New Mexico State University
Mechanical Engineering
Interim Report

Prepared for
The Engineering Accreditation Commission
Of
ABET, Inc.

June 2008
Table of Contents

Introduction .....................................................................................................................................1
Chapter 1 Executive Summary .......................................................................................................3
Chapter 2 Program Educational Objectives ....................................................................................4
Chapter 3 Program Outcomes and Assessment: Process ..............................................................16
Chapter 4 Program Outcomes and Assessment: Data ...................................................................45
Chapter 5 Program Outcomes and Assessment: Narrative ...........................................................99
Chapter 6 Program Concern: Criteria 4 Professional Component ..................................................104
Chapter 7 Concluding Remarks ..................................................................................................124

Appendix  ME Course Numbering and Descriptions .................................................................126
Introduction

The baccalaureate program in Mechanical Engineering at New Mexico State University has been continuously accredited by the Engineering Accreditation Commission (EAC) of ABET, Inc., since 1938. In response to a request for reaccreditation, a team representing the EAC of ABET, Inc., reviewed the program during a site visit on October 8-10, 2006. After due process, the EAC, at its 2007 Summer Meeting, voted to reaccredit the program until September 30, 2009. To continue accreditation beyond September 30, 2009, the program must submit a report describing the actions taken to correct shortcomings identified during the site visit. This document is that report.
Institutional Weakness: ABET, Inc., requires proper usage of terminology and accreditation identifiers in assorted publications by the institutions. The college website needs to conform appropriately to have identified the Engineering Accreditation Commission of ABET, Inc., as the accreditation body. Furthermore, identifying engineering co-op as accredited programs can be misleading to the public since there is no separate accreditation for the co-op engineering programs.

Due-process response: An extensive review has been made of college and departmental websites, publications, and miscellaneous printed material. All references to, and descriptions of, accreditation have been modified to meet ABET, Inc., requirements. The environmental engineering and co-op programs no longer mention ABET, Inc., or accreditation. All modifiers to accreditation have been removed. All references to ABET or Accreditation Board for Engineering and Technology have been changed to include the appropriate commission of ABET, Inc. Existing stocks of publications will continue to be used until exhausted. Replacements will contain the corrections.

Status after Due Process: The weakness is now cited as a concern.

Interim Report Progress: The college strives to make the individuals responsible for web page creation and maintenance aware of ABET, Inc., requirements, with respect to terminology and accreditation identifiers. Periodic sweeps are made of all university, college, and departmental websites in an attempt to identify and correct inappropriate references to ABET, Inc., and accreditation. All materials which contain references to ABET, Inc., or accreditation are now required to obtain approval from the Associate Dean of Engineering before publication.
Chapter 1 Executive Summary

Following the ABET site visit in Fall 2006, the ABET Engineering Accreditation Commission (EAC) in 2007 identified two weaknesses and one concern in the NMSU ME program:

Weakness – Criterion 2: Program Educational Objectives
Weakness – Criterion 3: Program Outcomes and Assessment
Concern – Program Criterion 4: Professional Component

During the period Spring 2006 through Spring 2008, the NMSU ME Department has taken the following actions to ensure compliance with ABET requirements:

1) New educational objectives were developed in 2007 to reflect the career and professional accomplishments for which graduates are being prepared.
2) The assessment process described in the 2006 NMSU self-study has now been in successful operation for five long semesters (Spring 2006 – Spring 2008), demonstrating full implementation of the assessment process.
3) The documentation requirements in the senior capstone design course have been expanded significantly to ensure that sufficient scope and depth in these projects is apparent in the documentation.

The layout of this document is as follows:

Chapter 2 addresses the weakness in Criterion 2, Program Educational Objectives. The new objectives developed in 2007 are stated.

Chapters 3 – 5 address the weakness in Criterion 3, Program Outcomes and Assessment. Chapter 3 describes the process that we have used during the past five long semesters to assess the program outcomes and educational objectives. Chapter 4 contains the bulk of the data used in the assessment process. Chapter 5 contains an assessment narrative for outcomes and objectives and is essentially an addendum to Chapters 2-4.

Chapter 6 addresses the concern in Program Criterion 4, Professional Component, describing the senior capstone design processes that ensure compliance with this program criterion.

Chapter 7 contains some possible future improvements in our assessment process for outcomes and objectives.
Chapter 2 Program Educational Objectives

1. Visit Finding -- Program Weakness: Criterion 2. Program Educational Objectives

“Program educational objectives were established in 2000 but these objectives are not broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve as required by Criterion 2. While this issue has been addressed with some of the constituencies, the program has yet to commence a process to re-define the objectives. This constitutes a weakness and requires remedial action.”

Due-process response: The EAC acknowledges the receipt of statement that the program ABET Outcomes and Assessment (O&A) Committee is soliciting input from the Mechanical Engineering industrial Advisory Committee and the Mechanical Engineering Academy and planning to solicit input from the students in this regard. The committee meets regularly and will bring a proposal to the mechanical engineering faculty for discussion and approval by the end of the spring 2007 semester. Furthermore, the educational objectives have been proposed by the Industrial Advisory Committee and are currently under consideration.

Status after Due Process: The weakness remains unresolved and will be a focus of the next review. In preparation for this review, the EAC anticipates further documentation of the application and assessment of the program’s educational objectives.

Current Status/Progress – ABET evaluators noted that our 2006 educational objectives (which were the same as those stated in 2000) were not distinct from program outcomes, but were merely a repackaging of them, whereas educational objectives are supposed to describe the career and professional accomplishments that are demonstrated by graduates in the work place.

Dr. Burton, department head, and Dr. Pederson, associate head, responded quickly to these observations. Dr. Burton elicited assistance from the Mechanical Engineering Academy (MEA) whose members are (or were) active in the industries and agencies to which our graduates aspire. In particular, one Academy member has been an ABET evaluator. He was helpful during the preparation of the initial self-study, and has been invaluable in the effort to reframe our educational objectives.

Dr. Pederson and the ABET coordinator also researched the educational objectives adopted by other mechanical engineering programs. A draft was presented during the annual Mechanical Engineering Academy meeting in February 2007 based on that research and on a slate of objectives used by the University of Virginia.

The O&A Committee reviewed this input in relation to possible measurement tools with the resulting objectives adopted by the department. Measurement goals were set, and tools defined.
The Educational Objectives adopted by the Mechanical Engineering Department in 2007 are:

**Objective 1. Technical knowledge**

Graduates will possess a mastery of the fundamentals of mechanical engineering necessary to be productive and innovative engineers in industry or government, prosperous entrepreneurs, and/or succeed in graduate or other professional schools, and to advance in their employment. This objective fulfills one of the key missions of New Mexico State University by providing individuals with a depth of knowledge in a specific field so that they may realize their full potential as informed, productive citizens with a lifelong commitment to innovation, learning, and service. Our goal is that within one year of graduation, our graduates will be professionally employed or in good academic standing in a graduate or professional school. Furthermore, we expect that our graduates will be recognized as being technically competent by their employers. We also expect that graduates who choose to pursue postgraduate studies will successfully obtain the advanced degree(s) they desire.

**Measurement:** Alumni Survey information, Questions 9 & 10: (9) number employed in ME field, (10) Number who complete MS graduate program within 3-5 years of graduation.

**Objective 2. Problem solving skills**

Graduates will be able to formulate, analyze, and creatively participate in the solution of multidisciplinary technical problems through the use of modern engineering tools, be they experimental, analytical, or computational. This objective recognizes that to remain globally competitive, companies need engineers at all degree levels who can creatively overcome the real technological challenges facing society, beginning in New Mexico and extending to the world, and that the ability to utilize modern engineering tools is essential to meeting these challenges. We expect that by providing our students with multidisciplinary technical problem solving skills, our graduates will be valued employees and entrepreneurs, and as a result, will earn competitive salaries and advance along their desired career path.

**Measurement:** Alumni Survey information, Question 6: (6) Participation on multidisciplinary teams; disciplines represented.

**Objective 3. Communication skills**

Graduates will be able to communicate clearly and effectively with fellow engineers, employers, and the general public. This objective recognizes that for individuals to be successful, they must have strong interpersonal skills, and be able to interact and share ideas with others in both oral and written form. For engineers, this includes both technical and non-technical audiences. We expect that developing strong communication skills will immediately benefit our graduates by enabling them to effectively discuss their qualifications with prospective employers, and thus enable them to successfully compete globally for the best available jobs. Furthermore, because communication skills are essential to effective leadership and management, our graduates who desire to assume leadership and management roles will begin to attain these roles within three to five years of graduation.
Measurement: Alumni Survey information, Questions 5 & 6: (5) supervision responsibility, (6) Participation on multidisciplinary teams; disciplines represented.

Objective 4. Professionalism

Graduates will possess the skills needed to fulfill their professional duties and responsibilities in teamwork, collegiality, ethics, technical leadership, business acumen, and lifelong learning. This objective underscores the need for professional integrity, a commitment to diversity, and a lifelong passion for learning, as set forth in the mission statements of the College and University. We expect that developing these attributes will enable our graduates to successfully advance along their desired career path. Furthermore, we expect that within ten years of graduation, a number of our alumni will be recognized as leaders in their professions and communities.

Measurement: Google search for status of graduates.


A report on the assessment activities related to the Educational Objectives is presented in Chapter 3 as part of the response to the identified weakness in our implementation of an assessment process.

Progress

Following adoption, in 2007, of the revised educational objectives, all course syllabi were updated to reflect the changes, assuring curriculum correspondence with the new objectives. Course objectives (which align with program outcomes) were also reviewed and updated where necessary.

A survey was distributed prior to the Mechanical Engineering Academy meeting in February 2008 soliciting input from the general Academy members about the ME program educational objectives and program outcomes as they applied to the workplace. The results are shown below, and a copy of the ME Academy Survey is included at the end of this chapter. Sixteen Academy members completed the survey.

When asked to rate the Educational Objectives by importance in the work place on a scale of 1 to 4, with 1 being the highest rank, 100% of the members chose Problem Solving Skills as most important, followed by Technical Knowledge, Professionalism, and Communication.
The Academy members were asked to identify other factors they thought contributed to work place success. Repeated responses included:

- Post graduate education and life-long learning
- Teamwork
- Ability to multi-task
- Mentors
- Perseverance and hard work
The survey also requested Academy members to rank the importance in the workplace of ME’s program outcomes. A chart showing their response is included below:

![Chart showing the importance of Program Outcomes in the Workplace](image)

Figure 2.2. Mechanical Engineering Academy rating of the importance of ME’s program outcomes in workplace success. (Number of respondents=16.)

The chart below ranks these ratings:

![Chart ranking the importance of Program Outcomes in the Workplace](image)

Figure 2.3 Rank of program outcomes based on Mechanical Engineering Academy evaluation of their importance in the workplace. (Number of respondents=16.)
Status Summary – Program Educational Objectives

In response to the August 2007 ABET final report and in consultation with the department’s Mechanical Engineering Academy and Industrial Advisory Committee (IAC), new program educational objectives were developed in 2007. All course syllabi were reviewed to reflect the changes. A survey of the MEA attendees at the February 2008 annual meeting was conducted to evaluate the importance of each objective. Alumni surveys of two and five year graduates are in process, but results of these surveys are limited. Assessment of the program educational objectives is discussed in Chapter 3. A copy of the Alumni Survey is also included at the end of this chapter.
Mechanical Engineering Academy Survey 2008

We are requesting your input into the mission and content of our program of study, specifically as it relates to the current workplace. All of you are, or have been, engaged in the professional practice of mechanical engineering and have significant experience from which to consider the relative importance of various areas of the curriculum. We would appreciate your completing this short survey and assure you that your responses will be used in assessing our program. Thank you for your time and concern.

Name (optional):

Professional field:

Status (delete one): Active Retired

Educational level (delete except highest level): Bachelor Master’s PhD

1. According to importance, what are the three most significant factors for success in your career?

<table>
<thead>
<tr>
<th>Factor?</th>
<th>Why Important?</th>
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<tbody>
<tr>
<td>a.</td>
<td>b.</td>
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<tr>
<td>c.</td>
<td>d.</td>
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<tr>
<td>e.</td>
<td>f.</td>
</tr>
</tbody>
</table>

Program Educational Objectives

2. The Mechanical Engineering Department has been guided in the design of its program and curriculum by the educational objectives listed in the table below.

- **RANK**: Please rank 1-4 how important you believe these 4 objectives to be as they relate to your professional career with 1 being the most important and 4 being the least important.

<table>
<thead>
<tr>
<th>Graduates will possess a mastery of the fundamentals of mechanical engineering necessary to be productive and innovative engineers in industry or government, prosperous entrepreneurs, and/or succeed in graduate or other professional schools, and to advance in their employment.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graduates will be able to formulate, analyze, and creatively participate in the solution of multidisciplinary technical problems through the use of modern engineering tools, be they experimental, analytical, or computational.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Graduates will be able to communicate clearly and effectively with fellow engineers, employers, and the general public.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Graduates will possess skills needed to fulfill their professional duties and responsibilities in teamwork, congeniality, ethics, technical leadership, business acumen, and lifelong learning.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
The Mechanical and Aerospace Engineering Department have adopted the following outcomes recommended by ABET (our accreditation standard).

- **RANK:** Please rank 1-4 how important you believe these outcomes to be as they relate to your professional career with 1 being extremely important and 4 being the least important.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apply knowledge of mathematics, science, and engineering;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design and conduct experiments, analyze and interpret data;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design a system, component, or process;</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Function on multi-disciplinary teams;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identify, formulate and solve engineering problems;</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Understand professional and ethical responsibility;</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Communicate effectively;</td>
<td></td>
<td></td>
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<tr>
<td>Understand the impact of engineering solutions in a global and societal context;</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engage in lifelong learning;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recognize contemporary issues;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use techniques, skills, and modern engineering tools for engineering practice.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Comments:**

*Thank you so much for taking the time to assist us with this interview.*

*Use the enclosed self-addressed stamped envelope to return the completed survey to the Mechanical Engineering Department.*
Alumni Survey 2007

The purpose of this survey is to determine whether you feel that your education in Mechanical Engineering at New Mexico State University adequately prepared you for your career. Your responses will assist us in making decisions about our program and curriculum design.

<table>
<thead>
<tr>
<th>Name:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Address:</td>
<td></td>
</tr>
<tr>
<td>(street)</td>
<td>(city)</td>
</tr>
<tr>
<td>Phone:</td>
<td>E Mail:</td>
</tr>
<tr>
<td>Graduating Class:</td>
<td>Major: Mechanical Engineering</td>
</tr>
</tbody>
</table>

Your Professional Status

3. What is your current employment status?

- [ ] Full time
- [ ] Part time
- [ ] Seeking employment (skip to question 8)
- [ ] Retired (skip to question 8)

4. What is the title of your present position? __________________________________________

5. Who is your present employer? ______________________________________________________

6. How long have you worked for your present employer? _________________

7. In your present job, how many individuals do you supervise? ____________

8. Please list any team projects and/or multi-disciplinary projects that you participated on in your present job. Please also list the disciplines which were represented on these projects or teams.

   ________________________________________________________________________________
   ________________________________________________________________________________
   ________________________________________________________________________________
   ________________________________________________________________________________

9. Please briefly describe your primary job responsibilities:

   ________________________________________________________________________________
   ________________________________________________________________________________
   ________________________________________________________________________________
   ________________________________________________________________________________

10. How many positions (total of employers and positions with each employer) have you held since graduating from NMSU? _______

11. Of these positions, how many are directly related to the training and education received in the Mechanical Engineering program at NMSU? _______
12. Please list any graduate studies that you pursued after graduating from NMSU:

Schools attended:

__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________

Degree(s) received:

__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________

13. According to importance, what are the three most significant factors for success in your career?

<table>
<thead>
<tr>
<th>Factor?</th>
<th>Why Important?</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>b.</td>
</tr>
<tr>
<td>c.</td>
<td>d.</td>
</tr>
<tr>
<td>e.</td>
<td>f.</td>
</tr>
</tbody>
</table>

**Program Educational Objectives**

14. The Mechanical Engineering Department has been guided in the design of its program and curriculum by the educational objectives listed in the table below.

- **RANK**: Please rank in order of 1 to 4 how important you believe these 4 objectives to be as they relate to your professional career with 1 being the most important and 4 being the least important.
- **PREPARATION**: Please rate how successfully we prepared you in these areas with 1 being “Not at All” to 5 being “Very Well”.

<table>
<thead>
<tr>
<th>RANK</th>
<th>OBJECTIVES</th>
<th>PREPARATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Graduates will possess a mastery of the fundamentals of mechanical engineering necessary to be productive and innovative engineers in industry or government, prosperous entrepreneurs, and/or succeed in graduate or other professional schools, and to advance in their employment.</td>
<td>e. 1 2 3 4 5</td>
</tr>
<tr>
<td>b.</td>
<td>Graduates will be able to formulate, analyze, and creatively participate in the solution of multidisciplinary technical problems through the use of modern engineering tools, be they experimental, analytical, or computational.</td>
<td>f. 1 2 3 4 5</td>
</tr>
<tr>
<td>c.</td>
<td>Graduates will be able to communicate clearly and effectively with fellow engineers, employers, and the general public.</td>
<td>g. 1 2 3 4 5</td>
</tr>
<tr>
<td>d.</td>
<td>Graduates will possess skills needed to fulfill their professional duties and responsibilities in teamwork, congeniality, ethics, technical leadership, business acumen, and lifelong learning.</td>
<td>h. 1 2 3 4 5</td>
</tr>
</tbody>
</table>
Quality of the Mechanical Engineering Program at NMSU

15. According to the following scale, please circle the number that best reflects your opinion on the given statements, where

<table>
<thead>
<tr>
<th>1 = Strongly Disagree</th>
<th>2 = Disagree</th>
<th>3 = Neutral</th>
<th>4 = Agree</th>
<th>5 = Strongly Agree</th>
</tr>
</thead>
</table>

The ME program provided me with sufficient knowledge and experience to:

- Apply knowledge of mathematics, science, and engineering; a. 1 2 3 4 5
- Design and conduct experiments, analyze and interpret data; b. 1 2 3 4 5
- Design a system, component, or process; c. 1 2 3 4 5
- Function on multi-disciplinary teams; d. 1 2 3 4 5
- Identify, formulate and solve engineering problems; e. 1 2 3 4 5
- Understand professional and ethical responsibility; f. 1 2 3 4 5
- Communicate effectively; g. 1 2 3 4 5
- Understand the impact of engineering solutions in a global and societal context; h. 1 2 3 4 5
- Engage in lifelong learning; i. 1 2 3 4 5
- Recognize contemporary issues; j. 1 2 3 4 5
- Use techniques, skills, and modern engineering tools for engineering practice. k. 1 2 3 4 5

16. According to the following scale, please circle the number that best reflects your agreement with the given statements, where

<table>
<thead>
<tr>
<th>1 = Strongly Disagree</th>
<th>2 = Disagree</th>
<th>3 = Neutral</th>
<th>4 = Agree</th>
<th>5 = Strongly Agree</th>
</tr>
</thead>
</table>

- Students’ have an excellent ability to handle real-world engineering problems; a. 1 2 3 4 5
- The quality of instruction in the ME program is excellent; b. 1 2 3 4 5
- The system of advising in the ME department is excellent; c. 1 2 3 4 5
- The NMSU Placement & Career Services system is excellent; d. 1 2 3 4 5
- The physical facilities (such as classrooms, labs, etc.) in the ME department are excellent; e. 1 2 3 4 5
- The computer facilities in the ME department are excellent; f. 1 2 3 4 5
- The Student Project Shop facilities are excellent. g. 1 2 3 4 5

17. Please list your memberships in any professional associations?
________________________________________________________________________________________
________________________________________________________________________________________

18. Please list any special engineering licenses or certifications that you have received, or are in the process of pursuing?
________________________________________________________________________________________
________________________________________________________________________________________

19. Approximately how many continuing education courses, workshops, or seminars have you taken since graduating from NMSU? ____________
20. Please list any activities or programs that were particularly helpful as preparation for your career while you were a student at NMSU.
________________________________________________________________________________________
________________________________________________________________________________________
________________________________________________________________________________________

21. Please suggest any courses/topics not offered in the ME program that would have better prepared you for your career.
________________________________________________________________________________________
________________________________________________________________________________________
________________________________________________________________________________________

22. Please give any suggestions for the ME Department that will help us better prepare our students for the workplace?
________________________________________________________________________________________
________________________________________________________________________________________
________________________________________________________________________________________
________________________________________________________________________________________

Thank you so much for taking the time to assist us with this interview. Use the enclosed self-addressed stamped envelope to return the completed survey to the Mechanical Engineering Department.

