

PENNSSTATE

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Department of Mechanical and Nuclear Engineering  
*College of Engineering*

MECHANICAL ENGINEERING  
ASSESSMENT PLAN  
ABET CRITERIA 2 & 3

From the ABET Self Study  
Prepared June 16, 2008  
Reviewed by MNE Assessment Committee

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## 2. Program Educational Objectives

### 2.a. Mission Statements

The objectives of the Mechanical Engineering B.S. program are consistent with the mission statements of Penn State University, the College of Engineering, and the Mechanical Engineering Program.

#### University Vision Statement

Penn State will be the nation's finest university in the integration of teaching, research, and service.

From the Penn State Strategic Plan at

[http://www.psu.edu/president/pia/strategic\\_planning/strategic\\_planning\\_brochure/full\\_report.pdf](http://www.psu.edu/president/pia/strategic_planning/strategic_planning_brochure/full_report.pdf)

#### University Mission Statement

Penn State is a multi-campus public land-grant university that improves the lives of people in Pennsylvania, the nation, and the world through integrated, high-quality programs in teaching, research, and service.

Our institutional mission includes undergraduate, graduate, and continuing and distance education informed by scholarship and research. Our research, scholarship, and creative activities promote human and economic development through the expansion of knowledge and its applications in the natural and applied sciences, social sciences, arts, humanities, and the professions.

As a land-grant university, we also hold a unique responsibility for outreach and public service to support the citizens of Pennsylvania. We engage in collaborative activities with industrial, educational, and agricultural partners here and abroad to disseminate and apply knowledge.

From <http://www.psu.edu/ur/about/mission.html> and in the Penn State Strategic Plan at [http://www.psu.edu/president/pia/strategic\\_planning/strategic\\_planning\\_brochure/full\\_report.pdf](http://www.psu.edu/president/pia/strategic_planning/strategic_planning_brochure/full_report.pdf)

#### College of Engineering Vision Statement

The vision of the College of Engineering is:

To have a partnership of faculty, students, staff, alumni and government and corporate leaders working together to provide the highest quality education and to continue building one of the nation's best engineering institutions. Further, our vision for the College is to create a climate that attracts and supports a diverse group of students, faculty and staff and in which effective learning, research and service are accomplished by working together.

From the Engineering Strategic Plan at <http://www.engr.psu.edu/AboutCOE/strategicplan.aspx>

## **College of Engineering Goals**

The College of Engineering will strive to:

- Attract and develop an outstanding and diverse faculty, student body and staff,
- Develop and deliver an undergraduate engineering curriculum based on active, problem-based and
- professionally oriented teaching and learning,
- Strengthen graduate programs,
- Develop research thrusts in areas of state and national needs,
- Enhance outreach to the Commonwealth and beyond, and
- Implement administrative and organizational actions to support strategic goals and increase effectiveness.

From the Engineering Strategic Plan at <http://www.engr.psu.edu/AboutCOE/strategicplan.aspx>

## **Department of Mechanical and Nuclear Engineering Vision Statement**

Our vision is to be a department that:

- Provides significant benefits to its students, the Commonwealth, the Nation and society; and achieves international recognition - in both mechanical and nuclear engineering - for its teaching, research and service;
- Is committed to the life-long intellectual growth and well-being of its faculty, staff and students; and provides an environment of respect for different cultures, backgrounds and viewpoints.

From <http://www.mne.psu.edu/AboutMNE.htm>

## **Mechanical Engineering Program Educational Mission Statement**

Cognizant of the unique mission of Penn State in the Commonwealth and the nation, our program endeavors to produce graduates who are capable of becoming productive citizens in modern society. The education provided encompasses the full breadth of the discipline of mechanical engineering and consists of technical content, interactive and participatory learning, and continual reinforcement of the skills and characteristics consistent with a successful professional.

The most important asset we bring to this mission is our faculty. We will leverage the rich background and research accomplishments of our faculty by making appropriate use of research results in the classroom.

In this endeavor, the primary focus is on the student. Through admission standards, professional advising, and consistently high expectations, we lead the students, through lecture and example, toward our common goal of life as a professional in our society.

(Last revised October 2000)

The Program Educational Mission Statement can be found in:

- the ME Program Undergraduate Manual at [http://www.mne.psu.edu/undergrad/ugmanuals/ME\\_Manual/nuclear\\_engineering.htm](http://www.mne.psu.edu/undergrad/ugmanuals/ME_Manual/nuclear_engineering.htm)
- the Mechanical Engineering Program Assessment web site at <http://www.mne.psu.edu/undergrad/ABET/MEIndex.htm>

## **2.b. Program Educational Objectives**

The objective of the Mechanical Engineering program is to prepare students for a wide range of career paths that use mechanical engineering principles and methodology. We will maintain and provide a curriculum that prepares our recent graduates for:

1. Working in industry and government including computer-aided design, simulation and analysis of products or systems, experimentation and testing, manufacturing, and technical sales.
2. Assuming increasing levels of responsibility in project, personnel, and budget management.
3. Working and leading effectively in multi-disciplinary and multi-cultural teams.
4. Communicating effectively and recognizing the global, societal, and ethical contexts of their work.
5. Entering into graduate and professional studies.

(Last revised May 25, 2006)

The Program Educational Objectives can be found in:

- the ME Program Undergraduate Manual at [http://www.mne.psu.edu/undergrad/ugmanuals/ME\\_Manual/nuclear\\_engineering.htm](http://www.mne.psu.edu/undergrad/ugmanuals/ME_Manual/nuclear_engineering.htm)
- the online information for prospective students at <http://www.mne.psu.edu/undergrad/WhyME.htm>
- the Mechanical Engineering Program Assessment web site at <http://www.mne.psu.edu/undergrad/ABET/MEIndex.htm>
- the Penn State Undergraduate Bulletin at <http://bulletins.psu.edu/bulletins/bluebook>
- the Engineering Undergraduate Programs Guide given to incoming freshmen and available online at <http://www.engr.psu.edu/AdvisingCenter/programguide.aspx>

## **2.c. Consistency of the Program Educational Objectives with the Mission of the Institution**

The Mechanical Engineering Program Educational Objectives are consistent with the mission of the university and college. The university mission broadly describes “high-quality programs in teaching” and “undergraduate education”, both of which include the undergraduate program in mechanical engineering. The college vision statement is also broad but includes the vision “to provide the highest quality education”. The college goals statement is more specific and includes: “Advance the quality of the undergraduate education experience with increased active learning and faculty/student interaction focusing on integration of design, communications, computation, and the contextual understanding of engineering.” The aspects of “design, communications, computation, and the contextual understanding of engineering” are included in the Mechanical Engineering Program Outcomes that prepare our graduates for the career paths

listed in our Program Educational Objectives. The courses in the Mechanical Engineering curriculum support the ME Program Outcomes, the college goals, and the university mission.

## **2.d. Constituencies**

For the development and assessment of the Program Education Objectives, the program constituencies are identified to be students, industry, faculty, and graduate schools. Other constituencies such as government, parents, and the public were not polled in the current assessment.

### ***2.d.1. Students***

The students are an important constituency because they invest much time and money in their education with the expectation that they will be prepared to work as engineers. Student evaluations and opinions are obtained through student surveys, student evaluation of teaching, Alumni Surveys, and in meetings with student leaders.

### ***2.d.2. Industry***

As the major employer of our students, input from industry representatives is considered essential in assessing student performance. There are four major sources for industry-based data: 1) the department Industrial and Professional Advisory Committee (IPAC), 2) surveys of employers of our students who are participating in the co-operative education program, 3) engineers sponsoring senior projects, and 4) FE Exam Results.

### ***2.d.3. Faculty***

The faculty has a strong interest in providing an excellent learning experience and in improving engineering education. As instructors, the faculty has an excellent opportunity to evaluate student outcomes and assess the effectiveness of the learning experience. Evaluations of student performance in classes are used as assessment tools.

