Annual Assessment Report

for the

Department of Mechanical Engineering

at

California State University, Sacramento

6000 J St.
Sacramento, California 95819

July 1, 2009
Annual Assessment Report
Mechanical Engineering
Bachelor of Science
California State University, Sacramento

ABET CRITERION 2. PROGRAM EDUCATIONAL OBJECTIVES

A. Mission Statement

California State University, Sacramento Mission Statement

The mission statement of Sacramento State recognizes the role of the university within the greater Sacramento region and California. The educational objectives of the Mechanical Engineering program were developed to be in support of that mission and in support of the needs of the community. The mission statement of the University, listed below, can be found on the University webpage at http://www.csus.edu/webpages/mission.stm.

California State University, Sacramento is an integral part of the community, committed to access, excellence and diversity.

California State University, Sacramento is dedicated to the life-altering potential of learning that balances a liberal arts education with depth of knowledge in a discipline. We are committed to providing an excellent education to all eligible applicants who aspire to expand their knowledge and prepare themselves for meaningful lives, careers, and service to their community.

Reflecting the metropolitan character of the area, California State University, Sacramento is a richly diverse community. As such, the University is committed to fostering in all its members a sense of inclusiveness, respect for human differences, and concern for others. In doing so, we strive to create a pluralistic community in which members participate collaboratively in all aspects of university life.

California State University, Sacramento is committed to teaching and learning as its primary responsibility. In both the academic and student support programs, success is measured in terms of student learning. In addition, the University recognizes the vital connections between pedagogy and learning, research activities and classroom instruction, and co-curricular involvement and civic responsibility. All students, regardless of their entering levels of preparation, are expected to complete their degree programs with the analytical skills necessary to understand the social, economic, political, cultural, and ecological complexities of an increasingly interconnected world.
Located in the capital of the nation's most populous and diverse state, California State University, Sacramento is dedicated to advancing the many social, economic, political, and scientific issues affecting the region and the state. The University's curricular and co-curricular programs continue to focus on these issues through undergraduate and post-baccalaureate programs that prepare graduates for successful careers dedicated to public service and the enhancement of the quality of life within the region and the state. Our research centers and much of our individual scholarly efforts also remain directed at the enhancement of the quality of life within the region and the state.

At California State University, Sacramento, we are constantly striving to create a sense of unity among faculty, staff, administrators, students, alumni, and community members. In pursuing the combined elements of our mission, we seek to foster a sense of pride in all who view this campus as their own – pride in Sacramento State as the institution of choice among our current students; pride among our alumni in the ongoing impact of the Sacramento State education upon their lives; pride among faculty, staff, and administration in their university's achievement of excellence in teaching, learning, and scholarship; and pride in Sacramento State as an asset to the community among residents of the Greater Sacramento region.

Approved on March 29, 2004

In addition to this mission statement, the University has developed a set of learning goals for a CSUS Baccalaureate degree. The Mechanical Engineering educational objectives must also encompass the Baccalaureate learning goals as listed below and on the University website at [http://www.csus.edu/acaf/Portfolios/GE/lrngls.stm](http://www.csus.edu/acaf/Portfolios/GE/lrngls.stm).

**CSUS Baccalaureate Learning Goals**

**A Statement of Principles:**

A baccalaureate education is focused on the premise that all students should explore how the great body of human knowledge is organized and become familiar with the methods for gaining, evaluating and extending that knowledge. Baccalaureate students should possess a range of knowledge, values, and skills that will enrich and shape their lives long after their formal education has ended.

Most of the learning expectations that follow emphasize ways of knowing and contexts for knowledge rather than specific content. More than any specific list of courses, these baccalaureate learning goals emphasize the development of knowledge, values and skills that will serve students throughout their lives, providing them with the resourcefulness and flexibility to adapt successfully to rapid social, economic and technological change, the understandings and tolerance necessary for informed citizenship and social action, and the interest and curiosity that is essential to the pursuit of learning throughout a lifetime.
Expectations of Undergraduate Learning:

Competencies in the Disciplines

Definition: The ability to demonstrate the competencies and values listed below in at least one major field of study. Additionally, this learning goal requires students to demonstrate informed understandings of other fields, drawing on the knowledge and skills of disciplines outside the major.

Specific Expectations: This expectation is demonstrated by a student's ability to:

a) examine, organize, and reveal significant understanding of at least one disciplinary way of knowing

b) apply at least one discipline's knowledge and methods to specific problems and issues

c) examine, organize, and integrate a variety of disciplinary perspectives and ways of knowing to reveal a broad understanding of the relationships between disciplines and the ways they strengthen and enliven each other.

Analysis and Problem Solving

Definition: The ability of students to identify and diagnose problems; organize and critically evaluate relevant information of a qualitative and quantitative nature; develop reasonable arguments and effective solutions.

Specific Expectations: This set of expectations is demonstrated by a student's ability, as an individual and in collaboration with others, to

a) analyze complex issues and make informed decisions

b) recognize and synthesize valid and relevant information from various sources in order to arrive at reasoned conclusions

c) diagnose and solve problems, including those which are quantitative in nature

d) evaluate the effectiveness of proposed solutions

Communication

Definition: The ability to read, write, speak and listen effectively. The ability to respond, with understanding and appreciation to a wide variety of communicative acts.