If you prefer, you may fill out and submit this form electronically at:

http://me.nmsu.edu/alumni/alumni_survey.html
Chapter 3 Program Outcomes and Assessment: Process


“An excellent assessment process has been implemented that addresses all of the stated program outcomes. However, this process has yet to be fully implemented and this constitutes a weakness in compliance with the criterion.”

Due-process response – The program reports progress in carrying out the outcomes and assessment process.

Status after Due Process: The weakness remains and will be the focus of the next review. In preparation for this review, the EAC anticipates further documentation of the full implementation of the outcome process.

Current Status/Progress – The Mechanical Engineering department has worked diligently to fully implement the outcomes and assessment plan adopted in 2006. We now have five semesters of data to describe how our courses are intended to enable students to achieve the ABET outcomes, and the results achieved.

Summary of NMSU's Mechanical Engineering Assessment Process.

The NMSU plan for assessment of outcomes and educational objectives was formulated during the period Fall 2005 – Spring 2006 and was reported as Chapter 3 of the 2006 self-study document. The plan outlined in the 2006 self-study document has been in force for the five long semesters Spring 2006 through Spring 2008. Descriptions of some elements of the plan are repeated here as appropriate, especially in cases for which changes have occurred (for example, the new educational objectives developed in 2007 were incorporated following their adoption). For the complete description of the assessment plan please refer to Chapter 3 of the 2006 self-study document. The purpose of this section is to describe the key elements of the plan that are used to demonstrate assessment of program outcomes and educational objectives, the use of these elements to “close the loop” of the assessment process, and the resulting continuous improvement of the undergraduate program.

Figure 3.1 depicts the improvement process as embedded in our institutional and departmental mission.

There are two primary levels of activity in the assessment of program outcomes. The first level is individual faculty assessment of achievement of student outcomes in specific courses, the results of which comprise one assessment tool. The second level is the broader, overall assessment by the Outcomes and Assessment Committee, utilizing all of the assessment tools described Chapter 3 of the self-study report and summarized in this chapter. The assessment of outcomes and objectives involves use of the Continuous Improvement Loop process depicted in Figure 3.1. This process is adapted to each level of activity, and this schematic forms the assessment format for each program outcome. The two assessment processes, as they have been implemented
during the past five semesters, are described in more detail here. In Chapter 4, “Outcomes Data”,
continuous application of the processes is demonstrated.
Figure 3.1 Continuous Quality Improvement Loop
Statement of Program Outcomes

The Mechanical Engineering Department has adopted ABET program outcomes (a) through (k) to foster achievement of the program educational objectives. These outcomes ensure that students have the skills, knowledge and behavior at the time of degree completion that will enable them to realize the educational objectives in their professional lives. **Program outcomes are stated below:**

a. an ability to apply knowledge of mathematics, science and engineering  
b. an ability to design and conduct experiments, as well as to analyze and interpret data  
c. an ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability  
d. an ability to function on multidisciplinary teams  
e. an ability to identify, formulate, and solve engineering problems  
f. an understanding of professional and ethical responsibility  
g. an ability to communicate effectively  
h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context  
i. a recognition of the need for, and an ability to engage in lifelong learning  
j. a knowledge of contemporary issues pertaining to the engineering field  
k. an ability to used the techniques, skills and modern engineering tools necessary for engineering practice.

Table 3.1 shows the relationship between the Program Outcomes and the new Program Educational Objectives.

### Table 3.1 Relationship of Program Educational Objectives to Program Outcomes

<table>
<thead>
<tr>
<th>Educational Objectives</th>
<th>Program Outcomes</th>
</tr>
</thead>
</table>
| Graduates will possess a mastery of the fundamentals of mechanical engineering necessary to be productive and innovative engineers in industry or government, prosperous entrepreneurs, and/or succeed in graduate or other professional schools, and to advance in their employment. | (a) ability to apply knowledge of math, science and engineering  
(e) ability to identify, formulate and solve engineering problems  
(k) ability to use techniques, skills and modern engineering tools for engineering practice |
Table 3.2 contains the matrix showing (as X’s) which ME required courses contribute to satisfaction of each program outcome, each educational objective, and each ME specific program criterion. The shaded X’s for a given course define the assessments that are scheduled to be done for that course. For each shaded X an assessment flow chart is developed and generated each semester by the course instructor. In this process, the faculty member defines the measures of student accomplishment to be used and then specifies how the assessment measures will be employed to judge student outcomes. Actual student performance is compared to the assessment metric. Based on this analysis, the faculty member recommends changes/improvements in learning strategies, teaching methods, and/or class content. Each such faculty-generated analysis is later considered as one of several assessment tools in the overall outcomes assessment performed by the O&A committee.
### Table 3.2  Mapping of Mechanical Engineering Curriculum to Program Outcomes

<table>
<thead>
<tr>
<th>Curriculum Area</th>
<th>Credits</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
<th>f</th>
<th>g</th>
<th>h</th>
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<th>j</th>
<th>k</th>
<th>A</th>
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<th>PC1</th>
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<tr>
<td><strong>Required Mechanical Engineering Courses</strong></td>
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As an example of the faculty assessment process, a set of outcomes assessment flow charts for Engineering Analysis (ME 329), outcome (a), is presented below. The course syllabus states the program objectives, program outcomes, professional components, and program specific criteria that are relevant to this course. The flow charts included here cover the history of outcome (a) for the five semesters Spring 2006 – Spring 2008. The block labeled “Measure” states the faculty-identified student work that is to be used in the assessment; in this case there are three measures. The block labeled “Assessment” states quantitative criteria used to evaluate the measures. The block labeled “Improvement” is the instructor assessment of steps needed to improve the quality of the course. The flow chart for the subsequent semester includes this plan as “Improvement Implemented.” The five flow charts for the five semesters of evaluation show the cycle of improvements made in given semesters and subsequently evaluated in succeeding semesters. This semester-by-semester improvement process for specific outcomes in individual courses is the backbone of our outcomes assessment process. According to Table 3.2, each semester thirty-five outcome flow charts are generated by faculty in sixteen different courses; each flow chart contains one or more measures used to assess one outcome in that course.
<table>
<thead>
<tr>
<th>Course Information</th>
<th>ME 329 Engineering Analysis II – Required – 3 credits</th>
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<tbody>
<tr>
<td><strong>Spring 2008</strong></td>
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<thead>
<tr>
<th><strong>INSTRUCTOR:</strong></th>
<th>Ian H Leslie</th>
</tr>
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<tbody>
<tr>
<td><strong>Office:</strong></td>
<td>JH112</td>
</tr>
<tr>
<td><strong>Phone:</strong></td>
<td>646-2335</td>
</tr>
<tr>
<td><strong>Email:</strong></td>
<td><a href="mailto:ileslie@nmsu.edu">ileslie@nmsu.edu</a></td>
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<tr>
<th><strong>ASSISTANTS:</strong></th>
<th>none</th>
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| **OFFICE HOURS:** | See office door. |

| **CATALOG DESCRIPTION:** | Numerical methods for roots of linear and nonlinear equations, numerical integration, and solution of ordinary differential equations with emphasis on software design and engineering applications. |

| **PREREQUISITES:** | Math 392 and ME 260 |

| **TEXT:** | Applied Numerical Methods with MATLAB, 2nd Ed., by Steven Chapra |

| **CLASS SCHEDULE:** | MWF 8:30 – 9:20 AM |

| **GRADES:** | Homework 70%, Quizzes 30% |

| **COURSE OBJECTIVES:** | • Students will learn a variety of numerical methods that are useful in both basic and advanced engineering calculations. (a, e)  
|                       | • Students will develop an appreciation for the hazards and limitations of numerical solutions, including accuracy, stability, and computer limitations of memory and speed. (e, k)  
|                       | • Students will learn the basics of Matlab. (k) |

| **TOPICS COVERED:** | • Roots of Equations  
|                    | • Linear systems of equations  
|                    | • Non Linear systems of equations  
|                    | • Interpolation and Curve fitting  
|                    | • Numerical differentiation and integration  
|                    | • Solution of Ordinary differential equations  
|                    | • Solution of Partial differential equations |

| **RELATIONSHIP TO PROGRAM EDUCATIONAL OBJECTIVES:** | A-mastery of the fundamentals of mechanical engineering necessary to be productive and innovative engineers, in industry or academia, and to advance in their employment. |

| **RELATIONSHIP TO PROGRAM OUTCOMES:** | a – ability to apply knowledge of math, science, and engineering  
|                                       | k – ability to use techniques, skills and modern engineering tools for engineering practice |

| **CONTRIBUTION TO PROFESSIONAL COMPONENT:** | PC2 – 1 year math and basic science |

| **RELATIONSHIP TO ABET SPECIFIC CRITERIA:** | ME2 – the ability to apply advanced mathematics through multivariate calculus and differential equations  
|                                               | ME3 – familiarity with statistics and linear algebra |

| **POLICIES:** | • Homework assignments must be turned in on time for full credit.  
|               | • Homework will be accepted up to two days late with a 20% per day penalty.  
|               | • Collaboration in the form of discussion of formulation of solutions or results is encouraged for homework; however, each individual must work independently to create the final homework solution.  
|               | • Collaboration in any form is not allowed for the Exams.  
|               | • Grades may be curved but the instructor makes no commitment to do so. |

| **AUTHOR/DATE:** | I. H. Leslie 8/20/2007 |
Outcome (a): Ability to apply knowledge of math, science, and engineering

Students will learn a variety of numerical methods that are useful in both basic and advanced engineering calculations.

Measure

Selected assignments:

Assignment # 8
Assignment # 10
Assignment # 12

Learning Strategies

In class development of theory
Q & A during class
Q & A during office hours
Feedback via instructor’s solutions to projects

Assessment

80% earn 70% or higher on projects.

Evaluation

55% earned 70% or higher on Assignment # 8
70% earned 70% or higher on Assignment # 10
75% earned 70% or higher on Assignment # 12

Improvements

Show class results of Gauss-Seidel iteration with relaxation and discuss features to look for and problems to avoid.

Work a non-linear fitting example in class that demonstrates clearly the difference between a linearized and non-linearized fit.

Demonstrate how to change limits for use with Gauss quadrature.

Display Material Reference:

Course syllabus
Homework assignments and supporting material from text.
Grade sheet
ME 329: Engineering Analysis II

Fall 2006

Outcome (a): Ability to apply knowledge of math, science, and engineering

Students will learn a variety of numerical methods that are useful in both basic and advanced engineering calculations.

Measure

Selected assignments:
1. Gauss-Seidel/Jordan
2. Polynomial Least Squares
3. Explicit Finite Differences

Learning Strategies

In class development of theory
Q & A during class
Q & A during office hours
Feedback via instructor’s solutions to projects

Assessment

80% earn 70% or higher on projects.

Evaluation

79% earned 70% or higher on # 1
53% earned 70% or higher on # 2
61% earned 70% or higher on # 3

Discretionary Step

Show class results of Gauss-Seidel iteration with relaxation and discuss features to look for and problems to avoid.

Work a non-linear fitting example in class that demonstrates clearly the difference between a linearized and non-linearized fit.

Demonstrate how to change limits for use with Gauss quadrature

Display Material Reference:

Course syllabus
Homework assignments and supporting material
Grade sheet

Improvement Implemented

Evaluate

Discussions relationships in more depth.

Work a 3rd order polynomial example in class that demonstrates clearly the difference between fitting linear and polynomial models.

Spend more time in class discussing the time marching process for the explicit finite difference method, and the impact of stability.
Outcome (a): Ability to apply knowledge of math, science, and engineering

Students will learn a variety of numerical methods that are useful in both basic and advanced engineering calculations.

Measure

Selected assignments:
Assignment # 2
Assignment # 10
Assignment # 13

Learning Strategies

In class development of theory
Q & A during class
Q & A during office hours
Feedback via instructor’s solutions to projects

Assessment

70% earn 70% or higher on projects.

Evaluation

92.9% earned average >= 70%

Improve(s) Implemented

(If different from planned improvement, please explain.)

Discuss recursion relationships in more depth.

Work a 3rd order polynomial example in class that demonstrates clearly the difference between fitting linear and polynomial models.

Spend more time in class discussing the time marching process for the explicit finite difference method, and the impact of stability.

Display Material Reference:

Course syllabus
ME 329: Engineering Analysis II  

Fall 2007

Outcome (a): Ability to apply knowledge of math, science, and engineering

Students will learn a variety of numerical methods that are useful in both basic and advanced engineering calculations.

Measure

Selected assignments:
- Assignment # 2
- Assignment # 10
- Assignment # 13

Learning Strategies

- In class development of theory
- Q & A during class
- Q & A during office hours
- Feedback via instructor’s solutions to projects

Assessment

80% earn 70% or higher on projects.

Evaluation

77.1% earned 70% or higher on selected projects.

Improvement(s) Implemented

Based on last semester’s performance, assessment goal set higher: 80% earn 70% or higher on projects.

No changes proposed.

Display Material Reference:

Course syllabus
ME 329: Engineering Analysis II          Spring 2008/Leslie

Outcome (a): Ability to apply knowledge of math, science, and engineering

Students will learn a variety of numerical methods that are useful in both basic and advanced engineering calculations.

Measure

Selected assignments:

Assignment # 2
Assignment # 10
Assignment # 13

Learning Strategies

In class development of theory
Q & A during class
Q & A during office hours
Feedback via instructor’s solutions to projects

Assessment

80% earn 70% or higher on projects.

Evaluation

86% earned 70% or higher on the three selected assignments.

Zeros were left out that reflected functional dropouts or people caught cheating.

Improvement(s) Implemented

Goal met.

Improvements

Replace one of the assignments with a quiz to better test ability. High results may reflect excessive collaboration.

Display Material Reference:

Course syllabus
The faculty-generated results for those courses assessed in a given semester are provided to the O&A committee for further review. The implementation of these individual course assessment tools, tied directly to the course syllabus, provides better quality control of course content than previously existed, because the same syllabus applies no matter who teaches the course.

Examples of flow charts reflecting improvements, and closing of the quality improvement loop are presented in Chapter 4: Outcome Data

As noted, the aforementioned individual course outcome assessments provide one assessment tool. The complete set of assessment tools that are used by the O&A committee are summarized in Table 3.2; a full description of the tools is presented in the 2006 Self-Study.
Table 3.2 Summary of Assessment Tools

<table>
<thead>
<tr>
<th>Tool</th>
<th>Primary Use</th>
<th>Secondary Use</th>
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<tbody>
<tr>
<td>Faculty Assessment in courses</td>
<td>Course outcome improvements</td>
<td>Overall curriculum assessment</td>
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<tr>
<td>FE Exam results</td>
<td>Assess outcomes in specific content areas</td>
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<tr>
<td>Senior Exit Survey</td>
<td>Student assessment of outcome achievement</td>
<td>Comparison with Alumni surveys</td>
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<td>Feedback on facilities, e.g. labs Curriculum</td>
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<td>Overview Backup to other outcome assessments</td>
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<td>Capstone Reviews by clients, IAC</td>
<td>Capstone Design evaluation, Outcomes Assessment</td>
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<tr>
<td>Placement &amp; Career Services, Co-op Reports¹</td>
<td>Educational objectives, co-op evaluation</td>
<td>Improvement in co-op, intern programs</td>
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<tr>
<td>Performance in project work and activity based</td>
<td>Outcomes Assessment</td>
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<td>learning – club functions, competitions,</td>
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<td>conferences</td>
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<td>IAC recommendations¹</td>
<td>Educational Objectives, curriculum</td>
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<tr>
<td>Mechanical Engineering Academy, Alumni Survey²</td>
<td>Assessment of Program Educational Objectives,</td>
<td>Comparison with similar sections of Senior Exit Survey</td>
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<td>Outcomes</td>
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<tr>
<td>Transcripts</td>
<td>Monitor student progress in required courses,</td>
<td>Used by individual faculty for improvement of instruction</td>
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<td>prerequisites, academic standing</td>
<td>(documentation needed).</td>
</tr>
<tr>
<td>Course/Instructor Evaluations</td>
<td>Dept. Head – evaluation of faculty instruction</td>
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</table>

1. Revision of Educational Objectives has resulted in postponement/delay in accumulating data.
2. Plans for this assessment tool were placed on hold while educational objectives were revised and the new objectives incorporated into the program and existing assessment procedures. We have received a limited response to date. The O&A Committee is exploring ways to increase alumni participation.
Role of the Outcomes and Assessment Committee

The Outcomes and Assessment Committee conducts its program analyses according to the timeline shown in Table 3.3. In addition, individual faculty and the O&A committee utilize the mapping of mechanical engineering courses to program outcomes, professional components, and ME specific criteria shown in Table 3.2. The O&A Committee maintains binders for each course, as well as for each outcome and the objectives. These are extremely beneficial as reference material for the committee and the faculty, especially in the case of courses that are rotated between or among different faculty.

Table 3.3 Timeline for Assessment Activities

<table>
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<th>Assessment Activity</th>
<th>How Often</th>
<th>Collection Date</th>
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<tr>
<td>Alumni Survey</td>
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<tr>
<td>Faculty Assessment in courses</td>
<td>Each semester</td>
<td>End of each semester</td>
</tr>
<tr>
<td>FE Exam Results</td>
<td>Yearly</td>
<td>Fall, Spring</td>
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<tr>
<td>Senior Exit Interviews</td>
<td>Yearly</td>
<td>Fall, Spring</td>
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<tr>
<td>Placement &amp; Career Services, Co-op Reports</td>
<td>Biennially</td>
<td>Continuous</td>
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<tr>
<td>Capstone Reviews by clients, IAC</td>
<td>Yearly</td>
<td>Fall, Spring</td>
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<tr>
<td>Performance in Project work, competitions</td>
<td>Biennially</td>
<td>As appropriate</td>
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<tr>
<td>IAC Recommendations, Mechanical Engineering Academy</td>
<td>Yearly</td>
<td>February</td>
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<tr>
<td>Transcripts</td>
<td>Each semester</td>
<td>Continuous</td>
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<tr>
<td>Course/Instructor Evaluations</td>
<td>Yearly</td>
<td>Fall, Spring</td>
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<td>Review</td>
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<tr>
<td>Program Educational Objectives</td>
<td>Yearly</td>
<td>Spring</td>
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<tr>
<td>Program Outcomes</td>
<td>Yearly</td>
<td>Spring</td>
</tr>
<tr>
<td>Assessment Process</td>
<td>Yearly</td>
<td>Spring</td>
</tr>
</tbody>
</table>

The O & A Committee meets throughout the year to review progress. Meetings are held during the fall and spring semester every other month to do routine committee chores such as review anything pertinent that has occurred, plan reports and reviews, and to discuss both particulars and global aspects of the process. At the end of each semester, the committee reviews all outcome flow charts and makes recommendations to faculty as appropriate. Recommendations take the form of a written memo, which is recorded along with the instructor’s reply and follow-up action. This documentation appears in appropriately titled columns of the summary report (summary report for Spring 2007 is included).

The review at the end of the spring semester also considers the overview of the year’s results and makes recommendations to the department head, undergraduate curriculum
committee, and faculty as appropriate. An example of the summary report for Spring 2007 is included as an addendum to this chapter. This addendum also contains a sampling of committee meeting minutes representative of the variety of agenda items considered.

Assessment of Educational Objectives

In Chapter 2 we stated the new educational objectives that were adopted in 2007. According to Table 3.2 the tools for assessment of these educational objectives are the following:

1. Employer Co-op Reports obtained in cooperation with NMSU Placement and Career Services.
2. IAC and ME Academy Recommendations
3. Alumni Surveys

The status of the assessment tools and their application is reported here. In general, the recent adoption of the new objectives has necessitated changes in the assessment instruments to accommodate the changes in the objectives.

We have not yet obtained data from the Employer Co-op Reports.

We have obtained one round of survey data from the ME Academy membership, reported in Figure 2.1. This survey asks the MEA members to rate the importance of each of the four objectives, based on their professional experience. Based on the reported responses we conclude that the MEA opinion is that the new educational objectives are appropriate. In 2009 and beyond additional MEA/IAC surveys will be conducted to solicit recommendations on possible curricular changes intended to enhance the achievement of the educational objectives.

During 2008 we have conducted one survey of mechanical engineering alumni using the survey shown in Chapter 2. The objective of this survey was to obtain data on alumni accomplishments and opinions allowing the degree of attainment of educational objectives to be assessed. We received four responses to this survey. Because of the small number of responses, the results were judged to be statistically uninformative, and they are not reported here. It appears that the successful implementation of future alumni surveys will require extensive direct personal contact with individual alumni prior to sending the survey to them. This was not done in disseminating our first survey. The top priority of the O&A effort during the next year will be to obtain statistically meaningful results from our alumni surveys. In addition, the assessment of our educational objectives appears to be critically dependent on this single assessment tool. Thus, it appears advisable to develop additional tools that can be used to assess the educational objectives.