### ***2.d.4. Graduate Schools***

Since only a few Penn State students may attend any particular graduate school in a given year, it is difficult to obtain useful input from graduate schools nationally. When Penn State ME students apply to graduate studies within the department, their record, including GRE scores, are compared with students from other institutions. Our MNE faculty members also teach graduate courses and advise graduate research, they can provide input on the preparedness of our undergraduates for graduate school. Two members of the MNE IPAC are from other universities and provide another form of input from graduate schools.

## **2.e. Process for Establishing Program Educational Objectives**

Before Fall 2002, the ME program had a list of outcomes at graduation, similar to the list in Section 3.b. The blue bold-faced general headings were considered the Program Educational Objectives and the items below each heading were the Program Outcomes. (At that time we

used the terms “Broad Objectives” and “Detailed Objectives” to describe Program Educational Objectives and Program Outcomes.) In the 2002 ABET accreditation visit, the college received a concern stating that the Program Educational Objectives should be written as achievements 3-5 years after graduation. In December 2003, a draft of ME Program Educational Objectives was written by the MNE Assessment Committee. Information about the career paths of our graduates was obtained from the Alumni survey. The Program Educational Objectives were discussed by the ME faculty in faculty meetings December 2004 and January 2005. IPAC reviewed the Program Education Objectives in March 2005. These comments were incorporated into the current Program Educational Objectives.

In March 2006, L. Pauley, the department ABET coordinator, met with the IPAC Committee to review program objectives and outcomes. These recommendations were discussed by the MNE Assessment Committee and changes made on May 3, 2006. The revised program objectives were discussed in an MNE faculty meeting and then emailed to the ME faculty for a vote. The vote closed on May 25, 2006 and the changes were approved. A revision history for the Program Educational Objectives and Program Outcomes can be found at [www.mne.psu.edu/undergrad/abet](http://www.mne.psu.edu/undergrad/abet). This revision history includes copies of all previous versions of the Program Educational Objectives and Outcomes.

As the Program Educational Objectives, hereafter referred to simply as Objectives, were being developed after the 2002 ABET visit, the Objectives were reviewed every year. After the first few years, the Objectives became an accurate reflection of the current program goals. The Objectives are now scheduled to be reviewed by all constituencies and updated every six years to reflect changes in the curriculum. Changes to the Objectives might be initiated before the scheduled review if warranted by the assessment results.

## **2.f. Achievement of Program Educational Objectives**

Assessment of the Objectives takes place at least twice in each accreditation cycle. Assessment data are collected from representatives of our four major stakeholder groups: students, industry, faculty, and graduate schools. Data from the senior survey identifies the types of jobs and responsibilities of graduates of the program. The Alumni Survey provides information regarding work responsibilities of recent graduates two to three years after graduation. Input from IPAC (Industrial and Professional Advisory Board) provides input from industry. Some Penn State ME undergraduates continue at Penn State for graduate studies. The success of our graduates in pursuing graduate studies can be determined by looking at the success of our previous undergraduates who now are in our ME graduate program.

Intentionally blank.



## **3. Program Outcomes**

### **3.a. Process for Establishing and Revising Program Outcomes**

When formulating the program outcomes, input was obtained from representatives of our four major stakeholder groups: students, industry, faculty, and graduate schools, as described in Section 2.d. The current students and alumni are asked for an evaluation of the importance of various aspects of an engineering education in the Senior Survey and Alumni Survey. This input was considered when writing the program outcomes. As the major employer of our students, information from industry representatives is considered essential to the formulation and maintenance of our program outcomes. We obtain input from industrial professionals through the senior projects survey, through the Co-op Employers survey, and in discussions with the MNE IPAC (Industrial and Professional Advisory Committee) that meets with department faculty once a year. MNE IPAC reviews the ME Program Outcomes at least once every six years. In other years, the IPAC discussions focus on the Program Educational Objectives, assessment results, or proposed curricular changes. Often IPAC has recommended changes to the Program Educational Objectives or Program Outcomes that were supported by the MNE Assessment Committee and approved by a vote of the ME faculty. All faculty members in the department advise graduate students. By advising graduate students, the faculty understands the skills and knowledge undergraduates should develop to be successful in graduate studies.

The draft of the program outcomes was written by the MNE Assessment Committee in Fall 1999, distributed to the entire faculty by email, and discussed in several faculty meetings. A revised draft was presented to the Industrial and Professional Advisory Committee (IPAC) on March 22, 2000 for review and comment. A department workshop on September 26, 2000 reviewed the program outcomes for both the Mechanical and Nuclear Engineering programs and also reviewed the assessment plan. After the department workshop, the MNE Assessment Committee finalized the program outcomes and presented them at a faculty meeting. The revised program outcomes were then presented to IPAC on March 15, 2001. In Fall 2001, the Professor-in-Charge of Undergraduate Programs met with the student officers of ME student organizations. The program outcomes were presented and comments were received.

In March 2006, L. Pauley, the department ABET coordinator, met with the IPAC Committee to review program objectives and outcomes. The recommendations from IPAC were then discussed by the MNE Assessment Committee and supported on May 3, 2006. The revised program objectives and outcomes were emailed to the ME faculty for a vote and approved through an electronic ballot that closed on May 25, 2006.

In response to observations from the Fall 2005 ME program assessment, changes to the ME Program Outcomes were recommended by the MNE Assessment Committee. These changes were discussed in two MNE faculty meetings and approved through an electronic ballot that ended on April 13, 2007. After this ballot, the MNE Assessment Committee found two outcomes required small modifications to be more inclusive. Small changes to Outcomes 3b and 4e were discussed and approved by a vote of ME faculty in the MNE faculty meeting on October 2, 2007.

A revision history for the Program Educational Objectives and Outcomes can be found at [www.mne.psu.edu/undergrad/abet](http://www.mne.psu.edu/undergrad/abet). This revision history includes copies of all previous versions of the Program Educational Objectives and Outcomes.

### **3.b. Program Outcomes**

The program outcomes of the Mechanical Engineering program are:

**Outcome I:** Students will demonstrate a knowledge of chemistry, physics, and mathematics.

Students will:

- a. demonstrate knowledge of chemistry
- b. demonstrate knowledge of calculus-based physics
- c. demonstrate ability to use multivariate calculus
- d. demonstrate ability to solve differential equations
- e. demonstrate familiarity with statistics
- f. demonstrate familiarity with linear algebra

**Outcome II:** Students will be able to apply fundamentals of mathematics, physics, and engineering to mechanical engineering analysis and design involving both mechanical and thermal/fluids systems. Students will:

- a. perform analysis of mechanical components
- b. perform analysis of thermal/fluids components
- c. demonstrate the ability to design components
- d. perform analysis of mechanical systems
- e. perform analysis of thermal/fluids systems
- f. demonstrate the ability to design systems

**Outcome III:** Students will demonstrate the ability to operate in a modern, diverse working environment in which they will work in multidisciplinary teams, communicate effectively and recognize the economic, global, societal, and ethical contexts of their work. Students will:

- a. work effectively on multidisciplinary teams
- b. demonstrate an appreciation of the economic, global, societal, ethical, and professional context of their work
- c. demonstrate a knowledge of contemporary issues
- d. demonstrate ability to communicate effectively with the written word
- e. demonstrate ability to communicate effectively in oral communications
- f. demonstrate ability to learn in less structured circumstances.

**Outcome IV:** Students will demonstrate the ability to use appropriate methods and technology for 1) measurement and analysis of data and 2) analysis and design. Students will:

- a. demonstrate an understanding of the principles of measurements, instrumentation methods, and experimental design
- b. exhibit broad understanding of instruments and sensors, both in theory and in practice
- c. assess, report on, and draw conclusions regarding the inherent uncertainty of data using appropriate statistical tools

- d. demonstrate the ability to develop and utilize models
- e. use software to solve engineering problems

(Last revised October 2, 2007)

In response to recommendations from the 2001 Program Assessment, the MNE Assessment Committee defined “contemporary issues” and “professionalism”.