Specific Expectations: This set of expectations is demonstrated by a student's ability to
a) express ideas and facts in a variety of written and quantitative formats and to a variety of audiences in discipline-specific, work-place, and civic contexts

b) comprehend, interpret, and analyze written and oral presentations

c) communicate orally in one-on-one and group settings

d) communicate in a language other than English

e) interpret, analyze, and evaluate ideas presented in a variety of creative formats, including written, verbal and visual.

**Information Competence**

**Definition**: The ability to make effective and ethical use of information resources and technology for personal and professional needs.

**Specific Expectations**: This set of expectations is demonstrated by a student's ability to

a) locate needed information using a variety of resources, including journals, books, and other media

b) use basic computer applications such as word processing software, e-mail, the internet, and electronic databases

c) learn, understand, evaluate and apply appropriate technologies to information processes, communication needs, and problem-solving in productive and sustained ways in both professional and personal settings

d) distinguish and make judgments among available information resources

**Cultural Legacies**

**Definition**: Acquisition of knowledge of human accomplishments in the creative and performing arts and the achievements of human thought.

**Specific Expectations**: This set of expectations is demonstrated by a student's

a) application of a broadly historical consciousness to the human condition, the social world, and human achievements in the arts and sciences

b) experience of and appreciation for the fine and performing arts

c) understanding of the development of world civilizations and the values of different cultural traditions
d) ability to apply aesthetic principles to various cultural expressions

**Values and Pluralism**

**Definition:** The ability to apply ethical standards in order to make moral judgments with respect to individual conduct and citizenship, and to recognize the diversity of human experiences and cultures, both within the United States and internationally. The development of positive social attitudes, values and behaviors.

**Specific Expectations:** This set of expectations is demonstrated by a student's

a) recognition of the moral dimensions of decisions and actions

b) understanding of and respect for those who are different from oneself

c) willingness to accept individual responsibility

d) ability to work collaboratively with those who come from diverse cultural backgrounds

e) ability to recognize and understand the implications of various social structures and the ways people are grouped by such characteristics as status, race, ethnicity, gender, sexual orientation

f) valuation of service as a component of active citizenship

The College of Engineering mission statement reflects the position of engineering education within the framework of the University’s mission. The College of Engineering Mission statement is listed below and can be found on the College website at http://www.ecs.csus.edu/index.php?content=mission.

**Mission Statement - College of Engineering and Computer Science**

The College of Engineering and Computer Science is dedicated to providing high quality education that will transform students into professionals who will contribute to technological knowledge and progress and to the well-being and development of the capital region and State.

The mission of the College of Engineering and Computer Science is to:

- Educate a diverse population of students for positions in engineering, computer science, mechanical engineering technology and construction management. Through dynamic, up-to-date curricula emphasizing theory and practice, graduates will be well-educated and prepared to participate in major changes in their disciplines.

- Educate students for advanced degrees in selected fields of engineering and computer science.
- Assist engineering and computer science professionals in maintaining currency in their fields by providing courses in new and evolving areas of engineering and technology.
- Provide laboratories and computer facilities that reflect state-of-the-art practice.
- Develop mutually beneficial partnerships with area industries and governmental agencies in the region and the state.
- Encourage opportunities for student participation in co-curricular activities, such as student design competitions, and in research projects.
- Build strong, cooperative relationships with local high schools and community colleges.

The mission of both the University and the College of Engineering is encompassed in the mission of the Mechanical Engineering Department. This mission statement is listed below and is posted on the department website.

**Mission Statement of the Department of Mechanical Engineering**

The mission of the Mechanical Engineering program is to educate students in the area of mechanical engineering, to prepare them for professional employment and/or graduate study.

**Goals:**

- Provide our graduates with a well-rounded education based on a solid understanding of science, mathematics, and engineering principles, together with an understanding of the global and societal impacts of engineering;
- Provide our graduates with knowledge in the fundamentals of mechanical engineering with an emphasis on the application of this knowledge to the techniques of engineering design;
- Encourage and facilitate the development of graphic, written, and oral communication skills of all graduates; and
- Impart the essential professional, ethical, and moral values required in the practice of engineering, including a commitment to life-long learning.

**Vision:**

The Mechanical Engineering program will offer a combination of required and elective courses that provide our students with:

- knowledge of the principles of science, mathematics, and engineering that are fundamental to the following areas of mechanical engineering practice: machine design, including solid mechanics and control theory; fluid mechanics, thermodynamics, and heat transfer; materials; and manufacturing;
- opportunities to develop the ability to apply scientific, mathematical and engineering principles in order to identify, formulate, and solve problems in the areas of machine design, thermal sciences, materials, and manufacturing, including the appropriate use of computer technology;
opportunities to learn how to plan, conduct, analyze, and interpret experiments and apply experimental results, using the principles of science and mathematics and appropriate computer technology;
• opportunities to apply creativity in the design of systems, components, or processes;
• experiences in working together on multi-disciplinary teams;
• knowledge and practice in communicating through speaking, writing, and graphics, including the use of appropriate computer technology;
• information on professional, ethical, and social responsibilities and the importance of life-long learning; and
• information on contemporary professional, societal, and global issues, as well as the nature and background of diverse cultures.