In summary, the new educational objectives have been adopted. The process for assessing these objectives is in place. Data on the appropriateness of the educational objectives has been obtained via the MEA survey. It is necessary to obtain data from alumni in order to measure the accomplishments of our graduates in the profession. This will be our priority in the near term.
Addendum to Chapter 3

1. Outcomes and Assessment Committee summary report for Spring 2007
2. Selection of Outcomes and Assessment Committee meeting minutes and reviews
### Outcomes & Assessment Committee

#### Review of Program Outcomes for Spring 2007

Thursday, May 24, 2007

Present: Ron Pederson, Richard Hills, Ed Conley, Vincent Choo, Helen Stork

<table>
<thead>
<tr>
<th>Course/Outcome(s)</th>
<th>Comments</th>
<th>Contacted</th>
<th>Response</th>
<th>Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME 102</td>
<td>?? ?? What are we to do?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 166</td>
<td>?? ?? What are we to do?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| ME 222/ Pederson  | 1) Improvement planned only for GDT; CAD & CAM not included  
                        2) For Fall 2006, add documentation/comment that planned change in topic schedule did not succeed because of lack of lab/shop availability | x | x | x |
| ME 236            | 1) Need numeric evaluation results  
                        2) Delete outcome (e) from assessment schedule | x | x | Need revised grade sheets |
| ME 237/ Garcia    | Change outcome designation from (c) to (e); content same | x | | |
| ME 237/ Burton    | 1) Measure needs to be more specific, e.g. “homework assignments 1-5,” “Exams 2 & 4”  
                        2) Assessment Goal and Evaluation should reflect specific Measure  
                        3) Delete outcome (a) | | | |
| ME 240/ Hardee    | 1) Measure and Assessment Goal need to be consistent  
                        2) Measure does not assess outcome (e). Specific homework assignments can be used, but not a design problem as presented | x | | Need grade sheets- will do in late summer, someone needs to speak to him |
<table>
<thead>
<tr>
<th>Course</th>
<th>Comment</th>
<th>Accepted</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME 260/</td>
<td>Goal should be adjusted because it is higher than normal statistical</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Garcia</td>
<td>spread for student achievement.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>x x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 326/</td>
<td>Revise chart for (j): Improvement to read “change to graded assignment.”</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Conley</td>
<td>x</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| ME 328/Hardee – outcome ME2 | 1) Inconsistency between Measure and Assessment Goal: measure general; goal based on specific homework assignment.  
                                2) Goal needs to include number/percentage of students achieving desired score.  
                                3) Evaluation needs to include student percentage. | x        | See ME 240 |
|          | x x x                                                                  |          |              |
| ME 328 – outcome ME3 | 1) Inconsistency between Measure and Assessment Goal: Measure states homework assignment #12; goal states (and uses) assignment #11.  
                                2) Goal needs to include number/percentage of students achieving desired score.  
                                3) Evaluation needs to include student percentage. | x        | x          |
<p>|          | x                                                                      |          |              |
| ME 329/  |                                                                       |          |              |
| Leslie   |                                                                       |          |              |
| ME 338/  | 1) Measure: state specific homework and exams used – as reported in   | x        | x-copies in; |
| Shashikanth | Evaluation.                               |          | will provide |
|          | 2) Change wording in Improvements from “works better” to “more realistic.” | x        | grades ASAP  |
|          | x x x                                                                  |          |              |
| ME 340/  | Accepted as is                                                          |          |              |
| Donaldson|                                                                       |          |              |
| ME 341/  | Accepted as is                                                          |          |              |
| Leslie   |                                                                       |          |              |
| ME 345/  | Accepted as is                                                          |          |              |
| Conley   |                                                                       |          |              |</p>
<table>
<thead>
<tr>
<th>Course/Instructor</th>
<th>Comments</th>
<th>Action 1</th>
<th>Action 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME 425/Choo</td>
<td>Change wording in Evaluation to reflect Measure and Assessment Goal, i.e., “total score” to “design project.”</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>ME 426/427/Park</td>
<td>Accepted as is</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 445/Donaldson</td>
<td>Improvement for outcome (g), written report: revise Class Notes. Suggestion: Include one complete sample report from outside source.</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>
| ME 449/Burton    | 1) Inadequate Measure. Refer to previous (and rotating) instructors.  
2) Include specific improvement plan. | 3) | 4) |
| FE Exam          | Change use from assessment tool to reference material. | | | |
Outcomes and Assessment Committee
Friday, March 9, 2007

Present: Ron Pederson, Ed Conley, Ian Leslie, Rich Hills, Helen Stork

Reports on Fall 2006 assessments were presented:

a) by course
b) by outcome, and compared to Spring 2006 results

Committee felt they needed to review measurement data before making comments/drawing conclusions from results.

Lack of process to show that improvements based on assessment evaluations have been implemented was addressed. The assessment flow chart will be revised to include a section to be filled out at the beginning of the semester noting improvements/changes that have been implemented based on (Instructor’s) previous semester’s results. Other changes may also be initiated and described in this section.

Process will be described with these revisions, and their purpose explained, at the next scheduled faculty meeting. Sample flow charts will be provided.

Also, at that meeting, assessment/improvement process for currently non-assessed courses will be introduced. Though not based directly on ABET outcomes (a)-(k), significant course objectives must be chosen for measurement, reflecting a commitment to continuous quality improvement.

Committee will meet again as soon as is convenient for all members. Priority attention will be given to revision of educational objectives.

Outcomes and Assessment Committee  
Friday, April 27, 2007


1. Program Outcomes: Clarified which courses are being assessed. All required courses are assessed with the exception of ME 159. ME 102 Mechanical Engineering Orientation was assessed (by David Seigel) in Spring 2006 for outcome (g), ability to communicate effectively as measured by oral report on lego car project. While continuing the project, current instructor Dean Hill does not include an oral report for this project. Committee will not require this course to be assessed. ME 166 may be dropped from curriculum. All outcomes are assessed through required courses, but not all required courses are assessed.

2. Educational Objectives. A discussion of proposed Educational Objectives engaged most of the meeting time. Modifications were made in explanatory section. (Revision is attached.).

3. O & A meeting to review Spring 07 outcomes, and overview of assessment process was scheduled for Monday, May 21, 8:30 a.m. to noon.

4. Agenda Items not addressed:
   a. Alumni surveys: Need to be done, but will need some revision as a result of change in educational objectives.
   b. Revised syllabi. Some instructors have reverted to pre-ABET syllabi. Should use revised version but can add whatever they like. Typically, topics and class schedules are added, as well as more elaborate explanation of grading and expectations, class policies.

Submitted by Helen Stork, May 14, 2007
To: Ron Pederson  
Undergraduate Curriculum Committee

Date: September 14, 2007  
Re: Recommendations of the ABET Outcomes & Assessment Committee  
Spring 2007

ME Program Outcomes
- Committee recommends that assessment activities in all non-required courses be reviewed by the Undergraduate Curriculum Committee annually. This review should include development of assessment flow charts for these courses.

Professional Component
- Committee recommends a review of general education requirements in light of current program Educational Objectives and Program Outcomes.

Program criteria specific for Mechanical Engineering
- Committee recommends increased emphasis on thermal systems design
- Committee also recommends additional topics in statistics be included throughout the curriculum.

Fundamentals of Engineering Exam
- Committee recommends department consider a controls course.

Submitted by Helen Stork, September 18, 2007.
ABET O & A Committee
Oct. 5, 2007
Minutes

✓ Map Educational Objectives to Program Outcomes – Chart was revised to reflect updated Educational Objectives – chart attached

✓ Alumni Survey – ideas on how to get more response
  ▪ Check with other departments on their success rate
  ▪ Enter name in drawing as incentive to completing survey
  ▪ In future, always ask for current e-mail address

✓ IAC assessment form - questions will be based on
  o PO: (g), (h) & (i). (g) already done with ME 426 review by IAC
  o EO: Educational objective 4 – related POs can be basis of questions

✓ ME Academy Survey for EO – base on characteristics of the contemporary workplace

✓ Interim Report – Ron directed that O & A committee meetings be held at least monthly to monitor progress.

Submitted by Helen Stork, October 15, 2007.
Outcomes & Assessment Committee Meeting
Friday, February 8, 2008

Agenda
1. Review of outcomes for Fall 2007

2. Updated charts
   a. Guidelines for Objectives, Program Outcomes, etc.
   b. Mapping of Curriculum to Program Outcomes
   c. Relationship of Educational Objectives to Program Outcomes

3. Review
   a. History of outcome implementation
   b. Revise courses to be assessed based on (a.)

4. Surveys
   a. Alumni – no progress
   b. ME Academy – sent out Jan. 30, 8 responses received
   c. IAC – do we plan one for them to administer during annual meeting events
   d. Employer – contacted Career Placement (Mary Berry); could provide list of co-op employers to survey for educational objectives.

   a. Input?
      Content
      Timeline
      Deadline

## Outcomes & Assessment Committee
## Review of Program Outcomes for Fall 2007

**Friday, February 8, 2008**
Present: Ron Pederson, Richard Hills, Ed Conley, Vincent Choo, Ian Leslie, Helen Stork

<table>
<thead>
<tr>
<th>Course/Outcome(s)</th>
<th>Comments</th>
<th>Contacted</th>
<th>Response</th>
<th>Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME 102</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 166</td>
<td>Eliminate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 222</td>
<td>Accepted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 236</td>
<td>Accepted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 237/Garcia</td>
<td>Accepted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 237/Genin</td>
<td>Accepted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 240/Hardee</td>
<td>Need (e) – thermo cycles Ron Pederson will speak to H.H.</td>
<td>x</td>
<td>x</td>
<td>H.H. gave Ron a written explanation of his approach &amp; grading</td>
</tr>
<tr>
<td>ME 260/Garcia</td>
<td>This is pre-requisite to ME 329; monitor relation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 326/Conley</td>
<td>Accepted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 328/Hardee – outcome ME2</td>
<td>Ron spoke to H.H. about need to specify quiz related to ME2 &amp; ME3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 328 – outcome ME3</td>
<td>Refer to above</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>ME 329/Leslie</td>
<td>Accepted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course</td>
<td>Instruction</td>
<td></td>
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<tr>
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<td>-------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 338/Wei</td>
<td>Check discrepancy on outcome flow chart</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 340/Donaldson</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 341/Leslie</td>
<td>This is being taught by H.H. for spring 2008; will not assess this semester.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 345/Conley</td>
<td>Accepted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 425/ Choo</td>
<td>Accepted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME 426/427/ Park</td>
<td>Accepted</td>
<td></td>
<td></td>
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<tr>
<td>ME 445/Donaldson</td>
<td>Accepted</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>ME 449/Burton</td>
<td></td>
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</tbody>
</table>
ABET Outcomes & Assessment Committee meeting
April 18, 2008
Present: Ron Pederson, Richard Hills, Ian Leslie, Ed Conley, Vincent Choo, Helen Stork

1. Report on meetings with Krist Petersen and Sonya Cooper
   a. Discussed requesting more review and assistance from Sonya prior to CoE deadline.
   b. Prepare first draft by May 2

2. Updated material
   a. Relationship of assessment tools to outcomes – received suggestions on activities that could be used as supplemental indirect measures. Will explore possibilities.
   b. Linked some outcomes assessed in (a) to (k) as appropriate to also assign to ME 1-4.

3. Surveys: ME Academy
   a. Faculty will review alumni list for those they have contact with, or could call. Each will choose 5 or more to contact, and forward names to Ron who will coordinate the calling.

4. Determine timeline for preparing report, and define content. – This was not completely addressed
   a. Timeline: meeting(s) to review S08 outcomes; meeting to prepare O & A recommendations; meeting to formally review completed document before submitting to CoE.
   b. Content: Agreement on what to include; in particular, support documentation

5. Other
   a. Drop assessment of ME 102 and ME 166 with rationale that they are too basic/early to be valid performance indicators.
   b. Discussed feasibility of requiring FE exam pass

Submitted by Helen Stork, April 21, 2008.
Chapter 4 Program Outcomes and Assessment: Data

This section contains a summary, in tabular and graphical forms, of the quantitative data used to assess program outcomes (a) – (k) and program specific outcomes 2 – 4. The data sheets presented also state the course improvements that were made by faculty as a result of the course assessment in each semester. There are three sets of data sheets contained here, as described below.

1. Outcome data sheets for Program Outcomes (a) – (k) and Program Specific Outcomes (2) – (4).

As an example, consider the data sheets for outcome (a), immediately following this narrative. Results are shown for five semesters for each of five courses (ME 236, 260, 329, 338, and 341). For each course, results are shown for each measure appearing in the flow chart for that course and semester. For example, for ME 329, the designation “329-1” is the first flow chart measure, “329-2” is the second flow chart measure, etc. The tabular results, as well as the accompanying graphs, summarize the actual student performance as a percentage of the performance goals established by the instructor for the given measures. These results are used by the instructors to assess student demonstration of the ability stated in outcome (a). These improvements made each semester by faculty, followed by continuous reassessment in subsequent semesters, constitutes a primary means of assessment of program outcomes, and the data summarized in this chapter for outcomes (a) – (k) demonstrates the continuous improvement in our assessment process.

In addition to data from the individual course flow charts, data from senior exit interviews for each outcome are presented in the outcome data sheets; the current exit interview form asks each graduating senior to assess the degree to which the program enabled the student to achieve each outcome (a) – (k). Results from the Fundamentals of Engineering exam relevant to each outcome are also presented.

2. Senior Exit Interview Surveys

Statistical summaries of senior exit interviews evaluating graduating seniors’ opinions as to attainment of outcomes (a) – (k) and their opinions on other aspects of the ME program are presented. Each semester 80 – 100% of the graduating seniors participate in this interview process.

3. Additional Course Flow chart results

Additional five-semester flow charts are shown for ME 222, ME 260, and ME 345 lab. Finally, a selection of flow charts reflecting improvements implemented to “close the loop” of continuous quality improvement are shown for a selection of courses and semesters.
Outcome (a): ability to apply knowledge of math, science and engineering

Faculty Assessment in Courses

In the accompanying graphs,

denotes full achievement of goal.

The (.-#) after the course number indicates the number of measures used to evaluate the outcome assessed in the course. For example, ME 236 used 4 measures in its evaluation. Typically these measures are a mix of home work assignments, specific quiz & exam questons, and projects.

Outcome (a) % of goal met - ME 236

<table>
<thead>
<tr>
<th></th>
<th>goal result</th>
<th>S06 %</th>
<th>goal result</th>
<th>F06 %</th>
<th>goal result</th>
<th>S07 %</th>
<th>goal result</th>
<th>F07 %</th>
<th>goal result</th>
<th>S08 %</th>
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<tr>
<td>236-1</td>
<td>75</td>
<td>60</td>
<td>80%</td>
<td>75</td>
<td>73</td>
<td>97%</td>
<td>70</td>
<td>52</td>
<td>74%</td>
<td>75</td>
</tr>
<tr>
<td>236-2</td>
<td>75</td>
<td>75</td>
<td>100%</td>
<td>75</td>
<td>82</td>
<td>109%</td>
<td>70</td>
<td>56</td>
<td>80%</td>
<td>70</td>
</tr>
<tr>
<td>236-3</td>
<td>75</td>
<td>75</td>
<td>100%</td>
<td>75</td>
<td>82</td>
<td>109%</td>
<td>70</td>
<td>52</td>
<td>74%</td>
<td>70</td>
</tr>
</tbody>
</table>

Improvements:

* More tutorial & review sessions; more attention to problem solving strategy; organize interactive web site for problem solution
** (different instructor) work more examples.
*** (S06 instructor) Require students to use interactive web site; increase weight of HW in final grade
**** (another instructor) More time to complete tests; more tutorials; more lecture hours on topic or decrease/remove dynamics part of curriculum
***** will give practice exam before the first exam; interactive website for homework did not work out, will do more during class time.

Outcome (a) % of goal met - ME 260

<table>
<thead>
<tr>
<th></th>
<th>goal result</th>
<th>S06 %</th>
<th>goal result</th>
<th>F06 %</th>
<th>goal result</th>
<th>S07 %</th>
<th>goal result</th>
<th>F07 %</th>
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<tbody>
<tr>
<td>260-1</td>
<td>70</td>
<td>52</td>
<td>74%</td>
<td>70</td>
<td>69</td>
<td>98%</td>
<td>70</td>
<td>48</td>
<td>69%</td>
<td>50</td>
</tr>
<tr>
<td>260-2</td>
<td>70</td>
<td>63</td>
<td>90%</td>
<td>70</td>
<td>66</td>
<td>94%</td>
<td>70</td>
<td>48</td>
<td>69%</td>
<td>50</td>
</tr>
</tbody>
</table>

Improvements:

* devote class time to basic matrix algebra
* manipulations with arrays; practical applications of pseudocode and flowchart methods; more emphasis on code syntax.
** Work more examples; research textbook use/possible problem
*** (#Committee advised goal was statistically too high.) Consider problem: low homework compliance; earliest class time; refer to course evaluations
**** Course can be improved with a better textbook or by further developing course material
### Outcome (a): ability to apply knowledge of math, science and engineering

#### Outcome (a) % of goal met - ME 329

<table>
<thead>
<tr>
<th></th>
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<th>F06</th>
<th>S07</th>
<th>F07</th>
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<tbody>
<tr>
<td>329-1</td>
<td>80</td>
<td>55</td>
<td>69%</td>
<td>80</td>
<td>79</td>
</tr>
<tr>
<td>329-2</td>
<td>80</td>
<td>70</td>
<td>88%</td>
<td>80</td>
<td>53</td>
</tr>
<tr>
<td>329-3</td>
<td>80</td>
<td>75</td>
<td>94%</td>
<td>80</td>
<td>61</td>
</tr>
</tbody>
</table>

**Improvements:**
- * Show class results of Gauss-Seidel iteration; work non-linear fitting example; demonstrate how to change limits for use with Gauss quadrature.
- ** Discuss recursion relationships in more depth; work a 3rd order polynomial example; more time on marching process for explicit finite difference method & impact of stability.
- *** Raise assessment goal

#### Outcome (a) % of goal met - ME 338

<table>
<thead>
<tr>
<th></th>
<th>S06</th>
<th>F06</th>
<th>S07</th>
<th>F07</th>
<th>S08</th>
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<tbody>
<tr>
<td>338-1</td>
<td>50</td>
<td>23</td>
<td>46%</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>338-2</td>
<td>50</td>
<td>68</td>
<td>136%</td>
<td>60</td>
<td>51</td>
</tr>
<tr>
<td>338-3</td>
<td>50</td>
<td>70.5</td>
<td>141%</td>
<td>60</td>
<td>76</td>
</tr>
<tr>
<td>338-4</td>
<td>60</td>
<td>64</td>
<td>107%</td>
<td>50</td>
<td>54</td>
</tr>
</tbody>
</table>

**Improvements:**
- * Raise assessment goal.
- ** (different instructor) Methods for presenting material for exam 1 will be examined and revised.
- *** (S06 instructor) Return to original assessment goal
- **** (Another instructor) More comprehensive review before final exam.

