# CRITERION 3 - STUDENT OUTCOMES

This chapter describes the process for establishing student outcomes and revising them and the relationship of student outcomes to program educational objectives.

**A. Process for the establishment and revision of the student outcomes**

Program outcomes were established in 2002. Initially, the same (a)-(k) outcomes suggested by ABET were selected. Program faculty members attended numerous national assessment conferences and ABET seminars during that period so as to equip themselves with current ideas and best practices. During this period the initial (a)-(k) had grown to include several additional outcomes. Some outcomes such as communication were broken into two separate outcomes: oral and written. However, by the end of 2002, the need for such separations appeared weak and so was not adopted. Suggested new outcomes were also abandoned because they were found to be unrelated to a focused and systematic continuous improvement process. Consequently, the original (a)-(k) were adopted as the program outcomes. This selection is reviewed and discussed several times a year by program faculty, usually during the periodic outcome reviews. The same suggestions arise as were proposed in 2002 and are rejected for the same reasons they were rejected then.

Program faculty members remain vigilant through ABET seminars and by serving as continuous improvement consultants for new technical and societal trends that may need to be addressed by additional outcomes; however, none has risen to the level of importance warranting adoption. The program faculty members have always supported student's addressing economic, ethical, societal context, environmental, and safety issues but have embedded these into the design component of the current outcomes. These matters are now addressed in the revised (1) –(7) outcomes being proposed by ABET. This more formal collection of these topics is certainly agreeable to the program faculty members since it closely aligns with their practice and thinking.

Since 2002, the outcomes have been reviewed many times by the program faculty and the Metallurgical Engineering Advisor Board. Both the faculty and the board have ruled that the outcomes are appropriate and adequate within the requirements established by ABET. Now that ABET proposes to change the (a) – (k) requirements in a way that combines the elements of some of the (a) – (k) into new outcomes (1) – (7), the program faculty and the Advisory Board recommend adoption of that structural change and further have found at the March 2016 meeting that the (1) – (7) as proposed by ABET are adequate and appropriate. However, the current review is entirely based on the (a) – (k) outcomes.

**B. Student outcomes**

The Outcomes for the BS Metallurgical Engineering Program correspond to the criteria for accrediting engineering programs during the 2010 to 2015 accreditation cycle so no additional mapping is needed. These outcomes are shown in Table 3-1.

All program continuous improvement system (CIS) program documents are posted on the program CIS website: www.ABETMetEng.org/SD . This website reflects all of the program CIS documents, which reside on and are backed up on program computers. The website provides for selective controlled-user access. All program faculty members have complete download access

to all CIS documents. The introduction of new documents to the CIS is controlled by the program designated CIS officer.

Table 3-1 Student Outcomes

a) Apply knowledge of mathematics, science, and engineering
b) Design and conduct experiments and analyze and interpret data
c) Design a system, component, or process with realistic economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability constraints
d) Function on multidisciplinary teams
e) Identify, formulate, and solve engineering problems
f) Know professional and ethical responsibility
g) Communicate effectively
h) Know the impact of engineering on global, economic, environmental, and societal issues
i) Recognize the need for life-long learning
j) Know contemporary issues
k) Use the techniques, skills, and modern engineering tools necessary for engineering practice.

In addition to the (a) – (k) outcomes, the university has general education outcomes and measures of achieving their satisfaction. These measures have been improving over the last few years and are now at a point where the program plans to include them in them in the CIS beginning in 2016. The BS Metallurgical Engineering Program assesses on a calendar year basis; consequently, no reference is made to hyphenated academic years. The results of those measurements are included here to provide a view of the planned inclusion.

Student outcomes are posted on the department bulletin board located outside MI 114.

**C. Relationship of student outcomes to program educational objectives**

Table 3-2 shows the relationship of the metallurgical engineering program objectives to the program outcomes.

Table 3-2 The relationship between metallurgical engineering program objectives and program outcomes

| Outcomes / Objectives | a | b | c | d | e | f | g | h | i | j | k |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 Apply Met Eng Prin. | ■ | ■ | ■ | | ■ | | | | | | |
| 2 Meet Societal Needs | | | | | | | | ■ | | ■ | |
| 3 Grow Prof & Personally. | | | | | | ■ | | | ■ | | ■ |
| 4 Serve Comm. & Profession. | | | | ■ | | ■ | ■ | | | ■ | |

Table 3-3 is a quality function deployment matrix (QFDM) that shows the relationship of curricular elements, which are shown along the top row, to the program outcomes, which are shown in the first column. A value of *9* indicates the curricular element is high important to the program outcome; whereas, a *1* indicates a low importance. No value indicates that there is no functional relationship. A non-linear scale (*0, 1, 3, 9*) is used to give emphasis to most important curricular elements since two elements rating 3 would not be as significant to achievement of a particular outcome as one element rated 9. Table 3-3 compares similar courses groups and also shows extra-curricular elements since the program graduate is formed by both course work and extra-curricular activities.