B. Program Educational Objectives

The Mechanical Engineering program will prepare graduates who:

I. Will enter professional employment and/or graduate study in the following areas of mechanical engineering practice: machine design, thermal and fluids systems, materials, and manufacturing;

II. Will use knowledge of the principles of science, mathematics, and engineering, to identify, formulate, and solve problems in mechanical engineering;

III. Will apply creativity in the design of systems, components, processes, and/or experiments and in the application of experimental results, working effectively on multi-disciplinary teams;

IV. Will communicate effectively through speaking, writing, and graphics, including the use of appropriate computer technology;

V. Will use their understanding of professional, ethical, and social responsibilities, the nature and background of diverse cultures, and the importance of life-long learning in the conduct of their professional careers.

C. Consistency of the Program Educational Objectives with the Mission of the Institution

The Mechanical Engineering objectives are consistent with the mission of the University, “committed to providing an excellent education to all eligible applicants who aspire to expand their knowledge and prepare themselves for meaningful lives, careers, and service to their community”. The University is part of the California State University system which is responsible for educating the workforce for the state of California. The mission of the university states:

Located in the capital of the nation's most populous and diverse state, California State University, Sacramento is dedicated to advancing the many social, economic, political, and scientific issues affecting the region and the state. The University's curricular and co-curricular programs continue to focus on these issues through
undergraduate and post-baccalaureate programs that prepare graduates for successful careers dedicated to public service and the enhancement of the quality of life within the region and the state.

The objectives of the program are consistent with educating individuals in the art and practice of Mechanical Engineering to satisfy the needs of the Sacramento region and the state.

D. Program Constituencies

Constituencies of CSU, Sacramento’s undergraduate Mechanical Engineering Department are:

- Prospective students
- Students
- Graduates of the program
- Graduate schools
- Employers hiring our graduates
- Faculty
- Industry Advisory Council.

E. Process for Establishing Program Educational Objectives

The Mechanical Engineering Department began developing the educational objectives prior to the last ABET review cycle. These objectives were developed through a series of faculty meetings, meetings with industry, and employer interviews. The objectives were also written to be consistent with the mission of the university and the criteria specified by ABET.

The faculty established the initial department objectives through a series of departmental meetings in which the overall program goals were discussed. These initial objectives were reviewed by the Industrial Advisory Committee (IAC) to obtain the perspective of industry representatives and alumni of the program. The process used to develop the initial objectives and program outcomes is shown in Figure 2-1.
After the last ABET review cycle had been completed, a strategic planning committee was formed with members from faculty and the IAC. The goal of this committee was to establish a long range plan for the department and to review the objectives. This committee met monthly for a period of one year and established the current objectives as documented in this report. The long range plan established for achieving the program objectives and beyond is shown in Figure 2-2.
F. Achievement of Program Educational Objectives

The program educational objectives are periodically reviewed through several different methods involving as many of the constituencies as possible. These methods include alumni surveys, employer visits, faculty reviews, and student exit interviews. The primary method for assessing the program objectives is to connect the objectives to the learning outcomes and curriculum. The process of assessing achievement of the learning outcomes then also assesses the achievement of the objectives. In addition to these assessment tools we also solicit feedback from our Industrial Advisory Committee. Table 2-1 shows the different constituencies and the methods and timeframe for evaluation.
Table 2-1: Methods for Assessing Program Objectives

<table>
<thead>
<tr>
<th>Constituency</th>
<th>Specific Group</th>
<th>Timeframe</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>Graduating Seniors</td>
<td>Every Semester</td>
<td>Exit Interviews</td>
</tr>
<tr>
<td>Alumni</td>
<td>Graduating Class Out Five Years, IAC members</td>
<td>Every five years, Every Semester</td>
<td>Survey, Meetings</td>
</tr>
<tr>
<td>Faculty</td>
<td>Full time faculty</td>
<td>Every Semester</td>
<td>Meetings</td>
</tr>
<tr>
<td>Employers</td>
<td>Industry Site Visits</td>
<td>Every Year</td>
<td>Meetings</td>
</tr>
<tr>
<td></td>
<td>IAC members</td>
<td>Every Semester</td>
<td>Meetings</td>
</tr>
</tbody>
</table>

The first method for assessing the program objectives is through exit interviews for graduating seniors. The department chair and members of the assessment committee meet with seniors completing the final semester of their senior design project class. The students are asked the following questions as a group:

1. What are the things you like about the ME program?
2. What are the things you don’t like?
3. What course did you find to be the most useful?
4. What course or courses should not be required?
5. Do you feel prepared to go into industry and develop new technology? Explain
6. Do you feel your education is complete?
7. How do you plan to keep yourself current?

The answers to these questions are reviewed by the assessment committee.

The alumni are surveyed every five years as part of both the assessment of the learning outcomes and the program objectives. Appendix E shows a sample of the questions asked on the alumni survey. The responses to the survey are compiled by the University office of institutional research and made available to the faculty. The faculty review the results as part of the department meetings.

Employer visits are conducted every spring semester. During these visits, a group of faculty meet with a local employer who has employed graduates of our program. Both alumni and their managers are present at the meeting. The employers are asked a set of questions as listed below and their responses are recorded and transcribed for faculty review. As the answers are given, additional follow-up questions are asked with regard to specific aspects of the program.