#### Outcome (a) % of goal met - ME 341

<table>
<thead>
<tr>
<th></th>
<th>S06</th>
<th>F06</th>
<th>S07</th>
<th>F07</th>
<th>S08</th>
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<tbody>
<tr>
<td>341-1</td>
<td>70</td>
<td>63</td>
<td>90%</td>
<td>70</td>
<td>64</td>
</tr>
<tr>
<td>341-2</td>
<td>80</td>
<td>77</td>
<td>96%</td>
<td>70</td>
<td>85</td>
</tr>
</tbody>
</table>

**Improvements:**
- * Change text to get new homework problems.
- ** Attempt to motivate students to begin homework early and stop by for help.
- *** Return to previous textbook; make up or modify 50% of homework problems; raise assessment goal for exam.
- **** Return to assessment goal for exam; take homework examples from new sources.
Outcome (a): ability to apply knowledge of math, science and engineering

Senior Exit Survey

Exit Surveys: Spring 2006-Spring 2008
Outcomes Assessment (a)

The ME program provided me with sufficient knowledge to:

- Apply knowledge of mathematics, science and engineering

Fundamentals of Engineering Exam: Comparison of ME average to National average 2006-2008

Subject areas addressing outcome (a), General & Mechanical AM questions:

\[ \geq 90\% \text{ National Average} \quad < 90\% \text{ National Average} \]
- Chemistry
- Engineering Mechanics
- Fluid Mechanics
- Strength of Materials
- Mathematics
- Electricity and Magnetism
- Material Properties
- Thermodynamics

Subject areas addressing outcome (a), General PM questions:

\[ \geq 90\% \text{ National Average} \quad < 90\% \text{ National Average} \]
- Advanced Engineering Math
- Engineering Probability and Statistics
- Application of Engineering Mechanics
- Engineering of Materials
- Fluid Mechanics
- Thermo & Heat Transfer

Subject areas addressing outcome (a), Mechanical PM questions:

\[ \geq 90\% \text{ National Average} \quad < 90\% \text{ National Average} \]
- Kinematics, Dynamics & Vibrations
- Measurements, Instruments & Controls
- Thermo & Energy Conservation
- Mechanical Design
- Materials and Processing
- Fluid Mechanics and Fluid Machinery
- Heat Transfer
- Refrigeration & HVAC
Outcome (b): ability to design and conduct experiments/analyze and interpret data

Faculty Assessment in Courses

In the accompanying graphs, ———— denotes full achievement of goal.
The (.-#) after the course number indicates the number of measures used to evaluate the outcome assessed in the course. For example, ME 445 used 2 measures in its evaluation. Typically these measures are a mix of home work assignments, specific quiz & exam questons, and projects.

Outcome (b) % of goal met - ME 345

<table>
<thead>
<tr>
<th></th>
<th>S06</th>
<th>F06</th>
<th>S07</th>
<th>F07</th>
<th>S08</th>
</tr>
</thead>
<tbody>
<tr>
<td>345-1</td>
<td>90</td>
<td>96</td>
<td>107%</td>
<td>90</td>
<td>100</td>
</tr>
<tr>
<td>345-2</td>
<td>90</td>
<td>97</td>
<td>108%</td>
<td>90</td>
<td>95</td>
</tr>
<tr>
<td>345-3</td>
<td>90</td>
<td>100</td>
<td>111%</td>
<td>90</td>
<td>100</td>
</tr>
</tbody>
</table>

Improvements: Goal met; no improvement planned at this time.

Outcome (b) % of goal met - ME 445

<table>
<thead>
<tr>
<th></th>
<th>S06</th>
<th>F06</th>
<th>S07</th>
<th>F07</th>
<th>S08</th>
</tr>
</thead>
<tbody>
<tr>
<td>445-1</td>
<td>90</td>
<td>100</td>
<td>111%</td>
<td>90</td>
<td>100</td>
</tr>
<tr>
<td>445-2</td>
<td>75</td>
<td>83</td>
<td>111%</td>
<td>75</td>
<td>100</td>
</tr>
</tbody>
</table>

Improvements: * Grade sheets need to be recorded for specifics described.
Outcome (b): ability to design and conduct experiments/analyze and interpret data

Senior Exit Survey

Exit Surveys: Spring 2006-Spring 2008
Outcomes Assessment (b)

The ME program provided me with sufficient knowledge to:

- Design and conduct experiments, analyze and interpret data

5 = Strongly Agree
4 = Agree
3 = Neutral
2 = Disagree
1 = Strongly Disagree

Fundamentals of Engineering Exam: Comparison of ME average to National average 2006-2008

Subject areas addressing outcome (b), General AM & PM questions

- Engineering Probability & Statistics

Spring 2006 - Spring 2008
## Outcome (c): ability to design a system, component, or process

### Faculty Assessment in Courses

In the accompanying graphs, ** denotes full achievement of goal.

The (-#) after the course number indicates the number of measures used to evaluate the outcome assessed in the course. For example, ME 326 used 1 measure in its evaluation. Typically these measures are a mix of home work assignments, specific quiz & exam questions, and projects.

### Outcome (c) % of goal met - ME 326

<table>
<thead>
<tr>
<th>goal</th>
<th>S06</th>
<th>result %</th>
<th>S07</th>
<th>result %</th>
<th>S08</th>
<th>result %</th>
</tr>
</thead>
<tbody>
<tr>
<td>326-1</td>
<td>80</td>
<td>75</td>
<td>94%</td>
<td>80</td>
<td>100</td>
<td>125%</td>
</tr>
</tbody>
</table>

**Improvements:**

* More effort to group organization & timely testing; more credit for lab testing and evaluation of projects

** More effort to group organization & timely testing; more credit for lab testing and evaluation of projects

### Outcome (c) % of goal met - ME 425

<table>
<thead>
<tr>
<th>goal</th>
<th>S06</th>
<th>result %</th>
<th>S07</th>
<th>result %</th>
<th>S08</th>
<th>result %</th>
</tr>
</thead>
<tbody>
<tr>
<td>425-1</td>
<td>100</td>
<td>100</td>
<td>100%</td>
<td>80</td>
<td>100</td>
<td>125%</td>
</tr>
</tbody>
</table>

**Improvements:**

Goal met; no improvements planned at this time.

* Goal raised to 80% score 75% or higher for completed design project

### Outcome (c) % of goal met - ME 426

<table>
<thead>
<tr>
<th>goal</th>
<th>S06</th>
<th>result %</th>
<th>S07</th>
<th>result %</th>
<th>S08</th>
<th>result %</th>
</tr>
</thead>
<tbody>
<tr>
<td>426/427-1</td>
<td>75</td>
<td>86</td>
<td>115%</td>
<td>75</td>
<td>90</td>
<td>120%</td>
</tr>
<tr>
<td>426/427-2</td>
<td>75</td>
<td>90</td>
<td>120%</td>
<td>75</td>
<td>100</td>
<td>133%</td>
</tr>
</tbody>
</table>

**Improvements:**

Goal met; no improvements planned at this time.
Outcome (c): ability to design a system, component, or process

Spring 2006 - Spring 2008

Senior Exit Surveys

Exit Surveys: Spring 2006-Spring 2008
Outcomes Assessment (c)
The ME program provided me with sufficient knowledge to:

Fundamentals of Engineering Exam: Comparison of ME average to National average 2006-2008

Subject areas addressing outcome (c), Mechanical PM questions:

\[
\begin{align*}
&>90\% \text{ National Average} \\
&<90\% \text{ National Average} \\
&\text{Mechanical Design & Analysis} \\
&\text{Refrigeration & HVAC}
\end{align*}
\]
Faculty Assessment in Courses

In the accompanying graphs, \( \text{---} \) denotes full achievement of goal. The (‐#) after the course number indicates the number of measures used to evaluate the outcome assessed in the course. For example, ME 426/427 used 2 measures in its evaluation. Typically these measures are a mix of home work assignments, specific quiz & exam questions, and projects.

Outcome (d) % of goal met - ME 426/427

<table>
<thead>
<tr>
<th>Course</th>
<th>S06</th>
<th>F06</th>
<th>S07</th>
<th>F07</th>
<th>S08</th>
</tr>
</thead>
<tbody>
<tr>
<td>426/427-1</td>
<td>100</td>
<td>70</td>
<td>70</td>
<td>100</td>
<td>143%</td>
</tr>
<tr>
<td>426/427-2</td>
<td>75</td>
<td>90</td>
<td>75</td>
<td>100</td>
<td>133%</td>
</tr>
</tbody>
</table>

Improvements: * Recruit more multidisciplinary projects and students from other disciplines such as EE and CE.

Senior Exit Surveys

Exit Surveys: Spring 2006-Spring 2008
Outcomes Assessment (d)

The ME program provided me with sufficient knowledge to:

- 5 = Strongly Agree
- 4 = Agree
- 3 = Neutral
- 2 = Disagree
- 1 = Strongly Disagree
### Outcome (e): ability to identify, formulate & solve engineering problems

#### Faculty Assessment in Courses

In the accompanying graphs, 
the ‘*’ after the course number indicates the number of measures used to evaluate the outcome assessed in the course. For example, ME 236 used 2 measures in its evaluation. Typically these measures are a mix of home work assignments, specific quiz & exam questions, and projects.

#### Outcome (e) % of goal met - ME 236

<table>
<thead>
<tr>
<th></th>
<th>S06</th>
<th>F06</th>
<th>S07</th>
<th>F07</th>
<th>S08</th>
</tr>
</thead>
<tbody>
<tr>
<td>236-1</td>
<td>75</td>
<td>87</td>
<td>116%</td>
<td>75</td>
<td>73</td>
</tr>
<tr>
<td>236-2</td>
<td>75</td>
<td>75</td>
<td>100%</td>
<td>75</td>
<td>100</td>
</tr>
</tbody>
</table>

**Improvements:** * More tutorial and review sessions; more attention to problem solving strategy.

#### Outcome (e) % of goal met - ME 237

<table>
<thead>
<tr>
<th></th>
<th>S06</th>
<th>F06</th>
<th>S07</th>
<th>F07</th>
<th>S08</th>
</tr>
</thead>
<tbody>
<tr>
<td>237-1</td>
<td>95</td>
<td>58</td>
<td>61%</td>
<td>70</td>
<td>79</td>
</tr>
<tr>
<td>237-2</td>
<td>80</td>
<td>25</td>
<td>31%</td>
<td>70</td>
<td>46</td>
</tr>
</tbody>
</table>

**Improvement:** * Review session before exam; set more realistic goal (85% demonstrate a score of 70%)
** Unusually weak class; compare with results in Spring 2008.

#### Outcome (e) % of goal met - ME 240

<table>
<thead>
<tr>
<th></th>
<th>S06</th>
<th>F06</th>
<th>S07</th>
<th>F07</th>
<th>S08</th>
</tr>
</thead>
<tbody>
<tr>
<td>240-1</td>
<td>50</td>
<td>72</td>
<td>144%</td>
<td>50</td>
<td>86</td>
</tr>
</tbody>
</table>

54
Outcome (e): ability to identify, formulate & solve engineering problems

### Outcome (e) % of goal met - ME 340

<table>
<thead>
<tr>
<th>Year</th>
<th>S06</th>
<th>F06</th>
<th>S07</th>
<th>F07</th>
<th>S08</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal</td>
<td>340</td>
<td>340</td>
<td>340</td>
<td>340</td>
<td>340</td>
</tr>
<tr>
<td>Result %</td>
<td>50</td>
<td>25</td>
<td>50</td>
<td>55</td>
<td>110%</td>
</tr>
<tr>
<td>Result %</td>
<td>50</td>
<td>38</td>
<td>76%</td>
<td>50</td>
<td>36</td>
</tr>
</tbody>
</table>

**Improvements:**
- * Assign more problems similar to FE.
- ** 59% were within 95% of goal.
- *** textbook problem in prerequisite course had impact; will be resolved by next semester.

### Outcome (e) % of goal met - ME 341

<table>
<thead>
<tr>
<th>Year</th>
<th>S06</th>
<th>F06</th>
<th>S07</th>
<th>F07</th>
<th>S08</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal</td>
<td>341</td>
<td>341</td>
<td>341</td>
<td>341</td>
<td>341</td>
</tr>
<tr>
<td>Result %</td>
<td>80</td>
<td>80</td>
<td>100%</td>
<td>80</td>
<td>84</td>
</tr>
<tr>
<td>Result %</td>
<td>80</td>
<td>87</td>
<td>109%</td>
<td>80</td>
<td>83</td>
</tr>
</tbody>
</table>

**Improvements:**
- * Assign additional problems focusing on First Law application
- ** New grading procedure that penalizes for not turning in homework (-10 pts on assignment)
- *** Modify or replace textbook problems to counteract copying

*Different instructor for Spring 2008 - course will not be assessed for this semester*
Outcome (e): ability to identify, formulate & solve engineering problems

Senior Exit Surveys

Exit Surveys: Spring 2006-Spring 2008
Outcomes Assessment (e)

The ME program provided me with sufficient knowledge to:

- Identify, formulate and solve engineering problems

5 = Strongly Agree
4 = Agree
3 = Neutral
2 = Disagree
1 = Strongly Disagree

Fundamentals of Engineering Exam: Comparison of ME average to National average 2006-2008

Subject areas addressing outcome (e), General & Mechanical AM questions:

- Fluid Mechanics
- Strength of Materials
- Electricity and Magnetism
- Thermodynamics

Subject areas addressing outcome (e), General PM questions:

- Application of Engineering Mechanics
- Engineering of Materials
- Fluid Mechanics
- Thermodynamics and Heat Transfer

Subject areas addressing outcome (e), Mechanical PM questions:

- Measurements, Instrumentation, Controls
- Thermo & Energy Conservation
- Heat Transfer
- Refrigeration & HVAC
- Fluid Mechanics and Fluid Machinery
- Mechanical Design & Analysis
- Materials & Processing
Outcome (f): understanding of professional and ethical responsibility

Faculty Assessment in Courses

In the accompanying graphs, --- --- --- --- --- denotes full achievement of goal.
The ( #: ) after the course number indicates the number of measures used to evaluate the outcome assessed in the course. For example, ME 326 used 1 measure in its evaluation. Typically these measures are a mix of home work assignments, specific quiz & exam questons, and projects.

Outcome (f) % of goal met - ME 326

<table>
<thead>
<tr>
<th>Goal</th>
<th>Result %</th>
<th>Goal</th>
<th>Result %</th>
<th>Goal</th>
<th>Result %</th>
<th>Goal</th>
<th>Result %</th>
<th>Goal</th>
<th>Result %</th>
</tr>
</thead>
<tbody>
<tr>
<td>S06</td>
<td>80</td>
<td>F06</td>
<td>83</td>
<td>S07</td>
<td>101%</td>
<td>F07</td>
<td>80</td>
<td>F08</td>
<td>100%</td>
</tr>
</tbody>
</table>

Improvements: Goal met; no improvements planned at this time.

Senior Surveys

Exit Surveys: Spring 2006-Spring 2008

Outcomes Assessment (f)

The ME program provided me with sufficient knowledge to:

- Understand professional and ethical responsibility

Fundamentals of Engineering Exam: Comparison of ME average to National average 2006-2008

Subject areas addressing outcome (f), General & Mechanical AM questions:

- >/= 90% National Average
- < 90% National Average

Ethics and Business Practice

Spring 2006 - Spring 2008
Outcome (g): ability to communicate effectively

Faculty Assessment in Courses

In the accompanying graphs,
\[------------------------\] denotes full achievement of goal.

The (#) after the course number indicates the number of measures used to evaluate the outcome assessed in the course. For example, ME 445 used 2 measures in its evaluation. Typically these measures are a mix of home work assignments, specific quiz & exam questons, and projects.

Outcome (g) % of goal met - ME 426/427

<table>
<thead>
<tr>
<th>Outcome (g) %</th>
<th>S06 %</th>
<th>F06 %</th>
<th>S07 %</th>
<th>F07 %</th>
<th>S08 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>426/427-1</td>
<td>75</td>
<td>67</td>
<td>89%</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>426-427-2</td>
<td>80</td>
<td>100</td>
<td>125%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Improvements: Goal met; no improvements planned at this time.

Outcome (g) % of goal met - ME 445

<table>
<thead>
<tr>
<th>Outcome (g) %</th>
<th>S06 %</th>
<th>F06 %</th>
<th>S07 %</th>
<th>F07 %</th>
<th>S08 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>445-1</td>
<td>80</td>
<td>100</td>
<td>125%</td>
<td>80</td>
<td>38</td>
</tr>
<tr>
<td>445-2</td>
<td>100</td>
<td>100</td>
<td>100%</td>
<td>100</td>
<td>89</td>
</tr>
</tbody>
</table>

Improvements:
* Raise assessment goal by 5%
** 63% reached previous goal; if downward trend continues, improvement will be planned.
*** Consider appropriateness of assessing writing aspect since course does not cover writing style; revise Class Notes; include sample of good report
**** Continue to revise Class Notes; change from "Tips" to "Requirements for Report Writing"
Outcome (g): ability to communicate effectively

Senior Surveys

Exit Surveys: Spring 2006-Spring 2008
Outcomes Assessment (g)

The ME program provided me with sufficient knowledge to:

- Communicate effectively

5 = Strongly Agree
4 = Agree
3 = Neutral
2 = Disagree
1 = Strongly Disagree
Faculty Assessment in Courses

Outcome (j): knowledge of contemporary issues

In the accompanying graphs, denotes full achievement of goal. The (‐#) after the course number indicates the number of measures used to evaluate the outcome assessed in the course. For example, ME 326 used 1 measure in its evaluation. Typically these measures are a mix of home work assignments, specific quiz & exam questions, and projects.

Outcome (j) % of goal met - ME 326

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>S06</td>
<td>80</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>F06</td>
<td>67</td>
<td>78</td>
<td>64</td>
</tr>
</tbody>
</table>

Improvements:
* Require this assignment
** Additional discussion of evolution of laws related to product liability
*** Change to graded assignment
**** Incorporate additional discussion of evolution of the body of law related to product liability responsibility of the professional engineer.
Outcome (j): knowledge of contemporary issues

Senior Survey

Exit Surveys: Spring 2006-Spring 2008
Outcomes Assessment (j)
The ME program provided me with sufficient knowledge to:

<table>
<thead>
<tr>
<th></th>
<th>Spring 2006</th>
<th>Fall 2006</th>
<th>Spring 2007</th>
<th>Fall 2007</th>
<th>Spring 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recognize</td>
<td>4.5</td>
<td>4</td>
<td>4</td>
<td>4.5</td>
<td>4.5</td>
</tr>
<tr>
<td>contemporary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>issues</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5 = Strongly Agree
4 = Agree
3 = Neutral
2 = Disagree
1 = Strongly Disagree

Fundamentals of Engineering Exam: Comparison of ME average to National average 2006-2008

Subject areas addressing outcome (j), General & Mechanical AM questions:
\[
\text{\geq 90\% National Average} \quad \text{\textless 90\% National Average}
\]
Engineering Economics

Subject areas addressing outcome (j), General PM questions:
\[
\text{\geq 90\% National Average} \quad \text{\textless 90\% National Average}
\]
Engineering Economics
Faculty Assessment in Courses

In the accompanying graphs, --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- denotes full achievement of goal.
The (.#) after the course number indicates the number of measures used to evaluate the outcome assessed in the course. For example, ME 222 used 3 measures in its evaluation. Typically these measures are a mix of homework assignments, specific quiz & exam questions, and projects.

Outcome (k) % of goal met - ME 166

<table>
<thead>
<tr>
<th>Goal</th>
<th>Result</th>
<th>Result</th>
<th>Result</th>
<th>Result</th>
<th>Result</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>166-1</td>
<td>50</td>
<td>87</td>
<td>174%</td>
<td>72</td>
<td>39</td>
<td>54%</td>
</tr>
<tr>
<td>166-2</td>
<td>50</td>
<td>64</td>
<td>128%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* New instructor for course
** Committee decided this course is at a base level and not a valid indicator in terms of outcome assessment

This course will no longer be assessed for outcomes.

Outcome (k) % of goal met - ME 222

<table>
<thead>
<tr>
<th>Goal</th>
<th>Result</th>
<th>Result</th>
<th>Result</th>
<th>Result</th>
<th>Result</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>222-1</td>
<td>80</td>
<td>91</td>
<td>114%</td>
<td>80</td>
<td>76</td>
<td>114%</td>
</tr>
<tr>
<td>222-2</td>
<td>80</td>
<td>94</td>
<td>118%</td>
<td>80</td>
<td>86</td>
<td>118%</td>
</tr>
<tr>
<td>222-3</td>
<td>80</td>
<td>86</td>
<td>108%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Improvements:
* Shorten tutorials in the CAM portion of the class
** More availability for help outside of class
*** Spend more time on GDT; give additional quiz on GDT; change emphasis on grades
**** Raise lab expectations; change assessment goal; lecture more on GDT
### Outcome (k): ability to use techniques, skills and modern engineering tools for engineering practice

#### Spring 2006 - Spring 2008

**Outcome (k) % of goal met - ME 236**

<table>
<thead>
<tr>
<th>Goal</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>236-1</td>
<td>75</td>
<td>75</td>
<td>100%</td>
</tr>
<tr>
<td>236-2</td>
<td>75</td>
<td>71</td>
<td>95%</td>
</tr>
<tr>
<td>236-3</td>
<td>75</td>
<td>35</td>
<td>47%</td>
</tr>
</tbody>
</table>

**Improvements:**
- * more tutorial & review sessions; increase availability out of class; organize interactive web site.
- ** (different instructor) Work more examples
- *** (S06 instructor) requirement to use interactive web site; increase weight of homework in final grade.
- **** (another instructor) more time to complete tests; more tutorials; more lecture time or reduce/remove dynamics part of curriculum
- ***** interactive website for homework did not work out, will do more during class.