Contemporary Issues: Students need to understand current societal issues even if these do not directly relate to the engineering profession. This is so that they are informed citizens. Although we cannot and should not prescribe what students should know, we should instill the idea that they should be interested in the world at large and informed about societal issues. Examples of these issues, given simply as a guide to the type of issues considered here, are: the U.S. energy policy, urban sprawl, the war on terrorism, discrimination based on race and gender, the national budget debate, campaign finance reform, etc. (Developed Spring 2002.)

Professionalism: Students will interact with students, faculty, and staff in a way appropriate for an engineer in industry. Interactions include conversations, presentations, emails, and written homeworks and reports. (Developed Spring 2002.)

In response to recommendations from the 2005 Program Assessment, the MNE Assessment Committee defined “develop models” and revised “contemporary issues”.

Develop Models: Modeling is the process of recasting a complicated system into a more tractable representation. A model might take the form of a set of mathematical equations, a computer-based representation in CAD, or a miniature scale likeness. The essence of modeling is recognizing the relevant and important behavior that needs to be captured to solve the problem at hand.

Examples of modeling as it is typically encountered in our undergraduate program are:

- Creating a mathematical model of the components in a gas turbine to determine cycle performance or of an aircraft landing gear by a spring-mass-damper system to examine its response to a landing.
- Creating a CAD model and then a physical model of the design.

(Developed Fall 2006.)

Contemporary Issues: “Contemporary issues” implies current issues affecting the practice of engineering that students need to understand. Examples include: climate change, water rights, alternate energy sources, globalization, energy policy, intellectual property, clean coal technology, hydrogen economy, CFC elimination, and flooding in New Orleans due to Hurricane Katrina. (Revised Spring 2008.)

The program outcomes for Mechanical Engineering map to the ABET a-k and ABET program outcomes as shown in the table below.

**Table 3.1.** Mapping of Program Outcomes to ABET Outcomes.

| Program Outcomes       | ABET Program Outcomes |   |   |   |   |   |   |   |   |   |   |    |  |
|------------------------|-----------------------|---|---|---|---|---|---|---|---|---|---|----|--|
|                        | a                     | b | c | d | e | f | g | h | i | j | k | ME |  |
| I.a: Chemistry         |                       |   |   |   |   |   |   |   |   |   |   |    |  |
| I.b: Physics           |                       |   |   |   |   |   |   |   |   |   |   |    |  |
| I.c: Calculus          |                       |   |   |   |   |   |   |   |   |   |   |    |  |
| I.d: Dif Eqns          |                       |   |   |   |   |   |   |   |   |   |   |    |  |
| I.e: Statistics        |                       |   |   |   |   |   |   |   |   |   |   |    |  |
| I.f: Linear Alg.       |                       |   |   |   |   |   |   |   |   |   |   |    |  |
| II.a: Mech. Comp.      |                       |   |   |   |   |   |   |   |   |   |   |    |  |
| II.b: Thermal Comp.    |                       |   |   |   |   |   |   |   |   |   |   |    |  |
| II.c: Design Comp.     |                       |   |   |   |   |   |   |   |   |   |   |    |  |
| II.d: Mech. Sys.       |                       |   |   |   |   |   |   |   |   |   |   |    |  |
| II.e: Thermal Sys.     |                       |   |   |   |   |   |   |   |   |   |   |    |  |
| II.f: Design Sys.      |                       |   |   |   |   |   |   |   |   |   |   |    |  |
| III.a: Mult. Teams     |                       |   |   |   |   |   |   |   |   |   |   |    |  |
| III.b: EGSE Context    |                       |   |   |   |   |   |   |   |   |   |   |    |  |
| III.c: Contemp Issue   |                       |   |   |   |   |   |   |   |   |   |   |    |  |
| III.d: Written Com.    |                       |   |   |   |   |   |   |   |   |   |   |    |  |
| III.e: Oral Com.       |                       |   |   |   |   |   |   |   |   |   |   |    |  |
| III.f: Less Structured |                       |   |   |   |   |   |   |   |   |   |   |    |  |
| IV.a: Exp Design       |                       |   |   |   |   |   |   |   |   |   |   |    |  |
| IV.b: Mech. Instr.     |                       |   |   |   |   |   |   |   |   |   |   |    |  |
| IV.c: Data Analy.      |                       |   |   |   |   |   |   |   |   |   |   |    |  |
| IV.d: Dev Models       |                       |   |   |   |   |   |   |   |   |   |   |    |  |
| IV.e: Eng. Software    |                       |   |   |   |   |   |   |   |   |   |   |    |  |

### 3.c. Relationship of Program Outcomes to Program Educational Objectives

The program outcomes have been developed to support the Objectives. The table below shows the mapping of Program Outcomes to Objectives. Two checks show outcomes that are critical to the Objectives. One check shows outcomes that are supporting the Objectives.

**Table 3.2.** Mapping of Program Outcomes to Program Educational Objectives.

| Program Outcomes                | Program Educational Objectives |    |    |    |    |
|---------------------------------|--------------------------------|----|----|----|----|
|                                 | 1                              | 2  | 3  | 4  | 5  |
| I.a: Chemistry                  | ✓                              |    |    |    | ✓✓ |
| I.b: Physics                    | ✓                              |    |    |    | ✓✓ |
| I.c: Calculus                   | ✓                              |    |    |    | ✓✓ |
| I.d: Dif Eqns                   | ✓                              |    |    |    | ✓✓ |
| I.e: Statistics                 | ✓                              | ✓  |    |    | ✓✓ |
| I.f: Linear Alg.                | ✓                              |    |    |    | ✓✓ |
| II.a: Mech. Comp.               | ✓✓                             |    |    |    | ✓✓ |
| II.b: Thermal Comp.             | ✓✓                             |    |    |    | ✓✓ |
| II.c: Design Comp.              | ✓✓                             |    |    |    | ✓✓ |
| II.d: Mech. Sys.                | ✓✓                             | ✓  |    |    | ✓✓ |
| II.e: Thermal Sys.              | ✓✓                             | ✓  |    |    | ✓✓ |
| II.f: Design Sys.               | ✓✓                             | ✓  |    |    | ✓✓ |
| III.a: Mult. Teams              | ✓✓                             | ✓✓ | ✓✓ |    | ✓✓ |
| III.b: EGSE Context             | ✓                              | ✓✓ | ✓✓ | ✓✓ |    |
| III.c: Contemp Issue            | ✓                              | ✓  | ✓✓ | ✓✓ |    |
| III.d: Written Com.             | ✓✓                             | ✓✓ | ✓✓ | ✓✓ | ✓✓ |
| III.e: Oral Com.                | ✓✓                             | ✓✓ | ✓✓ | ✓✓ | ✓✓ |
| III.f: Less Structured Learning | ✓✓                             | ✓✓ | ✓✓ |    | ✓✓ |
| IV.a: Exp Design                | ✓✓                             | ✓  |    |    | ✓✓ |
| IV.b: Mech. Instr.              | ✓✓                             | ✓  |    |    | ✓✓ |
| IV.c: Data Analy.               | ✓✓                             | ✓✓ |    |    | ✓✓ |
| IV.d: Dev Models                | ✓✓                             | ✓  |    |    | ✓✓ |
| IV.e: Eng. Software             | ✓✓                             | ✓  |    |    | ✓✓ |

✓ supporting Objectives

✓✓ critical to Objectives

### **3.d. Relationship of Courses in the Curriculum to the Program Outcomes**

After the program outcomes were written, the ME Curriculum Improvement Committee matched the program outcomes to courses taught within the Mechanical Engineering program. The ME Curriculum Improvement Committee members are the course leaders for eight required ME courses—ME 300 Thermodynamics, ME 320 Fluid Flow, ME 340 ME Design Methodology, ME 345 Instrumentation, Measurements, and Statistics, ME 360 Mechanical Design, ME 370 Vibration of Mechanical Systems, ME 410 Heat Transfer, and ME 450 Modeling of Dynamics Systems. In Fall 2000, each course leader met with the course caucus to determine which

program outcomes were covered in the course. The required courses that cover each outcome are listed in the second column in Table 3.3 shown below. For an outcome to be “covered” there needs to be a graded activity, not only class lecture. In some cases, the outcome was not covered in sufficient detail to be assessed, or the outcomes were not covered consistently in all sections. For these outcomes, the course number is listed in parentheses, {ME xx} in Table 3.3. After this information was compiled, the MNE Assessment Committee determined which outcomes would be assessed in each required ME course. Courses were selected in which the outcome was a strong component of the course. Distributing the assessments across all of the courses was also a consideration. The courses where each outcome is assessed are listed in the third column of the table below. Where the course is taught within the department, an outcome-based assessment is performed (see Section 3.i.2). For some outcomes, a course taught outside the department has a program outcome (such as technical writing) as its primary focus. In these cases, course grades are used as one form of assessment for the outcome (see Section 3.i.1).