A second QFDM for specific courses in the metallurgical engineering program is shown in Table 3-4. In this case the highest rating is 5 rather than 9 because 0, 1, 3, and 5 ratings better describe the effect of coursework on each outcome since effect is somewhat related to time-in-class spent on each outcome. The table at the bottom indicates the total importance to program outcomes of each element. The last column shows the number of *high importance* elements (highest rated) for each outcome.

The QFDM is used to determine where in the curriculum action should be directed to achieve improvement in a particular outcome. Of course, this information also satisfies this element of the self-study.

Table 3-3 Quality function deployment matrix for metallurgical engineering curriculum

| **Desired Outcomes** | | **Processes** | Advising | Indiv. assistance | Met 351/352 | Met 464/465 | Scholarship program | Math sequence | H&SS curriculum | Lab curriculum | Met Eng (lecture) | Elective courses | out-of-dept tech elect | PE, Music, MS | Student org act | TLC | Library services | ENGL seq | Study groups | Met electives | Free electives | Chem/physics seq | Placement Prog |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| System will | Retain students | | 9 | 9 | | | 9 | | 3 | 1 | | 1 | 1 | 3 | 3 | 3 | | | 3 | | 1 | | 1 |
| | Facilitate student employment | | 3 | 9 | | | 1 | | 1 | 9 | 9 | 9 | 3 | 1 | 1 | | 1 | 3 | | 3 | | | 9 |
| Graduates will | (a) Apply math, sci and eng prin | | | 3 | 3 | 3 | 1 | 9 | | 3 | 9 | 3 | 1 | | | 3 | 1 | | 1 | 3 | | 3 | |
| | (b1) Design and Conduct exps | | | 1 | 9 | 9 | | 3 | 1 | 9 | 1 | | | | | | 1 | | | 1 | | 1 | |
| | (b2) Analyze and interpret data and | | | 1 | 9 | 3 | | 3 | | 9 | 9 | | 1 | | | | 1 | | 1 | 1 | | 3 | |
| | (c1) Optimally select material | | | 1 | 9 | 9 | | 1 | | 1 | 3 | | | | | | 1 | | 1 | 3 | | | |
| | (c2) Design materials treatment and prod | | | 1 | 9 | 9 | | 1 | | 1 | 3 | | | | | | 1 | | 1 | 3 | | | |
| | (d) multidisciplinary teaming | | 1 | | 9 | 9 | | | 1 | 3 | 1 | | | 3 | 9 | | | 1 | | 1 | | 1 | |
| | (e) Ident, form, & solve eng prob | | | 1 | 9 | 9 | | 3 | | 3 | 9 | 1 | | | 1 | | 1 | | | 3 | | 1 | |
| | (f) Knowing prof and ethic respon | | 1 | 1 | 3 | 1 | | | 1 | | 3 | | | | | | 1 | | | 1 | | | |
| | (g) Communicate effectively | | | 1 | | 3 | | 1 | 1 | 9 | 1 | | | | | | | 9 | 3 | 1 | | | |
| | (h) impact of eng in a glob context | | | 1 | 3 | 3 | | | 9 | 1 | 3 | | | | 1 | | 1 | | 1 | 1 | | | |
| | (i) Be life-long learner | | 1 | 1 | 1 | 1 | | | 1 | 9 | 1 | 2 | 1 | | 1 | | 9 | | 1 | 3 | 9 | | |
| | (j) Know contemporary issues | | | 1 | | | | | 9 | | 3 | | | | 1 | | 1 | | | 1 | | | |
| | (k) Use tech, skills, & mod tools | | | 3 | 1 | 1 | | | | 9 | 3 | | | | | | 1 | | | 1 | | | |
| | | | 15 | 34 | 65 | 60 | 11 | 21 | 27 | 67 | 58 | 16 | 7 | 7 | 17 | 6 | 20 | 13 | 12 | 26 | 10 | 9 | 10 |