**Outcome (k) % of goal met - ME 329**

<table>
<thead>
<tr>
<th>Goal</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>329-1</td>
<td>80</td>
<td>70</td>
<td>88%</td>
</tr>
<tr>
<td>329-2</td>
<td>80</td>
<td>45</td>
<td>56%</td>
</tr>
</tbody>
</table>

**Improvements:**
- * Spend 1 lecture reviewing MatLab; give quizzes in computer lab; test basic MatLab skills later in course.
- ** Spend 2 classes reviewing MatLab; assign a MatLab programming skill homework; give quizzes on MatLab programming skills; change goal.
- *** Change assessment back to 80%
- **** Give specific MatLab exercise prior to quiz (many performance problems are MatLab related).
- ***** Shift measure from Quiz1 to Quiz#2 to give students longer to recall MatLab skills; closed-book to force memorization of commands and simple programming.
Outcome (k): ability to use techniques, skills and modern engineering tools for engineering practice

Outcome (k) % of goal met - ME 341

<table>
<thead>
<tr>
<th>Course</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>341-1</td>
<td>80</td>
<td>73</td>
<td>91%</td>
</tr>
<tr>
<td>341-2</td>
<td>80</td>
<td>53</td>
<td>66%</td>
</tr>
</tbody>
</table>

Improvements:
* Use in-class demo of Excel; greater weight to HW assignment to increase participation
** Prob with students handing in assignments(?); institute help session between assignments.
*** Start Excel earlier in course.

Senior Surveys

Exit Surveys: Spring 2006-Spring 2008
Outcomes Assessment (k)
The ME program provided me with sufficient knowledge to:

- Use techniques, skills and modern engineering tools for engineering practice
  5 = Strongly Agree
  4 = Agree
  3 = Neutral
  2 = Disagree
  1 = Strongly Disagree

Fundamentals of Engineering Exam: Comparison of ME average to National average 2005-2008
Subject areas addressing outcome (e), General AM, PM and PM Mech questions:
>/= 90% National Average
<90% National Average

- Measurements, Instrumentation & Controls
- Thermodynamics & Energy Conservation
- Kinematics, Dynamics & Vibrations

Computers
Refrigeration & HVAC
Outcome (ME2): ability to apply advanced mathematics through multivariate calculus and differential equations

Faculty Assessment in Courses

In the accompanying graphs, —— denotes full achievement of goal.
The (#) after the course number indicates the number of measures used to evaluate the outcome assessed in the course. For example, ME 222 used 3 measures in its evaluation. Typically these measures are a mix of home work assignments, specific quiz & exam questions, and projects.

Outcome (ME2) % of goal met - ME 328

<table>
<thead>
<tr>
<th></th>
<th>F06</th>
<th></th>
<th>F07</th>
<th></th>
<th>S08</th>
</tr>
</thead>
<tbody>
<tr>
<td>328</td>
<td>44%</td>
<td>49%</td>
<td>62%</td>
<td>70</td>
<td>50%</td>
</tr>
<tr>
<td>Goal</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Outcome (ME2) % of goal met - ME 329

<table>
<thead>
<tr>
<th></th>
<th>F06</th>
<th></th>
<th>F07</th>
<th></th>
<th>S08</th>
</tr>
</thead>
<tbody>
<tr>
<td>329</td>
<td>50%</td>
<td>136%</td>
<td>70</td>
<td>50%</td>
<td>80</td>
</tr>
<tr>
<td>Goal</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Improvements: *Replace homework assignment with quiz to better test ability.

Outcome (ME2) % of goal met - ME 341

<table>
<thead>
<tr>
<th></th>
<th>F06</th>
<th></th>
<th>F07</th>
<th></th>
<th>S08</th>
</tr>
</thead>
<tbody>
<tr>
<td>341</td>
<td>70</td>
<td>136%</td>
<td>70</td>
<td>77</td>
<td>110%</td>
</tr>
<tr>
<td>Goal</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

* Different instructor teaching course for this semester

Spring 2006 - Spring 2008
Outcome (ME3): familiarity with statistics and linear algebra

Faculty Assessment in Courses

In the accompanying graphs,
--- --- --- --- --- denotes full achievement of goal.
The (-#) after the course number indicates the number of measures used to evaluate the outcome assessed in the course. For example, ME 328 used 1 measure in its evaluation. Typically these measures are a mix of home work assignments, specific quiz & exam questons, and projects.

**Outcome (ME3) % of goal met - ME 345**

<table>
<thead>
<tr>
<th></th>
<th>goal</th>
<th>result</th>
<th>%</th>
<th>goal</th>
<th>result</th>
<th>%</th>
<th>goal</th>
<th>result</th>
<th>%</th>
<th>goal</th>
<th>result</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>345-1</td>
<td>S06</td>
<td>90</td>
<td>95</td>
<td>106%</td>
<td>80</td>
<td>88%</td>
<td>90</td>
<td>80</td>
<td>89%</td>
<td>80</td>
<td>80</td>
<td>89%</td>
</tr>
<tr>
<td>Goal</td>
<td></td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: instructors alternate

* Discuss more examples and assign more homework
** Additional homework to evaluate mean and standard deviation of a Gaussian variable
*** Discuss more examples and assign more homework
**** Adjust assessment goal to more realistic level: 80%; additional homework practice

**Outcome (ME3) % of goal met**

- **345-1**
- **Goal**
Outcome (ME4): ability to work professionally in both thermal and mechanical systems including the design and realization of such systems

Faculty Assessment in Courses

In the accompanying graphs, — — — — — — — — — — — — denotes full achievement of goal.
The (-#) after the course number indicates the number of measures used to evaluate the outcome assessed in the course. For example, ME 328 used 1 measure in its evaluation. Typically these measures are a mix of home work assignments, specific quiz & exam questions, and projects.

### Outcome (ME4) % of goal met - ME 326

<table>
<thead>
<tr>
<th>Goal</th>
<th>Result</th>
<th>%</th>
<th>Goal</th>
<th>Result</th>
<th>%</th>
<th>Goal</th>
<th>Result</th>
<th>%</th>
<th>Goal</th>
<th>Result</th>
<th>%</th>
<th>Goal</th>
<th>Result</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>326</td>
<td>80</td>
<td>70</td>
<td>0.875</td>
<td>80</td>
<td>100</td>
<td>125%</td>
<td>80</td>
<td>64</td>
<td>80%</td>
<td>80</td>
<td>86</td>
<td>108%</td>
<td>80</td>
<td>75</td>
</tr>
</tbody>
</table>

Goal
100% 100% 100% 100% 100%

**Improvements:**
* Devote more effort to group organization and timely testing of mechanisms.
** Assign more credit to successful and timely laboratory testing and evaluation of projects.

### Outcome (ME4) % of goal met - ME 425

<table>
<thead>
<tr>
<th>Goal</th>
<th>Result</th>
<th>%</th>
<th>Goal</th>
<th>Result</th>
<th>%</th>
<th>Goal</th>
<th>Result</th>
<th>%</th>
<th>Goal</th>
<th>Result</th>
<th>%</th>
<th>Goal</th>
<th>Result</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>425</td>
<td>100</td>
<td>100</td>
<td>100%</td>
<td>80</td>
<td>100</td>
<td>125%</td>
<td>80</td>
<td>100</td>
<td>125%</td>
<td>80</td>
<td>100</td>
<td>125%</td>
<td>80</td>
<td>100</td>
</tr>
</tbody>
</table>

Goal
100% 100% 100% 100% 100%

**Improvements:**
* Goal met, will be raised to higher score - from 65% to 75%
The ME program provided me with sufficient knowledge and experience to:

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Spring 2006</th>
<th>Fall 2006</th>
<th>Spring 2007</th>
<th>Fall 2007</th>
<th>Spring 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apply knowledge of mathematics, science and engineering</td>
<td>4.27</td>
<td>4.43</td>
<td>4.54</td>
<td>4.43</td>
<td>4.33</td>
</tr>
<tr>
<td>Design and conduct experiments, analyze and interpret data</td>
<td>4.07</td>
<td>4.14</td>
<td>3.92</td>
<td>3.92</td>
<td>4.21</td>
</tr>
<tr>
<td>Design a system, component, or process</td>
<td>4.33</td>
<td>4.43</td>
<td>4.58</td>
<td>4.29</td>
<td>4.25</td>
</tr>
<tr>
<td>Function on a multidisciplinary team</td>
<td>4.47</td>
<td>4.56</td>
<td>4.65</td>
<td>4.29</td>
<td>4.42</td>
</tr>
<tr>
<td>Identify, formulate and solve engineering problems</td>
<td>4.33</td>
<td>4.47</td>
<td>4.38</td>
<td>4.07</td>
<td>4.25</td>
</tr>
<tr>
<td>Understand professional and ethical responsibility</td>
<td>4.53</td>
<td>3.69</td>
<td>3.96</td>
<td>4.14</td>
<td>4.14</td>
</tr>
<tr>
<td>Communicate effectively</td>
<td>4</td>
<td>4.21</td>
<td>4.31</td>
<td>4.19</td>
<td>4.14</td>
</tr>
<tr>
<td>Understand the impact of engineering solutions in a global and societal context</td>
<td>4</td>
<td>4.08</td>
<td>4.36</td>
<td>4.57</td>
<td>4.29</td>
</tr>
<tr>
<td>Engage in lifelong learning</td>
<td>4.27</td>
<td>4.21</td>
<td>4.36</td>
<td>3.92</td>
<td>4.58</td>
</tr>
<tr>
<td>Engage in lifelong learning</td>
<td>4.33</td>
<td>4.42</td>
<td>4.42</td>
<td>4.13</td>
<td>4.58</td>
</tr>
<tr>
<td>Recognize contemporary issues</td>
<td>4</td>
<td>4</td>
<td>4.07</td>
<td>4.14</td>
<td>4.12</td>
</tr>
<tr>
<td>Use techniques, tools and modern engineering tools for engineering practice</td>
<td>4.27</td>
<td>4.31</td>
<td>4.14</td>
<td>4.57</td>
<td>4.29</td>
</tr>
</tbody>
</table>

### Senior Exit Surveys 2006-2008

#### Part 3:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4=Excellent</td>
<td>3=Good</td>
<td>2=AVERAGE</td>
<td>1=Poor</td>
<td>3=Excellent</td>
</tr>
<tr>
<td>Please rate the following</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students' ability to handle real-world engineering problems</td>
<td>4.0</td>
<td>3.5</td>
<td>3.3</td>
<td>3.0</td>
</tr>
<tr>
<td>Quality of instruction in the ME program</td>
<td>3.5</td>
<td>3.0</td>
<td>2.5</td>
<td>2.3</td>
</tr>
<tr>
<td>ME departments' system for advising students</td>
<td>3.0</td>
<td>3.0</td>
<td>2.5</td>
<td>2.2</td>
</tr>
<tr>
<td>NMSU's Placement &amp; Career Services system</td>
<td>2.5</td>
<td>2.5</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Physical facilities (such as classrooms, etc.)</td>
<td>3.5</td>
<td>3.0</td>
<td>2.5</td>
<td>2.3</td>
</tr>
<tr>
<td>Computer facilities</td>
<td>3.0</td>
<td>3.0</td>
<td>2.5</td>
<td>2.2</td>
</tr>
<tr>
<td>NMSU's Placement &amp; Career Services system</td>
<td>2.5</td>
<td>2.5</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Spring 2006</td>
<td>2.93</td>
<td>3.2</td>
<td>3.33</td>
<td>2.93</td>
</tr>
<tr>
<td>Fall 2006</td>
<td>3.14</td>
<td>3.14</td>
<td>3.14</td>
<td>3.57</td>
</tr>
<tr>
<td>Spring 2007</td>
<td>3.28</td>
<td>3.19</td>
<td>3.19</td>
<td>3.10</td>
</tr>
<tr>
<td>Fall 2007</td>
<td>3.29</td>
<td>3</td>
<td>2.79</td>
<td>3.07</td>
</tr>
<tr>
<td>Spring 2008</td>
<td>3.25</td>
<td>3.21</td>
<td>2.5</td>
<td>3.04</td>
</tr>
<tr>
<td>Average</td>
<td>3.178</td>
<td>3.148</td>
<td>2.99</td>
<td>3.168</td>
</tr>
</tbody>
</table>
Senior Exit Surveys 2006-2008

Outcomes (a-k):

Exit Surveys: Spring 2006-Spring 2008
Outcomes Assessment (a)
The ME program provided me with sufficient knowledge to:

- Apply knowledge of mathematics, science and engineering
  - 5 = Strongly Agree
  - 4 = Agree
  - 3 = Neutral
  - 2 = Disagree
  - 1 = Strongly Disagree

Exit Surveys: Spring 2006-Spring 2008
Outcomes Assessment (b)
The ME program provided me with sufficient knowledge to:

- Design and conduct experiments, analyze and interpret data
  - 5 = Strongly Agree
  - 4 = Agree
  - 3 = Neutral
  - 2 = Disagree
  - 1 = Strongly Disagree

Exit Surveys: Spring 2006-Spring 2008
Outcomes Assessment (c)
The ME program provided me with sufficient knowledge to:

- Design a system, component, or process
  - 5 = Strongly Agree
  - 4 = Agree
  - 3 = Neutral
  - 2 = Disagree
  - 1 = Strongly Disagree

Exit Surveys: Spring 2006-Spring 2008
Outcomes Assessment (d)
The ME program provided me with sufficient knowledge to:

- Function on a multidisciplinary team
  - 5 = Strongly Agree
  - 4 = Agree
  - 3 = Neutral
  - 2 = Disagree
  - 1 = Strongly Disagree
Senior Exit Surveys 2006-2008

Outcomes (a-k):

Exit Surveys: Spring 2006-Spring 2008
Outcomes Assessment (e)
The ME program provided me with sufficient knowledge to:
- Identify, formulate and solve engineering problems

Exit Surveys: Spring 2006-Spring 2008
Outcomes Assessment (f)
The ME program provided me with sufficient knowledge to:
- Understand professional and ethical responsibility

Exit Surveys: Spring 2006-Spring 2008
Outcomes Assessment (g)
The ME program provided me with sufficient knowledge to:
- Communicate effectively

Exit Surveys: Spring 2006-Spring 2008
Outcomes Assessment (i)
The ME program provided me with sufficient knowledge to:
- Engage in lifelong learning
Senior Exit Surveys 2006-2008

Outcomes (a-k):

Exit Surveys: Spring 2006-Spring 2008
Outcomes Assessment (j)
The ME program provided me with sufficient knowledge to:
- Recognize contemporary issues

Exit Surveys: Spring 2006-Spring 2008
Outcomes Assessment (k)
The ME program provided me with sufficient knowledge to:
- Use techniques, skills and modern engineering tools for engineering practice
Senior Exit Surveys 2006-2008

Miscellaneous Items:

1. **ME department's system for advising students**
   - Spring 2006: 4
   - Fall 2006: 3.5
   - Spring 2007: 3
   - Fall 2007: 2.5
   - Spring 2008: 2

2. **Students' ability to handle real-world engineering problems**
   - Spring 2006: 3.5
   - Fall 2006: 3.5
   - Spring 2007: 3.5
   - Fall 2007: 3.5
   - Spring 2008: 3.5

3. **Quality of instruction in the ME program**
   - Spring 2006: 4
   - Fall 2006: 3.5
   - Spring 2007: 3
   - Fall 2007: 2.5
   - Spring 2008: 2

4. **NMSU's Placement & Career Services system**
   - Spring 2006: 3.5
   - Fall 2006: 3.5
   - Spring 2007: 3.5
   - Fall 2007: 3.5
   - Spring 2008: 3.5
Senior Exit Surveys 2006-2008

Miscellaneous Items:

- **Physical facilities (classrooms, etc.):**
  - Spring 2006: 2.5
  - Fall 2006: 3
  - Spring 2007: 2.5
  - Fall 2007: 2.5
  - Spring 2008: 1

- **Computer facilities:**
  - Spring 2006: 3.5
  - Fall 2006: 3.5
  - Spring 2007: 3.5
  - Fall 2007: 3.5
  - Spring 2008: 3.5

- **ME Shop:**
  - Spring 2006: 3.5
  - Fall 2006: 3.5
  - Spring 2007: 3.5
  - Fall 2007: 3.5
  - Spring 2008: 3.5
ME 222: Intro to Product Development  

Spring 2006

Outcome k:
The student will become familiar with the more advanced CAD/CAM tools needed to model, analyze, manufacture, and document engineering projects (Unigraphics)

Measure:
Monitor the scores on the 3 course exams

Optional Inputs:

Learning Strategies:
In each area (CAD, GD&T, CAM), start with tutorials, continue with homework to be completed on their own, have them work a practice exam

Optional Inputs:
Students say tutorials too long in CAM material

Assessment:
Of the students that pass the course with a C- or better, 80% will receive a score of 70% or better on each of the 3 exams (curved grades)

Evaluation:
Exam1: Motion
91.4% had a score of 70 or better
Exam2: GD&T
94.3% had a score of 70 or better
Exam3: Manufacturing
85.7% had a score of 70 or better

Improvements:
Rethink (shorten) the tutorials in the CAM portion of the course.
Did not like Manufacturing at the end of the course – shop too busy to machine students’ paperweights.

Display Material Reference:
Exam Grade Summary
ME 222: Intro to Product Development

Outcome k:
The student will become familiar with the more advanced CAD/CAM tools needed to model, analyze, manufacture, and document engineering projects (Unigraphics)

Measure:
Monitor the scores on the 3 course exams in Exam CAD, Exam GDT, and Exam CAM

Optional Inputs:

Learning Strategies:
In each area (CAD, GD&T, CAM), start with tutorials, continue with homework to be completed on their own, have them work a practice exam

Optional Inputs:
Students say tutorials too long in CAM material

Assessment:
Of the students that pass the course with a C- or better, 80% will receive a score of 70% or better on each of the 3 exams (curved grades)

Evaluation:
Exam1: Motion
75.9% had a score of 70 or better
Exam2: GDT
86.2% had a score of 70 or better
Exam3: Manufacturing
79.3% had a score of 70 or better

Improvements:
Make myself and the TAs available more outside of class to try to enhance the CAD understanding.

Display Material Reference:
Exam Grade Summary
Outcome (k): ability to use techniques, skills and modern engineering tools for engineering practice

- The student will become familiar with the more advanced CAD/CAM tools needed to model, analyze, manufacture and document engineering projects (Unigraphics).

Measure
Monitor the scores on the 3 course exams, ExamCAD, ExamGDT, and ExamCAM

Learning Strategies
In each area (CAD, GDT, CAM), start with tutorials, continue with homework to be completed on their own, have them work a practice exam.

Assessment Goal
Of the students who pass the course with a C- or better, 80% will receive a score of 70% or better on each of the 3 exams (curved grades).

Evaluation
CAD exam: 69% had a score of 70 or better
CAM exam: 66% had a score of 70 or better
GDT exam: 54% had a score of 70 or better

Improvement(s) Implemented
(If different from planned improvement, please explain.)
Increase instructor and TA availability outside of class to enhance CAD understanding.

Improvement(s) Planned
1. Spend more time on GDT
2. Give an additional quiz on GDT to encourage more students to read the book.
3. Don’t emphasize the students’ course grades before the GDT exam (too many figured that they couldn’t raise or lower their current course grade).

Display Material Reference:
Course syllabus
Grade sheet
Copy of homework assignment, exam, etc., used as measurement
Outcome (k): ability to use techniques, skills and modern engineering tools for engineering practice

- The student will become familiar with the more advanced CAD/CAM tools needed to model, analyze, manufacture and document engineering projects (Unigraphics).

Measure
Monitor the scores on the 3 course exams, ExamCAD, ExamGDT, and ExamCAM

Learning Strategies
In each area (CAD,GDT,CAM), start with tutorials, continue with homework to be completed on their own, have them work a practice exam.

Assessment Goal
Of the students who pass the course with a C- or better, 80% will receive a score of 70% or better on each of the 3 exams (curved grades).

Evaluation
CAD Exam: 82% had a score of 70 or better
CAM Exam: 78% had a score of 70 or better
GDT Exam: 64% had a score of 70 or better
All higher than Spring 2007, but CAM & GDT do not meet goal.

Improvement(s) Implemented
(If different from planned improvement, please explain.)
1. Spend more time on GDT
2. Give an additional quiz on GDT to encourage more students to read the book.
3. Don’t emphasize the students’ course grades before the GDT exam (too many figured that they couldn’t raise or lower their current course grade).

