DEPARTMENTAL PLAN FOR ASSESSMENT OF STUDENT LEARNING

2014-2015 ACADEMIC YEAR

Department: Mechanical Engineering
Program: Bachelor of Science (B.S.) in Mechanical Engineering / Combined B.S. and Master of Science (M.S.) in Mechanical Engineering

Mission Statement: The Mechanical Engineering Department prepares students at all levels to effectively apply modern engineering principles to the evolving needs of industry and society through focused efforts in manufacturing, materials science, mechanical design, thermal sciences, and aerospace applications. The Department supports an accessible, collaborative, multidisciplinary research and learning environment that stimulates students and faculty members to reach their highest potential through hands-on education, leadership opportunities, and life-long learning.

Student Learning Goals & Objectives:

ABET, the accreditation body for engineering programs, specifies two levels of assessment for student learning – program outcomes, tied closely with curriculum content and learning while pursuing the degree, and program objectives, intended to describe the activities and achievements of graduates after they complete their degree program. For our program outcomes are typically assessed through regular collection and review of course materials and student work. Objectives are assessed through periodic surveys of alumni and their employers. Both sets of measures are presented below.

Student Learning Outcomes

a. Ability to apply mathematics, science and engineering principles.
b. Ability to design and conduct experiments, analyze and interpret data.
c. Ability to design a system, component, or process to meet desired needs.
d. Ability to function on multidisciplinary teams.
e. Ability to identify, formulate and solve engineering problems.
f. Understanding of professional and ethical responsibility.
g. Ability to communicate effectively.
h. The broad education necessary to understand the impact of engineering solutions in a global and societal context.
i. Recognition of the need for and an ability to engage in life-long learning.
j. Knowledge of contemporary issues.
k. Ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

Program Educational Objectives
The Mechanical Engineering Department at the University of North Dakota is committed to graduating mechanical engineers who, 3-5 years after graduation:

1. Apply mechanical engineering principles in the areas of mechanical design, thermal systems, or manufacturing and materials in the public or private sectors,
2. Practice mechanical engineering across a broad range of job functions or pursue advanced degrees,
3. Complete engineering projects alone or as part of a team, exhibiting the appropriate teamwork, leadership and communication skills,
4. Understand the broader implications of their engineering efforts on local, national and global society and apply the highest standards of professional and ethical conduct, and
5. Maintain relevant knowledge of contemporary engineering and professional issues and an understanding of modern engineering tools through regular participation in professional development activities.

Educational Experiences:

The Mechanical Engineering Department recognizes the need for a variety of educational experiences, and corresponding assessment methods, to maximize student learning the professional preparation of future engineers. Following the most recent ABET accreditation visit (2009-2010), the department reviewed its assessment methods and created a matrix of courses and assessment instruments to be used for gauging student achievement of ABET outcomes. This matrix has been reviewed annually and refined to provide the best assessment of each outcome and alignment with current ABET best practices. The courses chosen are required courses taken by all undergraduate ME students. Students in the combined B.S.M.E./M.S.M.E. program must take the same required courses; the program differs only in the potential selection of technical electives. The courses chosen for assessment are listed below with their corresponding ABET outcome, educational experiences in the courses, and assessment instruments.

<table>
<thead>
<tr>
<th>ABET Outcome</th>
<th>UND Course</th>
<th>Educational Activities</th>
<th>Assessment Instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>ME 322</td>
<td>Team design project</td>
<td>Assessment survey,</td>
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<tr>
<td></td>
<td>ME 341</td>
<td>Individual homework</td>
<td>collection of student</td>
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<tr>
<td></td>
<td></td>
<td>and exams</td>
<td>work, senior exit</td>
</tr>
<tr>
<td>b</td>
<td>ME 483</td>
<td>Structured lab exercises and student-designed experimentation</td>
<td>Assessment survey,</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>collection of student work,</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>senior exit interview</td>
</tr>
<tr>
<td>c</td>
<td>ME 487/488</td>
<td>Design, build, and testing of an engineering prototype including oral and written presentations of work</td>
<td>Assessment survey,</td>
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<td></td>
<td></td>
<td></td>
<td>collection of student work,</td>
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<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td>d</td>
<td>ME 487/488</td>
<td>See above</td>
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<td>e</td>
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<td>Individual homework</td>
<td>Assessment survey,</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>work,</td>
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<tr>
<td>f</td>
<td>ME 480</td>
<td>Individual written reports and oral presentations</td>
<td>Assessment survey, collection of student work, senior exit interview</td>
</tr>
<tr>
<td>g</td>
<td>ME 487/488</td>
<td>See above</td>
<td></td>
</tr>
<tr>
<td>h</td>
<td>ENGR 460</td>
<td>Individual homework and term project</td>
<td>Assessment survey, collection of student work, senior exit interview</td>
</tr>
<tr>
<td>i</td>
<td>ME 301</td>
<td>Individual term paper and oral presentation, group homework assignment</td>
<td>Assessment survey, collection of student work, senior exit interview</td>
</tr>
<tr>
<td>j</td>
<td>ME 487/488</td>
<td>See above</td>
<td></td>
</tr>
<tr>
<td>k</td>
<td>ME 301</td>
<td>See above</td>
<td>Assessment survey, collection of student work, senior exit interview</td>
</tr>
</tbody>
</table>

