California State University, Los Angeles

Department of

**Mechanical Engineering**

College of Engineering, Computer Science, and Technology

# PROGRAM ASSESSMENT

# 2001-2002

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11/02

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# I Introduction

The Mechanical Engineering program provides instruction in the basic sciences, in economic, ethical and social issues, and in engineering design and analysis. The undergraduate program has approximately 150 students and awards the Bachelor of Science in Mechanical Engineering to its graduates. Because mechanical engineering is one of the most general branches of engineering, the breadth and flexibility of a mechanical engineer's education provide a wide choice of careers and movement into a variety of engineering areas.

In general terms, mechanical engineers are concerned with the production, transmission, and use of energy. A series of core courses that is completed by all students in the program provides a general mechanical engineering knowledge. Following the completion of the core courses, the students select their area of specialization from applied mechanics, machine design, thermal-fluid sciences and manufacturing. The undergraduate educational experience is brought to closure with a capstone experience in which teams of seniors are assigned design projects. This capstone experience allows students to utilize of the skills and knowledge they have gained throughout the program.

In 1999, the Mechanical Engineering program implemented a program assessment strategy based on student learning. The motivation for implementing originated in four places:

1. The faculty
2. Accreditation Board for Engineering and Technology
3. The WASC Accreditation guidelines
4. The University faculty handbook

This assessment program that is used to ensure achievement of the objectives and outcomes can be described as in a two-loop figure.

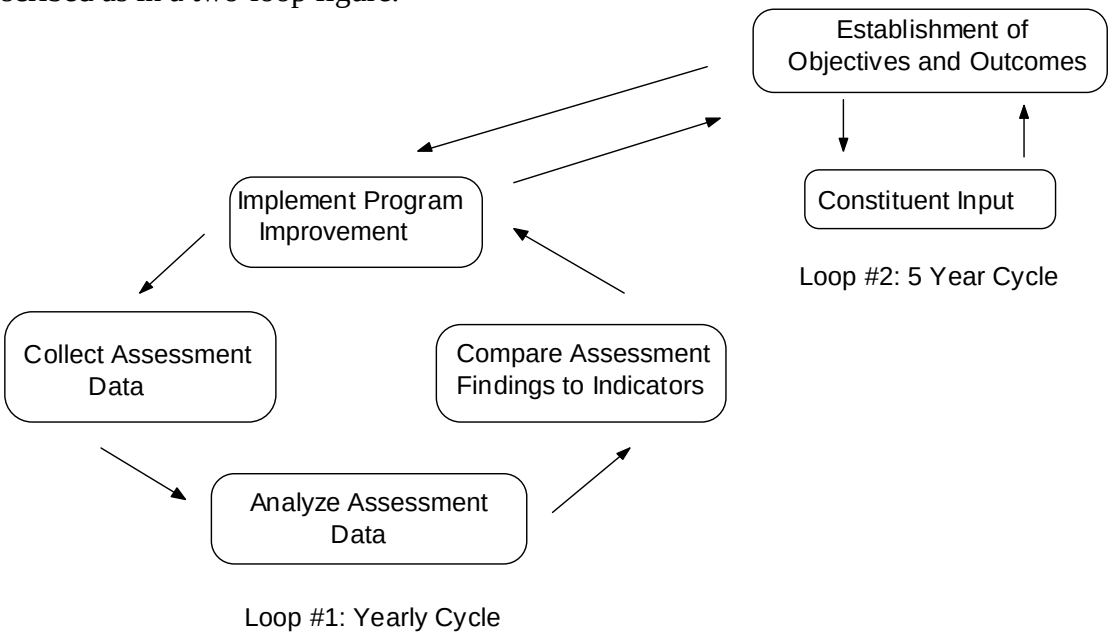



Fig. 1. Yearly implementation of assessment program

Loop #1 is implemented each year. This ensures continual improvement and development of the Mechanical Engineering program. Loop #2 will be implemented every 5 years. This will ensure that the direction in which the program is developing is in line with the desires of the program constituents.

# II Combined Resources of the College of Engineering and Technology

Although each unit (Civil Engineering, Electrical Engineering, Mechanical Engineering, Computer Science, Technology) has the ultimate responsibility of assessing its program, because of the small size of our unit, we decided that it would be inefficient to have each program launch its own program assessment process. Therefore, we chose to launch a co-operative, College-wide effort in which representatives of each of the programs work along with the administration of the college to implement the program assessment process. This process first started in earnest at the beginning of spring quarter, 1999.

Prior to the start of spring quarter, 1999, in cooperation with the chairs, one faculty member was identified from each program/department to fill the role of departmental assessment coordinator. Each individual was offered a total of 12 units of released time spread over three quarters with the expectation that each would devote 10 hours/week for every 10-month period. The cost of the released time is being supported partially with college resources and partially with University resources set aside to support faculty in doing assessment work.
Through this process the following Assessment Project Team was identified:

- Russ Abbott - CS*
- Charles Liu – EE
- Rupa Purasinghe – CE
- Ethan Lipton - Project leader**
- Darrell Guillaume - ME
- Keith Mew - Technology
- Ray Landis - Project leader

*Note: Russ Abbott joined the task force Spring 2001
**Note: Ethan Lipton replaced Ray Landis as Project Leader Summer 2001

# III Status of College Vision and Mission Statement

Since the beginning of this assessment process, the definitions of key terminology have been understood to be important. The table below provides the current definitions used by the assessment task force. This is a "living" list in that the number of terms grow and the definitions change over time.

***Definition of Key Terms***

| ***Term*** | ***Definition*** | ***Applicable Unit*** |
|---|---|---|
| *Vision* | *Where we want to be or how we want to be viewed* | *College* |
| *Mission* | *Description of what we do (i.e., what "business" are we in)* | *College* |
| *Educational objectives* | *Broad statements of what knowledge our graduates will have, what skills they will possess, and what attitudes they will hold* | *Programs* |

| | | |
|---|---|---|
| *Program outcomes* | *Measurable indicators that educational objectives have been met (Generally more specific)* | *Programs* |
| *Performance indicators* | *Detailed metrics (measures) that indicate whether a specific out-come has been achieved* | *Program* |
| *Performance criteria* | *Performance level required to satisfy a particular performance indicator* | *Program* |
| *Constituents (Stakeholders)* | *A group of people with common expectations of an educational program (e.g., students, alumni, faculty, staff, employers)* | *College/ Program* |

Fig. 2. Definition of Key Terms

The Vision and Mission statements for the College of Engineering and Technology are:

***Vision Statement***

***To be a pre-eminent engineering and technology program that prepares students from diverse backgrounds for productive careers by providing them with a student-centered, practically-focused quality learning experience.***

***Mission Statement***

***The mission of the College of Engineering and Technology is to graduate well-educated engineers and technologists who are prepared to meet the challenges of a rapidly changing, increasingly complex world. This will be accomplished through:***

- *A well-qualified faculty who care about students and their success.*
- *A dynamic, up-to-date curriculum that has an optimal balance between theory and practice.*
- *Laboratories, computer facilities, and instructional classrooms on par with any engineering and technology program in the nation.*
- *Unique co-curricular opportunities for students such as participation in student design competitions, professional student organizations, and pre-professional employment.*
- *Opportunities for undergraduate and graduate students to participate in research and industry-funded design clinic projects.*
- *Mutually beneficial partnerships with area industry that take advantage of our location in one of most concentrated high-tech centers in the nation.*
- *Strong cooperative relationships with local high schools and community colleges and with other four-year institutions.*

# IV Status of Educational Objectives and Program Outcomes

The next task for assessment was to develop the following:

- Educational objectives for each program
- Program outcomes for each educational objective

Educational outcomes were defined as broad statements of attributes of graduates of the program. We decided to develop three such statements as follows:

1. One statement describing the knowledge that graduates will have
2. One statement describing the skills that graduates will possess
3. One statement describing the attitudes graduates will hold

Every five years these objectives will be reassessed. The process used to develop these statements was to seek input from various "constituencies" (program faculty, program students, industry representatives, employers, alumni) as to what knowledge, skills, and attitudes they believe graduates of the specific program should have.

- As a starting point for the input from the industry representatives, the assessment coordinator used the ABET a) - k) criteria. For additional input from industry, the assessment coordinator used the findings of the 1917 SME (Society of Manufacturing Engineers) Manufacturing Education Plan: Phase 1 Report.

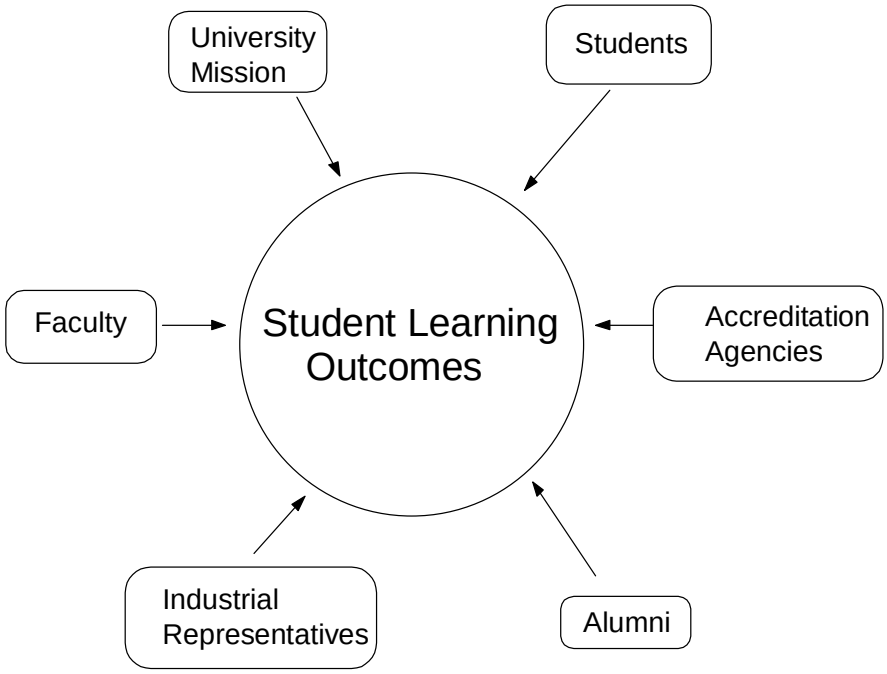



Fig. 3. Determining Student Learning Outcomes

Specifically, the procedure that will be used to update the Mechanical Engineering program objective statements and student outcomes is:

1. Survey the constituents to obtain their opinion of the educational objective statements we are currently using and to determine their desired student outcomes for each objective statement.
2. Use the constituent input to modify the objective statements and all of the desired student outcomes.
3. Resurvey the constituents to obtain approval of the modified objective statements and to obtain a ranking of all the desired student outcomes.
4. Send the final draft of the Mechanical Engineering objective statements and corresponding student outcomes to all constituents for final approval.