Improvement(s) Planned
1. Since the lab grade is always so high, I have asked Mr. Park to raise his expectations in an effort to make the students more accountable in the lab.
2. Change Assessment Goal: “Of the students who pass the lecture part of the course with a C- or better, 80% will receive a score of 70% or better on each of the 3 exams (curved grades).” (See re-evaluation on Display Materials)
3. Lecture more on GDT, rely less on students reading the supplemental material.

Display Material Reference:
Course syllabus
Grade sheet
Copy of homework assignment, exam, etc., used as measurement
**ME 222: Intro to Product Development**

**Spring 2008/Pederson**

**Outcome (k):** ability to use techniques, skills and modern engineering tools for engineering practice

- The student will become familiar with the more advanced CAD/CAM tools needed to model, analyze, manufacture and document engineering projects (Unigraphics).

**Measure**

Monitor the scores on the 3 course exams, ExamCAD, ExamGDT, and ExamCAM

**Learning Strategies**

In each area (CAD,GDT,CAM), start with tutorials, continue with homework to be completed on their own, have them work a practice exam.

**Assessment Goal**

Of the students who pass the lecture part of the course with a C- or better, 80% will receive a score of 70% or better on each of the 3 exams (curved grades).”

**Improvement(s) Implemented**

(If different from planned improvement, please explain.)

4. Since the lab grade is always so high, I have asked Mr. Park to raise his expectations in an effort to make the students more accountable in the lab.

5. Change Assessment Goal: “Of the students who pass the lecture part of the course with a C- or better, 80% will receive a score of 70% or better on each of the 3 exams (curved grades).” (See re-evaluation on Display Materials)

6. Lecture more on GDT, rely less on students reading the supplemental material.

**Improvement(s) Planned**


**Display Material Reference:**

Course syllabus
Copy of homework assignment, exam, etc., used as measurement
ME260: Mechanical Engineering Problem Solving

Outcome a: An ability to apply knowledge of math, science and engineering

Students will learn how to develop solutions to problems by divide and conquer strategy.

Measure

- Homeworks # 12 and 13
- Exams #2 and 4

Feedback

- Instructor evaluation of assignment and exams

Learning Strategies

- Utilize top-down design process of starting with a large task and breaking it down into smaller, more easily understandable pieces (sub-tasks) which a portion of the desired task. Each sub-task may in turn be subdivided into smaller sub-tasks if necessary
- Utilize pseudocode and flow charts

Feedback

- Quizzes and tests results
- Students monthly questionnaires
- Students' course evaluation

Assessment

- 70% demonstrate score of 80% or higher on homework
- 70% demonstrate a score of 80% or higher on exams

Evaluation

- 52% got a score of 80% and higher on the exams
- 63 % got a score of 80% and higher on the homeworks

Improvements

- Since not everybody has taken required MATH 185, find a possibility to devote one class to basic matrix algebra and manipulations with arrays.
- More attention to practical applications of pseudocode and flow charts methods.
- Put more emphasis on code syntax

Display Material Reference:

- Course Syllabus
- Homework Assignments
- Exams
Outcome a:

Students will learn how to develop solutions to problems by the divide and conquer strategy.

Measure

- Homework #8 - 19
- Exams 1-3

Feedback

- Instructor evaluation of homework’s and exams

Learning Strategies

- Utilize top-down design process of starting with a large task and breaking it down into smaller, more easily understandable pieces (sub-tasks) which a portion of the desired task. Each sub-task may in turn be subdivided into smaller sub-tasks if necessary
- Utilize pseudocode and flow charts

Assessment

- 70% demonstrate a score of 80% or higher on homework measure
- 70% demonstrate a score of 80% or higher on exams measure

Evaluation

68.6% obtained a score of 80% or better on the homework and 65.7% obtained a score of 80% or better on the exams.

Improvements

Homework and Exam percentages were close to the cutoff. If I had changed the cutoff score to 79% then I would have made the 80% or better mark.

Work more examples.

From the evaluations the only thing that stuck out was the textbook. Most students didn’t use the textbook. This is the 3rd textbook for this course. Initially I didn’t have a textbook, but students asked for one in previous evaluations. For convenience I post the problems on WebCT. So perhaps this is making it too easy for the students not to use the textbook.

Display Material Reference:

- Course syllabus
- Homework Assignments
- Exams
Outcome a:

Students will learn how to develop solutions to problems by the divide and conquer strategy.

Measure

- Homework #8 - 19
- Exams 1-3

Learning Strategies

- Utilize top-down design process of starting with a large task and breaking it down into smaller, more easily understandable pieces (sub-tasks) which a portion of the desired task. Each sub-task may in turn be subdivided into smaller sub-tasks if necessary
- Utilize pseudocode and flow charts

Assessment Goal

- 70% demonstrate a score of 80% or higher on homework measure
- 70% demonstrate a score of 80% or higher on exam measure

Evaluation

48.1% obtained a score of 80% or better on the homework and 48.1% obtained a score of 80% or better on the exams.

Display Material Reference:

- Course syllabus
- Homework Assignments
- Exams

Changes based on previous semester evaluation

Homework and Exam percentages were close to the cutoff during previous semester. More examples were worked in greater detail to help improve percentages.

Will begin the process of evaluating other textbooks to replace existing textbook.

Improvements

The percentage of students that obtained a score of 80% on the homework and exam measure is lower than the previous semester. Students simply didn’t turn in the homework. This may explain the lower test scores.

SP07 is also the first semester that the class time was changed from 10:00 a.m. to 8:00 a.m. It is believed that this lowered the average class attendance.

The course evaluations will be beneficial in deciding how to possibly improve performance.
Interim Report Mechanical Engineering

ME260: Mechanical Engineering Problem Solving

Chapter 4 O & A: Data

Outcome a:

Students will learn how to develop solutions to problems by the divide and conquer strategy.

Measure

- Homework #6 - 12, 14 - 16
- Exams 1-3

Learning Strategies

- Utilize top-down design process of starting with a large task and breaking it down into smaller, more easily understandable pieces (sub-tasks) which a portion of the desired task. Each sub-task may in turn be subdivided into smaller sub-tasks if necessary.
- Utilize pseudocode and flow charts

Assessment Goal

- 50% demonstrate a score of 80% or higher on homework measure
- 50% demonstrate a score of 80% or higher on exam measure

Evaluation

63% obtained a score of 80% or better on the homework and 68% obtained a score of 80% or better on the exams.

Display Material Reference:

- Course syllabus
- Homework Assignments
- Exams

Improvement(s) implemented

The percentage of students that obtained a score of 80% or better on the homework and exam measure was 48%. This is lower than previous semesters but is consistent with a normal distribution with a class mean grade of 80%. Therefore the assessment goal will be changed to 50%.

SP07 was the first semester that the class time was changed from 10:00 a.m. to 8:00 a.m. This time change has resulted in lower class attendance. It is believed that the lower class attendance has negatively affected the students’ performance in the class. Need to get the scheduled class time back to 10:00 a.m. Will try to improve class attendance by enforcing attendance policy.

To improve student performance on homework and exams, the amount of time spent on working examples in class will be increased.

Improvements

Enforced class attendance policy by taking row every class period and lab session. As a result of the attendance policy class attendance improved significantly. In addition to the enforcement of the attendance policy, more time was spent on working examples and going over homework problems. These two factors lead to significant improvements, over the previous semester in terms of student performance on homework and exam scores.

By continuing the enforcement of class attendance policies and spending more time on examples and homework student performance should be maintained. The course can be improved with a better textbook or by further developing course material.
Outcome a:

Students will learn how to develop solutions to problems by the divide and conquer strategy.

Measure

- Homework #6 - 12, 14 - 16
- Exams 1-4

Changes based on previous semester evaluation

Enforced class attendance policy by taking roll every class period and lab session. As a result of the attendance policy class attendance improved significantly. In addition to the enforcement of the attendance policy, more time was spent on working examples and going over homework problems. These two factors lead to significant improvements, over the previous semester in terms of student performance on homework and exam scores.

By continuing the enforcement of class attendance policies and spending more time on examples and homework student performance should be maintained. The course can be improved with a better textbook or by further developing course material.

Learning Strategies

- Utilize top-down design process of starting with a large task and breaking it down into smaller, more easily understandable pieces (sub-tasks) which a portion of the desired task. Each sub-task may in turn be subdivided into smaller sub-tasks if necessary
- Utilize pseudocode and flow charts

Assessment Goal

- 50% demonstrate a score of 80% or higher on homework measure
- 50% demonstrate a score of 80% or higher on exam measure

Evaluation

65% obtained a score of 80% or better on the homework and 65% obtained a score of 80% or better on the exams.

Display Material Reference:

- Course syllabus
- Homework Assignments
- Exams

Improvements

The structure of the course was changed significantly midway through the semester. Class attendance was improved through the taking of roll, but the computers were a distraction during lecture. As a result of this the class was moved to a normal lecture room and quizzes were given each class period. With the move to the normal classroom programming examples went from writing code using MATLAB to writing flow charts to solve programming problems.

It is believed that this change in the presentation of the material will help students improve their programming skills and increase their programming abilities. MATHCAD was also dropped from the curriculum to focus more on programming skills.

These midway changes will be adopted and implemented for the Fall 08 course.
 Outcome (b): Ability to design and conduct experiments/analyze and interpret data

Measure

Student design own experiment to utilize available technology.

Learning Strategies

Student conducts experiment, and resolves differences in expectations with actual results.

Assessment

90% of students acquire correct and adequate data, and also perform an analysis to resolve errors as reflected in the report grade

Evaluation

28 of 29 (96%) of students achieve proposed goals

Improvements

Break out grading into laboratory grade and also report/oral presentation grade

Display Material Reference:

Syllabus
Experiment/Report grade sheet
Outcome (b): Ability to design and conduct experiments/analyze and interpret data

Student-proposed experiment, data acquisition, data analysis, results presentation, and report.

Measure

Student design own experiment to utilize available technology.

Learning Strategies

Student conducts experiment, and resolves differences in expectations with actual results.

Assessment

90% of students acquire correct and adequate data, and also perform an analysis to resolve errors as reflected in the report grade

Evaluation

100% of students scored 85% and above in this specific laboratory report.

Improvements

Goal met, no improvement planned.

Display Material Reference:

Syllabus
Experiment/Report grade sheet
ME 345: Experimental Methods I

Outcome (b): Ability to design and conduct experiments/analyze and interpret data

<table>
<thead>
<tr>
<th>Measure</th>
<th>Improvement(s) Implemented</th>
</tr>
</thead>
</table>
| Student design own experiment to utilize available technology | (If different from planned improvement, please explain.)

<table>
<thead>
<tr>
<th>Learning Strategies</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Student conducts experiment, and resolves differences in expectations with actual result</td>
<td>Students achieved goal in Spring 2006; no improvements in Learning Strategies required. Grades for experiment and report will be presented separately.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assessment Goal</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>90% of students acquire correct and adequate data, and also perform an analysis to resolve errors as reflected in the report grade</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>Improvement(s) Planned</th>
</tr>
</thead>
<tbody>
<tr>
<td>36 of 37 (97%) of students achieve proposed goals</td>
<td>No improvements necessary</td>
</tr>
</tbody>
</table>

Display Material Reference:

Course syllabus
Grade sheet
Copy of homework assignment, exam, etc., used as measurement
Outcome (b): Ability to design and conduct experiments/analyze and interpret data

Student proposed experiment, data acquisition, data analysis, results presentation, and report

Measure

Student design own experiment to utilize available technology

Learning Strategies

Student conducts experiment, and resolves differences in expectations and actual results.

Assessment Goal

90% of students acquire correct data, and also perform an analysis to resolve errors, as reflected in the report grade (80% or above)

Evaluation

95% of students scored over 80% or higher on the report.

Improvement(s) Implemented

(If different from planned improvement, please explain.)

Goal met, no improvement needed.

Improvements

Goal met; no improvements planned.

Display Material Reference:

Course syllabus
Project assignment
Laboratory report grade sheet
Outcome (b): Ability to design and conduct experiments/analyze and interpret data

Measure

Student design own experiment to utilize available technology

Learning Strategies

Student conducts experiment, and resolves differences in expectations with actual result

Assessment Goal

90% of students acquire correct and adequate data, and also perform an analysis to resolve errors as reflected in the report grade (70 or better).

Evaluation

35 of 35 (100%) of students (minimum grade = 70) achieved proposed goals

Display Material Reference:
Course syllabus
Copy of Experiment grades
Copy of experiment proposal, report, and presentation, used as measurement

Improvement(s) Implemented

Goal met; no improvements planned.

Improvement(s) Planned

No improvements necessary
ME 341: Heat Transfer  

Outcome (k): Ability to use techniques, skills and modern engineering tools for engineering practice.

Students will learn to use Excel to solve 2-D steady-state and 1-D transient problems

Measure

Homework assignments 12 and 13

Learning Strategies

Careful development of numerical equations in class
Discussion of good Excel techniques
Provide instructor solutions for review

Will provide students with a help session on using Excel.

Assessment

80% earn 70% or better on Excel projects.

Evaluation

52.2% earned 70% or better on Excel projects

Improvements

Start Excel earlier in course

Display Material Reference:

Course syllabus
Outcome e:
An ability to apply concepts of friction to a variety of problems including ramps, sliding vs. tipping, wedges, and belts

Measure
- Homeworks # 26-28
- Quize # 5
- Midterm exam #3
- Final exam

Learning Strategies
- Lectures
- Questions and answers
- Homeworks

Assessment Goal
77 % demonstrate score corresponding to B (75/100, 22/30, or 7/10) or higher for quiz, homeworks, and tests

Evaluation
The assessment is satisfactory for homeworks. Some improvements required for quizzes and exams

Improvements
1. Make a requirement for students to use the interactive web site for problem solving.

Display Material Reference:
Course Syllabus;
Assignment schedule
Outcome e: ability to identify, formulate and solve engineering problems

Ability to model a dynamic system and determine its forces and displacements.

Measure

- Homework #2,3,13,14,16,18,20-25,30,31
- Exams 1-3, Final Exam

Learning Strategies

- Discussion of basic dynamic concepts and illustrative problems in class. Discussion in class of good and bad designs of physical systems as noted in the literature and current events.

Assessment Goal

- 70% demonstrate a score of 80% or higher on homework measure
- 70% demonstrate a score of 80% or higher on exam measure

Evaluation

78.6% obtained a score of 80% or better on the homework and 46.4% obtained a score of 80% or better on the exams.

Changes based on previous semester evaluation

No Information from previous semester

Improvements

Exam scores could be improved by having a review session, but not during class time. There is too much material to cover during the semester so it would not be a good idea to sacrifice material to increase exam scores.

The 70% demonstration of 80% or higher on the exams is not realistic. Dynamics is a difficult subject for most students. Will change this to 80% demonstrate a score of 70% or higher on the exam measure.

Display Material Reference:

- Course syllabus
- Homework Assignments
- Exams
Outcome (c):
An ability to design a machine element or a machine element assembly using principles of engineering science, failure theories, materials selection; and rules of thumb, and to work effectively as part of a design team.

Measure
- Design Project

Learning Strategies
- Homework assignments
- In-class quizzes
- Discussion of Design Project
- Lectures

Assessment Goal
75% of the students score 80% and above for completed design project.

Evaluation
100% of the students scored 80% and above in the total score in the course

Improvement Implemented
Based on previous semester results, goal was raised from 65% to 75% score 80% or better on completed design project.

Improvement(s) Planned
Goal met, no improvement planned.
Outcome (b): ability to design and conduct experiments/analyze and interpret data

- Provide students with opportunities to predict outcomes of experiments based on theoretical models and verify predictions by measurement.
- Analyze and present data.

Measure

Pipe Flow experiment:
- Pre-lab exercises
- Final lab report

Learning Strategies

Lecture
Hands-on lab experiments
Feedback from reviewed reports

Assessment Goal

Final Reports:
90% of groups will complete all requirements for each lab, and there will be adequate correspondence between pre-lab data and comparison in final report

Evaluation

5/7 or 71% of groups completed requirements including correspondence between pre-lab data and comparison as reflected in 65% and above on analytical grading.

Improvement(s) Implemented

(If different from planned improvement, please explain.)

No improvements needed at this time.

Improvement(s) Planned

Grade sheets need to be recorded for specifics described.

Display Material Reference:
Course syllabus
Grade sheet
Copy of homework assignment, exam, etc., used as measurement
ME 338: Fluid Mechanics  Fall 2007

**Outcome (a): ability to apply knowledge of math, science, and engineering**

Course objective: Applications of mass, momentum and energy conservation laws to fluid mechanics problems.

**Measure**

Homework assignments 6, 7, 8  
Midterm exam 2  
Final exam, problem 2

**Learning Strategies**

Classroom discussion  
Q & A during class hours  
Q & A during office hours

**Assessment Goal**

50% of class scores 60 or higher on exams  
50% of class scores 70 or higher on homework

**Evaluation**

Midterm exam 2: 51.4% of class scored 60 or higher  
Final exam, problem 2: 34.3% of class scored 60 or higher  
HW #6: 65.7% of class scored 75 or higher  
HW #7: 57.1% of class scored 75 or higher  
HW #8: 71.4% of class scored 75 or higher

**Improvements**

Student performance meets the goal for homeworks and midterm-exam 2, but not for the final exam problem: more comprehensive before-final review is suggested. The assessment goal is reasonable and should be kept.

**Instructor Experience**

NA – First time this instructor has taught the course

**Display Material Reference:**

Course syllabus  
Copies of homework and exams  
Grade sheet
ME 236: Engineering Mechanics I  
Spring 2008

Outcome a
An ability to apply equilibrium conditions to force systems

Measure
- Homeworks # 3-11 and 34 - 36
- Exam 1 and Exam 4 (Problem 3)

Changes based on previous semester evaluation
- Make a requirement for students to use the interactive web site for problem solving.
- Increase the weight of homework in the final grade

Learning Strategies
- Lectures
- Questions and answers
- Homework

Assessment Goal
- 70% demonstrate score corresponding to B (8/10 for homework, 24/30 for Exam 1, and 8/10 for Problem 3 of Exam 4.)

Evaluation
- 68% demonstrate score of B for homework
- 32% demonstrate score of B for Exam 1
- 84% demonstrate score of B for Problem 3 of Exam 4

Improvements
- Students did not perform as well as expected on exam 1. It is believed that this is due to the fact that this was the first exam in the class and they underestimated the amount of studying that was needed to obtain a “B” on the first exam. A practice exam given before the first exam will help address this problem.
- More students would have obtained a “B” or better in the homework if they just worked the problems. It is unrealistic to require the students to use interactive websites for problem solving. There is also a lot of downloading problems from websites so putting more weight on the homework will not guarantee that students are solving the homework problems.
- Solving the homework problems in class has helped students understand the material. The plan is to work more homework problems during class time.

Display Material Reference:
- Course Syllabus;
- Assignment schedule;
Outcome (ME3): familiarity with statistics and linear algebra

Apply basic statistical analyses to Gaussian variable

Measure

Student successfully applies basic Gaussian statistics in order to determine the normalized mean and standard deviation

Learning Strategies

In-class assignment. Homework assignment.

Assessment

90% of students perform a rudimentary statistical analysis involving mean and standard deviation measures

Evaluation

80% of students of students submitted correct answers

Improvements

Goal not met. Adjust assessment goal to a more realistic level: 80%. Assign additional homework to practice evaluating mean and standard deviation of a Gaussian variable.

Display Material Reference:

Syllabus
In-class assignment
Grade sheet
Outcome (a): Ability to apply knowledge of math, science, and engineering

Students will learn a variety of numerical methods that are useful in both basic and advanced engineering calculations.

Measure

Selected assignments:
- Assignment # 2
- Assignment # 10
- Assignment # 13

Learning Strategies

In class development of theory
Q & A during class
Q & A during office hours
Feedback via instructor’s solutions to projects

Assessment

80% earn 70% or higher on projects.

Evaluation

86% earned 70% or higher on the three selected assignments.
Zeros were left out that reflected functional dropouts or people caught cheating.

Improvement(s) Implemented

Goal met.

Improvements

Replace one of the assignments with a quiz to better test ability. High results may reflect excessive collaboration.

Display Material Reference:

Course syllabus
Chapter 5 Program Outcomes and Assessment: Narrative

This chapter is supportive, rather than central, and contains material that supports Chapters 2, 3, and 4. The purpose of this chapter is to present an overview analysis that essentially assesses the educational objectives from an internal, outcomes point of view. The relation of the four program educational objectives to the eleven outcomes (a) – (k) is shown in Table 3.1. Thus, noting for example that outcomes (a), (e), and (k) are identified with educational objective 1 (fundamentals/technical knowledge), students who are doing well in all three outcome areas are likely being well prepared to succeed professionally in the capabilities that demonstrate achievement of educational objective 1. Conversely, if students are not doing well in any of the outcome areas (a), (e), and (k), one may expect difficulty in achieving educational objective 1 after graduation. Thus, consideration of “groups of outcomes” associated with given educational objectives can serve as an indicator of the likely achievement later on of the associated educational objectives (of course, the achievement of the educational objectives must be independently assessed based on accomplishments after graduation, as discussed in Chapter 3).