**Assessment Methods:**

Faculty teaching each course are responsible for reviewing specific course material for student achievement of the applicable outcome(s). They review the assessment materials according to a set of rubrics that have been adopted by the Department for this purpose. This information is collected by the departmental ABET Coordinator, Dr. Marcellin Zahui, and discussed by the faculty at our annual retreat (August). The figure below shows a sample rubric used to evaluate the performance of students relative to outcome d (multidisciplinary teams). Additional information is compiled from the results of senior exit interviews performed by the Department Chair, Dr. Matthew Cavalli, each fall and spring semester.
In addition to the course-specific assessment instruments, results from the Fundamentals of Engineering (FE) exam are used to compare the performance of our students with engineering students across the nation. The FE exam is an eight hour exam comprising a morning and an afternoon section. Students are encouraged, but not required, to take the exam. It is the first step on the road to becoming a licensed professional engineer (PE). The ‘industrial exemption’ allows mechanical engineers to practice engineering under the supervision of a PE without being licensed themselves. For this reason, a smaller fraction of our students tend to take the exam than other disciplines like Civil Engineering. However, students are repeatedly encouraged to take the exam throughout their time at UND for the potential personal benefit and for the overall good of the profession.

Because the FE exam was designed as a licensing tool rather than an assessment tool, caution must be used when evaluating the results for assessment purposes. The primary value of the results is in identifying short- and long-term trends in student exam participation and performance. For example, starting in Spring 2015, the FE exam moved to a computer-based format and there is no approved testing center in Grand Forks (Fargo is the nearest location). We saw a significant reduction in students completing the exam in all disciplines across the college (80+% reduction). Topics covered by the FE exam include those that are directly under the control of ME faculty as well as supporting course topics like mathematics, chemistry, and physics. Results from each year are compiled and presented for discussion at the annual ME faculty retreat. The ME faculty has adopted the goal that UND ME students will perform at or above the national average on the FE exam in terms of overall pass rate and performance on individual exam sections.

Program Educational Objectives are assessed via a survey of alumni and their employers every two to three years. The last survey was performed in 2012-2013. Every three years the PEOs themselves are reviewed according to a process that includes input from the faculty, students,
and alumni. Alumni three to five years after graduation and their employers are targeted. The survey asks respondents to rank both the importance of each PEO for themselves (or their employees) and the level of attainment they (or their employees) have achieved. Results of the survey are compiled and presented to the ME faculty at the faculty retreat in August.

**Timeline:**

Collection of outcomes-related assessment materials are on a three-year cycle. Information for outcomes a, c, e, g, and i is being collected during the 2014-2015 academic year. Information for outcomes b, d, f, h, and j was collected during the 2013-2014 academic year. The collection process will pause during the 2015-2016 year (the next scheduled ABET visit) and will resume with outcomes b, d, f, h, and j during the 2016-2017 academic year.

**Responsibilities:**

Dr. Marcellin Zahui is the ABET Coordinator for the ME Department. He has developed the course mapping for outcomes assessment and coordinates the regular collection of assessment data. Each individual faculty member is responsible for collection of the required assessment information. Electronic files for each outcome, including all collected assessment materials, are maintained by staff in the ME office.