The educational objective statement for the Mechanical Engineering program is shown below.

***Educational Objectives and Program Outcomes***
***For the Mechanical Engineering Program***

*The following describe the characteristics that the Cal. State LA Mechanical Engineering program is seeking to produce in its graduates in the three areas:*

- *The knowledge they will have*
- *The skills they will possess*
- *The attitudes they will hold*

*Knowledge*

*Graduates of the Mechanical Engineering program will have the knowledge in math, science and engineering fundamentals, as well as societal issues, that allows them to approach real-world Mechanical Engineering problems with an understanding of their impact on society.*

*This educational objective will be demonstrated by the following outcomes:*

1. *an ability to apply knowledge of mathematics, science, and engineering (abet a)*
   *In particular, an ability to apply knowledge of:*
   *a) chemistry and calculus-based physics.*
   *b) advanced mathematics through multivariate calculus and differential equations.*
   *c) statistics and linear algebra.*
2. *an understanding of professional and ethical responsibility (abet f)*
3. *the broad education necessary to understand the impact of engineering solutions in a global/societal context (abet h)*
4. *knowledge of current events and societal contemporary issues -- non-engineering related. (abet j)*
5. *a knowledge of computer aided design and simulation software*
6. *a knowledge of measurement and manufacturing techniques*
7. *a knowledge of how mechanical engineering integrates into inter-disciplinary systems*

*Skills*

*Graduates of the Mechanical Engineering program will be able to work in group and individual settings to define and solve problems related to thermal and mechanical systems and manufacturing processes by applying engineering fundamentals and engineering tools with a logical approach and be able to clearly communicate their findings.*

*This educational objective will be demonstrated by the following outcomes:*

1. *an ability to design and conduct experiments as well as to analyze and interpret data (abet b)*
2. *an ability to design a system, component, or process to meet desired needs (abet c)*
3. *an ability to function on multidisciplinary teams (abet e)*
4. *an ability to communicate effectively (abet g)*
5. *an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice (abet k)*
6. *an ability to select materials and manufacturing processes*
7. *an ability to visualize designs from engineering drawings*
8. *an ability to think in a logical sequential process*

*Attitudes*

*Graduates of the Mechanical Engineering program will be confident in their abilities to be successful in industrial, academic, and governmental positions and will have the positive and inquisitive outlook on life and learning necessary to promote their continued professional and personal development throughout their careers.*

*This educational objective will be demonstrated by the following outcomes:*

1. *an understanding of professional and ethical responsibility (abet f)*

2. *a recognition of the need for an ability to engage in lifelong learning (abet i)*
3. *an understanding of responsibility and accountability*
4. *a desire to be a professional that exhibits values, dedication and a need for continual improvement*
5. *a desire to be a flexible and adaptable team player (collaborative attitude)*

# V The Assessment Process

## Standing Committee

To ensure a continuous assessment process, a permanent committee within the department has been formed. These committees have a 3 year, rotating membership that allows all department faculty to participate in the assessment process. They meet on a bi-monthly basis.

Members: Maj Mirmirani (Chair)
Lih-Min Hsia
Darrell Guillaume
Steve Felszeghy

The purpose of this committee is to ensure that data are collected and analyzed for the current year. Specifically, the committee is charged with:

- specifying the assessment tools
  - ⇒ assessing the effectiveness of current tools
  - ⇒ evaluating possible new tools
- determining the timing for the implementation of assessment tools
  - ⇒ specifying the audience and location
  - ⇒ verifying that the tools are implemented
- analysis of results
- reporting assessment results to the department
- specifying where changes in the curriculum are required
- verifying that changes have been implemented
- documenting evidence of the changes

# VI Relation between Curriculum and Program Outcomes

The process of documenting where within the curriculum and to what extent each program outcome is being accomplished was conducted during summer, 1999. A subcommittee at the college level consisting of Rupa Purasinghe and Charles Liu developed a template for this purpose. A sample of this template is presented in Appendix 1.

Each program has a list of course coordinators. Each course coordinator was asked to indicate what program outcomes are being addressed in their course and at what level. Nine points were awarded where the focus on the program outcome is "high," three points where the focus is "medium," one point where the focus is "low," and no points where there is no focus. With these data, the total points were computed for each program outcome. This provided initial

indications of where the curriculum is doing a good job in achieving the program outcome and where there are deficiencies.

| Educational Outcome | Current Curriculum Strength |
|---|---|
| Knowledge | |
| Graduates of the Mechanical Engineering program will have the knowledge in math, science and engineering fundamentals, as well as societal issues, that allows them to approach real-world Mechanical Engineering problems with an understanding of their impact on society. | |
| | |
| This educational objective will be demonstrated by the following outcomes: | |
| 1. an ability to apply knowledge of mathematics, science, and engineering (abet a)<br>a) In particular, an ability to apply knowledge of:<br>b) chemistry and calculus-based physics.<br>c) advanced mathematics through multivariate calculus and differential equations.<br>d) statistics and linear algebra. | 120 |
| 2. an understanding of professional and ethical responsibility (abet f) | 94 |
| 3. the broad education necessary to understand the impact of engineering solutions in a global/societal context (abet h) | 56 |
| 4. knowledge of current events and societal contemporary issues -- non-engineering related. (abet j) | 33 |
| 5. a knowledge of computer aided design and simulation software | 115 |
| 6. a knowledge of measurement and manufacturing techniques | 87 |
| 7. a knowledge of how mechanical engineering integrates into inter-disciplinary systems | 75 |
| | |
| Skills | |
| Graduates of the Mechanical Engineering program will be able to work in group and individual settings to define and solve problems related to thermal and mechanical systems and manufacturing processes by applying engineering fundamentals and engineering tools with a logical approach and be able to clearly communicate their findings. | |
| | |
| This educational objective will be demonstrated by the following outcomes: | |
| 1. an ability to design and conduct experiments as well as to analyze and interpret data (abet b) | 74 |
| 2. an ability to design a system, component, or process to meet desired needs (abet c) | 118 |
| 3. an ability to function on multidisciplinary teams (abet e) | 62 |
| 4. an ability to communicate effectively (abet g) | 124 |
| 5. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice (abet k) | 133 |
| 6. an ability to select materials and manufacturing processes | 74 |
| 7. an ability to visualize designs from engineering drawings | 48 |
| 8. an ability to think in a logical sequential process | 159 |
| | |
| Attitudes | |
| Graduates of the Mechanical Engineering program will be confident in their abilities to be successful in industrial, academic, and governmental positions and will have the positive and inquisitive outlook on life and learning necessary to promote their continued professional and personal development throughout their careers. | |
| | |
| This educational objective will be demonstrated by the following outcomes: | |
| 1. an understanding of professional and ethical responsibility (abet f) | 92 |
| 2. a recognition of the need for an ability to engage in lifelong learning (abet i) | 93 |
| 3. an understanding of responsibility and accountability | 128 |
| 4. a desire to be a professional that exhibits values, dedication and a need for continual improvement | 124 |
| 5. a desire to be a flexible and adaptable team player (collaborative attitude) | 124 |

Fig. 4. Current Curriculum Strength for Each Outcome

# VII Assessment Tools and Process

The schedule for implementation of the assessment tools is shown in Fig. 5.

| Assessment Tool | Implementation Frequency | Year Results are Reported |
|---|---|---|
| 1 Capstone design course | | |
| a Oral presentation (Appendix 2) | Every Year | **This Report** |
| b Written presentation | Every two Years* | 2002-2003 |
| 2 Webfolio | | |
| a Industry Assessment | Every Two Years | **This Report** |
| b Faculty Assessment (Appendix 3) | Every Two Years | 2002-2003 |
| c Alumni Assessment (Appendix 3) | Every Two Years | 2002-2003 |
| 3 Surveys of seniors (Appendix 4) | Every Year | **This Report** |
| 4 Surveys of recent graduates | Every Five Years | 2004-2005 |
| 5 Survey of Faculty | | |
| 6 Surveys of employers | Every Five Years | 2004-2005 |
| 7 Educational Benchmarking Inc. Survey (Appendix 5) | Every Year | **This Report** |
| 8 Engineering-in-Training Exam | Every Year | **This Report** |

* Implementation was delayed one year since program modification is currently being implemented

Fig. 5. Implementation Schedule for Assessment Tools

A matrix of which program outcome can be assessed by each assessment tool is shown below.