The remainder of this section contains overview assessments of student performance in the “groups of outcomes” associated with each of the four educational objectives.

Group 1: Program outcomes (a), (e), (k) – Related to and supporting Educational Objective 1 – Fundamentals/Technical Knowledge.

Technical knowledge (of ME fundamentals) is primarily presented in early and intermediate level courses. Program outcomes are assessed in the following courses:

- ME 222 – Introduction to Product Development (k)
- ME 236 – Engineering Mechanics I (a), (k)
- ME 237 – Engineering Mechanics II (e)
- ME 240 – Thermodynamics I (e)
- ME 260 – Mechanical Engineering Problem Solving (a)
- ME 329 – Engineering Analysis II (a), (k)
- ME 338 – Fluid Mechanics (a)
- ME 340 – Thermodynamics II (e)
- ME 341 – Heat Transfer (a), (e), (k)

Results strongly suggest that students are achieving well in courses assessed for outcome (a). Scores in at least one measure increased in each of the five courses assessed for this outcome.

Scores on the FE exam also evidence strength in outcome (a), with results equal to or above 90% of the national average in 17 out of 24 categories.
Graduating seniors rated the program at between 4.0 and 4.5 (out of 5.0) for supporting their outcome (a) skills.

The four courses assessed for outcome (e) showed mixed results. Introductory courses (100 & 200 level) are more likely to show lower-than-goal achievement since some of these students will find that engineering is not their field. We know there have been changes in approach in ME 240 that affect results, and ME 340 cites a textbook problem as influencing goal achievement. Both of these are Thermodynamics courses; performance in the second obviously is linked, to some extent, to experiences in the first. The O&A Committee will closely monitor assessment in these courses and make recommendations based on a lengthier collection of data and observations.

Scores on the FE exam also evidence strength in outcome (e), with results equal to or above 90% of the national average in 10 out of 16 categories.

Graduating seniors rated the program at close to 4.5 (out of 5.0) for supporting their outcome (e) skills.

Outcome (k) is also represented by a mix of 200 & 300 level courses. Goal achievement fluctuated but the overall trend is positive, with improvements predominating.

Flow charts document changes implemented to improve results. For example, the instructor for ME 341 tried a new textbook – and then returned to the original. He also raised the goal when achievement stayed above 100% for three semesters.

A change in instructor for ME 240 for Spring 2008 also brought a change in measurement tool. This instructor based a quiz on FE exam questions, with results surpassing goal. This demonstrated a class’s grasp of basic thermodynamic concepts.

Again citing ME 341 activities, the instructor planned to modify or replace textbook problems to counteract homework copying.

Other instructors responded to results by modifying lecture or assignment techniques.

Scores on the FE exam for categories related to outcome (k), were equal to or above 90% of the national average in 3 out of 5 categories.

Graduating seniors rated the program at between 4.0 and 4.5 (out of 5.0) for supporting their outcome (a) skills.

Group 2: Program Outcomes (b), (c), (d), and also (e) & (k) – Related to, and supporting, Educational Objective 2 – Problem Solving

The ME Academy survey respondents were in 100% agreement in ranking Problem Solving as the #1 educational objective of importance in the work place. Skills involved
draw on many of the program outcomes. Our department supports this objective with program outcomes: (b), (c), (d), (e) and (k), with assessments performed in 12 courses:

- ME 326 – Mechanical Design (c)
- ME 345 – Experimental Methods I (e)
- ME 425 – Design of Machine Elements (c)
- ME 426/7 – Capstone Design (c), (d)
- ME 445 – Experimental Methods II (e)
- In addition to courses applied to EO 1 (ME 222, 236, 237, 240, 329, 340 & 341).

Our design courses (ME 326, 425 and 426/7) all show steady positive goal achievement, with the two upper level courses always meeting or exceeding goals for outcome (c).

ME 326 uses the ASME Annual Student Design Contest as one of its projects, with the goal of sending at least one team to the ASME regional competition usually held in April. The annual ASME challenge aligns with the academic year so both fall and spring semester students are involved in the same project.

ME 326 has distinguished itself many times in the ASME contests. Since the self-study of 2006, ME 326 teams have placed first in the regional competitions and gone on to place in the international competition held in the early winter.

The 2005-2006 ASME challenge was to design a fishing pole for quadriplegics such that it could be reproduced by a lay handyman with easily acquired tools. The ME 326 design team went on to place third at the international competition. Hurricane Katrina provided the impetus for the 2006-2007 challenge. The students were asked to design a human-powered still that could purify enough water for drinking in an emergency situation. The ME 326 design team went on to place second in the 2007 international competition. The team leader for the 2007 challenge was subsequently invited to be on a national team of 5 students organized by ASME, with two faculty members from Western Kentucky University as mentors, to continue the project introduced in the ASME competition.

Although teamwork is a significant aspect of many ME courses, only ME 426/7, the Capstone course, meets the definition of multidisciplinary [outcome (d)] as a team that includes members from more than one department or discipline. The instructor for ME 426/427 has recruited students from other departments to meet the multidisciplinary requirement successfully since Fall 2006; this effort must be maintained every semester. Industrial Engineering students are often included in the spring semester. Their Capstone requirement is for this semester only.

Collaboration with the English department offers master’s candidates in Technical Writing the option to participate on one of the engineering teams as the Document Manager, coordinating reports, the binder and other writing elements.
The ME and English instructors for the course received the best poster award at the first National Capstone Design Conference held at the University of Colorado at Boulder in June 2007. Their poster focused on four key ways that they have attempted to address areas that alumni felt needed strengthening: increased multidisciplinary experience, more emphasis on all forms of communication skills, a more global perspective of the design process, and more experience in large-scale planning and project management.

As indirect evidence, ME students also participate on multidisciplinary teams such as the Mini Baja and Flying Aggies. For example, the 2006 team included ME, ME Technology, and even a Geography major.

Two Experimental Methods courses are assessed as evidence of outcome (b). Experimental Methods I has continually met or surpassed its evaluation goal, while Experimental Methods II dipped slightly below goal in Fall 2007 but results rose in the following semester.

Experimental Methods II (ME 445) is a strenuous course with six experiments, each requiring a full professional style report. These experiments include fluids, heat transfer and thermal systems, concluding with a team designed experiment in keeping with the focus areas of the course. This course is also assessed for outcome (g), and Criterion 8 outcome 3, with indirect contribution at present to outcome 4.

ME students met or surpassed the 90% of national average goal for the related category on the FE exam.

Graduating seniors rated the program at between 4.0 and 4.5 (out of 5.0) for supporting their outcome (e) skills.

**Group 3: Program Outcomes (d) and (g) – Related to, and supporting Educational Objective 3 – Communication.**

Communication skills are developed in numerous ME courses through reports, presentation and through communication as a team dynamic. Outcomes (d) and (g) are preparation for successful communication in the work place.

The Capstone course, ME 426/7, incorporates an array of communication activities. Teams present their project ideas and progress at various stages to a variety of audiences: mentors, clients, and the Industrial Advisory Committee (of the ME Academy). Effective team/client relations depend on communication strengths developed through weekly team meetings and periodic progress reports to clients. While these are interpersonal and oral skills, requirements for a documentation binder (meeting minutes, memos, design plan etc.) and summary report encourage writing skills which will be essential in any workplace.

Outcome assessments have been consistently above goal for these outcomes in ME 426/7.
Oral presentation and report writing are assessed in another upper level course, ME 445 Experimental Methods II. Specifically, 80% of the course grade is based on written and oral reports of experiments. Content/analytical component and the written/oral component are equally considered in the evaluation.

The oral presentation measure has consistently been between 90 and 100% of goal, while the report writing poses a greater challenge. There has been significant fluctuation in these results. Improvement efforts have been implemented with varying success.

ME 449, the one-credit Senior Seminar course contains a writing assignment on a contemporary issue discussed in seminar. The instructor responds with a written critique and a one-on-one interview/discussion of the paper. This assignment has consistently achieved or exceeded goal.

Indirect measure: ASME competition requires a poster describing the process and particulars of whatever design product is involved in that year’s challenge. Points for the poster are one determinant of ranking in the competition.

**Group 4: Program Outcomes (f), (h), (i), and (j) – Related to and Supporting Educational Objective 4 Professionalism.**

Outcome (h), broad education, is addressed in the general education courses. The student senior exit interview average for this outcome is the lowest among the eleven outcomes (4.01/5.0).

The student senior exit interviews indicate that students view their knowledge and experience in outcomes (f) and (i) to be above average among the eleven outcomes (4.5/5.0 for outcome (f) and 4.42/5.0 for outcome (i)). These outcomes are addressed mainly in the senior seminar course, with outcome (i) also addressed indirectly in the general education courses.

Outcome (j), contemporary issues, is addressed in Design I (ME 326) and in Senior Seminar (ME 449). The senior exit interview average of 4.12/5.0 is noticeably lower than for outcomes (f) and (i), indicating that additional material related to this outcome needs to be included in the seminar or elsewhere.

**Summary of Chapter 5**

The ad hoc overview analysis presented in this chapter is useful as a diagnostic tool to predict future achievement of educational objectives. The use of “groups of outcomes” identified with the educational objectives may be a useful assessment tool that will point to needed curricular improvements to better prepare students to achieve educational objectives in the profession.
Chapter 6 Program Concern: Criteria 4 Professional Component


“This criterion requires a major design experience based on the knowledge and skills acquired in earlier coursework and incorporating engineering standards and multiple realistic constraints. The program has such a design experience but final reports produced by student design teams do not appear to reflect the expected scope and depth required by this criterion.”

Due-process response: The EAC acknowledges the receipt of statement that the program reports that it will monitor to ensure that all students place the documentation of various elements of their design experience in the design binders

Status after Due Process: The concern remains unresolved and will be a focus of the next review. In preparation for this review, the EAC anticipates further documentation of the application and assessment of the Professional Component.

Current status/progress – At the time of the ABET site visit in October 2006, the binders/reports required as documentation of projects undertaken for the Capstone Design course were not standardized. The team, mentor and client determined the format and content best suited to their project.

In Fall 2006, ME426/427 instructors initiated a structured format for the final product (binder, report & presentation) based on “A Five-Stage Model of the Design Process” employed in the overall activities of the course. Though this improvement had been implemented, it did not appear in the Spring 2006 material examined by the ABET evaluator. This design process is illustrated in Figure 6.1
Figure 6.1 Five-Stage Model of the Design Process

The binder incorporates the elements of the design method and reflects not only the depth and scope of the project but also documents the process. Each facet of the process is addressed and explained through a lecture scheduled to coordinate with the design stage. The lecture materials become reference and guidelines for the process and binder production.
The design method structure determines the actual binder contents and presentation. The first two binder sections deal with course material and requirements. These sections are followed by those in the Table 6.1 below:

**Table 6.1 Binder Structure Related to Five-Stage Model of the Design Process**

<table>
<thead>
<tr>
<th>Design Phase</th>
<th>Binder Sections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Need Statement</td>
<td>Problem Definition</td>
</tr>
<tr>
<td>Conceptual Development</td>
<td>Concept Development</td>
</tr>
<tr>
<td></td>
<td>Feasibility Assessment</td>
</tr>
<tr>
<td>Preliminary Design</td>
<td>Engineering Model</td>
</tr>
<tr>
<td></td>
<td>Analysis and Synthesis</td>
</tr>
<tr>
<td></td>
<td>Preliminary Design</td>
</tr>
<tr>
<td>Detailed Design</td>
<td>Detailed Design</td>
</tr>
<tr>
<td>Design Communication</td>
<td>Purchase Requisition and ordering information</td>
</tr>
<tr>
<td></td>
<td>Weekly Progress Reports</td>
</tr>
<tr>
<td>Optional</td>
<td>Production Planning and Tooling Design</td>
</tr>
<tr>
<td></td>
<td>Meeting Agenda and Minutes</td>
</tr>
</tbody>
</table>

Regular monitoring of the process (and, by extension, the binder development) is performed through the Weekly Progress meetings, periodic meetings with the Client, and frequent follow-up by the instructor.

Each team has a faculty mentor whose major role is to insure that the students have a primary point of contact. The mentor is involved in the weekly meeting and is provided with information on the past week’s progress, problems needing resolution, team plan updates, and actions planned for the next week.

Each team includes members with strictly defined roles:

1. **Team Manager:**
   a. maintains document control and integrity;
   b. ensures process is followed;
   c. assesses design from the perspective of the client;
   d. approves all technical design documents prior to submission to mentor;
   e. and works in close cooperation with the Lead Engineer.

2. **Lead Engineer:**
   a. assigns tasks, and coordinates activities of the team members;
   b. serves as focal point for interface with faculty mentor;
   c. and reviews purchase requisitions, project appropriateness, logistics requirements.

3. **Documentation Manager:**
   a. prompts members to contribute to documentation;
   b. manages document review;
   c. maintains project documents;
   d. and coordinates the written documentation.
At the end of the semester, student teams submit a design package that includes the
design binder, a final report, and a CD-ROM with all data. The format structure allows
them to organize and present the large amount of documentation they have gathered and
created in an orderly manner that best suits their particular project.
The final report, a 15-30 page summary of the data and activities contained in the design
binder, is submitted as secondary to the comprehensive binder. Students are provided
with a guideline for the final report. The requirement document is included here.

**Final Report Format for ME 426/427 Capstone Design**

A formal technical report is written at the end of a project. Generally, it is a complete,
stand-alone document aimed at persons having widely diverse backgrounds. Therefore, a
detailed description of the project is required. The outline of a typical formal report is:

- **Title page**
- **Summary (abstract):** An abstract or summary should contain a brief overview
  of the report, including its conclusions and recommendations if there are any. A
good length for an abstract is 300 words; some scientific journals actually specify
this number of words explicitly. The abstract of a scientific paper or report is
considered to be capable of 'standing alone' and being published separately. For
this reason the heading 'abstract' in a report is usually not numbered. Numbering
usually starts with the introduction.
- **Table of contents**
- **Introduction:** This section contains background to the work to acquaint reader
  with the problem and the purpose for carrying on the work.
- **Method:** In the 'method' section you should describe the way the work was
  carried out, what equipment you used, and any particular problems that had to be
  overcome.
- **Results:** Results are usually given as plainly as possible, and without any
  comment. You should include enough data to enable to reader to be confident that
  you have done what you said you would do, and that your conclusions will be
  trustworthy.
- **Discussion:** In this section the author provides an interpretation of the results,
  compares them with other published findings -- if there are any -- and points out
  any potential shortcomings in the work. In particular, if your findings are unusual,
  or very much at odds with other people's conclusions, you should explain why
  you think this might be. Otherwise the reader will probably assume you have just
  made a mistake.
- **Conclusion:** The conclusion gives the overall findings of the study. It is
  important to realize that 'conclusion' does not just mean 'the last bit of the report'.
  Your conclusions should really be statements that can be concluded from the rest
  of the work.
- **Recommendations:** In this section the author normally includes any advice he or
  she wishes to offer the reader. Some people use the recommendations sections for
  suggestions of further work.
• **References and bibliography**: The purpose of citing references is to allow the reader to follow up your work, and perhaps check that the conclusions you draw really follow from the sources you cite.

• **Appendices**: The appendices are where the author will usually place any material that is not directly relevant to the report, and will only be read by small number of people. Appendices may be used for mathematical proofs, electrical circuit diagrams and sections of computer programs.

The team’s binder is rated on points assigned to the individual sections which correspond to the design stages as described in Table 6.1.

An example of the rubric used in evaluating the binder is displayed in Table 6.2.

### Table 6.2 ME 426/427 Outcome Assessment (c) Evaluation for Spring 2007

<table>
<thead>
<tr>
<th>Capstone Design Process Component Check List</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Name</td>
</tr>
<tr>
<td>---------------</td>
</tr>
<tr>
<td>Air Conditioner</td>
</tr>
<tr>
<td>ASME Design</td>
</tr>
<tr>
<td>Balloon</td>
</tr>
<tr>
<td>Biomass Instru</td>
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<tr>
<td>Biomass II</td>
</tr>
<tr>
<td>Biomass Engine</td>
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<tr>
<td>Energy Island</td>
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<tr>
<td>Glovebox</td>
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<tr>
<td>Interior Cargo</td>
</tr>
<tr>
<td>Nanosat</td>
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<tr>
<td>Raytheon</td>
</tr>
<tr>
<td>Sandia</td>
</tr>
<tr>
<td>Suspension</td>
</tr>
<tr>
<td>Wildfire</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assessment Measure</th>
<th>75% follow structured design process</th>
<th>8.0 out of 10 for average design process component score</th>
</tr>
</thead>
<tbody>
<tr>
<td>AG (Assessment Goal)</td>
<td>No. of Teams</td>
<td>Percentage</td>
</tr>
<tr>
<td>Team &gt; AG</td>
<td>13</td>
<td>92.9%</td>
</tr>
<tr>
<td>Team &lt; AG</td>
<td>1</td>
<td>7.1%</td>
</tr>
</tbody>
</table>
The five semester history of this outcome assessment is an element of the outcomes results section, outcome (c): ability to design a system, component or part. Below is the chart used in that section. The line denoting 426/427-2 refers to the Capstone Design Process Checklist (Binder components).
Addendum to Chapter 6

A Five-Stage Model of the Design Process
Material accompanying course lectures

Introduction: Management
As an engineer, you will be called upon to design a wide variety of devices and systems. You may be asked to design simple mechanical components such as a holding fixture for use in a manufacturing assembly environment. On the other hand, you may have to design an entire machine or building, along with all of the related subcomponents. You may be responsible for the entire project individually, or you may have an entire team of engineers, scientists, and business staff working on the developed formal design procedures, and you will probably be asked to use that procedure. Other businesses may not have formal design and review procedures, and the decision of how to manage the entire design project is yours. We will use a design procedure in this class. This formal approach fosters a strong team-oriented working relationship with the client, helps students to learn what to expect in working together. The multi-faceted approach to product development allows us to perform concurrent engineering, by performing activities on more than one facet at a time, but it also leads us in the direction of where the primary focus of the team should be at various stages in the process.

Facet 1. Recognize and Quantify the Need
- Market Demand
- Assess competing solutions for the need
- Budgetary Parameters

Facet 2. Define the problem
- Design Objective
- Design Constraints – Budget, Time, Legal, Personnel, Material properties and availability, manufacturability
- Design Specifications

Facet 3. Concept Development
- Brainstorming Techniques (Pros and Cons, what is the essential elements for the concept)
- Any other methods
- Literature Review

Facet 4. Feasibility Assessment
- Technical Feasibility
- Economical Feasibility
- Schedule Feasibility
- Evaluation Criteria
Facet 5. Preliminary Design
   • Preliminary Drawing Package
   • Assembly and Component Drawings
   • Bill of Materials and Supplier Identification

Facet 6. Analysis and Synthesis (Engineering Models – Simulation, Testing, and/or Hardware)
   • Software simulation and CAD model
   • Rapid prototype and physical representations
   • Proof of concept Prototype

Facet 7. Detailed Design (DFx)
   • Comprehensive Drawing Packages
   • Review of Codes and Standards
   • Design factors include: Safety, Manufacturability, Maintenance, Assembly, Manufacturing, Disassembly, Recycling, Quality

Facet 8. Production Planning and Tooling Design
   • Pre-Production Prototype
   • Flexible work cell design, die design, fixtures, tooling, automation
   • Process diagrams and process flow sheets

Facet 9. Pilot Production
   • Commercial market assessment
   • Development plan by manufacturer(s)
   • Demonstration of latest vendor product to user community

Facet 10. Full Scale Production
   • Capitalization
   • Standardization and interchangeability
   • Product marketing demonstration to potential buyers

Facet 11. Product Acquisition and Deployment
   • Customer feedback for continuous product improvement
   • Product maintenance and logistics support
   • User training
   • Sales, Service, and Support

**Brainstorming**

Brainstorming is a group technique for generating ideas in a nonthreatening, non-inhibiting atmosphere. It is a group activity in which the collective creativity of the
group is tapped and enhanced. The objective of brainstorming is to generate the greatest number of alternative ideas from the uninhibited responses of the group.

**Approach**

Brainstorming can be done either individually or in a group. In group brainstorming, the participants are encouraged, and often expected, to share their ideas with one another as soon as they are generated. Complex problems or brainstorm sessions with a diversity of people may be prepared by a chairman. The chairman is the leader and facilitator of the brainstorm session.