In Spring 2007, the course caucuses reviewed and updated column 2 showing the mapping of program outcomes to the required courses in the ME curriculum.

**Table 3.3.** Mapping of ME Program Outcomes to Courses.

|  | <b>Outcome Covered in</b>                                  | <b>Outcome Assessed in</b>         |
|--|--|------------------------------------|
| <b>Outcome I:</b> Students will demonstrate a knowledge of chemistry, physics, and mathematics. Students will: | Last reviewed by Course Caucuses in Spring 2007            |                                    |
| a. demonstrate knowledge of chemistry  | CHEM 110 (42) & CHEM 112 (43)                              | Final grade in CHEM 110 & CHEM 112 |
| b. demonstrate knowledge of calculus-based physics   | PHYS 211, 212, 214, ME 320 (33), ME 370 (54), ME 410 (442) | Final grades in PHYS 211, 212, 214 |
| c. demonstrate ability to use multivariate calculus  | MATH 231, ME 320 (33), ME 410 (442)                        | Final grade in MATH 231            |
| d. demonstrate ability to solve differential equations   | MATH 251, ME 320 (33), ME 370 (54), ME 410 (442)           | Final grade in MATH 251            |
| e. demonstrate familiarity with statistics   | ME 345 (82)  | ME 345 (82)                        |
| f. demonstrate familiarity with linear algebra.  | MATH 220, ME 370 (54), ME 410 (442), ME 450 (440)          | Final grade in MATH 220            |
| <b>Outcome II:</b> Students will be able to apply fundamentals of mathematics, physics, and engineering to     |  |                                    |

|  |  |  |
|--|--|--|
| mechanical engineering analysis and design involving both mechanical and thermal/fluids systems. Students will:  |  |  |
| a. perform analysis of mechanical components   | ME 360 (54), ME 370 (54), ME 345 (82), ME 440W (415W), {ME 441W (414W)}                                    | ME 360 (54), ME 370 (54)   |
| b. perform analysis of thermal/fluids components   | ME 300 (30), ME 320 (33), ME 345 (82), ME 410 (412), ME 441W (414W)  | ME 300 (30), ME 410 (412)  |
| c. demonstrate the ability to design components  | ME 320 (33), ME 360 (54), ME 340, ME 440/ 441 (415/414), ME 410 (412)                                      | ME 320 (33), ME 340, ME 360 (54)   |
| d. perform analysis of mechanical systems  | ME 370 (54), ME 440W (415W), ME 450 (440), {ME 441W (414W)}  | ME 370 (54), ME 450 (440)  |
| e. perform analysis of thermal/fluids systems  | ME 300 (30), ME 320 (33), ME 410 (412), ME 441W (414W)   | ME 300 (30), ME 320 (33)   |
| f. demonstrate the ability to design systems.  | ME 340, ME 410 (412), ME 440W/ 441W (415W/414W), ME 450 (440)  | ME 340, ME 440W/ 441W (415W/414W)  |
| <b>Outcome III:</b> Students will demonstrate the ability to operate in a modern, diverse working environment in which they will work in multidisciplinary teams, communicate effectively and recognize the economic, global, societal, and ethical contexts of their work. Students will: |  |  |
| a. work effectively on multidisciplinary teams (IE 312, ME 340, and ME 345 include only ME students.)  | ED&G 100, IE 312, ME 340, ME 345 (82), ME 440/441 (415W/414W), ME Labs, PHYS 211, PHYS 212, PHYS 214       | ME 340, ME 440W/441W (415W/414W)   |
| b. demonstrate an appreciation of the economic, global, societal, ethical, and professional context of their work  | AHS courses, ECON course, ME 320 (33)(societal) ME 340, 360 (54) (ethics), ME 410 (412) (econ), ME 440/441 | ME 320 (33) (societal), ME 340, ME 360 (54)(ethics), ME 410 (412) (econ), ME 440/441, ECON |
| c. demonstrate a knowledge of contemporary issues  | ME 300 (30), ME 370 (54), ME 440W/441W (415W/414W), ME 450 (440)   | ME 300 (30), ME 370 (54), ME 440W/441W (415W/414W), ME 450 (440)                           |

|  |  |  |
|--|--|--|
| d. demonstrate ability to communicate effectively with the written word  | ENGL 15, ENGL 202C,<br>ME 340, ME 345 (82),<br>ME 440W/441W<br>(415W/414W), ME 450 (440),<br>{ME 320 (33)} | Final grades in<br>ENGL 15<br>and ENGL 202C                |
| e. demonstrate ability to communicate effectively in oral communications   | CAS 100, ME 340,<br>ME 440W/441W<br>(415W/414W), {ME 320 (33)}   | ME 440W/441W<br>(415W/414W )and final<br>grades in CAS 100 |
| f. demonstrate ability to learn in less structured circumstances.  | ME 345 (82), {ME 410 (412)},<br>ME 340,<br>ME 440W/441W<br>(415W/414W), ME Labs                            | ME Labs  |
| <b>Outcome IV:</b> Students will demonstrate the ability to use appropriate methods and technology for 1) measurement and analysis of data, and 2) analysis and design. Students will: |  |  |
| a. demonstrate an understanding of the principles of measurements, instrumentation methods, and experimental design  | ME 345 (82), ME Labs,<br>{ME 440W/441W<br>(415W/414W )}  | ME 345 (82), ME Labs                                       |
| b. exhibit broad understanding of instruments and sensors, both in theory and in practice  | ME 320 (33), ME 345 (82),<br>ME 410 (412), ME Labs, {ME<br>440W/441W (415W/414W )}                         | ME 345 (82), ME 410<br>(412)                               |
| c. assess, report on, and draw conclusions regarding the inherent uncertainty of data using appropriate statistical tools  | ME 345 (82), ME Labs,<br>{ME 320 (33)}, {ME 410<br>(412)}, {ME 440W/441W<br>(415W/414W )}                  | ME 345 (82), ME Labs                                       |
| d. demonstrate the ability to develop and utilize models   | ME 300 (30), ME 320 (33),<br>ME 370 (54), ME 410 (412),<br>ME 440W/441W<br>(415W/414W ), ME 450 (440)      | ME 320 (33), ME 450<br>(440)                               |
| e. use software to solve engineering problems  | CMPSC 201, ME 370 (54),<br>ME 450 (440), {ME<br>440W/441W (415W/414W )}                                    | ME 370 (54), ME 450<br>(440)                               |

{ME xx}= Parentheses show courses where the outcome is not covered consistently in all sections. For ME 414 and ME 415, the course number is shown in parenthesis because it is difficult to satisfy the outcome for all students since the projects vary greatly.