1) What CSUS learning experiences were most valuable to you in your career?
2) What knowledge and skills that you acquired during your education have you used most?
3) What knowledge do you use the least?
4) What do you wish you had learned in school but did not?

5) What are the emerging and expanding fields in mechanical engineering and mechanical engineering technology?

6) What critical skills and knowledge will mechanical engineers need for the future?

7) For Managers: What are the strengths and what are the weaknesses of our graduates of the ME program?

Finally, the faculty keep an ongoing dialog with both the students and the members of the Industry Advisory Committee. The students are regularly engaged in discussions about the program both individually and in town hall meetings. The faculty meet with the IAC members every semester to discuss the program. IAC members participate in subcommittees with faculty to address specific issues with regard to the program such as improving the senior project and the long range strategic plan for the department. The students and IAC members interact as well through IAC participation in the senior project reviews; seminars given by IAC members on engineering careers; and a social “Evening with Industry” event.
ABET CRITERION 3. PROGRAM OUTCOMES

A. Process for Establishing and Revising Program Outcomes

The Mechanical Engineering Department involves all identified constituencies except prospective students and graduate schools in our assessment of the effectiveness of our program. Input from faculty, students, graduates, employers and the IAC was used to establish our program outcomes. We continue to solicit input from these constituencies to monitor and refine these outcomes.

Outline of Process

The sequence of steps in the assessment process are:

i. Define goals, objectives, and learning outcomes

ii. Identify performance criteria and measurement metric for each learning outcome and identify the courses that support the outcome.

iii. Identify assessment tools and provide data relevant to each learning outcome

iv. Develop plan to assess achievement of program goals and learning outcomes

v. Identify problem areas and develop strategies for improving delivery of learning outcomes

vi. Implement strategies targeted at improving specific learning outcomes and assess the effectiveness of the changes

vii. Reassess objectives and learning outcomes and continue the process

Assessment began in Fall 1998. As means of reviewing, updating, and revising the curriculum, the Mechanical Engineering department began using a framework of identifying specific program goals, objectives and learning outcomes. These were developed over a period of time during the 1998-99 academic year through a series of department meetings, meetings with alumni, and meetings with the department’s Industry Advisory Committee. During the first iteration of our assessment process, surveys of graduating seniors and recent alumni were conducted to determine how effectively the goals were being accomplished and to identify particular areas of weakness.

We surveyed first- and second-semester senior students and alumni regarding the learning outcomes. They were asked specifically about the following outcomes.

Student Learning Outcomes

(1) Knowledge of science, math, engineering

(2) Problem solving ability

(3) Conduct experiments and interpret results

(4) Apply creativity in design

(5) Function effectively as part of a team

(6) Communicate effectively
They were asked to rate the importance of each learning outcome with regard to their careers on the following scale:

1 = very low, 2 = low, 3 = high, 4 = very high.

The individual averages for the different groups varied by plus/minus 0.2 from these averages. The survey results are presented in Appendix E.

Another survey of senior students and alumni asked them to identify specific courses that they believed contributed to their achievement of the program's student learning outcomes. With few exceptions, the students agreed with the faculty as to which objectives were actively addressed in each course.

Writing and communication in engineering was selected as one of the focus areas. Many of our students reach the upper division courses with inadequate writing skills. Effective ways to incorporate a solution to this problem has begun in our upper division courses. We will use the data from several semesters to evaluate the effectiveness of new strategies.

The results were the following learning outcomes:

Each graduate of the Mechanical Engineering program will be able to:

a. Demonstrate a knowledge of the science, mathematics, and engineering principles that are fundamental to thermal and mechanical systems design and manufacturing; (ABET a: Ability to apply knowledge of mathematics, science, and engineering).

b. Identify, analyze, and solve technical problems in the areas of machine design, including solid mechanics and control systems; fluid mechanics, thermodynamics, and heat transfer; materials properties and selection; and manufacturing, using the principles of multivariate calculus and differential equations, including the appropriate use of computer technology; (ABET e: ability to identify, formulate, and solve engineering problems).

c. Plan, conduct, analyze, and interpret experiments and apply experimental results, using the principles of science and mathematics and appropriate computer technology; (ABET b: ability to design and conduct experiments, as well as to analyze and interpret data).

d. Apply creativity in the design of systems, components, or processes to meet desired needs; (ABET c: ability to design a system, component, or process to meet desired needs).

e. Function effectively as part of a team; (ABET d: ability to function on multidisciplinary teams).

f. Communicate effectively through speaking, writing, and graphics, including the appropriate use of computer software; (ABET g: ability to communicate effectively; and ABET k: ability to use the techniques, skills, and modern engineering tools necessary for engineering practice).
g. Show understanding of professional, ethical, and social responsibilities and the need for a commitment to life-long learning and participation in professional societies; \((\text{ABET f: an understanding of professional and ethical responsibility; and ABET i: a recognition of the need for, and an ability to engage in life-long learning})\).

h. Show understanding of contemporary professional, societal, and global issues, as well as awareness of and respect for diverse cultures. \((\text{ABET j: a knowledge of contemporary issues; and ABET h: the broad education necessary to understand the impact of engineering solutions in a global and societal context})\).

These outcomes were reviewed again by the assessment committee after the last ABET review cycle. The outcomes and the objectives were modified to more closely reflect the ABET learning outcomes.