The key to brainstorming is to not interrupt the thought process. As ideas come to mind, they are captured and stimulate the development of better ideas. Thus a group brainstorm session is best conducted in a moderate-sized room, and participants sit so that they can all look at each-other. A flip chart, blackboard, or overhead projector is placed in a prominent location. The room is free of telephones, clocks, or any other distractions.

In order to enhance creativity a brainstorm session has four basic rules:

**Focus on quantity**

This rule is a means of enhancing divergent production, aiming to facilitate problem solving through the maxim quantity breeds quality. The greater the number of ideas generated, the greater the chance of producing a radical and effective solution. An individual may revisit a brainstorm, done alone, and approach it with a slightly new perspective. This process can be repeated without limit. The result is collaboration with your past, present and future selves.

**No criticism**

It is often emphasized that in group brainstorming, criticism should be put 'on hold'. Instead of immediately stating what might be wrong with an idea, the participants focus on extending or adding to it, reserving criticism for a later 'critical stage' of the process. By suspending judgment, you create a supportive atmosphere where participants feel free to generate unusual ideas. However, persistent, respectful criticism of ideas by a minority dissenter can reduce groupthink, leading to more and better ideas.

**Unusual ideas are welcome**

To get a good and long list of ideas, unusual ideas are welcomed. They may open new ways of thinking and provide better solutions than regular ideas. They can be generated by looking from another perspective or setting aside assumptions. If an idea is too "wild" to be feasible, it can be tamed down to a more appropriate idea more easily than think up an idea.

**Combine and improve ideas**

Good ideas can be combined to form a very good idea, as suggested by the slogan "1+1=3". Also, existing ideas should be improved. This approach leads to better
and more complete ideas than just generation of new ideas, and increases the generation of ideas, by a process of association.

**Feasibility Assessment Steps**

**Step 1** Prepare and distribute the plan for performing a feasibility assessment of the proposed design concepts.

1. Prepare a list of questions based on the Needs Statement and Problem Definition that can be equally applied to each design concept. Be sure to cover technical, economic, schedule, market, and performance issues with the questions.

2. Agree on a weighting scale to be used in answering each question. Assume 0 indicates that the concept totally fails to meet the criteria, while a 3 indicates full compliance. Make sure that the scale for each question is applicable to all concepts, and will discriminate between concepts.

3. Assign individuals to perform background research required to answer each feasibility question for each concept. Each response should be supported by appropriate documentation.

**Step 2** Each individual should research their assigned feasibility question and concept, and prepare a written report on their findings.

**Step 3** Prepare a formal MS Word report summarizing all available information about the feasibility assessment. The report should consist of (i) summary of the Step 1 tasks, consisting of the questions and scoring criteria, (ii) a tabulation of results of the assessment, (iii) a radar chart comparing the concept alternatives, (iv) a recommendation (v) supporting documentation for each response to each question, such as price quotes, stress analysis, parts count, market data etc. This report should become Section of your final report at the end of the semester.

**Step 4** Distribute the report to all team members so that everyone has a common basis for subsequent facets of the design process.

**Additional Information**
All team members should bring any background information they have available to the team meeting, including knowledge of bar codes, molding manufacturing, retail needs, automation, related experiences, questions they would like to have answered, etc.
Sample Feasibility Assessment Questions

Project: Battlebots Competition

Question Type: Technical Question 1
Question: Does the team have the skills needed to implement all aspects of the technologies for the concept?

Question Type: Technical Question 2
Question: Does the team have the resources for the concept?

Question Type: Performance Question 1
Question: Is the concept durable?

Question Type: Performance Question 2
Question: Can the concept achieve speed and agility?

Question Type: Economic Question 1
Question: Can the team members cover the cost of construction?

Question Type: Schedule Question 1
Question: Can the concept be built by the time of the competition?

Question Type: Marketing Question 1
Question: Is the concept reusable?

Question Type: Marketing Question 2
Question: Is the concept reusable?
**Feasibility Assessment Worksheet**

**Project:**

**Question Type:** Technical Question 1

**Generic Question:** *Does the team have the skills needed to implement all aspects of the technology for this concept?*

<table>
<thead>
<tr>
<th>Score</th>
<th>Customize the scoring for your specific project in this column</th>
<th>Genetic Scoring Template</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>No, and we have no idea where to get someone with this expertise, at any price. It would be difficult or impossible to complete one or more technical aspects of this concept as proposed.</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>We wish we could be stronger in one or more technical area needed to implement this concept. A technical consultant would help a great deal in getting us over one or two hurdles.</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Between the team members, we have basic areas required to implement this concept. Individuals may have to push themselves a little bit, but the basic technology is within grasp.</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Between the team members, we have superior competence in all technical areas of the project. Individuals are highly proficient in the skills needed for all technical aspects of this concept.</td>
</tr>
</tbody>
</table>

Record additional notes or classifications in the space below

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
**Feasibility Assessment Worksheet**

**Project:**

**Question Type:** Economic Question 1

**Generic Question:** *How much will it cost to bring this concept to the customer?*

<table>
<thead>
<tr>
<th>Score</th>
<th>Customize the scoring for your specific project in this column</th>
<th>Genetic Scoring Template</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>This concept is so expensive that failing on this product concept would be damage the customer or our company so much financially that it would take years to recover.</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>Failing on this project would make the team look bad, but would not severely damage the firm financially. The customer would feel the concept was a waste of money if it fails.</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>We may overrun the budget initially planned for the project, but discussions with the customer suggest that the benefits outweigh the increased financial risks.</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>We can absorb the cost for this concept out of allotted budget. This concept can be completed with the originally planned finances.</td>
</tr>
</tbody>
</table>

Record additional notes or classifications in the space below

________________________________________________________________________
________________________________________________________________________
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________________________________________________________________________
**Feasibility Assessment**

Project:

**Question Type:** Economic Question 1

**Question:** *Can the team members cover the cost of construction?*

<table>
<thead>
<tr>
<th>Score</th>
<th>Concept 1</th>
<th>Concept 2</th>
<th>Concept 3</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td>Concept will need finer adjustments such as bearing, advanced metal shaping, and higher accuracy machining</td>
<td>With no sponsors, cost of the complete concept will be above $150 per member of the group</td>
</tr>
<tr>
<td>1</td>
<td>Concept need only abundant materials, but motors, ties, and electronics are more costly.</td>
<td>Concept need only abundant materials, but motors, ties, and electronics are more costly.</td>
<td>With no sponsors, cost of the complete concept will be between $100-$150 per member of the group</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>With no sponsors, cost of the complete concept will be between $50-$100 per member of the group</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>Cost of robot per person with no sponsors, is less than $50</td>
</tr>
</tbody>
</table>

Record additional notes or classifications in the space below

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
### Feasibility Assessment

#### Task Planner

<table>
<thead>
<tr>
<th>Concept/Feasibility Question</th>
<th>Assigned Team Member</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept 1 / Technical 1</td>
<td></td>
</tr>
<tr>
<td>Concept 1 / Technical 2</td>
<td></td>
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<tr>
<td>Concept 1 / Economic 1</td>
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<td>Concept 2 / Technical 1</td>
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<td>Concept 4 / Performace 4</td>
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</tbody>
</table>
Analysis and Synthesis

During an engineering design, you will undoubtedly encounter a number of problems need to be resolved. Attacking each problem in a methodical fashion will allow you to be more productive individually, and to communicate the results of your analysis more readily to the other members of your design team. You will commonly iterate between synthesis and analysis during your design. The engineering problem solving method presented here is a reasonable template for solving problems ranging from a classwork-problem to a large-scale analysis in support of an industrial design.

Stage 1. Problem Statement

Before solving a problem, you must state clearly and concisely the problem that you have been tasked to solve. Think of the problem statement as if you were writing your own homework assignment.

Stage 2. Summarize Known Information

During this stage of the analysis, you gather historical information, and relevant facts pertinent to your design. Sometimes, the known information comes directly from the problem statement. More commonly, the known information is taken from reference materials, supplier data sheet, material property database, and things of that nature.

Stage 3. Summarize Desired Information

Unlike the problem statement, which sets forward a strategic goal, the list of desired information consists of a series of tactical tasks that must be accomplished in order to achieve the full solution.

Stage 4. Assumptions

We need to list the basic assumptions and constraints under which our analysis will proceed. For example, if we make the assumption of one dimensional heat transfer, we would list that assumption at this point in the design document, and identify whether it is a conservative or a non-conservative assumption. Further, we need to support the validity of our assumptions, or note that the validity remains to be determined.

Stage 5. Schematic and Given Data

In this stage, we gather drawings, sketches, and numerical data to support our design. This is where we deal with instrumentation issue, gathering property information, and things of that nature. This step becomes rather voluminous. You may gather the data in a spreadsheet format.
Stage 6. Analysis

This is the stage where we get into the essence of the problem. If you developed a mathematical model for your problem, you recall the governing equations of physics that apply to the problem. Then you substitute the known information, apply the simplifying assumptions, and solve for the unknowns.

Stage 7. Review results

Before we make any judgments about a design, we must convince ourselves that the analysis performed was reasonable and accurate. After you have completed an analysis, have an independent member of your design team check your problem statement, known information, desired data, your sketches, your assumptions and their justification, and your solution. Stand back together and confirm whether your answers appear reasonable and have the proper units.

Stage 8. Synthesis

Use the findings from your analysis to revise the underlying design of your product, device, or system. Many times, the solution you develop form the analysis will require you to revise your drawings. Sometime, you can fundamentally simplify the design concept based on your findings. On other occasions, your detailed analysis findings may lead you to the conclusion that you need to rethink your design at a more basic level.

**Engineering Model**

Developing an engineering model is when you can actually put your ideas to the test. An objective of engineering model development is to learn how to plan a test program for your engineering model. We will use the following steps for the engineering model:

**Step 1:** Build the model generated during the preliminary design phase. The model may be a software computer simulation, such as a finite element model, or it can be a scale model, or a full scale prototype. In addition to building the model, we need to prepare a test plan, and sequence of operations, along with a series of questions to be investigated.

**Step 2:** Perform the testing indicated in the test plan. Be sure to recall all original data in your logbooks, and document all experiments and interpretation of the experimental data as well.

**Step 3:** Prepare a report of your findings, along with an interpretation of your results.

**Step 4:** Use the findings from your experiments and your report findings to make improvements to your design.
Detailed Design

Many issues are considered during the detailed design phase of a product or process. Typical detailed design tasks are:

- Detailed drawings
- Quantification prototype testing
- Bill of materials
- Decisions on make/buy
- Detailed product specification
- Detailed cost estimate
- Final design review
- Release to manufacturing

1. Comprehensive Drawing Package – the material that you work on during the course of the project will be compiled into a technical data package that accompanies the final design drawing package that you produce.

- General organization of the drawing package with assemblies, subassemblies, and parts, components
- Title Block, entries, meanings, and use of each part
- Bill of Materials, Item numbers and cross references, balloon callouts
- Introduction to ANSYy14
- Checking out drawings and document control

2. Bill of Materials

- Items present in the BOM
- Identify supplies and alternatives
- Getting price estimates and quotes
- Enter supplies into database
- Prepare purchase requisitions
- Purchasing approval process
  Prepare purchase requisitions

3. Engineering Design Communications

- Using your log book to document contacts with supplies
- Proper use of email for correspondence
- Formal letters and request for quotation
- Working in a design team and communications within your team
- Specifying a document manager

4. Design for X – x is used to denote a performance measure of design

- Design for Manufacturability and Performance
Locations and clearance fits
- Using the Mark’s handbook for the applicable standards for the fits
- Getting a feeling for what constitutes a tight tolerance for various manufacturing processes

- Design for Compliance – Codes and Standards
  - ANSI
  - ASME
  - ISO
  - SAE
  - AIAA
  - Locations on the web for finding standards
  - Resources on campus for finding codes and standards
  - Line by line review of codes and standards

- Design for Safety
  - Independent safety review
  - How to design for safety
  - Failure analysis
  - Machine guarding – distances, openings, mechanical guards, switches, etc.

- Design for Assembly
  - Parts count
  - Fixturing
  - Tool inventory, process instruction
  - Assembly operator as in inspector

Roles of Faculty Mentor:

1. Each team mentor sets up weekly team mentor hours outside of class time. In the weekly mentor meeting, a team leader provides the team mentor with the following information:
   - Progress during the past week
   - Problems that have not been resolved
   - Team work plan updates and planned activities for next week

   During the team mentor meeting, the team mentor asks questions related to the projects activities and provide students with suggestions for project direction.

2. All faculty mentors meet bimonthly to discuss issues raised by team members or by individual faculty member. The prospective meeting time is from 2:30 p.m. to 3:30 p.m. on Wednesday.
3. The major role of faculty mentors is to lead the team projects to insure that the students have a primary point of contact. The three faculty of ME426/427/IE480/ENGL 478 multidisciplinary courses serve as the consultant for their discipline students, however all faculty are available for consulting in their special area. Dr. Riley, Dr. Wojahn, and Dr. Park consult with those students on how to complete their tasks in support of the design project and help them through any problems that students may have.

4. Each team has a lead engineer, a team manager, and documentation manager. If a graduate student is assigned to the team, the graduate student is recommended to act as a team manager.

5. **Responsibilities of team manager are:**
   - Maintain document control and integrity
   - Insure that all review and revision processes are followed
   - Assess the design from the perspective of the customer and adherence to design objectives and performance specifications and make sure no system requirements were missed
   - Maintain the “customer” view of the design
   - Approve all technical design documents prior to submission to the mentor
   - Work in close cooperation with the Lead Engineer

**Responsibilities of lead engineer are:**
- Assign individuals to work on subassemblies and coordinate the responsibilities of team members to complete all tasks associated with the project
- Serve as the focal point for interface with faculty mentor
- Review all purchase requisitions for budget, project appropriateness, delivery/schedule/logistics requirements

**Responsibilities of documentation manager are:**
- Prompt all members to contribute to documents
- Manage document reviews
- Maintain project documents
- Coordinate written documentation of the various project phase
Chapter 7 Concluding Remarks

Status Summary

Our outcomes assessment process was in place, but not fully implemented, in 2006. New educational objectives were adopted in 2007. During the past five semesters (Spring 2006 through Spring 2008) the outcomes assessment process has been fully implemented. We have collected a significant amount of data, and both of our assessment approaches have been demonstrated: 1) the faculty assessment of specific outcomes in individual courses, accompanied by a five semester cycle of improvements, and 2) the O&A Committee’s broader assessment, accompanied by recommendations for improvements. It is necessary in the near term to establish a record of assessment of educational objectives through more active implementation of the alumni surveys.

The scope and depth of the capstone design experience, along with a required student documentation process that demonstrates this scope and depth, has been in place since Fall 2006, as described fully in Chapter 6.

Future Improvements in Our Assessment Process

Based on the experience of our five semesters of assessment work, we have determined that some improvements in the process appear to be warranted. Accordingly, during the 2008 – 2010 period we plan to consider the following actions to improve our assessment process:

1) Regarding the faculty course/outcome flowcharts: it would be desirable to implement a greater degree of similarity in the measures and assessments used in the various courses for a given outcome. This would improve internal consistency and would result in less “dislocation” when different instructors teach a given course in successive semesters.

2) Regarding the educational objectives: the new educational objectives adopted in 2007 require us to obtain measures of performance of our graduates after they have spent some time in the workplace or in graduate school. This will require a reformulation of our alumni survey and the development of a more active process to obtain responses. This needs to be a near term priority.

3) The Department’s Outcomes and Assessment Committee has operated separately from the undergraduate curriculum committee during the past several years. The department will be considering some curriculum revisions during the 2008 – 2010 period. It would be advisable to combine the functions of ABET O&A and curriculum revision into a single committee, because of the effect of each on the other. This is planned starting Fall 2008.
4) A greater emphasis on the FE exam through promotion among the student body may enable us to obtain more data that would improve our ability to assess outcomes in specific subject areas. The advantage of these data is that they are nationally normed.

Because our assessment of educational objectives is critically dependent on the alumni surveys, it appears worthwhile to develop other, independent sources of data that would allow quantification of the accomplishments of graduates during
# Appendix ME Course Numbering and Descriptions

<table>
<thead>
<tr>
<th>COURSE</th>
<th>CR</th>
<th>DESCRIPTION</th>
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</thead>
<tbody>
<tr>
<td>M E 102. Mechanical Engineering Orientation</td>
<td>1 cr.</td>
<td>Emphasis on tours of M E labs and NMSU facilities that illustrate possible career paths for mechanical engineers. Students are introduced to department faculty, student organizations, and support services at NMSU. Topics include role of good communication skills, using modern technology, team building, and intellectual property. Students are advised in planning balance of their academic program. Restricted to majors.</td>
</tr>
<tr>
<td>M E 159. Graphical Communication and Design</td>
<td>2 cr.</td>
<td>Sketching and orthographic projection. Covers detail and assembly working drawings, dimensioning, tolerance specification, and design projects.</td>
</tr>
<tr>
<td>M E 166. Introduction to Mechanical Engineering</td>
<td>2 cr.</td>
<td>Introduction to mechanical engineering and the software tools used for communication and computation in engineering. Restricted to majors. Corequisite: MATH 191.</td>
</tr>
<tr>
<td>M E 222. Introduction to Product Development</td>
<td>3 cr.</td>
<td>(2+3P) Introduction to modern methods used in the realization of products. Traditional manufacturing processes, such as metal stamping, turning, milling, and casting are reviewed. Modern methods of rapid prototyping and model making are discussed in context of computer-aided design. Techniques for joining metals, plastics, and composites are discussed. Role of quality control is introduced. Prerequisite: M E 159.</td>
</tr>
<tr>
<td>M E 240. Thermodynamics</td>
<td>3 cr.</td>
<td>First and second laws of thermodynamics, irreversibility and availability, applications to pure substances and ideal gases. Prerequisite: PHYS 215.</td>
</tr>
<tr>
<td>M E 326. Mechanical Design</td>
<td>3 cr.</td>
<td>Design methodology and practice for mechanical engineers. Prerequisites: M E 237 and C E 301.</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>Credits</td>
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<tr>
<td>M E 331.</td>
<td>Intermediate Strength of Materials</td>
<td>3 cr.</td>
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<tr>
<td>M E 345.</td>
<td>Experimental Methods I</td>
<td>3 cr.</td>
</tr>
<tr>
<td>M E 400.</td>
<td>Undergraduate Research</td>
<td>1-3 cr.</td>
</tr>
<tr>
<td>M E 405.</td>
<td>Special Topics</td>
<td>3 cr.</td>
</tr>
<tr>
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<td>Course Title</td>
<td>Credits</td>
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<tr>
<td>ME 426</td>
<td>Design Project Laboratory I</td>
<td>3 cr. (6P)</td>
</tr>
<tr>
<td>ME 427</td>
<td>Design Project Laboratory II</td>
<td>3 cr. (6P)</td>
</tr>
<tr>
<td>ME 430</td>
<td>Environmental Management Seminar II</td>
<td>1 cr.</td>
</tr>
<tr>
<td>ME 443</td>
<td>Internal Combustion Engines</td>
<td>3 cr.</td>
</tr>
<tr>
<td>ME 445</td>
<td>Experimental Methods II</td>
<td>3 cr. (2+3P)</td>
</tr>
<tr>
<td>ME 449</td>
<td>Mechanical Engineering Senior Seminar</td>
<td>1 cr.</td>
</tr>
<tr>
<td>ME 452</td>
<td>Introduction to Automation and Control System Design</td>
<td>3 cr. (2+3P)</td>
</tr>
<tr>
<td>ME 460</td>
<td>Applied Finite Elements</td>
<td>3 cr.</td>
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<tr>
<td>ME 461</td>
<td>Polymers, Their Composites, and Mechanical Behavior</td>
<td>3 cr. (2+3P)</td>
</tr>
<tr>
<td>ME 463</td>
<td>Low Speed Aerodynamics</td>
<td>3 cr.</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>Credits</td>
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<tr>
<td>M E 480</td>
<td>Nuclear Systems</td>
<td>3 cr.</td>
</tr>
<tr>
<td>M E 482</td>
<td>Concepts in Computer-Integrated Manufacturing</td>
<td>3 cr.</td>
</tr>
<tr>
<td>M E 484</td>
<td>Biomechanics</td>
<td>3 cr.</td>
</tr>
<tr>
<td>M E 487</td>
<td>Mechatronics</td>
<td>3 cr.</td>
</tr>
<tr>
<td>M E 499</td>
<td>Advanced Topics</td>
<td>1-3 cr.</td>
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