## **Course Outcomes**

In Fall 1999, course outcomes were written for all required Mechanical Engineering courses, lab courses, and senior capstone design courses. These outcomes were used in developing the program outcomes. In Spring 2001, the course outcomes were reviewed and updated by the course caucuses. On February 17, 2006, the Director of Engineering Instructional Services conducted a workshop for the course leaders of required courses to better learn how to develop and assess effective course objectives and outcomes. In Spring 2006, the course outcomes were reviewed and updated by the course caucus for each required course. At that time, the course objectives were written for the required ME courses. Using the ME required course information as an example, course outcomes were updated for the ME technical electives and course objectives were written. The current course objectives and outcomes for all ME undergraduate courses can be found in Appendix A. The course objectives and outcomes are also posted at [http://www.mne.psu.edu/undergrad/ugmanuals/ME\\_Manual/ME\\_Required\\_Courses.htm](http://www.mne.psu.edu/undergrad/ugmanuals/ME_Manual/ME_Required_Courses.htm) and [http://www.mne.psu.edu/undergrad/ugmanuals/ME\\_Manual/ME\\_Tech\\_Elects.htm](http://www.mne.psu.edu/undergrad/ugmanuals/ME_Manual/ME_Tech_Elects.htm).

### **3.e. Documentation**

For the ABET visit, course binders and textbooks will be available for all ME courses. Also available will be the assessment binders for the Fall 2007 assessment that includes all assessment data and samples of student work demonstrating each outcome. The ME assessment reports from 2001, 2005, and 2007 will also be available. The reports contain all assessment data, observations, recommendations, and actions taken for each program outcome. When the ME evaluator is identified, a CD containing the 2001, 2005, and 2007 assessment reports will be sent.

### **3.f. Achievement of Program Outcomes**

Assessment of student outcomes for the program outcomes takes place at least twice in each six-year accreditation cycle. Assessment data are collected from representatives of our four major stakeholder groups: students, industry, faculty, and graduate schools.

The responsibility for collecting, reporting, assessing, and archiving data is shared among the following:

- MNE Faculty and course instructors
- ABET Coordinator in MNE
- Professor-in-Charge of Undergraduate Programs in MNE (PIC) and MNE Undergrad Office staff
- Department Head of Mechanical and Nuclear Engineering (MNE)
- The Associate Dean for Undergraduate Studies in the College of Engineering

The outcome-based assessment is conducted at least twice in each six year accreditation cycle in all core MNE courses by the course instructors. The data are collected by each course instructor and submitted to the Undergraduate Programs Office. The Undergraduate Programs Office staff,

under the supervision of the Professor-in-Charge, prepares a summary report of the outcome-based assessments for each course. The preparation and formatting of the assessment report is reviewed by the MNE ABET Coordinator.

The Associate Dean for Undergraduate Studies in the College of Engineering is responsible for administering the Senior and Alumni Surveys and distributing the results to each department. Coordination and collaboration with the colleges responsible for the basic math and science courses, as well as general education, are also the responsibility of the Associate Dean.

The MNE Undergraduate Office, under the direction of the Professor-in-Charge (PIC) of Undergraduate Programs in MNE, is responsible for collecting assessment data from the various sources and compiling the data into an assessment report. This report collects pertinent assessment data and summarizes them in a concise and readable format. The assessment data in the report are reviewed by the MNE Assessment Committee, chaired by the ABET Coordinator. The committee draws conclusions and makes recommendations based on the data. The conclusions and recommendations are presented to the faculty in a faculty meeting and distributed by email. The recommendations are identified as related to the curriculum, the assessment process, or the preparation of the assessment report. Recommendations for the assessment process are discussed by the MNE Assessment Committee. When the proposed action is a change in the Program Educational Objectives or Program Outcomes, the changes are presented to the ME faculty and a vote is taken.

Implementation of recommendations in courses or curriculum is discussed by the ME Curriculum Improvement Committee (MECIC) who are the course leaders in the required Mechanical Engineering courses. Recommended course changes are presented by the course leader to the course caucus and discussed in a caucus meeting. The course leader then discusses the implementation of course changes with the instructors of the course for that year. Curriculum changes are discussed by the MECIC, with input from course caucuses. Any specific curriculum change proposal is written and submitted to the Undergraduate Policy Committee for review before being presented and discussed in an MNE faculty meeting. The proposal is distributed to ME faculty for an electronic vote.

It is understood that ultimate responsibility for assessment and, in particular, historical trends, lies with the faculty. The Undergraduate Programs Office maintains historical data in the form of assessment reports and the data that were used to write those reports.

### **3.g. Student-Based Assessment Data**

#### ***3.g.1. Alumni Survey***

Every two years, the College of Engineering sends an Alumni Survey to engineers who graduated two and three years prior. The last Alumni Survey was conducted in 2006 and was sent to graduates from Spring 2003 to Fall 2005. The results of the survey provide the perceptions of graduates on their educational preparedness, importance of particular abilities in their work, career paths (including continuing education), and tasks performed on the job. The 2006 Alumni Survey had 364 respondents across the college. This was an 11.8% response rate.

In Mechanical Engineering, 65 students responded with a response rate of 13.5%. For survey questions that rate preparation and importance, we consider an adequate level of achievement when the preparation is no less than 0.5 points below the importance or a rating of at least 4.0, whichever is less. This defines preparation levels above the red line shown in the sample assessment results on page 74.

### **3.g.2. Senior Survey**

Each semester the graduating seniors are asked to fill out an exit survey commenting on their education and future plans. For many years the exit survey was written and results summarized within the department. Typical response rates to the survey had been 25%. Starting in Spring 2001, the exit survey has been administered on the web by the college. Many questions are standardized across the college but each program has the opportunity to add its own questions. In Spring 2001, there was a 48% response rate from graduating Mechanical Engineering seniors. In the most recent senior survey, Spring, the response rate from Mechanical Engineering seniors was 63 of 164 students (38%). The senior survey is announced to graduating students by email. Several email reminders are also sent to students in the weeks before graduation. Students completing the survey receive a Penn State vinyl cling to display on a window and are entered in a random prize drawing. We consider an adequate level of achievement when the senior survey responses are above 3 out of 5.

### **3.g.3. The Classroom Activities and Outcomes Survey**

A Classroom Activities and Outcomes (CAO) Survey was developed with support of the National Science Foundation through the ECSEL Coalition Grant. This survey was given to students in the freshman engineering graphics course and in the senior capstone design course. The questionnaire asks about the student's family and educational background, experiences in the design course, and perceptions about how much the course may have shaped the student's engineering-related skills.

A new NSF grant, AWISE, is expanding this effort to include all courses, not only design courses. The CAO survey has been modified and expanded to collect information about student experiences in lecture courses, laboratory courses, and design courses. The focus of the AWISE study is to investigate the impact of various course formats on the learning of women students. Since the survey includes both men and women, the results can be used to assess all students in the courses.

### **3.g.4. Co-op Student Survey**

Each semester that a student is on Co-op they are asked to complete a Co-op Survey. Besides asking about the Co-op experience and support through the Co-op office, the survey asks the student about the academic preparation for the Co-op position. Questions ask the students to evaluate their preparation in engineering analysis, design, communication skills, and professional skills. We consider an adequate level of achievement when the Co-op survey responses are above 3 out of 5.

### **3.g.5. SRTE's (composite data only)**

The Student Rating of Teaching Effectiveness (SRTE) is administered in all classes at the University. In all classes, the students are asked to rate the overall quality of the course and the overall quality of the instructor. In addition to these two questions, each program selects 10 questions for the SRTE's. Each instructor receives the SRTE scores for his or her course. Across the college, the SRTE scores are reported in aggregate for required courses, elective courses, lab courses, and graduate courses. The students are also asked to give short answers to the questions of what they liked best and least about the course and suggestions for changes.