In 2008, the assessment plan was again reviewed with the intent to improve the focus on specific areas within the learning outcomes. As part of that process, the faculty were asked to answer the following questions:

If you were hiring a Mechanical Engineer for your own company in your area of expertise, what attributes would you consider to be the most important? What would you want to see from the student before you offered him/her a job? How would you want to verify the student actually had the attributes you wanted?

The results were used to create key outcomes on which to focus a direct assessment plan. The areas that were identified were:

a. **Documentation** – the student must be able to write a coherent technical report (e.g. lab, analysis, test, etc.), they must be able to create and understand an engineering drawing (e.g. machine drawing, process diagram, schematic, etc.), and they must be able to create and understand a technical graph/illustration/diagram.

b. **Expertise in Technology** – the students must be able to demonstrate competence (i.e. understand and apply key concepts) in dynamics and statics; thermodynamics, heat transfer, and fluids; manufacturing and mechanical design; and have an understanding of other engineering disciplines and technology tools.

c. **Design** – the student must be able to solve an open ended design problem.

d. **Teamwork** – the student must be able to work in teams and demonstrate the ability to delegate responsibilities, communicate requirements, and interact with teammates.

e. **Professional Practice** – the students will demonstrate an understanding of the necessity for continuing education and an understanding of the engineering code of ethics.

An assessment plan was established to monitor these key areas and the outcomes they represent.
B. Program Outcomes

The learning outcomes for the Mechanical Engineering program are as follows.

Each graduate of the Mechanical Engineering program will be able to:

a. Demonstrate a knowledge of the science, mathematics, and engineering principles that are fundamental to thermal and mechanical systems design and manufacturing; (ABET a: Ability to apply knowledge of mathematics, science, and engineering).

b. Plan, conduct, analyze, and interpret experiments and apply experimental results, using the principles of science and mathematics and appropriate computer technology; (ABET b: ability to design and conduct experiments, as well as to analyze and interpret data).

c. Apply creativity in the design of systems, components, or processes to meet desired needs; (ABET c: ability to design a system, component, or process to meet desired needs).

d. Function effectively as part of a multidisciplinary team.

e. Identify, analyze, and solve technical problems in the areas of machine design, including solid mechanics and control systems; fluid mechanics, thermodynamics, and heat transfer; materials properties and selection; and manufacturing, using the principles of multivariate calculus and differential equations, including the appropriate use of computer technology; (ABET e: ability to identify, formulate, and solve engineering problems).

f. Show understanding of professional, ethical, and social responsibilities; (ABET f: an understanding of professional and ethical responsibility).

g. Communicate effectively through speaking, writing, and graphics, including the appropriate use of computer software; (ABET g: ability to communicate effectively).

h. Show understanding of the impact of engineering solutions in a global and societal context; (ABET h: the broad education necessary to understand the impact of engineering solutions in a global and societal context).

i. Show understanding of the need for a commitment to life-long learning and participation in professional societies; (ABET i: a recognition of the need for, and an ability to engage in life-long learning).

j. Show understanding of contemporary issues; (ABET j: a knowledge of contemporary issues).

k. Use the techniques, skills, and modern engineering tools necessary for engineering practice with proficiency in design, manufacturing, materials science, thermal and fluid systems; (ABET k: ability to use the techniques, skills, and modern engineering tools necessary for engineering practice).

These outcomes are documented in the policies and procedures manual for the Mechanical Engineering Department (currently under revision) and on the department web site.
C. Relationship of Program Outcomes to Program Educational Objectives

The program objectives are as follows:

Graduates

I. will enter professional employment and/or graduate study in the following areas of mechanical engineering practice: machine design, thermal and fluids systems, materials, and manufacturing;
II. will use knowledge of the principles of science, mathematics, and engineering, to identify, formulate, and solve problems in mechanical engineering;
III. will apply creativity in the design of systems, components, processes, and/or experiments and in the application of experimental results, working effectively on multi-disciplinary teams;
IV. will communicate effectively through speaking, writing, and graphics, including the use of appropriate computer technology;
V. will use their understanding of their professional, ethical, and social responsibilities, the nature and background of diverse cultures, and the importance of life-long learning in the conduct of their professional careers.

The relationship between the learning outcomes and the objectives are listed below in Table 3-1.

Table 3-1: Relationship Between Learning Outcomes and Objectives

<table>
<thead>
<tr>
<th>Learning Outcomes</th>
<th>a</th>
<th>b</th>
<th>c</th>
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D. Relationship of Courses in the Curriculum to the Program Outcomes

The curriculum is designed to meet the learning outcomes stated with courses designed as a coherent portion of the comprehensive whole. The curriculum learning outcomes are supported on a course by course basis with each course in the Mechanical Engineering curriculum designed to produce the learning outcomes identified in the Outcomes/Course matrix in Table 3-2.
Table 3-2: Department of Mechanical Engineering Outcomes/Course Matrix

