of encouraging innovation has not been achieved.

The Task Force

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- David Binning
- John Orr
- Kashy Aminian
- Bill Hametter
- Jeff Fergus
- Tom Jewell
- Jim McCarter
- Jessica Matson

(Original Chair: Elizabeth Judson)

Charge to the C3 Task Force (2009)

- **Develop a systematic process to assess, evaluate, and recommend improvements of Criterion 3.** The process should define and involve the **constituents** of Criterion 3. The process should explore potential metrics that may be used to assess and evaluate the effects of Criterion 3 on the quality of engineering education. The goals should consider the definition of **engineering in a global context** and **encourage innovation** and differentiation in engineering education and the engineering profession, rather than conformity

Notes

- ~ **75 potential additions** to the Outcomes were identified by the Task Force
- This work began prior to Harmonization which moved the assessment activities from C3 to C4
- It became clear that the Outcomes should be developed in concert with Curricular Requirements (C5)

Categories of Outcomes

- **Technical:** the specialized skills that are required by a practitioner in the discipline.
- **Business:** the skills required to function within a larger enterprise.
- **Communication:** the skills to convey information effectively using a variety of methods, and media.
- **Professionalism:** the personal and professional conduct and qualities expected for a practicing engineer.
- **Individual** – Skills such as creativity, leadership, innovation, and practical ingenuity are desirable qualities that can be emphasized to the degree that meets a program's mission.

Initial Findings

- The continuing substantial number of shortcomings on Criterion 3 (and their assessment) should not be ignored, and the underlying causes of these continuing shortcomings should be identified.
- Some outcomes have proven difficult to assess in a useful and repeatable manner
 - Ability to function on multidisciplinary teams
 - Understanding of professional and ethical responsibility
 - Impact of engineering solutions in a global, economic, environmental and societal context
 - Recognition and ability to engage in life-long learning
 - Knowledge of contemporary issues

Initial Findings (continued)

- With very few exceptions, programs have chosen to adopt and assess only the required [a-k] criteria, with little evidence of innovation involving student outcomes
- Academic constituents continue to report inconsistent application and interpretation of the criteria by program evaluators.
- Several constituencies regularly propose enlargement of the existing criteria, with substantial arguments

Guiding Goal

- Develop a set of Outcomes that are applicable across all engineering programs, that are **necessary** for professional practice, and the accomplishment of which can be evaluated to some reasonable degree within the engineering curriculum

Draft Outcomes (Criterion 3)

- The program must have documented student outcomes that prepare graduates to enter the engineering profession.
- Student outcomes are outcomes (1) through (6) plus any additional outcomes that may be articulated by the program.
 1. An ability to use the principles of science and mathematics to **identify, formulate and solve** engineering problems.
 2. An ability to apply both **analysis and synthesis** in the engineering design process, resulting in designs that meet constraints and specifications. **Constraints and specifications** include societal, economic, environmental, and other factors as appropriate to the design.
 3. An ability to develop and conduct appropriate experimentation and testing procedures, and to **analyze and draw conclusions from data**.
 4. An ability to **communicate effectively** with a range of audiences through various media.
 5. An ability to demonstrate **ethical principles** in an engineering context.
 6. An ability to establish goals, plan tasks, meet deadlines, manage risk and uncertainty, and function effectively **on teams**.

Comments on Current Draft

- “Identify and formulate engineering problems” is important to include in the outcomes
- The list of constraints in the engineering design outcome may be too prescriptive or limiting
- “Modern engineering tools” is important to include in C3 or C5
- Criterion 5 should be reviewed in a comprehensive sense.
- Allowance of Outcomes in program criteria should be considered
- A number of members feel that “multidisciplinary” is important to include, perhaps in C5

Draft Criterion 5

- The curriculum requirements specify subject areas appropriate to engineering but do not prescribe specific courses. The curriculum **must support attainment of the student outcomes** and must include:
 - (a) **one year** of a combination of college level **mathematics and basic sciences** (some with experimental experience) **appropriate to the program**. Basic sciences are defined as biological, chemical, and physical sciences.

Draft Criterion 5 (continued)

b) **one and one-half years of engineering topics**, consisting of engineering sciences and engineering design appropriate to the program and incorporating modern engineering tools. The engineering sciences have their roots in mathematics and basic sciences but carry knowledge further toward creative application. These studies provide a bridge between mathematics and basic sciences on the one hand and engineering practice on the other. **Engineering design is** the process of devising a system, component, or process to meet desired needs within constraints such as sustainability, ethics, health and safety, and manufacturability. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and the engineering sciences are applied to convert resources optimally to meet these stated needs.

Draft Criterion 5 (continued)

- c) a **general education** component that complements the technical content of the curriculum and is **consistent with the program educational objectives**.
- Students must be prepared for engineering practice through a curriculum culminating in a **major design experience** based on the knowledge and skills acquired in earlier course work and incorporating appropriate engineering standards and multiple constraints.
- One year is the lesser of 32 semester hours (or equivalent) or one-fourth of the total credits required for graduation.
- Note: only 2.5 years (of 4) is specified.

The Process

- Discussion draft presented by the Criteria Committee to EAC in July, 2014
- July, 2014-May, 2015: solicit input from societies, deans, faculty, industry reps and advisory councils. Make changes.
- July, 2015: First reading action at EAC
- Earliest date for visits: 2017-18 (optional)
- Earliest date required for visits: 2018-19
- Possible longer phase-in period

Direct Comments and Questions

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