### **3.g.6. Meetings with Student Leaders**

The Professor-in-Charge of Undergraduate Programs meets once every two years with the officers of the student organizations. The student organizations in Mechanical Engineering include the American Society of Mechanical Engineers; the Society of Automotive Engineers; and Pi Tau Sigma, the Mechanical Engineering Honor Society. The students are asked about their preparedness to work in multidisciplinary teams, to communicate in written and oral form, to use computers as an analysis tool, to understand contemporary issues facing engineers, and to appreciate the economic, global, and ethical context of an engineer's work. Students are then shown the detailed Mechanical Engineering Program Educational Objectives and Program Outcomes and asked to comment on the stated outcomes.

## **3.h. Industry-Based Assessment**

### **3.h.1. IPAC Focused Reviews**

The Industrial and Professional Advisory Committee (IPAC) for the MNE Department meets on campus every spring to review the department. During the overview of department activities from the previous year, the ABET Coordinator presents an overview of the assessment process and outcomes followed by discussion and questions from the IPAC members. Each year, a particular aspect of the program outcomes or assessment is selected for more detailed review. Topics for the period from 2000 to 2008 are given below.

March 2000: Use of computers in the curriculum

March 2001: Professionalism and an appreciation of the economic, global, social, and ethical context of engineering problems

March 2002: Review the Assessment Plan

March 2003: Review Recommendations from 2001-02 Assessment

March 2004: Input on proposed ME curriculum changes

March 2005: Program Educational Objectives

March 2006: Review and comment on all MNE program outcomes

March 2007: Review 2005 assessment recommendations. Discuss what programming language ME students should know

March 2008: Discuss what numerical methods ME students should be covered in ME courses.

In each year the comments and suggestions from IPAC were received and discussed by the MNE Assessment Committee. The input from IPAC usually results in changes in the particular area discussed. Future IPAC meetings will focus on other aspects of the program outcomes and assessment.

### **3.h.2. Co-Op Employer Surveys**

The College of Engineering Co-operative Education Program conducts a survey of every Co-Op employer at the end of each Co-Op assignment. The survey is filled out with respect to a particular student (i.e., the employer fills out one survey for each student on assignment.) The college Co-Op office summarizes the data annually and sends it to the department undergraduate programs office. We consider an adequate level of achievement when the Co-op survey responses are above 3 out of 5.

### **3.h.3. Senior Capstone Design Project Surveys**

Several industry engineers visit our campus throughout the semester to aid in our capstone design. At both the beginning and end of each semester, most of them gather for meetings with the students to present projects and for the students to present results. At the end of the semester-long design project, the industrial representatives complete a questionnaire evaluating the student design effort.

### **3.h.4. FE Exam Results**

Each year 40-50 Mechanical Engineering students take the Fundamentals of Engineering Exam (FE) previously called the Engineering in Training Exam (EIT). The FE exam is given in the fall and the spring. Each time the exam is given, the department receives a report showing the number of students who passed the exam and the average score received in individual topics on the exam. This information can be used as evidence of student ability and compared to the state and national averages. We consider an adequate level of achievement when the program FE results are above the national average.

## **3.i. Faculty-Based Reviews**

### **3.i.1. Transcript Grades**

For outcomes that appear as the primary focus of a course, course grades can be pulled from student transcripts electronically to demonstrate the students' ability. For the ABET program specific requirements of basic science, multivariate calculus, and differential equations the students are required to take specific courses that focus on these topics. The linear algebra course transcript grade is used to assess the Program Outcomes 1c. Written and oral communication courses are also required of all Mechanical Engineering students. For each course, the distribution of course grades for Mechanical Engineering students is compared to the course grade distribution for other engineers in the course to determine the preparation that students obtain in the pre-engineering courses. Since students take many of these courses before declaring a major, it was decided that transcripts would be studied for the group of students who are graduating in a particular semester. In each course, the grade distribution for Mechanical Engineering students is compared to the grade distribution of all other Engineering students who took that course. We consider an adequate level of achievement when the program grade distribution is similar to the distribution of all students taking the course.

### **3.i.2. Outcome-Based Assessment in Courses**

The Faculty Advisory Board of the Leonhard Center meets each month to discuss curricular issues, often ABET preparation. Each program has a representative on that board and the college also has members representing the Dean's office and Engineering Assessment and Instructional Support. L. Pauley represents Mechanical Engineering and brings information from the meeting to the department. The Faculty Advisory Board decided that an outcome-based assessment would be used for all programs in the college. Outcome-based assessment uses selected scores from homeworks or exams to demonstrate the students' ability. The numerical data from the grades is calibrated using sample student work for each assignment to determine satisfactory or excellent performance.

The MNE Assessment Committee has prepared an assessment plan that uses outcome-based assessment of the core Mechanical Engineering courses, that is, courses that every Mechanical Engineering undergraduate is required to take. The core Mechanical Engineering courses are:

- ME 300, Engineering Thermodynamics
- ME 320, Fluid Flow
- ME 340, Mechanical Engineering Design Methodology
- ME 345, Instrumentation, Measurements, and Statistics
- ME 360, Mechanical Design
- ME 370, Vibration of Mechanical Systems
- ME 410, Heat Transfer
- ME 450, Modeling of Dynamics Systems
- ME 440W/441W, Mechanical/Thermal Systems Design Project
- ME Labs (ME 315, 325, 355, 375) in heat transfer, fluid mechanics, controls, and vibrations.

During Fall 2000, each course caucus met to decide which ME program outcomes were covered in each course. This information was compiled, and the ME Curriculum Improvement Committee decided which outcomes would be assessed in each course. The assessments were selected so that each outcome is assessed in at least one course. Because Outcome II focuses on engineering content, it was decided that each item in Outcome II would be assessed in at least two courses.

For each outcome to be assessed, two or more outcome grades are recorded when possible. (There may be some outcomes, such as oral communication, where only one activity occurs in a particular course and, therefore, only one grade could be recorded.) The outcome grades could be for an entire exam, one exam problem, a homework assignment, or one part of a homework assignment. The grades are recorded in spreadsheet form for all students in the course. In addition, a copy of the assignment or exam problem for each outcome grade is saved, and copies of the work from three students for each outcome grade are saved—an example of very good, good, and satisfactory work (A, B, and C grades). The sample work for each assignment is not necessarily from the same three students. A spreadsheet of outcome grades for all students and three samples of student work for each assessed activity (homework or exam) are collected by the Undergraduate Programs Office at the end of the semester. The histogram and statistics reports are prepared by the Undergraduate Programs Office staff to present the results in a uniform manner.

The results are compiled and then reviewed with other assessment data by the MNE Assessment Committee. Recommendations from the assessment that are related to curriculum and course content are forwarded to the ME Curriculum Improvement Committee, and the Committee decides what changes should be made to the core courses. Recommendations related to the assessment process, Program Educational Objectives, or Program Outcomes are discussed by the MNE Assessment Committee. Some recommendations are related to the formatting and presentation of assessment data. These recommendations are forwarded to the MNE Undergraduate Programs Office staff.

It is important that the assessment scores have a uniform scale or can be calibrated to compare with other sections. The three samples of student work for each assessment grade allow the MNE Assessment Committee to calibrate the results and determine satisfactory and excellent achievement. Each instructor is also asked to evaluate student performance and identify the range of scores which show excellent, very good, satisfactory, not satisfactory, and failing performance. We consider an adequate level of achievement when very few students perform below the satisfactory level. On each course outcomes assessment summary plot, the minimum satisfactory level is marked with a red line. For example, see the sample assessment results on page 78.

For most program outcomes, there are many course learning outcomes (performance criteria) that map to the outcome. For the program assessment, the instructor in the course may collect student scores from activities in one or several course learning outcomes. Through the program assessment, there were several program outcomes that were found to not have detailed performance criteria listed as course learning outcomes. The MNE Assessment Committee (MNEAC) developed performance criteria for assessment of Outcome 3a, work effectively on multidisciplinary teams. The team evaluation is conducted in the junior-level (ME 340) and senior-level (ME 440W, 441W) design courses. Each student evaluates every member of the team, including themselves, and answers 0 (never), 1 (rarely), 2 (sometimes), 3 (usually), 4 (always) to each question.

Has the student attended your group meetings?

