Continuous Improvement Committee Recommendations

September 3, 2019

Sections:

1) Background
2) Strengths Noted
3) Potential Improvements
4) Proposed Actions

1) Background

Industrial Advisory Board Recommendations

Strengths:

1) Hiring New Faculty
2) Introduction to Mechanical Engineering Course
3) ECE Minor
4) Department Newsletter
5) One-On-One Faculty Interactions

Recommendations:

1) Develop Strategy to Sustain & Grow Faculty Positions
2) Better Define & Strengthen Relationship with SDL
3) Introduce Breadth Curriculum with Other Departments
4) MAE Teach Introduction to Programming
5) Use Existing Projects to Hone Presentation & Briefing Skills
6) Promote Industry Engagement and Guest Lectures

Student Exit Interviews and Exiting Student Surveys

The ABET student survey was administered to MAE 4810 students, allowing students to report responses of "strongly agree," "agree," "neutral," "disagree," "strongly disagree," or "null." Satisfactory performance in a competency area is defined as an average response of "neutral." The spring 2019 semester survey shows that over 50% of students agree or strongly agree with all competency questions, with the lowest percentages of students responding in these two areas at 51.5% for "I can use statistics to evaluate experimental error." 62.9% for "I can identify current critical issues confronting mechanical engineers." And 63.9% for "I can design a thermal system, component, or process."

The exit surveys, rating instruction quality and equality of treatment, also show average responses above "neutral," with the most negative responses occurring in "quality of instruction by faculty in: Manufacturing Science (not a specific MAE course)" at 71.3% of students selecting neutral or better.

Evaluations of Student Outcomes by Instructors of Courses

Numerical instructor evaluations for this assessment period are incomplete. During the MAE fall faculty retreat, held August 19, 2019, faculty accepted a proposal to transition from instructor evaluation of students in individual courses into a programmatic focus area group evaluation of student strengths and weaknesses. This will facilitate a more programmatic evaluation of student performance, a more effective identification of weakness areas, and a more targeted and systematic response to issues that are identified. The ABET chair provides pertinent assessment data for each of the focus area groups to consider in their discussions.

Each of the programmatic focus area discussions is led by a member of the Continuous Improvement Committee (CIC) who instructs students in that focus area. The Strengths Noted, Potential Improvements, and Proposed Actions sections in this report document the results of these meetings.

Student Assessments on Student Outcomes on IDEA Surveys

Student assessments on student outcomes obtained through course-end IDEA course surveys [currently awaiting Merilee providing missing data – known data shows no deficiencies].

Fundamentals of Engineering Results

In the previous ABET review cycle, FE performance in each subject category was evaluated using the MAE average percentile in comparison to the national average, with adequacy defined as the 50^{th} percentile or above. This is equivalent to a performance ratio of 1.0 between MAE student performance and average performance. Although the Electricity and Magnetism subject area dropped down below national average (0.94) spring semester, NCEES recommends that action be delayed until deficiency is noted over multiple examination periods. The CIC resultantly has determined to particularly track student performance in this area in the upcoming year. Student performance in all other subject areas was at or above a ratio of 1.0.

	F15	S16	F16	S17	F17	S18	F18	S19
Mathematics	1.11	1.06	1.04	1.02	1.09	1.11	1.06	1.06
Probability and Statistics	1.02	1.03	0.98	1	1	1.05	1.06	1.03
Computational Tools	1.17	1.1	1.06	1.1	1.09	1.15	1.15	1.1
Ethics and Professional Practice	1.03	1.07	1.02	1.03	1.1	1.02	1.05	1.12
Engineering Economics	0.86	0.88	0.85	0.97	0.96	1.01	1.04	1.03
Electricity and Magnetism	1.07	1.05	1	0.97	0.99	1	1.04	0.94
Statics	1.13	1.05	1	1.04	1.07	1.1	1.07	1.14
Dynamics Kinematics and Vibrations	1.08	1.1	1.05	1.04	1.03	1.09	1.07	1.05
Mechanics of Materials	1.14	1.06	1.09	1.06	1.1	1.05	1.1	1.06
Material Properties and Processing	1.09	1.05	1.01	1.07	1.06	1.03	1.02	1.06
Fluid Mechanics	1	1.07	1.09	1.07	1.03	1.05	1.06	1.05
Thermodynamics	1.03	1.01	0.97	1	1.03	1	1	1.02
Heat Transfer	1.13	1.01	1.07	1.07	1.06	1.07	1.05	1.09
Measurements Instrumentation and Controls	1.04	1.01	1.04	0.96	1.07	1	1.03	1.06
Mechanical Design and Analysis	1.08	1.06	1.05	1.05	1.07	1.07	1.1	1.02

2) Strengths Noted

FE Exam & General Technical Performance

Student FE exam scores are consistently high relative to peer institutions. General technical competency is also supported anecdotally by industry feedback. When industrial advisory board members and capstone project sponsors are asked about what they perceive as being the strength of USU MAE students relative to other regional programs, they consistently respond that MAE graduates have a reputation for exceptional technical skills.

Character & Work Ethic

Faculty note the general character and work ethic of students entering the program as being exceptionally high. This is supported by anecdotal reports from industry entities that they specifically recruit from USU because USU students' character and background tend to result in easy security clearance processes.

Trial & Error Approach to Labs

Although faculty would prefer students to more directly apply theory that they learn their coursework, students have shown themselves proficient in a trial-and-error approach to solving engineering problems presented to them in labs.