<table>
<thead>
<tr>
<th>Course</th>
<th>a. Knowledge of science, math, and engineering principles</th>
<th>b. Plan, conduct, analyze, and interpret experiments</th>
<th>c. Apply creativity in design of systems, components, processes</th>
<th>d. Function effectively as a member of a team</th>
<th>e. Identify, analyze, and solve engineering problems</th>
<th>f. Understand professional, ethical and social responsibilities</th>
<th>g. Communicate effectively through speaking, writing, and graphics</th>
<th>h. Understand the impact of engineering solutions in a global and societal context</th>
<th>i. Understand the commitment to life-long learning and participation in professional societies</th>
<th>j. Develop an understanding of contemporary issues</th>
<th>k. Ability to apply techniques, skills, and modern engineering tools necessary for engineering practice</th>
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</table>
E. Documentation

The materials are organized by courses. Starting with a specific course, one can access the syllabus, sample work of the students, exams, and homework assignments. This information will be available for the visiting team in a hard copy format and soft copy (online). The materials are also organized by program outcomes that lead to the courses that contribute to the outcome in questions. This information will also be available in a hard copy format and soft copy (online).

F. Achievement of Program Outcomes

The assessment plan was revised in 2008 to focus on the key areas discussed in section A above. The revised plan involves both direct and indirect assessment methods to evaluate the learning outcomes.

Methods

The program outcomes will be assessed using a variety of methods. The direct assessment methods include:

1. Evaluation of project documentation for the senior project classes.
   The assessment committee will evaluate the senior project reports for ME 190 and ME 191 using a standardized rubric. The reports will be evaluated for composition, technical content, and completeness. In addition, the design drawing packages within the senior project reports will be evaluated by a committee of faculty, industry representatives, and shop personnel.

2. Outside evaluation of the senior project presentations.
   The senior project presentations are evaluated by both faculty and industry representatives. The evaluation is based on content, presentation material, and teamwork.

3. Evaluation of technical competence using targeted exam questions in key classes.
   Courses have been selected within each area of expertise to be used as indicators of technical competence within that area. Targeted exam questions will be used to quantify the level of understanding from each of the classes.

4. Data from the FE exam.

Indirect assessment methods include:

1. Graduating senior surveys and alumni surveys.
2. Targeted surveys of students at different levels of the program.
3. Interviews with local employers.
4. Employer surveys.

Table 3-3 shows the relationship between assessment methods and program outcomes.
Table 3-3: Assessment Procedures versus Learning Outcomes.

<table>
<thead>
<tr>
<th>Assessment Procedure</th>
<th>Learning Outcomes</th>
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<tr>
<td></td>
<td>a  b  c  d  e  f  g  h  i  j  k</td>
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<td>Alumni Survey</td>
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<td>Writing/Documentation Reviews</td>
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<td>Employer Surveys</td>
<td>x    x    x    x    x    x    x    x    x    x    x</td>
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<tr>
<td>Interviews with Employers</td>
<td>x    x    x    x    x    x    x    x    x    x    x</td>
</tr>
</tbody>
</table>

In addition to this specific assessment, additional methods are used to assess the effectiveness of the program.

**Faculty Assessment**

Faculty assess student work by traditional means including grading homework, exams, lab reports, term papers and project reports (both oral and written.) Students must earn a C- grade or better in courses that are prerequisites for other courses in the curriculum. A standard 4.0 grade scale is used (A= 4.0) with a C grade described in the CSUS catalog as: *Satisfactory achievement of the course objectives. The student is now prepared for advanced work or study.*

Students must earn a grade point average of 2.0 or better in four categories:

- All upper division courses in the major
- All CSUS coursework
- General Education
- All coursework

**College Evaluation of Faculty Teaching**

Each faculty is also evaluated each term as part of the College of Engineering and Computer Science “Teaching Effectiveness” survey. These results are primarily used in the Retention, Tenure and Promotion process, and also provide feedback to faculty regarding their teaching effectiveness and areas for improvement. After the results have been compiled the comments and scores, and the department average score are provided to each faculty member. Each faculty member is encouraged to review the material and strive for improvement in teaching effectiveness.
College Level Assessment

The department also collaborates on assessment issues with faculty from other departments within the college. A College assessment committee was established to coordinate assessment activities across the college. These activities include: writing and presentation assessment between departments; cooperation on developing rubrics for evaluating different outcomes; methods for assessing ethics; and coordinating assessment through the use of outside agencies. Appendix E shows the writing rubric developed by the college assessment committee and the questions asked as part of the ethics assessment.
ABET CRITERION 4. CONTINUOUS IMPROVEMENT

A. Information Used for Program Improvement

The information used for continuous improvement of the program includes survey results, faculty reviews, and consultation with the constituencies. The consultations with constituencies include:

1. **Students** – The department uses exit interviews with the graduating seniors to determine the effectiveness of the program and to identify any areas that need improvement. In addition, the department uses town hall meetings to get feedback from a wider cross section of the student population.

2. **Alumni/Employers** – The department maintains an active Industrial Advisory Committee to advise the department. This committee is composed of industry representatives some of whom are alumni. Members of the IAC interact directly with the students, reviewing senior projects and acting as mentors. IAC members also participate on committees with faculty tasked with specific goals such as strategic planning. Finally, IAC members interact with faculty in regular meetings.

3. **Employers** – The faculty visit local employers every year to evaluate the effectiveness of the program and to identify any emerging technologies which should be incorporated into the curriculum.