Has the student notified a teammate if he/she would not be able to attend a meeting or fulfill a responsibility?

Has the student made a serious effort at assigned work before the group meetings?

Does the student attempt to make contributions in group meetings when he/she can?

Does the student cooperate with the group effort?

For the assessment of oral communication skills, the MNE Assessment Committee reviewed the evaluation forms used in different courses. It was found that the forms had different formats but all evaluated similar performance criteria. MNE Assessment Committee recommended that one evaluation form be used by all MNE courses but several instructors did not want to change the format used. MNE Assessment Committee decided that different formats would not affect the assessment results since all evaluation forms included similar performance criteria. The performance criteria for oral communication are:

Structure: targeting the audience, clarity of organization, persuasiveness

Visual Aids: ease of reading, proper level of detail, communication of content

Delivery: engaging the audience, avoiding distracting habits

### 3.j. Summary of Methods of Assessment for Each Program Outcome

Table 3.4 shows which assessment methods are applied to each program objective.

**Table 3.4.** Methods of Assessment for Each Detailed Program Outcome.

| Detailed Program Outcomes | Method for Assessment |                   |                |                  |                         |          |                    |                        |             |                 |                     | Courses Assessed in i.1 or i.2                     |
|---------------------------|-----------------------|-------------------|----------------|------------------|-------------------------|----------|--------------------|------------------------|-------------|-----------------|---------------------|--|
|                           | g.1 Alumni Survey     | g.2 Senior Survey | g.3 CAO Survey | g.4 Co-Op Survey | g.6 Meet w/ Stud. Lead. | h.1 IPAC | h.2 Co-op Employer | h.3 Design Proj. Engr. | h.4 FE Exam | i.1 Transcripts | i.2 Outcome Assess. |  |
| I.a: Chemistry            |                       |                   |                |                  |                         |          |                    |                        |             |                 |                     | CHEM 110, 112                                      |
| I.b: Physics              |                       |                   |                |                  |                         |          |                    |                        |             |                 |                     | PHYS 211, 212, 214                                 |
| I.c: Calculus             |                       |                   |                |                  |                         |          |                    |                        |             |                 |                     | MATH 231   |
| I.d: Dif Eqns             |                       |                   |                |                  |                         |          |                    |                        |             |                 |                     | MATH 251   |
| I.e: Statistics           |                       |                   |                |                  |                         |          |                    |                        |             |                 |                     | ME 345   |
| I.f: Linear Alg.          |                       |                   |                |                  |                         |          |                    |                        |             |                 |                     | MATH 220   |
| II.a: Mech. Comp.         |                       |                   |                |                  |                         |          |                    |                        |             |                 |                     | ME 360, ME 370                                     |
| II.b: Thermal Comp.       |                       |                   |                |                  |                         |          |                    |                        |             |                 |                     | ME 300, ME 410                                     |
| II.c: Design Comp.        |                       |                   |                |                  |                         |          |                    |                        |             |                 |                     | ME 320, ME 340, ME 360                             |
| II.d: Mech. Sys.          |                       |                   |                |                  |                         |          |                    |                        |             |                 |                     | ME 370, ME 450                                     |
| II.e: Thermal Sys.        |                       |                   |                |                  |                         |          |                    |                        |             |                 |                     | ME 300, ME 320                                     |
| II.f: Design Sys.         |                       |                   |                |                  |                         |          |                    |                        |             |                 |                     | ME 340, ME 440/441                                 |
| III.a: Mult. Teams        |                       |                   |                |                  |                         |          |                    |                        |             |                 |                     | ME 340, ME 440/441                                 |
| III.b: EGSE Context       |                       |                   |                |                  |                         |          |                    |                        |             |                 |                     | ECON, ME 320, ME 340, ME 360, ME 410, ME 440W/441W |
| III.c: Contemp Issue      |                       |                   |                |                  |                         |          |                    |                        |             |                 |                     | ME 300, ME 370, ME 450, ME 440/441                 |
| III.d: Written Com.       |                       |                   |                |                  |                         |          |                    |                        |             |                 |                     | ENGL 15 & 202C                                     |
| III.e: Oral Com.          |                       |                   |                |                  |                         |          |                    |                        |             |                 |                     | CAS 100, ME 440/441                                |
| III.f: Self-Learning      |                       |                   |                |                  |                         |          |                    |                        |             |                 |                     | ME Labs  |
| IV.a: Exp Design          |                       |                   |                |                  |                         |          |                    |                        |             |                 |                     | ME 345, ME Labs                                    |
| IV.b: Mech. Instr.        |                       |                   |                |                  |                         |          |                    |                        |             |                 |                     | ME 345, ME 410                                     |
| IV.c: Data Analy.         |                       |                   |                |                  |                         |          |                    |                        |             |                 |                     | ME 345, ME Labs                                    |
| IV.d: Dev Models          |                       |                   |                |                  |                         |          |                    |                        |             |                 |                     | ME 320, ME 450                                     |
| IV.e: Eng. Software       |                       |                   |                |                  |                         |          |                    |                        |             |                 |                     | ME 370, ME 450                                     |



Conducted less than once a year.



Conducted one or more times a year.



The assessment methods are numbered in the same way as in the sections above.

- g.1 Alumni Survey
- g.2 Senior Survey
- g.3 The Classroom Activities and Outcomes (CAO) Survey
- g.4 Co-op Student Survey
- g.5 Student Rating of Teaching Effectiveness (SRTE)
- g.6 Annual Meetings with Student Leaders
- h.1 Industrial and Professional Advisory Committee (IPAC) Focused Reviews
- h.2 Co-Op Employer Surveys
- h.3 Senior Capstone Design Project Surveys
- h.4 FE Exam Results
- i.1 Transcript Grades
- i.2 Outcome Based Assessment in Courses

### **3.k. Review of Assessment Plan**

The assessment process for engineering programs at Penn State has been discussed extensively since Fall 1998 in the Faculty Advisory Board of the Leonhard Center. The Faculty Advisory Board meets four or five times each semester and two or three times during the summer. The Faculty Advisory Board includes a representative from each program in the Engineering College. L. Pauley currently represents the department at these meetings. In the MNE Department, the assessment process has been discussed and developed by the MNE Assessment Committee with input from faculty in faculty meetings, the ME Curriculum Improvement Committee meetings, and the department workshop on September 26, 2000. The result of these many meetings and discussions was the 2001 Assessment Plan document.

In Fall 2000, a trial assessment was conducted in one section of several courses to refine the assessment process before implementing in all sections of required courses. The course leaders for five ME core courses were teaching a section of the course and participated in the trial assessment. One undergraduate lab and one NucE course were also included. The instructors of these courses were members of the MNE Assessment Committee, which met monthly to discuss the trial assessment and the assessment plan. The data collected from the trial assessment were reviewed by the MNE Assessment Committee. From the trial assessment, the MNE Assessment Committee made recommendations for future course assessments. These recommendations are included in Section 4.e.

The assessment cycle started in 2001 resulted in significant change to the ME curriculum. (See Actions to Improve the Program, Section 4.b.) The curriculum improvement process was the primary focus of the ME faculty for over two years. During that time, there were discussions at every faculty meeting, course caucus meetings, faculty retreat, and several curricular votes. The time required to make significant curricular changes was longer than first expected. We have therefore realized that the time to complete one assessment loop may be variable, and we have now listed the frequency as “at least twice in each six year accreditation cycle”.

As the department continues to conduct an assessment of its academic programs, the assessment process is being refined. The evaluation of the assessment process (or assessment of the assessment) was conducted annually for several years by the MNE Assessment Committee. Now that the assessment process has been refined, it will be reviewed every six years.