Assessment Tool versus Student Outcome

| | Capstone Course | Webfolios | Surveys of Employers | Surveys of Students | Pretests/ Tests |
|---|---|---|---|---|---|
| **Knowledge** | | | | | |
| Math/Science/Engineering | No | No | **Yes** | **Yes** | **Yes** |
| Contemporary Issues | No | Yes | **Yes** | **Yes** | No |
| Broad Education | No | No | **Yes** | **Yes** | No |
| Ethics | **Yes (Test)** | No | **Yes** | **Yes** | No |
| **Skills** | | | | | |
| Experimental work | Maybe | **Yes** | **Yes** | **Yes** | No |
| Problem solving | **Yes** | No | **Yes** | **Yes** | No |
| Design | **Yes** | **Yes** | **Yes** | **Yes** | No |
| Communication skills | **Yes** | **Yes (written)** | **Yes** | **Yes** | **Yes (WPE)** |
| Work in teams | **Yes** | No | **Yes** | **Yes** | No |
| Use tools | **Yes** | No | **Yes** | **Yes** | No |
| Information competency | Maybe | No | **Yes** | **Yes** | No |
| **Attitudes** | | | | | |
| Lifelong learning | No | Yes | **Yes** | **Yes** | No |
| Professionalism | **Yes** | **Yes** | **Yes** | **Yes** | No |
| All other attitudes | No | Yes | **Yes** | **Yes** | No |

Fig. 6. Corresponding Assessment Tool for Each Student Outcome

The data obtained from these initiatives were compiled, analyzed, and interpreted during summer, 1999.

# VIII Results of Assessment

Summary of the Strengths and Areas for Improvement 2000-2001

In last year's study, we determined the strongest outcomes and the areas for improvement that were identified by 1) student input, 2) alumni input, and 3) industry input. These are presented below along with the corresponding changes that have been identified to improve the program.

Strengths

- Ability to apply knowledge of engineering for solving problems
- Ability to conduct an experiment
- Ability to analyze and interpret data obtained from an experiment
- A desire to be a professional that exhibits values, dedication and a need for continual improvement
- An ability to design a system, component, or process to meet desired needs
- An recognition of the need for an ability to engage in lifelong learning

Areas for Improvement (unimproved from 1999-2000)

- Ability to write technical documents
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

New Areas for Improvement (for 2000-2001)

- An ability to design and conduct experiments as well as to analyze and interpret data
- An understanding of professional and ethical responsibility

(See Mechanical Engineering program Assessment 1999-2000 and Mechanical Engineering program Assessment 2000-2001 for more details).

The assessment presented in this section of this year's report measures these outcomes again to determine if the program changes are effective. Thus, for each tool presented, the areas for improvement identified during the 1999-2000 assessment period are examined and compared to the results obtained during the 2000-2001 assessment period.

The major goal of this report period is to compare the results of this assessment period with last year's results. Thus, for each tool, the areas for improvement identified in the 2000-2001 report will be reviewed to determine if the outcome that corresponds to the area has:

1. improved

2. declined
3. not changed

in the 2001-2002 results. If an outcome being studied is not addressed by a particular tool, a dashed line (----) is given.

For each assessment tool, thresholds are identified. Although all outcomes vary in performance from year to year, only the weakest performing outcomes (those scoring below threshold levels) are considered an "area for improvement." As those are improved, the threshold is raised and other outcomes will then be identified as an Area for Improvement based on their measured performance.

## Capstone design course

### Oral Presentation

For the 2001-2002 assessment process, the final oral presentation in the senior design capstone course was used to assess the following outcomes:

- Design an experiment
- Conduct an experiment
- Analyze data
- Design a system or component
- Use modern engineering tools/techniques
- Function as a cohesive team
- Display professionalism
- Knowledge of contemporary issues

The following are included in the chart and are assessed but are not currently one of the identified outcomes for the Mechanical Engineering program. They are documented here for possible future use.

- Clearly define an objective
- Devise a plan of action
- Produce a sufficient amount of work
- Exhibit progress on the project
- Organize the flow of information
- Use visual aids
- Use presentation time effectively
- Answer questions posed

Each student group presented a formal oral presentation which was 15 minutes long and addressed audience questions in a subsequent 5-minuute question period. There are typically between two and three students per group and each group member is required to participle in the oral presentation (i.e. each student speaks for approximately five minutes).

Using the instrument shown in Appendix 2, the following constituents were assessed:

- fellow students

- faculty
- industrial constituents

The results, shown below, are based on a 0 to 4 point scale with 4 being the highest.

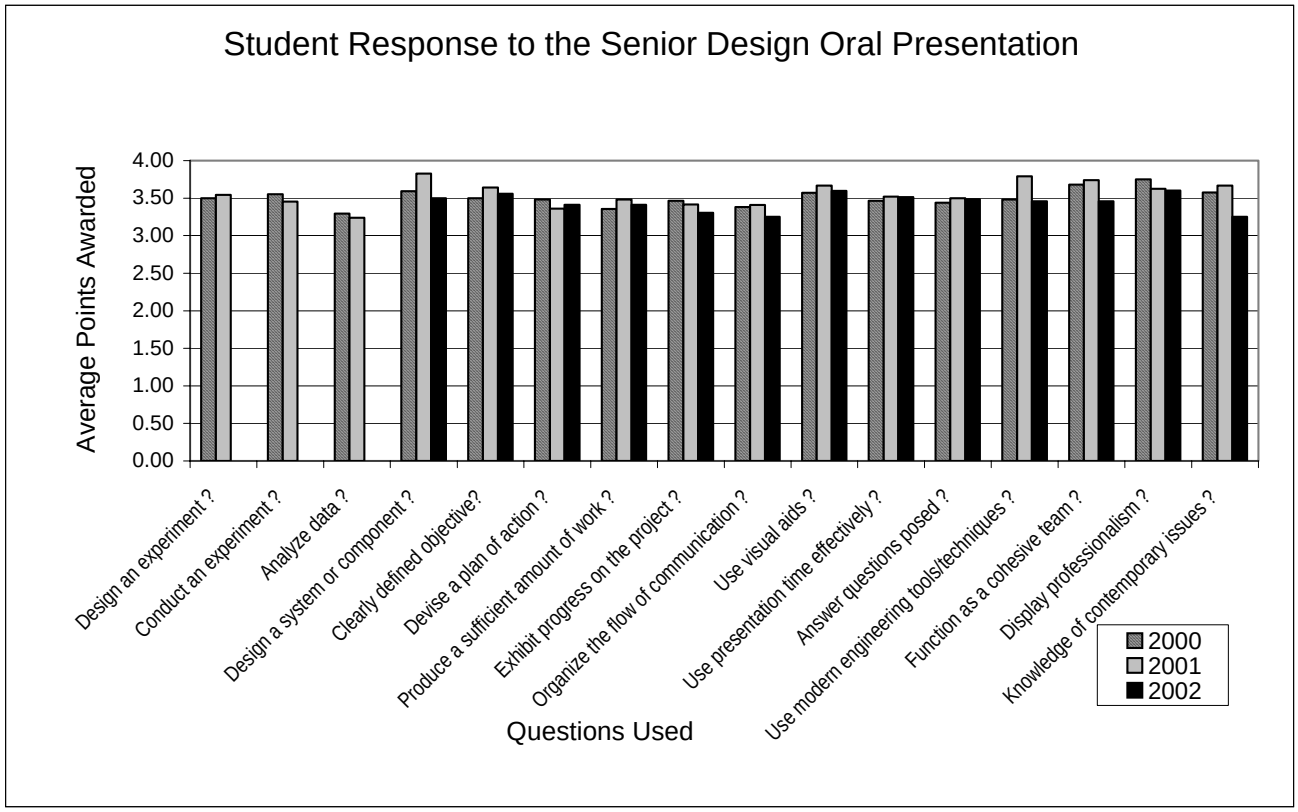



Fig.7. Student Assessment of the Final Oral Presentation in the Senior Capstone Course

| 2000-2001 Areas for Improvement | 2001-2002 Performance |
|---|---|
| | |
| Ability to write technical documents | ---- |
| An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice | declined |
| An ability to design and conduct experiments as well as to analyze and interpret data | ---- |
| An understanding of professional and ethical responsibility | not changed |

2001-2002 Observations

Strength identified: None

Area for improvement identified: Knowledge of contemporary Issues

An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice (abet k)