The faculty reviews are accomplished through a series of regular meetings. The faculty hold an all day retreat at the beginning of each semester to discuss the goals for the program. The faculty are also asked to participate in collaborating on issues such as teaching effectiveness. Faculty are asked to prepare a presentation on teaching techniques for one of the regular faculty meetings. In addition, the faculty within each specialization meet regularly to review the courses within this specialization.

B. Actions to Improve the Program

The department has taken several actions to improve the program since the last review. These include modifications to the course content, addition of new faculty, revisions to the assessment plan, and modifications to the curriculum.

**Course Content**

The department has made the following modifications to the course content:

1. **Standardization on Solidworks** – The department changed the standard CAD package taught and used in courses from AutoCad to Solidworks. This was done in response to requests from local industry that we use a parametric modeling system in the curriculum.

2. **Modernization of Data Acquisition** – The department has begun using LabView in lab courses. The department has also purchased data acquisition hardware in support of lab courses. This was done in response to feedback from both students and local industry.
New Faculty

The department has added new faculty in response to requests from local industry and in support of specific areas.

1. Ilhan Tuczu – Aerospace and Design, 2008

Revisions to the Assessment Plan

The assessment plan was revised beginning in 2007 to better evaluate the effectiveness of the learning outcomes. The revised plan is described in CRITERION 3 - Section F. This was done to use more direct assessment methods and was recommended as a result of faculty reviews.

Modifications to the Curriculum

The greatest change to the program is a revision to the Mechanical Engineering curriculum. The modifications were initiated in 2008 and will be implemented in Fall 2009. These modifications were the direct result of student and alumni feedback, faculty reviews, and alumni survey results. The primary goal of these revisions was to eliminate any duplication in material between courses. The courses needed to be structured such that key material was introduced in one course then re-enforced in latter courses with practice and advanced concepts. The secondary goal of the curriculum revisions was to reduce the number of units in the program. In comparisons with other institutions, it was determined that the number of required courses in the existing program did not allow for flexibility in choosing electives. The course load in the existing program allowed for only two electives while most comparable programs offered four electives. The revisions were implemented with the idea of teaching the core material in as few units as possible without compromising quality. Efforts were also implemented to reduce the number of General Education units required in the program. The final result was a program with fewer units, focused on the key areas of study in the program objectives. The number of required electives remained the same but the course load is structured so that the students have the option of taking more electives.

The process for these modifications was to first gather information on the effectiveness of the curriculum. This information came from student feedback, employer interviews, alumni surveys, and comparisons with comparable institutions. The faculty reviewed the information as part of the regular faculty meetings. A total unit goal for the curriculum was set with a target number of units allocated to each area of specialization identified in the department objectives. The faculty used a top down approach to decide the courses and course content within each specialization. This approach involved creating a set of learning outcomes for each specialization which could be mapped into the department outcomes (CRITERION 3 - Section B). These new learning outcomes could then be mapped into desired courses and course level outcomes to support the curriculum. The outcomes for applied mechanics and design, manufacturing, thermal systems, and materials science are listed below.
Applied Mechanics and Design Outcomes

The student will be able to:

a. Understand the design process and translate product attributes into engineering requirements; manage the design process using appropriate project management techniques and work on a design project as part of a team. (ME outcomes c, d, e, g, k)

b. Document a mechanical design through coherent reports, specifications, and mechanical drawings. Understand machine tolerance and how it is applied in design practice. (ME outcomes c, d, e, g, k)

c. Understand how to use common machine components (i.e. bearings, gears, cams, springs, etc.). (ME outcomes c, e)

d. Understand how to determine forces and moments in mechanical systems (i.e. any system with moving components) through the use of engineering mechanics and vibrations. (ME outcomes a, b, e, k)

e. Use computer modeling to analyze systems in two and three dimensions; perform finite element analysis for mechanical components under static and dynamic loads. (ME outcomes a, k)

f. Develop mathematical models of physical systems using interdisciplinary modeling techniques; perform computer simulations of systems in the time and frequency domains for linear or non-linear models; demonstrate knowledge of control system design. (ME outcomes a, b, c, k)

g. Size and/or select components, materials, and manufacturing processes to ensure the safe and efficient operation of products and mechanical systems. (ME outcomes a, c, k).

Manufacturing Outcomes

The students will be able to:

a. Understand principles of various manufacturing processes and apply this knowledge for developing manufacturing plans of designed products. (ME outcomes a, c, k)

b. Demonstrate knowledge of modern systematic methodologies such as Concurrent Engineering (CE), Design for Manufacturing and Assembly (DFMA), Design to Cost (DTC), Design to Life Cycle Cost (DTLCC) and Supply Chain Management so that they can effectively integrate design and manufacturing processes for product developments. (ME outcomes a, c, f, k)

c. Demonstrate knowledge of modern product development processes such as Quality Function Deployment (QFD), Value Engineering, Design for Quality and Reliability, Design for Serviceability, and Design for Performance so that they can develop product considering business structures, customers, society, and the global environment. (ME outcomes a, b, c, e, k)

d. Carry out Quality Control (QC), Quality Assurance (QA) and continuous improvement processes through tools such as Failure Modes and Effects Analysis (FMEA), Statistical Process Control (SPC), and Cause and Effect Diagram. (ME outcomes a, c, f, k)
e. build hardware mechanical systems by fabricating necessary mechanical components with conventional machine tools, welding machines, and modern computer controlled manufacturing machines such as CNC machines. (ME outcomes a, b, c, e, k)
f. inspect manufactured parts to check if they conform to design specifications and to produce data necessary for Quality Control. (ME outcomes a, b, c, e, k)
g. function effectively as part of design and manufacturing teams (ME outcomes d, f, g, k)