In Fall 2005, the MNE Assessment Committee reviewed the Assessment Plan. The plan was updated to reflect the steady-state process instead of the initial development of the assessment process. Changes were made to the mapping of outcomes to courses in Table 3.3 because of the changes in the ME curriculum. In addition, the frequency of assessment cycles was changed from once every three years to twice in a six year accreditation cycle. This change was made after finding that the extensive curriculum changes resulting from the 2002 assessment required over 3 years to design and implement. In Spring 2007, the ME Curriculum Improvement Committee updated the second column of Table 3.3, and the Assessment Committee updated the third column of Table 3.3.

A summary of changes and suggestions to the assessment process can be found in Section 4.d.

#### **Revision History of Assessment Plan**

- 3/2000: Draft prepared by J.F. Gardner, MNE ABET Coordinator.
- 3/22/2000: Input from M&NE IPAC.
- 9/2000: Course Assessment Plan prepared by the Assessment Committee.
- 9/26/2000: Assessment Plan reviewed by MNE faculty in a department workshop
- 2/2001: Course Assessment Plan reviewed and refined based on results of trial assessment in Fall 2000.
- 3/15/2001: Review of Assessment Plan by MNE IPAC.
- 5/2001: Assessment Plan revised by L.L. Pauley, MNE ABET Coordinator.
- 8/2001: Assessment Plan reviewed by Assessment Committee.
- 9/2001: Suggested changes made to Assessment Plan.
- 9/23/2005: Assessment Plan reviewed and revised by MNE Assessment Committee.
- Spring 2006: Program Objectives and Outcomes and Course Objectives and Outcomes were updated by Course Caucuses.
- 1/10/2007: Editorial changes by L.L. Pauley, MNE ABET Coordinator.
- Spring 2007: Mapping of program outcomes to courses (Table 3.3, column 2) was updated by course caucuses.
- Spring 2007: Outcomes assessment in courses (Table 3.3, column 3) was updated by MNE Assessment Committee.
- January 2008: L.L. Pauley edited the ME Assessment Plan to follow the new ABET Self-Study format.
- February 2008: Mapping of Program Outcomes to Program Education Objectives (Table 3.2) was discussed by MNE Assessment Committee.

The revision history of the Program Educational Objectives and the Program Outcomes, including the text of each document version, can be found at [www.mne.psu.edu/undergrad/abet/MErevhist.html](http://www.mne.psu.edu/undergrad/abet/MErevhist.html)

### **3.I. Assessment Plan Timeline**

Summarized below are the assessment activities in the department since the last ABET review in 2002. The assessment cycle was established by the MNE Assessment Committee.

The acronyms and the initials of persons used below are:

MAC: MNE ABET Coordinator

UPA: Undergraduate Programs Assistant

MNEAC: MNE Assessment Committee

MECIC: ME Curriculum Improvement Committee (Required ME Course Leaders)

UPC: Undergraduate Policy Committee

IPAC: Industry and Professional Advisory Committee

#### Year 1 (2002-03)

- MNE Assessment Committee recommends changes to the ME curriculum based on assessment data.
- Course sequence committees are formed to carefully review a particular area in the ME curriculum and present recommendations.
- IPAC reviews the assessment plan and the plan for curriculum reform.

#### Year 2 (2003-04)

- Faculty retreat on February 12, 2004 to discuss the programs assessment process.
- Faculty develops Program Educational Objectives.
- IPAC give input on proposed ME curriculum changes.

#### Year 3 (2004-05)

- Faculty vote on and approve curricular changes.
- Curriculum and course proposals are prepared for approval by ME faculty, college, and Faculty Senate.
- Revise Program Educational Objectives through consultation with students, Leonhard Center Faculty Advisory Board, and IPAC.

#### Year 4 (2005-06)

- Implement curriculum changes with incoming junior class.
- Course Caucuses review mapping to program outcomes.
- MNEAC reviews and revises ME Assessment Plan.
- Conduct course assessment in Fall 2005.
- IPAC reviews Program Outcomes.
- Collect assessment data and prepare assessment data in the Assessment Report in Spring 2006.
- MNEAC reviews assessment data in Summer 2006 and writes observations and recommendations.
- Course caucuses for required ME courses update course outcomes and develop course objectives.

Year 5 (2006-07)

- Some recommendations are forwarded to the MEIC for consideration and discussion with course caucuses.
- Other recommendations are related to the program assessment and are discussed by MNEAC.
- Course outcomes are updated for ME elective courses and course objectives are written.

Year 6 (2007-08)

- Fall 05 program assessment changes implemented in courses in Fall 2007.
- Continue to update course outcomes for ME elective courses.
- Assessment in ME required courses in Fall 2007.
- MNE Assessment Committee reviews assessment data in Fall 2008.
- Collection of course binders in Fall 2007 and Spring 2008.
- Prepare Self Study Report in Spring 2008.

The ME program assessment is conducted at least twice in every six-year accreditation cycle. A complete program accreditation cycle takes two years to complete. The full cycles includes collecting assessment data, reviewing the data, discussing changes, and implementing changes. The last two program assessment cycles followed the timeline presented in Table 3.5 below.

**Table 3.5.** Assessment Plan Timeline for Mechanical Engineering.

| Date             | Event/Milestone  | Responsible Parties |
|------------------|--|---------------------|
| <b>Year One</b>  |  |                     |
| Fall             | Assessment of Core ME Courses, Labs, and Capstone Design Courses                               | Course Instructors  |
| October-December | Assessment Report survey data prepared   | MAC, UPA            |
| January-February | Assessment Report course data prepared   | MAC, UPA            |
| January          | Meet with students groups to receive input on Program, Objectives, and Outcomes                | MAC                 |
| March & April    | Review assessment data and write observations and recommendations                              | MNEAC               |
| April            | Discuss assessment results   | IPAC                |
| <b>Year Two</b>  |  |                     |
| Fall             | Course and Curriculum recommendations from MNEAC are reviewed and implementation is discussed. | MECIC               |
| Fall-Spring      | Assessment process recommendations are discussed and implemented                               | MNEAC               |
| Spring           | Course content/delivery changes are implemented  | Course Instructors  |

|             |   |            |
|-------------|---|------------|
| February    | Review curriculum and course proposals from MECIC                 | UPC        |
| March       | Reviews actions taken from assessment                             | IPAC       |
| March-April | Curriculum and course proposals presented to ME faculty for vote. | ME Faculty |

### **3.m. College Level Assessment Activities**

The following college-level groups participated in assessment discussions and reviews:

*College Task Groups on Core Curriculum and Professional Aspects* (Reported conclusions in Fall 1997.)

*Engineering Faculty Council (EFC)*—Governance body for the College.

*ABET Coordinators*—Responsible for ABET preparation for each program.

*Undergraduate Coordinators and Staff Assistants*—Faculty and staff responsible for undergraduate students.

*Engineering Coordination Council (ECC)*—Associate deans and division heads from all Colleges and other campuses offering engineering programs; meets annually.

*School of Engineering Technology and Commonwealth Education (SETCE)*—Faculty teaching in engineering and engineering technology at the other campus locations.

*Executive Committee and Academic Council*—Deans, department heads and directors of academic support services.

*Industrial and Professional Advisory Committees (IPAC)*—External advisers to each program and College as a whole; meet with departments annually for several days.

*Engineering Assessment and Instructional Support (EAIS)*—Organizes resources, workshops, new faculty teaching assistant/intern training and assessment methodology.

*Leonhard Center for the Enhancement of Engineering Education*—Endowed center providing support for teaching and learning innovations, collaboration, curriculum integration and other activities related to producing “World Class Engineers.”

*Leonhard Center Faculty Advisory Board (FAB)* — Formed in fall 1997 with representatives from each department, meets bimonthly during fall and spring semesters, monthly in summer. Key responsibilities: think tank on teaching and learning, assessment, curriculum improvement and reform; ABET processes, discussion and planning

*Leonhard Center (External) Advisory Board*—Industry professionals, entrepreneurs and others; meets in fall and spring semesters.

MNE department representatives participated in many of the college level activities listed above. A summary of meeting discussions for FAB, the MNE Assessment Committee, and the ME Improvement Committee can be provided upon request.