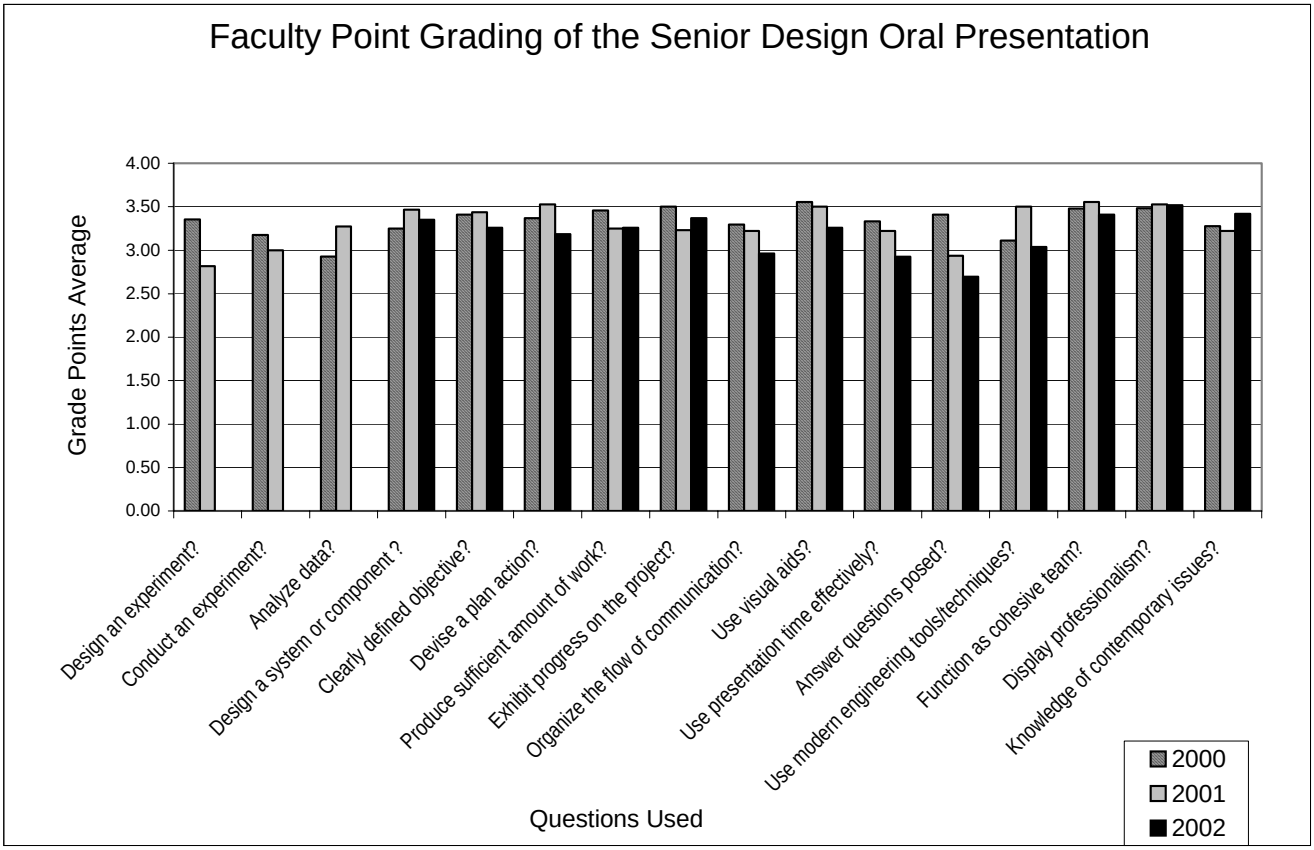



Fig.8. Faculty Assessment of the Final Oral Presentation in the Senior Capstone Course

| 2000-2001 Areas for Improvement | 2001-2002 Performance |
|---|---|
| | |
| Ability to write technical documents | ---- |
| An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice | declined |
| An ability to design and conduct experiments as well as to analyze and interpret data | ---- |
| An understanding of professional and ethical responsibility | not changed |

2001-2002 Observations

Strength identified: Knowledge of contemporary Issues

Area for improvement identified: Answer questions posed
An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice (abet k)

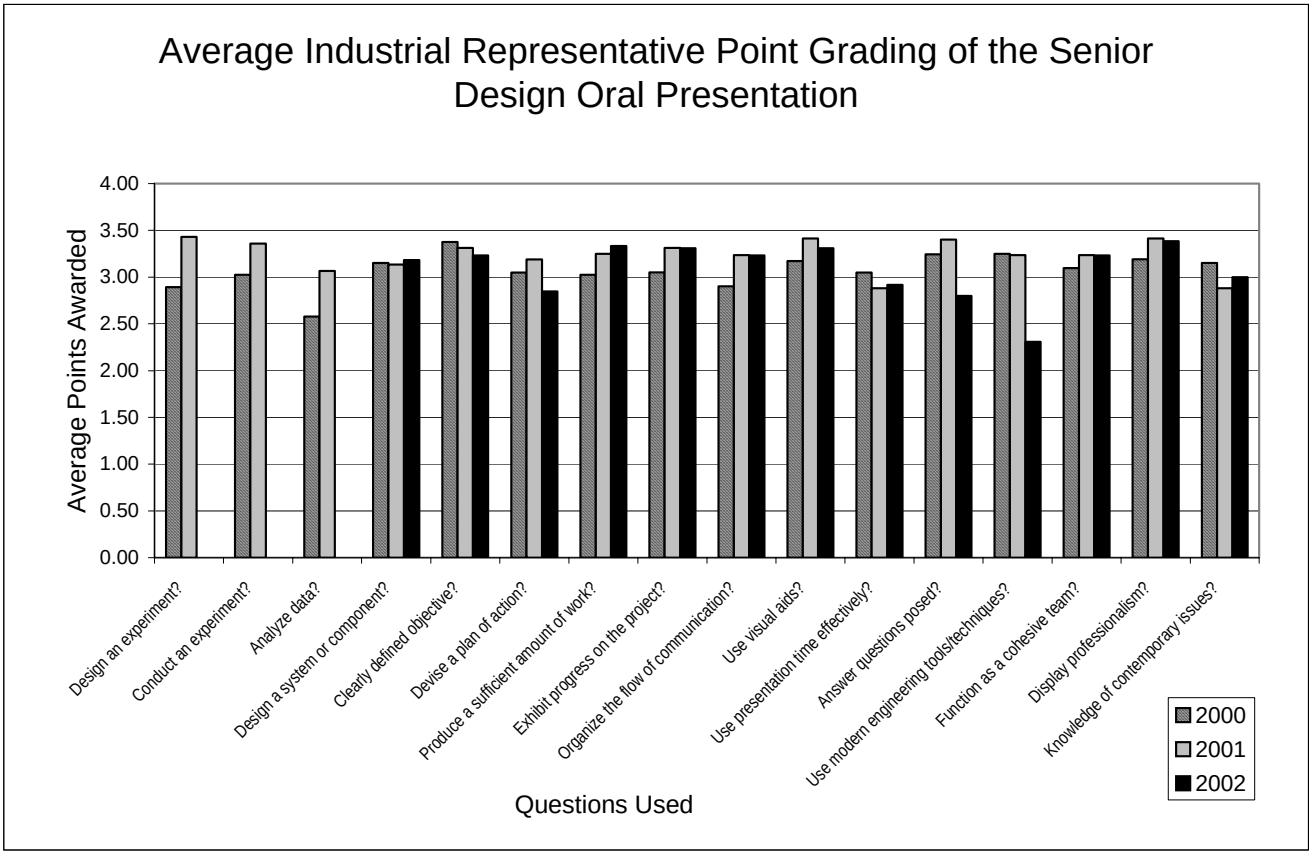



Fig.9. Industry Assessment of the Final Oral Presentation in the Senior Capstone Course

| 2000-2001 Areas for Improvement | 2001-2002 Performance |
|---|---|
| | |
| Ability to write technical documents | ---- |
| An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice | declined |
| An ability to design and conduct experiments as well as to analyze and interpret data | ---- |
| An understanding of professional and ethical responsibility | not changed |

2001-2002 Observations

Strength identified: None.

Area for improvement identified: Answer questions posed
An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice (abet k)

**Surveys of seniors**

The opinions of senior students were assessed using the survey shown in Appendix 4 on the following outcomes:

**Key for Curriculum Assessment**

1 An ability to apply knowledge of math, science, and engineering (abet a)
  In particular, an ability to apply knowledge to:
  a chemistry and calculus-based physics
  b advanced math through multivariate calculus and differential equations
  c statistics and linear algebra
2 An understanding of professional and ethical responsibility (abet f)
3 A broad education necessary to understand the impact of engineering solutions in a global/societal context (abet h)
4 A knowledge of current events and societal contemporary issues – non-engineering related (abet j)
5 A knowledge of computer aided design and simulation software
6 A knowledge of measurement and manufacturing techniques
7 A knowledge of how mechanical engineering integrates into inter-disciplinary systems
8 An ability to design and conduct experiments as well as to analyze and interpret data (abet b)
9 An ability to design a system, component, or process to meet desired needs (abet c)
10 An ability to function on multidisciplinary teams (abet e)
11 An ability to communicate effectively (abet g)
12 An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice (abet k)
13 An ability to select materials and manufacturing processes
14 An ability to visualize design from engineering drawings
15 An ability to think in a logical sequential process
16 An understanding of professional and ethical responsibility (abet f)
17 An recognition of the need for an ability to engage in lifelong learning (abet i)
18 An understanding of responsibility and accountability
19 A desire to be a professional that exhibits values, dedication and a need for continual improvement
20 A desired to be a flexible and adaptable team player (collaborative attitude)