**Use of Results and Process for Documentation & Decision-Making:**

The Mechanical Engineering ABET Coordinator oversees collection and review of the assessment data. He presents a summary of the results to the ME faculty at the annual faculty retreat in August. Based on this discussion, decisions are made on possible additional collections or modifications to specific courses or educational activities. Every six years the assessment results are reviewed by ABET. The most recent ABET visit occurred in the 2009-2010 academic year and the Mechanical Engineering program was accredited for a full term of six years.
DEPARTMENTAL PLAN FOR ASSESSMENT OF STUDENT LEARNING

2012-2013 ACADEMIC YEAR

Department: Mechanical Engineering
Program: Bachelor of Science (B.S.) in Mechanical Engineering / Combined B.S. and Master of Science (M.S.) in Mechanical Engineering

Mission Statement: The primary mission of the Mechanical Engineering Department is to prepare graduates to function effectively as mechanical engineers in a wide spectrum of industries. The department’s further mission is to engage in research and scholarly activity that contributes to basic and applied discovery to enhance student learning while being of benefit to the state, region, and nation.

Student Learning Goals & Objectives:

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Student Learning Outcomes

a. Ability to apply mathematics, science and engineering principles.
b. Ability to design and conduct experiments, analyze and interpret data.
c. Ability to design a system, component, or process to meet desired needs.
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i. Recognition of the need for and an ability to engage in life-long learning.
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Program Educational Objectives

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Educational Experiences:

The Mechanical Engineering Department recognizes the need for a variety of educational experiences, and corresponding assessment methods, to maximize student learning the professional preparation of future engineers. Following the most recent ABET accreditation visit (2009-2010), the department reviewed its assessment methods and created a matrix of courses and assessment instruments to be used for gauging student achievement of ABET outcomes. The courses chosen are required courses taken by all undergraduate ME students. Students in the combined B.S.M.E./M.S.M.E. program must take the same required courses, the program differs only in the potential selection of technical electives. The courses chosen for assessment are listed below with their corresponding ABET outcome, educational experiences in the courses, and assessment instruments.

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<tbody>
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<td>a</td>
<td>ME 322</td>
<td>Individual and team homework and term projects with mid-term and final exams</td>
<td>Assessment survey, collection of student work (homework, exams, project report)</td>
</tr>
<tr>
<td>b</td>
<td>ME 483</td>
<td>Structured lab exercises and student-designed experimentation</td>
<td>Collection of student work (student choice lab report)</td>
</tr>
<tr>
<td>c</td>
<td>ME 488</td>
<td>Design, build, and testing of an engineering prototype including oral and written presentations of work</td>
<td>Assessment survey, collection of student work (final project report)</td>
</tr>
<tr>
<td>d</td>
<td>ME 488</td>
<td>See above</td>
<td>See above</td>
</tr>
<tr>
<td>e</td>
<td>ME 474</td>
<td>Individual homework and exams</td>
<td>Assessment survey, collection of student work (homework, exams)</td>
</tr>
<tr>
<td>f</td>
<td>ME 480 / 488</td>
<td>/ See above</td>
<td>Assessment survey and collection of student work (written paper)</td>
</tr>
<tr>
<td>g</td>
<td>ME 480</td>
<td>See above</td>
<td>Collection of student work (written papers and recorded</td>
</tr>
</tbody>
</table>
**Assessment Methods:**

Following collection of the assessment instruments, the ME ABET Coordinator, Dr. Marcellin Zahui, convenes review teams for each ABET outcome. They review the assessment materials according to a set of rubrics that have been adopted by the Department for this purpose. The figure below shows a sample rubric used to evaluate the performance of students relative to outcome d (multidisciplinary teams). Results of the reviews are compiled by Dr. Zahui and presented to the faculty for discussion during the annual faculty retreat. The ME Department Chair, Dr. Matthew Cavalli, will compile the results of the student exit interviews that he performs with every graduating senior.

<table>
<thead>
<tr>
<th>Letter</th>
<th>Course</th>
<th>Assessment</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>h</td>
<td>ENGR 460</td>
<td>Individual homework and term projects with midterm and final exams</td>
<td>Collection of student work (written papers)</td>
</tr>
<tr>
<td>i</td>
<td>N/A</td>
<td>Multiple courses include requirements for students to take learning 'beyond the classroom' but none are explicitly assessed for this outcome</td>
<td>Senior exit interview</td>
</tr>
<tr>
<td>j</td>
<td>ME 301</td>
<td>Individual homework and term projects, group discussion and open-ended exam questions</td>
<td>Collection of student work (written papers and exams)</td>
</tr>
<tr>
<td>k</td>
<td>ME 323/L</td>
<td>Individual homework and exams, group term project</td>
<td>Assessment survey</td>
</tr>
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In addition to the course-specific assessment instruments, results from the Fundamentals of Engineering (FE) exam are used to compare the performance of our students with engineering students across the nation. The FE exam is an eight hour exam comprising a morning and an afternoon section. Students are encouraged, but not required, to take the exam. It is the first step on the road to becoming a licensed professional engineer (PE). The ‘industrial exemption’ allows mechanical engineers to practice engineering under the supervision of a PE without being licensed themselves. For this reason, a smaller fraction of our students tend to take the exam than other disciplines like Civil Engineering. However, students are repeatedly encouraged to take the exam throughout their time at UND for the potential personal benefit and for the overall good of the profession. Because the FE exam was designed as a licensing tool rather than an assessment tool, caution must be used when evaluating the results for assessment purposes. The primary value of the results is in identifying short- and long-term trends in student exam participation and performance. Topics covered by the FE exam include those that are directly under the control of ME faculty as well as supporting course topics like mathematics, chemistry, and physics. Results from each year are compiled and presented for discussion at the annual ME faculty retreat. The ME faculty has adopted the goal that UND ME students will perform at or above the national average on the FE exam in terms of overall pass rate and performance on individual exam sections.