**LEGEND**

9 High importance
3 Medium Importance
1 Low Importance
No importance

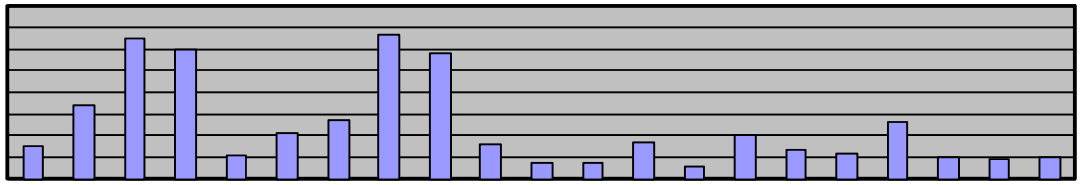
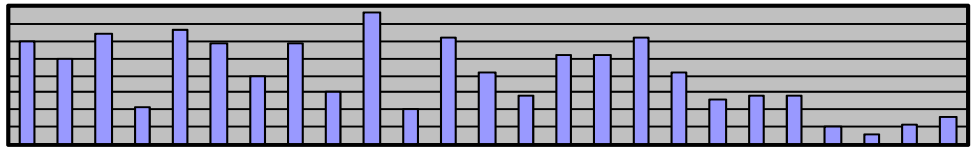


Table 3-4 Quality function deployment matrix for metallurgical engineering courses

| Outcome Criteria | Course | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MET 220 | MET 220L | MET 231 | MET 232 | MET 310 | MET 310L | MET 320 | MET 321 | MET 330 | MET 330L | MET 332 | MET 351/352 | MET 422 | MET 433 | MET 440 | MET 440L | MET 464/465 | MET Electives | Math sequence | Required Eng Courses | H&SS curriculum | Elective Courses | PE, Music, Band, MS | ENGL Sequence | Chem/Physics Seq |
| (a) Apply mathematics, science and engineering principles | **5** | 3 | 3 | **5** | **5** | **3** | **5** | 3 | **5** | **5** | **5** | 1 | **5** | 5 | 3 | 3 | 1 | 3 | **5** | **5** | | 3 | | | 3 |
| (b) Ability to design and conduct experiments and interpret data | 3 | **5** | **5** | | 3 | **5** | 3 | 3 | 3 | **5** | | 1 | 3 | | 3 | **5** | 1 | 3 | 3 | | | | | | 3 |
| (c) Ability to design a system, component, or process to meet design needs | 3 | | | 3 | 3 | 3 | 3 | **5** | | | | **5** | **5** | 3 | 3 | 3 | **5** | 3 | 1 | | | | | | |
| (d) Ability to function on multidisciplinary teams | 1 | 3 | **5** | | 1 | 1 | | | | **5** | | **5** | | | 1 | 3 | **5** | 1 | | | 1 | | 3 | 1 | 1 |
| (e) Ability to identify, formulate, and solve engineering problems | **5** | 3 | 3 | 3 | 3 | 3 | 3 | **5** | **5** | **5** | **5** | **5** | **5** | 1 | **5** | 3 | **5** | 3 | 3 | 5 | | 1 | | | 1 |
| (f) Understanding of professional and ethical responsibility | 3 | 1 | 1 | | 3 | 1 | 1 | **5** | 1 | 3 | | 3 | | | 3 | 1 | 3 | 1 | | | 1 | | | | |
| (g) Ability to communicate effectively | 3 | **5** | 3 | | 3 | **5** | 1 | 3 | | 3 | | **5** | | | 3 | **5** | **5** | 1 | 1 | | 1 | | | **5** | |
| (h) The broad education necessary to understand the impact of engineering solutions in a global | 3 | | **5** | | 3 | 1 | 1 | | | 3 | | | | | | | | 1 | | 1 | **5** | | | | |
| (i) Recognition of the need for and an ability to engage in life-long learning | | | 3 | | 3 | 1 | | | | 3 | | 1 | | | 1 | | 1 | 3 | | | 1 | 1 | | | |
| (j) Knowledge of contemporary issues | 3 | | 1 | | 1 | 1 | | **5** | 1 | 1 | | | | | 1 | | | 1 | | | **5** | | | | |
| (k) Ability to use the techniques, skills, and modern engineering tools necessary for | 1 | 5 | 3 | | **5** | **5** | 3 | | | **5** | | **5** | 3 | **5** | 3 | 3 | **5** | 1 | | 3 | | | | | |
| | 30 | 25 | 32 | 11 | 33 | 29 | 20 | 29 | 15 | 38 | 10 | 31 | 21 | 14 | 26 | 26 | 31 | 21 | 13 | 14 | 14 | 5 | 3 | 6 | 8 |

**LEGEND**

| | |
|---|---|
| 5 | High importance |
| 3 | Medium Importance |
| 1 | Low Importance |
| | No importance |



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