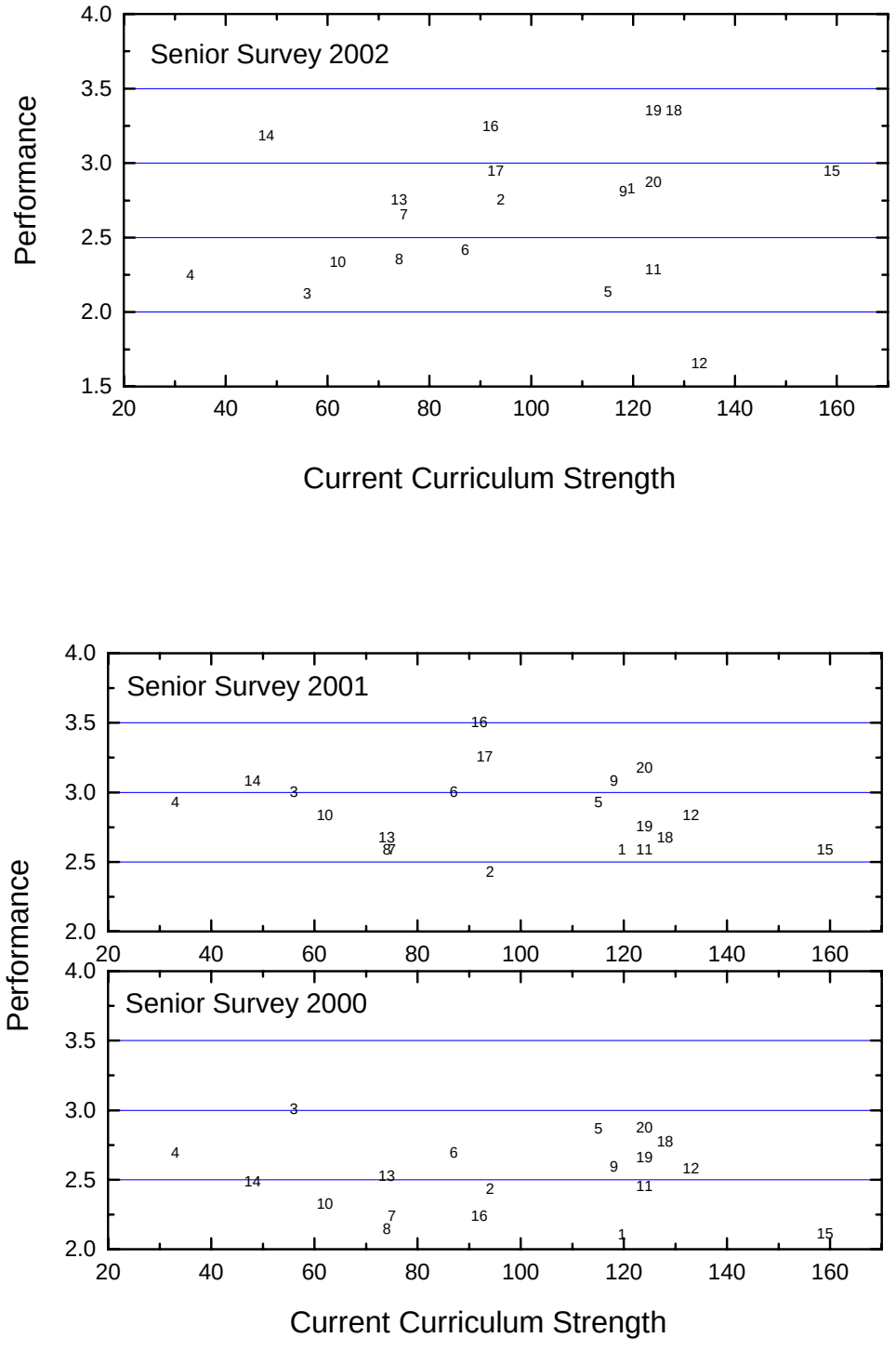



Fig. 10. Graphs Showing Student Opinion of Outcome Performance Versus the Current Curriculum Strength (See Key for Curriculum Assessment on previous page)

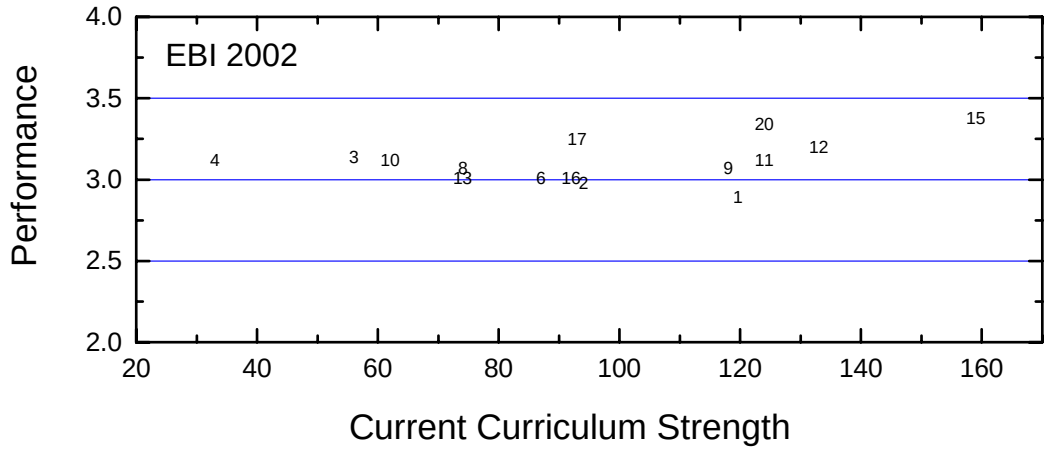
| 2000-2001 Areas for Improvement | 2001-2002 Performance |
|---|---|
| | |
| Ability to write technical documents (11) | declined |
| An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice (12) | declined |
| An ability to design and conduct experiments as well as to analyze and interpret data (8) | declined |
| An understanding of professional and ethical responsibility (2) | improved |

2001-2002 Observations

Strength identified: An understanding of responsibility and accountability
A desire to be a professional that exhibits values, dedication and a need for continual improvement

Area for improvement identified: An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice (abet k)

**EBI Data and Analysis**



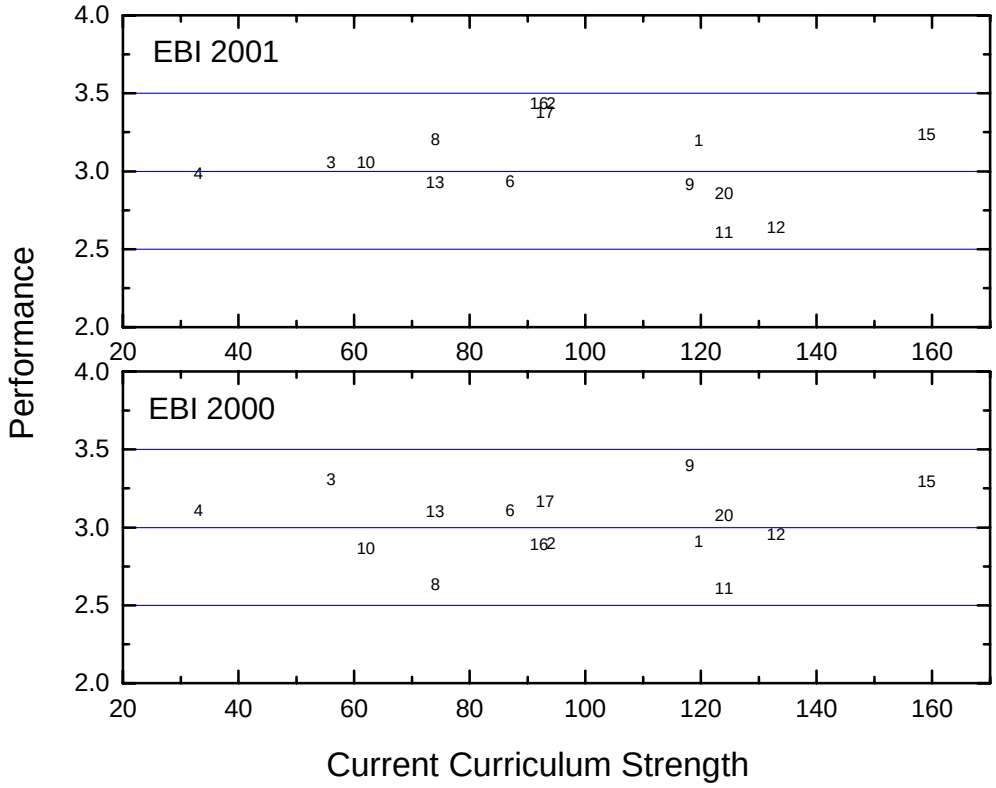



Fig. 11. Graphs Showing EBI Results of Outcome Performance Versus the Current Curriculum Strength

| 2000-2001 Areas for Improvement | 2001-2002 Performance |
|---|---|
| | |
| Ability to write technical documents (11) | improved |
| An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice (12) | Improved |
| An ability to design and conduct experiments as well as to analyze and interpret data (8) | --- |
| An understanding of professional and ethical responsibility (2) | Decreased |

2001-2002 Observations

Strength identified: A recognition of the need for an ability to engage in lifelong learning
An ability to think in a logical sequential process
A desire to be a flexible and adaptable team player (collaborative attitude)

Area for improvement identified: None below threshold

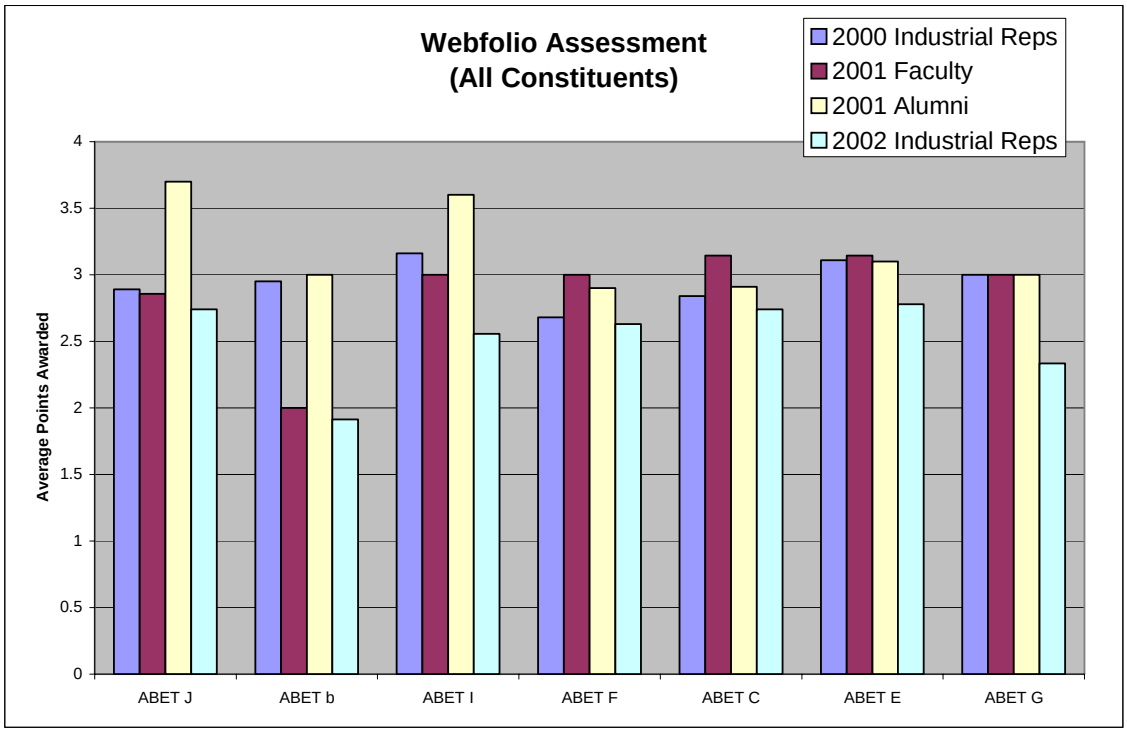
**Webfolio**

Webfolios are web-based portfolios that are used to collect key elements that correspond to the program's student learning outcomes. These elements are collected throughout the students' academic career at Cal. State LA with the final design element collected in the students' senior level capstone course. The complete portfolios are assessed by selected members of the program's constituents with a rubric based on the program's outcomes. The elements included in the portfolio are:

- A lifelong learning plan
- A resume'
- A laboratory report
- An executive summary of the student's capstone design project

The Internet location of the webfolio along with an assessment rubric were emailed to Industrial Representatives, Faculty, and Alumni to obtain their assessment of this sample work. The goal of these webfolios is to evaluate the following outcomes:

- abet (b) An ability to design and conduct experiments as well as to analyze and interpret data
- abet (c) An ability to design a system, component, or process to meet desired needs
- abet (e) An ability to think in a logical sequential process that lends itself to identifying, formulating and solving engineering problems
- abet (f) An understanding of professional and ethical responsibility
- abet (g) An ability to communicate effectively
- abet (i) A recognition of the need for an ability to engage in lifelong learning
- abet (j) Knowledge of current events and societal contemporary issues -- non-engineering related.



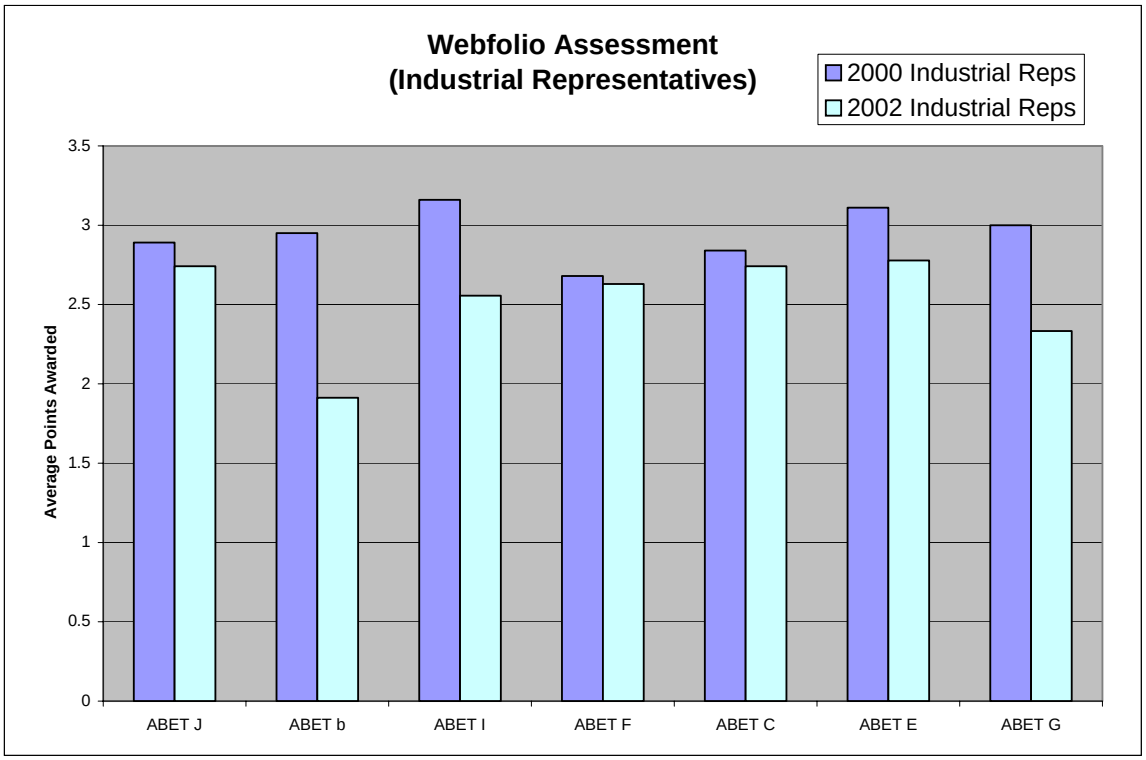




Fig. 12. Graphs Comparing Webfolio Results Obtained from Industrial Representatives in 2000 with Faculty and Alumni Results Obtained in 2001

| 2000-2001 Areas for Improvement | 2001-2002 Performance |
|---|---|
| | |
| Ability to write technical documents (g) | declined |
| An ability to design a system, component, or process to meet desired needs (c) | --- |
| An ability to design and conduct experiments as well as to analyze and interpret data (b) | declined |
| An understanding of professional and ethical responsibility (f) | --- |

2001-2002 Observations

Strength identified: A recognition of the need for an ability to engage in lifelong learning

Area for improvement identified: An ability to design and conduct experiments as well as to analyze and interpret data

**Engineer in Training Exam (EIT)**

ABET Criteria 2000 include "nationally-normed subject content examinations" as one component of an effective assessment program. Because the EIT is designed to focus on the basic "*ability to apply knowledge of mathematics, science, and engineering (abet a)",* it is the ideal nationally-normed exam to assess engineering programs. Nationwide, colleges are beginning to make the attempt at this exam a requirement for graduation.

Currently, the Mechanical Engineering program is collecting data from the senior students who have attempted the EIT. Although passing the exam is not a graduation requirement, attempting the exam is. The college currently reimburses students who successfully pass the exam to provide motivation for success. Because we graduate a small number of students per year, we are waiting to utilize this information once we have data on a significant number of students.

For this assessment period, 15 student attempted the exam and eight passed.

**Faculty-Student Focus Groups (personal interaction with students)**

To add to the knowledge gained during the assessment of our program, faculty members have formed small focus groups of students The students were asked about ways that the Mechanical Engineering program could be modified to improve their learning experience. Through this direct interaction with students the following areas for improvement have been identified. They are listed below in order of the frequency of the observation. Specifically, the first one on the list was the most frequently mentioned area to improve while the last one on the list was the least frequently mentioned.

1. Too many courses are cancelled during each quarter
2. Several courses seem to cover redundant material

3. Many of the prerequisites for courses are not necessary and prevent student from making timely progress on the degree
4. The tuition is increasing beyond affordability
5. More financial support is needed for Senior Design Projects
6. Adequate space is not provided for students' projects and extracurricular activities
7. Space is not provided for student organizations
8. More useful software installed on the computers in the Senior Project Lab
9. There aren't enough undergraduate research activities for students to get involved

# IX Program Strengths and Areas for Improvement Identified

Mechanical Engineering Strengths and Areas for Improvement 2001-2002

We found the strongest outcomes and the areas for improvement that were identified by 1) surveys, 2) webfolios, and 3) Exams. These are presented below along with the corresponding changes that have been identified to improve the program.

Strengths

- Ability to think in a logical sequential process
- A desire to be a flexible and adaptable team player (collaborative attitude)
- A desire to be a professional that exhibits values, dedication and a need for continual improvement
- An understanding of professional and ethical responsibility

Areas for Improvement (improved from 2000-2001)

- An understanding of professional and ethical responsibility

Areas for Improvement (unimproved from 2000-2001)

- Ability to write technical documents
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
- an ability to design and conduct experiments as well as to analyze and interpret data

New Areas for Improvement (for 2001-2002)

- Knowledge of contemporary issues
- Ability to answer questions posed during an oral presentation
- Too many courses are cancelled during each quarter
- Several courses seem to cover redundant material
- Many of the prerequisites for courses are not necessary and prevent student from making timely progress on the degree

# X Program Modifications

The department believes that all of these areas of improvement can be addressed by making 5 major modifications to the curriculum:

**Area of Improvement #1:**

**Knowledge of contemporary issues is lacking**

**Solution:**

**Distribute assignments in key courses in the curriculum that emphasize contemporary issues**

There will be an increase in assignments related to contemporary issues in two key courses: ethics and senior design. Guest speakers will be brought into the required ethics course to present ethical case studies that are relevant to the contemporary issues that are on the front page of current newspapers. Likewise, in the first quarter of the senior design course series, design case studies will be presented by industrial representatives that address projects that are relevant to contemporary issues.

**Area of Improvement #2:**

**The students' ability to use the techniques, skills, and modern engineering tools necessary for engineering practice needs improvement**

**Solution:**

**More emphasis will be placed on utilizing tools in the curriculum**

We have learned that the students feel that they get adequate instruction in the use of these tools, but do not believe that they get enough practical usage of the tools. The department has agreed to assign more design problems in the upper-division elective courses (400 level courses) that require the use of modern engineering tools.

We have also agreed to pilot several more practical course using our special topics course (ME 454) that focus on tools. Specifically, we hope to pilot a Finite Element Course and eventually add it to the curriculum.