Program Educational Objectives are assessed via a survey of alumni and their employers every two to three years. The last survey was performed in 2009-2010. Every three years the PEOs themselves are reviewed according to a process that includes input from the faculty, students, and alumni. That process is currently underway with input from students and alumni expected in early 2013. Once revisions to the PEOs have been finalized, the next survey will be sent to alumni and employers in the Spring 2013 semester. Alumni three to five years after graduation will be targeted. The survey asks respondents to rank both the importance of each PEO for themselves (or their employees) and the level of attainment they (or their employees) have achieved. Results of the survey will be compiled and presented to the ME faculty at the faculty retreat in August.

**Timeline:**

Collection of outcomes-related assessment materials are on a three-year cycle. Information for outcomes a, c, e, g, and i was collected during the 2011-2012 academic year. Information for outcomes b, d, f, h, and j is being collected during the 2012-2013 academic year. The process will repeat in 2013-2014 and 2014-2015. There will be no assessment collection during the 2015-2016 academic year. This is the next scheduled ABET accreditation visit.

**Responsibilities:**

Dr. Marcellin Zahui is the ABET Coordinator for the ME Department. He has developed the course mapping for outcomes assessment and coordinates the regular collection of assessment data. Each individual faculty member is responsible for collection of the required assessment information and Dr. Zahui designates teams of faculty to perform the review for each outcome. Electronic files for each outcome, including all collected assessment materials, are maintained by staff in the ME office.
Use of Results and Process for Documentation & Decision-Making:

The Mechanical Engineering ABET Coordinator oversees collection and review of the assessment data. He presents a summary of the results to the ME faculty at the annual faculty retreat in August. Based on this discussion, decisions are made on possible additional collections or modifications to specific courses or educational activities. Every six years the assessment results are reviewed by ABET. The most recent ABET visit occurred in the 2009-2010 academic year and the Mechanical Engineering program was accredited for a full term of six years.
DEPARTMENTAL PLAN FOR ASSESSMENT OF STUDENT LEARNING

2005-2006 ACADEMIC YEAR

Department: Mechanical Engineering

Program:

Mission Statement: The primary mission of the Mechanical Engineering Department is to prepare graduates to function effectively as mechanical engineers in a wide spectrum of industries. The department’s further mission is to engage in research and scholarly activity that contributes to basic and applied discovery to enhance student learning while being of benefit to the state, region, and nation.

Continuous assessment of student learning in accordance with specific program outcomes including input from program constituents such as students, alumni, employers and industry advisory groups, provides opportunity to measure success in meeting the mission of the department.

Student Learning Goals & Objectives:

Educational objective contributing to the overall mission are:

1. Develop students' critical thinking and problem solving skills using the principles of science and mathematics.

2. Give students a broad understanding of Mechanical Engineering including the areas of (a) thermal sciences, (b) mechanical design, and (c) materials & manufacturing processes.

3. Give students a design experience that blends scientific knowledge and engineering analysis that includes a breadth of knowledge in social and humanities.

4. Equip graduates with the knowledge, technical skills, leadership skills, and communication skills to qualify for a range of entry-level professional positions in the multitude of industries employing mechanical engineers.

5. Provide opportunities for students to prepare for graduate school.

Educational Experiences:
The Mechanical Engineering Department defined fourteen instruments to be used in assessing the success of our graduates in meeting ABET desired outcomes "a" through "k." Instruments one through eight are **direct** instruments that the faculty can adjust, to some degree, in response to feedback from the process. Instruments nine through fourteen are **indirect** instruments that cannot be adjusted directly but can be influenced, in the long term, by changes made to the **direct** instruments.