Written and Verbal Communication Skills

Recognizing an overall need among engineering programs to improve written and verbal communication skills of graduates, faculty and administration have made significant changes in recent years to improve these skills. The College of Engineering instituted a junior-level technical communications course and Engineering Writing Center resource. The Thermal Fluids

and Instrumentation and Measurements Laboratories curriculum were both modified to require over double the writing volume required by a general education English course. The capstone program requires reviewed requirements contract and design baseline documents. Mike Lazalier, program manager for the Air Force Research Lab University Design Challenge noted in a recent interview that the USU team showed exceptional written and verbal communication skills. "It was obvious they knew everything about the project from every angle," said Lazalier. "It's rare to find young engineers who communicate so effectively." Capstone faculty commonly receive similar feedback from competition organizers and industry sponsors.

Basic Statistics Understanding

Three years ago, in an informal continuous improvement effort, laboratory course faculty met together to discuss strategies to address student weaknesses in the laboratory courses. One area of concern was students' understanding of basic statistics concepts entering into the Thermal Fluids Laboratory. The Instrumentation and Measurements Course curriculum was re-worked, with review and commentary incorporated from a tenure track mathematics faculty member. Both FE scores in this area and understanding assessment quizzes at the beginning of the Thermal Fluids course show significant improvement in student performance.

3) Potential Improvements

Mathematics Proficiency – Ordinary Differential Equations, Non-trivial Integrals

Mathematics proficiency is a longstanding concern for program faculty. Resolution of the concern has proved problematic with all of the foundational mathematics courses taught by a department external to the College of Engineering. At one time, the program attempted to address this concern by teaching an upperclassman course in engineering mathematics, but this course reportedly fell victim to graduation credit limits.

The Dynamics, Controls, & Navigation Program Focus faculty, in particular, noted student weakness compared to expectations in student ability to properly solve ordinary differential equations, to perform non-trivial integrals. This weakness is likely perceived more strongly by the constituency supporting "advanced degrees in engineering," than by constituencies associated with graduate success "in entry-level engineering positions with mechanical or aerospace firms," as technical expertise is generally recognized as a strength by students, alumni, and employers.

Current assessment methods include FE exam results and an early-course mathematics quiz in a navigation-based course. Solution strategies considered included the following: requiring a preliminary FE exam to be taken and restricting entry into the professional program by math score, generating an independent mathematics exam that students must pass in order to be accepted into the professional program, and identifying example problems from the early-course math quiz that students struggle responding correctly to and sending an emissary to the

math department to brainstorm improvement of student performance on those problem types, tracking and communicating changes to the math department using the quiz.

Understanding Math in (and Significance of) Derivations

Faculty in three of the four program focus areas noted that improved student understanding of the importance of derivations and the significance (or meaning) of the mathematical functions applied would significantly improve their ability to practice engineering. They noted student resistance to participate in derivation exercises and an undeveloped understanding of the physical or graphical significance of partial derivatives, double integrals, gradients, etc. Although the early-course mathematics exam may capture some aspects of this issue, its existence is primarily identified by verbal and IDEA survey response to time spent in derivations. Potential solution strategies considered included introducing the importance and significance of derivations and related functions during the Introduction to Mechanical Engineering course taught to freshmen and finding a guest lecturer from a student-respected industry who would be willing to lend credibility by citing benefits from an industry perspective.

Physics Understanding – Gravitation Laws / Potentials

The Dynamics, Controls, & Navigation Program Focus faculty also particularly noted student weakness in understanding gravitation laws related to potentials. This subject matter is again taught outside of the engineering college by the physics department. A potential solution considered again involved using the Introduction to Mechanical Engineering course to introduce the importance of the subject prior to students taking the physics course series.

FE Examination Target Values

Discussions have been instigated by the CIC within the within the programmatic focus areas about potentially adjusting adequacy limits for each of the FE subject areas. In particular, it has become apparent that although students in the program consistently perform significantly above average on the FE mathematics questions, faculty (particularly those associated with the aerospace program emphasis) perceive students as being weak in this area. By individually evaluating the levels of performance in each subject needed to support the program mission, faculty can better track performance and focus department efforts where necessary to ensure that the program mission and objectives are met.

4) Proposed Actions

Mathematics Proficiency

- Obtain example problems students struggle with. (10/31/19)
- Discuss the possibility of instituting a mathematics exam for entry into the professional program with the Dean's Office (and advising center) and determine future actions. (12/20/19)
- Determine the reasons why the engineering mathematics course was discontinued and whether it would be possible to reinstate it in some form. (12/20/19)
- Identify potential mathematics department faculty to collaborate with. (1/15/20)
- Meet with mathematics department faculty, provide examples, define strategy, and determine future actions. (5/15/20)

Understanding Math in (and Significance of) Derivations

- Meet with Intro to Mech. Engineering instructor to plan additional function visualization and physics examples into course curriculum. (9/1/19)
- Contact Space Dynamics Laboratory about providing guest lecturer to discuss the importance of understanding derivations and mathematical function significances. (9/30/19)
- Schedule and finalize related lecture(s). (10/15/19)

Physics Understanding – Gravitation Laws / Potentials

- Meet with Intro to Mech. Engineering instructor to plan additional function visualization and physics examples into course curriculum. (9/1/19)

FE Examination Target Values

- Generate CIC proposal for new FE subject area target values. (1/5/20)
- Vote-in new FE subject area target values in spring department meeting.