**Area of Improvement #3:**

**A basic oral communication skills is lacking: Students need to learn how to answer questions posed by the audience**

**Solution:**

**Students need practice forming and fielding questions**

To prepare the students for their oral presentations in the final course in the senior design series (ME 497c), emphasis will be placed on fielding questions from both faculty and students during the midterm and final oral presentation observed in the second course in the series (ME 497b). When faculty are present, they are typically not shy about asking challenging questions. Students, however, seem to have an unwritten code that discourses them from presenting challenging questions to each other. Thus, incentive must be provided. Our approach to improving the results on this outcome this year is:

1) All ME faculty will be encouraged to attend and ask questions at the end of each talk
2) All students will be required to write a challenging question for each presentation they observe
    a) These questions will be graded by the instructor and will affect the students participation grade
        i) + will be assigned for an exceptional question
        ii) √ will be assigned for a reasonable question
        iii) – will be assigned for poor questions
    b) At the end of the presentation, the instructor will call on at least two students to pose their questions to the presenters
    c) The instructor will provide each presentation group with the questions written by their classmates that correspond to their talk
        i) The groups will be encouraged to practice these questions when practicing their presentations
        ii) The instructor will ask at least one of these questions during the students' final presentation in the final capstone course

**Area of Improvement #4:**

**The students' laboratory experience needs to be improved so that they can:**

**a) Improve students technical report writing skills**

**b) Improve students ability to design and conduct experiments as well as to analyze and interpret data**

**c) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice**

**Solution:**

**Improvement of the Mechanical Engineering Laboratory Experience**

The laboratory structure of the Mechanical Engineering Curriculum needs to be modified to address the areas of weakness determined in this assessment cycle. Specifically, the labs needs to increase the focus on: 1) technical writing, 2) the ability to conduct an experiment and analyze date, and 3) instruction in the use of modern engineering tools.

Proposed New Structure for ME Undergraduate Required Laboratories:

- Curricular Goals:
  - ⇒ Teach technical report writing
  - ⇒ Provide exposure to the experimental process and teach students to design an experiment in support of a hypothesis
  - ⇒ Teach valid laboratory safety and procedures
  - ⇒ Have students learn to use measurement instruments (sensors) and measurement techniques
  - ⇒ Provide knowledge of the statistical nature of data, accuracy, repeatability, and curve fitting
  - ⇒ Provide laboratory experiments that supplement the fundamental core mechanical engineering courses and reinforce theoretical Concepts (Mechanics, Thermodynamics, Fluid Dynamics, Materials, Control)
  - ⇒ Provide an introduction to data acquisition
- Pedagogical Goals
  - ⇒ To improve content and delivery
  - ⇒ To improve the student laboratory experience
    - Better designed labs
    - Better equipment,
    - Focus on current faculty skills
    - Better maintenance and technician support
    - Ensure consistent offering (no cancellations)
- Overview:
  - ⇒ A Series of Two Required Courses
    - ME 3** Mechanical Engineering Lab 1 (only 200 level prerequisites)
    - ME 4** Mechanical Engineering Lab 2 (only 300 level course are all prerequisites)
  - ⇒ 2 Unit Courses
    - Faculty earn 4 units of credit making it equal to a standard course
    - Course meets twice a week

| Course | First Five Weeks | Second Five Weeks |
|---|---|---|
| Mechanical Engineering Lab 1 | • Technical Report Writing<br>⇒ Direct individual instruction with constructive feedback.<br>• Assessment of the students' report writing abilities from external sources | • Good Laboratory Practices<br>⇒ Safety<br>⇒ Procedures<br>⇒ Experimental methodology<br>• Mechanical Measurements Lab<br>⇒ Introduction to basic mechanical engineering measurement techniques<br>⇒ Similar to our current ME310 but optimized |
| Mechanical Engineering | • Fluid/Thermal/Aero Experiments: A five-week | • Mechanics/Materials/ Manufacturing Experiments: A |

| | | |
|---|---|---|
| Lab 2 | exposure to experiments that complement:<br>⇒ ME303<br>⇒ ME306<br>⇒ ME326a<br>⇒ ME403 | five-week exposure to experiments that complement:<br>⇒ ME312<br>⇒ ME321<br>⇒ ME323<br>⇒ ME327 |

This is only the proposed structure to date. The department is working on a final version of this new laboratory structure and is planning to implement it during the 2002-2003 academic year.

## Area of Improvement #5:

**Students concerns about the course content and prerequisites need to be addressed:**

**a) Redundant courses are in the curriculum**

**b) Course prerequisites and excessive and hinder student progress towards their degrees**

## Solution:

**Review curriculum to delete Redundant Courses and reduce prerequisites**

After a thorough review of the Mechanical Engineering courses and their content, the department curriculum subcommittee has implemented the proper paperwork to delete the following courses:

- ME 426 Thermodynamics III 4 units
- ME 404 Turbomachinery
- ME 420 Power Plants
- ME 425 Process Heat Transfer
- ME 426 Thermodynamics III
- ME 427 Thermal Systems Laboratory II
- ME 491 Robotics Laboratory

The removal of these courses will not affect the strength of the curriculum. The fundamental material addressed in these courses is already provided in the required Mechanical Engineering junior and senior courses.

All prerequisites have been reviewed. The following table documents the changes that are currently being implemented.

| course # | Current Prerequisites | Proposed Prerequisites |
|---|---|---|
| | | |
| ENGR 100 | None | No Change |
| ME 103 | Drafting or TECH 110 | No Change |
| CE/ME 201 | PHYS 201, MATH 207 | No Change |

| | | |
|---|---|---|
| ME 204 | PHYS 203 | No Change |
| CE/ME 205 | CE/ME 201 | No Change |
| ENGR 207 | CHEM 101, MATH 206, PHYS 201 | CHEM 101, MATH 206 |
| CE/ME 210 | MATH 208, PHYS 201 | MATH 208 |
| CE/ME 211 | MATH 208, PHYS 201 | MATH 208 |
| ENGR 300 | None | No Change |
| ENGR 301 | Senior standing | None |
| ME/CE 303 | CE/CE 320, PHYS 202 | PHYS 202 |
| ME 306 | CE/ME 303 or ME 326a, MATH 215 | MATH 208, PHYS 202 |
| ME 310 | EE 210, WPE | WPE |
| CE/ME 312 | CE/ME 205, ME 310, ME 103 | CE/ME 205 |
| ME 319 | CS 290, CE/ME 303, ME 306, ME 323, ME 326a | CE/ME 210, CE/ME 211, MATH 215 |
| CE/ME 320 | CE/ME 201 | No Change |
| ME 323 | CE/ME 205 | ME 103, CE/ME 205, ENGR 207, MATH 208 |
| ME 326a | MATH 208, PHYS 202 | No Change |
| ME 326b | ME 326a | No Change |
| ME 327 | ENGR 207 | ENGR 207, ME 323 |
| ME 497a | Senior, WPE, Instructor's consent | No Change |
| ME 497b | Senior, WPE, Instructor's consent | No Change |
| ME 497c | Senior, WPE, Instructor's consent | No Change |
| ME 321 | ME 319 | ME 320 |
| ME 402 | ME 323, MATH 215 | No Change |
| ME 403 | CE/ME 303, ME 319, MATH 215 | CE/ME 303, MATH 208 |
| ME 404 | CE/ME 303, ME 326b | CE/ME 303, ME 326a |
| ME 406 | ME 306, CS 290 | ME 303, ME 306 |
| ME 407 | ENGR 300, ME 306, ME 326b | ME 306, ME 326a |
| ME 408 | CE/ME 303, ME 319, MATH 215 | CE/ME 303, MATH 208 |
| ME 409 | CE/ME 320, ME 306 | CE/ME 320, ME 306, ME 319, ME 303 |
| ME 410 | CE/ME 303, ME 306, CS 290, MATH 215 | PHYS 204, MATH 215. ME 306 |
| ME 411 | ME 320, MATH 215 | No Change |
| ME 414 | ME 323 | No Change |
| ME 415 | ME 306, ME 326b | ME 306, ME 326a |
| ME 416 | ME 326b | ME 326a |
| ~~ME 420~~ | ~~ME 326b~~ | ~~ME 326a~~ |
| ME 421 | ME 321 | No Change |
| ME 422 | ME 319, ME 323 | PHYS 204, MATH 215, ME 306 |
| ~~ME 425~~ | ~~ME 406~~ | ~~ME 306~~ |
| ~~ME 426~~ | ~~ME 326b, ME 319~~ | ~~ME 326b~~ |
| ME 428 | ME 327 | No Change |
| ME 430 | ENGR 207, ME 327 | No Change |
| ME 431 | ENGR 207, ME 327 | No Change |
| EE/ME 481 | ME 410 or EE 360 | CE/ME 320 or EE 360 |
| ME 454 | None | Consent of Department Chair |
| CE/ME 313 | CE/ME 303, ME 103 | CE/ME 303 |
| ME 315 | ME 326a, ME 306, ME 310 | ME 326a, ME 306 |
| ME 412 | CE/ME 312, CE 360 or ME 323 | No Change |
| CE/ME 413 | CE/ME 313, CE 387 or ME408 | No Change |
| ME 417 | ME 321, ME 323, ME 310 | ME 323, ME 310 |

| | | |
|---|---|---|
| ~~ME 427~~ | ~~ME 315, ME 326b~~ | ~~ME 315, ME 326a~~ |
| ~~EE/ME 491~~ | ~~EE/ME 481~~ | ~~No Change~~ |

The reduction in prerequisites will increase student's eligibility to enroll in many more courses and will increase flexibility in their course schedules.

# Appendices

## Appendix 1: Sample Course Coordinator Survey

To: Professor _____
Course Coordinator for _____

From: Assessment Coordinator
Subject: ABET Course Coordinator Survey

We are seeking your input to determine which, and to what degree, the mechanical engineering program outcomes are 1) currently being met by ME_____ and 2) could be met in ME_____ with minor course modifications in the future. If you have any questions, please do not hesitate to contact me.