**Direct** instruments can be found in student portfolios and include samples of student work. For assessment purposes, we selected eleven “primary” mechanical engineering courses to sample routinely. These courses were chosen for their potential to efficiently demonstrate performance with respect to desired outcomes because they represent a culmination of knowledge and skills learned in contributing courses. If assessment of a primary course reveals a deficiency, a special assessment of a contributing course can be scheduled for the next assessment cycle.

The engineering science group is comprised of ME-301, ME-342, ME-418, and ME-474. This set includes samples from all three areas of mechanical engineering: thermal sciences, mechanical design, and materials/manufacturing processes.

The open-ended problems group is comprised of ME-323, ME-418, and ME-474. All four courses are strong in engineering science as well as containing open-ended problems. Thus, two of the three are found in both groups. ME-323, Design of Machine Components, is exceptionally strong in open-ended problems and is, in fact, co-listed in the design projects group. The laboratory skills group is comprised of ME-323L and ME-483. These courses are strong contributors to measurement skills, data analysis skills, teamwork, contemporary engineering skills, and communication skills.

The design project group is comprised of ME-201, ME-323, and ME-487/88. These courses are strong contributors to design skills, teamwork skills, problem-solving skills, contemporary engineering skills, and communications skills. Because societal and economic factors must be considered in designs, they also contribute to professional and ethical perspectives.

The technical paper group is comprised of ME-301and ME-480. Both courses include preparation of papers on contemporary mechanical engineering issues. ME-480 also contributes to professional and ethical perspectives through preparation of a professional ethics paper. The idea of lifelong learning, promoted throughout the curriculum, is assessed in these courses.

The oral presentation group is comprised of ME-480 and ME-487/88. ME-480 includes oral presentations as well as written papers on both contemporary issues and professional ethics. ME-487/88 includes team presentations on design project accomplishments.

**Assessment Methods:**
The Fundamentals of Engineering (FE) exam is a nationally normed exam that offers potential to compare performance of our students with a nationwide performance level. Because the exam was designed as a licensing tool rather than an assessment tool, we must be cautious when using it for assessment purposes. We have followed the paper: Using the Fundamentals of Engineering (FE) Examination to Assess Academic Progress by Walter LeFevre, John W. Smith, John W. Steadman, and Kenneth R. White.

The subject breakdown of the general exam, however, is almost identical to the subject breakdown of the morning exam. Thus, reviewers also have the option of using morning exam data to evaluate performance within a subject area.

Following the above format, the subject area breakdown becomes:

- Electric Circuits
- Chemistry
- Computers
- Dynamics
- Engineering Economics
- Ethics
- Fluid Mechanics
- Mathematics
- Material Science/Structure of Matter
- Mechanics of Materials
- Statics
- Thermodynamics

Note that not all subjects are under the direct control of Mechanical Engineering faculty. For subjects where we do not teach the courses directly (i.e., mathematics), we still have an obligation to monitor performance and to work with faculty from the responsible department in the event corrective action is needed and items that are to be collected in portfolios of student work. For assessment purposes, courses are categorized as either primary or supporting. Primary courses are upper division courses that are expected to be very rich in assessment data. For primary courses, samples of student work are collected and analyzed every year. Supporting courses are sampled and analyzed at the discretion of the Assessment Coordination Committee. Eleven required courses make up the primary course list. We have organized them into groups (note there is overlap) according to the type of information we seek from each group.

Senior exit interviews are comprised of two parts. First, each student completes an anonymous numerical questionnaire related to ABET outcomes "a" through "k". Second, the department chair conducts a confidential personal interview with each student.

The department staff compiles responses to the numerical questionnaire. Means and standard deviations are calculated. Annually, the Assessment Coordination Committee reviews these results and considers them in recommending changes to the program. The Assessment Coordination Committee also sets performance standards for these numerical
results. Performance standards are set annually and may be in the form of target improvements for the following year.

**Timeline:**
Throughout the semesters student work and surveys are completed - it is being done continuously. Every year alumni are surveyed - one and six years from graduation. Alumni advisory council is surveyed each year.

**Responsibilities:**
Faculty and staff

**Use of Results and Process for Documentation & Decision-Making:**

The Mechanical Engineering Assessment Coordination Committee assimilates the information each semester. Every six years the information is reviewed by Engineering Accreditation Commission of Accreditation Board of Engineering and Technology (ABET). The ME dept just had a review in 2003 and the Mechanical Engineering major was accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology for a full term of six years.