Thermal Sciences Outcomes
By the end of the thermal-fluids sequence, each student will be able to:

a. State the laws of thermodynamics, describe the forms of energy and its transfer, and explain the operation of common power cycles, refrigeration cycles, and psychrometric processes (ME outcome a).
b. State the fundamental principles of mass and momentum conservation, explain the principles of internal and external flows and describe viscous flows and laminar and turbulent boundary layers (ME outcomes a).
c. Formulate and solve real-world problems by applying the laws of thermodynamics and principles of fluid flow and heat transfer (ME outcomes e, k).
d. Plan and conduct experiments, analyze data, calculate experimental uncertainty, present results and draw justified conclusions (ME outcomes b, g).
e. Evaluate and explain the environmental, economic and social impacts of energy systems (ME outcomes f, h, j).
f. Locate and utilize sources of thermal-fluid information and material properties (ME outcome i).

Materials Science Outcomes
The student will be able to:

a. understand how fundamental materials properties such as atomic bonding, atomic arrangements, and microstructure impact macroscopic properties; (ME outcome e)
b. conduct and interpret the results from standard mechanical tests; (ME outcomes b, g, k)
c. optimize materials choices for design applications including cost considerations; (ME outcome c)
d. understand the stress-strain relationships for simple and complex loading situations including yielding and fracture; (ME outcomes a, b, e)
e. use stress-based and strain-based approaches to fatigue; (ME outcomes a, b, e)
f. utilize binary equilibrium phase diagrams and their use to predict properties; (ME outcomes a, e, g)
g. understand the processes of solid state diffusion, the effects and limitations of alloying, and the processes and effects of standard heat treatments; (ME outcomes a, e)
h. understand fundamentals of electrochemical behavior; (ME outcomes a, e)
i. utilize experimental skills to measure and evaluate materials including microstructural analysis and mechanical properties; (ME outcomes b, g)
j. use analytical models for evaluation of deformation, mechanical, or chemical behaviors. (ME outcomes a, e)
Each group made recommendations as to the course sequence required to meet the outcomes. A summary of the changes to the program is listed below:

1. Delete from lower division required courses: ME 75
2. Replace ME 175 (3 units) with new course, ME 105 (3 units)
3. Replace E 115 (2 units) with new course, ME 108 (2 units)
4. Replace ME 118 (3 units) with new course, ME 116 (2 units)
5. Replace ME 119 (3 units) with new course, ME 117 (2 units)
6. Delete from upper division required courses: ME 125 (2 units)
7. Replace ME 127 (3 units) with new course, ME 128 (3 units)
8. Delete ME 115 (3 units)
9. Add new course, ME 172 (3 units)
10. Require all students to take ME 171 rather than a choice of ME 171 or ME 114
11. Reduce the number of units in ME 180 from 4 to 3
12. Reduce the number of units in ME 191 from 3 to 2

The specifics for these changes are as follows:

1. Eliminate ME 75 because students come to the program much more computer literate.
2. Replace ME 175 with ME 105 – continue to address the few essential topics from ME 75 with the additional material from ME 175.
3. Eliminate ME 125 and ME 127 creating one course, ME 128, with the essential material from both.
4. Replace ME 118 and ME 119 (Product Design) with more relevant, modern courses (in fact, what ME 118 and ME 119 were becoming) ME 116 and ME 117 (Machine Design).
5. Have all students take ME 171. Faculty want all students to have the same required program. Move ME 114 (previously the other choice) to elective status.
6. Replace ME 115 with ME 172. Move ME 115 to elective status. From comparison data and survey data it is apparent that the more essential material is in the area of Controls (ME 172).
7. Replace Engr 115 with a new course, ME 108. Mechanical Engineers need an introduction to both Engineering Statistics and Engineering Economics. The ME program has required one or the other of Engr 115 (Engineering Statistics) or Engr 140 (Engineering Economics) over the years depending on the focus of ABET comments. After discussion with the Civil Engineering Department (they are responsible for both Engr 115 and Engr 140) it was determined that the best solution would be to teach selected topics from both courses. (Something similar was done in response to ABET comments when EEE 120 was created for the EEE program using Engr 115 as the core).
8. Reduce ME 180 from 4 units to 3. There was overlap in topics in ME 180 and ME 119. This is eliminated in the new program. Modern materials topics (polymers, composites, etc.) will be moved to electives.
9. Reduce ME 191 from 3 units to 2. Students need more flexibility in their schedules which will result by eliminating one formal lab period. Lab remain open for student use outside of formal lab period.

A side by side comparison of the new curriculum and the old can be seen in Table 4-1.

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<tr>
<td>Phys 11C General Physics:Elec, Mag.</td>
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<td>Engr 6 Engineering Graphics CAD</td>
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<td>Engr 17 Intro to Circuit Analysis</td>
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<td>Engr 45 Engineering Materials</td>
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Table 4-1: Comparison of Curricula
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