Please indicate with
H=High M=Medium L= Low N= No

### 1) knowledge:

Graduates of the Mechanical Engineering program will have the knowledge in math, science and engineering fundamentals, as well as societal issues, that allows them to approach real-world Mechanical Engineering problems with an understanding of their impact on society.

| Measurable outcomes: | current | future |
|---|---|---|
| an ability to apply knowledge of mathematics, science, and engineering (abet a)<br>In particular, an ability to apply knowledge of:<br>a) chemistry and calculus-based physics.<br>**b) advanced mathematics through multivariate calculus and differential equations.**<br>c) statistics and linear algebra. | | |
| **an understanding of professional and ethical responsibility (abet f)** | | |
| the broad education necessary to understand the impact of engineering solutions in a global/societal context (abet h) | | |
| **knowledge of current events and societal contemporary issues -- non-engineering related. (abet j)** | | |
| a knowledge of computer aided design and simulation software | | |
| a knowledge of measurement and manufacturing techniques | | |
| a knowledge of how mechanical engineering integrates into inter-disciplinary systems | | |

## 2) Skills

**Graduates of the Mechanical Engineering program will be able to work in group and individual settings to define and solve problems related to thermal and mechanical systems and manufacturing processes by applying engineering fundamentals and engineering tools with a logical approach and be able to clearly communicate their findings.**

| Measurable outcomes: | current | future |
|---|---|---|
| an ability to design and conduct experiments as well as to analyze and interpret data (abet b) | | |
| an ability to design a system, component, or process to meet desired needs (abet c) | | |
| an ability to function on multidisciplinary teams (abet e) | | |
| an ability to communicate effectively (abet g) | | |
| an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice (abet k) | | |
| an ability to select materials and manufacturing processes | | |
| an ability to visualize designs from engineering drawings | | |
| an ability to think in a logical sequential process | | |

## 3) Attitudes

**Graduates of the Mechanical Engineering program will be confident in their abilities to be successful in industrial, academic, and governmental positions and will have the positive and inquisitive outlook on life and learning necessary to promote their continued professional and personal development throughout their careers.**

| Measurable outcomes: | current | future |
|---|---|---|
| an understanding of professional and ethical responsibility (abet f) | | |
| a recognition of the need for an ability to engage in lifelong learning (abet i) | | |
| an understanding of responsibility and accountability | | |
| a desire to be a professional that exhibits values, dedication and a need for continual improvement | | |
| a desire to be a flexible and adaptable team player (collaborative attitude) | | |

## Appendix 2: Sample Capstone Oral Presentation Assessment Tool

**Date: _____**

**Please circle the appropriate response.**

**Student** **Faculty** **Industrial Representative**

**If applicable to the senior design report being assessed, to what extent has the team demonstrated their ability to:**

| **(1 shows high ability ……...…. 5 shows poor ability)** | High Low |
|---|---|
| 1) Design an experiment? | 1 2 3 4 5 NA |
| 2) Conduct an experiment? | 1 2 3 4 5 NA |
| 3) Analyze data and interpret data? | 1 2 3 4 5 NA |
| 4) Design a system or component? | 1 2 3 4 5 NA |
| a) Clearly defined objective? | 1 2 3 4 5 NA |
| b) Devise a plan of action? | 1 2 3 4 5 NA |
| c) Produce a significant amount of work? | 1 2 3 4 5 NA |
| d) Exhibit progress on the project? | 1 2 3 4 5 NA |
| 5) Communicate? | 1 2 3 4 5 NA |
| a) Organize the flow of communication? | 1 2 3 4 5 NA |
| b) Use of visual aids? | 1 2 3 4 5 NA |
| c) Use presentation time effectively? | 1 2 3 4 5 NA |
| d) Answer questions posed? | 1 2 3 4 5 NA |
| 6) Use Modern Engineering tools/techniques? | 1 2 3 4 5 NA |
| 7) Function as a cohesive team? | 1 2 3 4 5 NA |
| 8) Display professionalism? | 1 2 3 4 5 NA |
| 9) Knowledge of contemporary issues? | 1 2 3 4 5 NA |

# Appendix 3: Sample Webfolio Assessment Sheet

**Date: _____** **Reviewer's Name: _____**
**Student's Name: _____**

**MECHANICAL ENGINEERING WEBFOLIO ASSESSMENT**

Industrial Representatives:

**Please consider the 5 Folders in the Student's Web folio and rate the student's performance.**
**5 shows high ability ……...…. 0 shows poor ability**
**NA shows that there is insufficient evidence to make a judgment**

| For the **Benefits of Current Issues** Folder, how well has the student demonstrated: | |
|---|---|
| *Knowledge of current events and societal contemporary issues -- non-engineering related. (abet j)* | 5 4 3 2 1 NA |

| For the **Lab Report** Folder, how well has the student demonstrated: | |
|---|---|
| *An ability to design and conduct experiments as well as to analyze and interpret data (abet b)* | 5 4 3 2 1 NA |

| For the **Life Long Learning Plan** Folder, how well has the student demonstrated: | |
|---|---|
| A recognition of the need for an ability to engage in lifelong learning (abet i) | 5 4 3 2 1 NA |

| For the **Resume** Folder, how well has the student demonstrated: | |
|---|---|
| *An understanding of professional and ethical responsibility (abet f)* | 5 4 3 2 1 NA |

| For the **Senior Design Project Extended Abstract** Folder, how well has the student demonstrated: | |
|---|---|
| *An ability to design a system, component, or process to meet desired needs (abet c)* | 5 4 3 2 1 NA |
| An ability to think in a logical sequential process that lends itself to identifying, formulating and solving engineering problems (abet e(abet e) | 5 4 3 2 1 NA |

| For the **Overall Webfolio Presentation**, how well has the student demonstrated: | |
|---|---|
| An ability to communicate effectively (abet g) | 5 4 3 2 1 NA |
| An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice (abet k) | 5 4 3 2 1 NA |
| A desire to be a professional that exhibits values, dedication and a need for continual improvement | 5 4 3 2 1 NA |

# Appendix 4: Sample Student Survey

**Senior Survey** **Today's Date: _____**
**Mechanical Engineering** **Expected Graduation Date: _____**

| **Question** | **Rating** |
|---|---|
| How satisfied are you with your education at CSULA in meeting the following:<br>**(1 is very satisfied …….. 5 is very dissatisfied)** | **Satisfied** **Dissatisfied** |
| **Knowledge** | |
| 1. Ability to apply knowledge of mathematics to solving engineering problems. | 1 2 3 4 5 NA |
| 2. Ability to apply knowledge of mathematics to solving science problems. | 1 2 3 4 5 NA |
| 3. Ability to apply knowledge of engineering to solving problems. | 1 2 3 4 5 NA |
| 4. An understanding of the global impact engineering solutions can have on society. | 1 2 3 4 5 NA |
| 5. A knowledge of contemporary issues. | 1 2 3 4 5 NA |
| 6. A knowledge of computer aided design and simulation software. | 1 2 3 4 5 NA |
| 7. A knowledge of measurement and manufacturing techniques. | 1 2 3 4 5 NA |
| 8. A knowledge of how mechanical engineering integrates into inter-disciplinary systems. | 1 2 3 4 5 NA |
| **Skills** | |
| 9. Ability to design a statistically valid experiments. | 1 2 3 4 5 NA |
| 10. Ability to conduct an experiment | 1 2 3 4 5 NA |
| 11. Ability to analyze and interpret data obtained from an experiment. | 1 2 3 4 5 NA |
| 12. Ability to design a system, component or process to meet a desired need. | 1 2 3 4 5 NA |
| | 1 2 3 4 5 NA |

| | |
|---|---|
| 13. Ability to function on multi-disciplinary teams. | 1 2 3 4 5 NA |
| 14. Ability to orally present ideas on engineering designs or solutions. | 1 2 3 4 5 NA |
| 15. Ability to write technical documents. | 1 2 3 4 5 NA |
| 16. Ability to use modern engineering tools necessary for engineering practice. | 1 2 3 4 5 NA |
| 17. Ability to select materials and manufacturing processes. | 1 2 3 4 5 NA |
| 18. Ability to visualize designs from engineering drawings. | 1 2 3 4 5 NA |
| 19. Ability to think in a logical sequential process. | |
| Do you agree that your education at CSULA provided the following:<br>**(1 is agree …….. 5 disagree)** | **Agree Disagree** |
| <u>Attitudes</u> | |
| 20. An understanding of professional and ethical responsibility. | 1 2 3 4 5 NA |
| 21. A Recognition of the need for life-long learning. | 1 2 3 4 5 NA |
| 22. An understanding of responsibility and accountability. | 1 2 3 4 5 NA |
| 23. A desire to be a professional that exhibits values, dedication, and a need for continual improvement. | 1 2 3 4 5 NA |
| 24. A desire to be a flexible and adaptable team player. | 1 2 3 4 5 NA |

# Appendix 5: Survey of Recent Graduates (EBI)

Educational Benchmarking Inc. develops national benchmarking studies that allow the user to analyze their performance and compare the results to select peers and competitors.

In the survey instrument used in this study , questions 38 to 66 come directly from ABET Criteria 2000 standards. Participating colleges will be sent surveys and asked to distribute and collect surveys from graduating students either in senior design sections or as part of a "filing for graduation" process.

Colleges are able to choose six peer institutions from which to receive specific comparative data. Confidentiality of all college data is maintained by the reporting structure which does not identify who is who within the comparison group.

Seventy-one questions were asked covering satisfaction of graduates in the following fourteen major categories:

Quality of instruction in major courses (Questions 1-5)
Quality of teaching in math and science courses (Questions 6-9)
Other aspects of major courses (Questions 10-13, 14-17,20, 21)
Co-curricular activities (Questions 18-19)
Academic advising (Questions 24, 25)
Computing resources (Questions 26-29)
Characteristics of fellow students (Questions 30-32)
Career services and placement (Questions 33-37)
Engineering Skill Development (Questions 38-44, 47, 50, 51)
Ethics, global context, lifelong learning (Questions 45, 46, 52)
Oral and written communication (Questions 48, 49)
Capstone design experience (Questions 53-63)
Laboratory facilities (Questions 64-66)
Overall satisfaction with engineering program (67-71)