UNIVERSITY of CALIFORNIA Riverside

BOURNS COLLEGE OF Engineering

Self-Study Report

Mechanical Engineering

Submitted by:
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A. Background Information

A.1 Degree Titles

The Bourns College of Engineering consists of four departments (Chemical and Environmental Engineering, Computer Science and Engineering, Electrical Engineering, Mechanical Engineering) and four research centers, offering the following degrees. A fifth department, Bioengineering, will become independent of Chemical and Environmental Engineering in the fall of 2006.

Degree	Title	Established/Effective Dates
BS	Bioengineering	Fall 2005
BS	Chemical Engineering: Concentration in Biochemical Engineering	Established fall 1986, effective as of fall 2002
BS	Chemical Engineering: Concentration in Biochemistry	Established fall 1986, effective through 2001-02 academic year
BS	Chemical Engineering: Concentration in Bioengineering	Effective beginning fall 2003
BS	Chemical Engineering: Concentration in Chemical Engineering	Effective beginning fall 2002
BS	Chemical Engineering: Concentration in Chemistry	Established 1986, effective through the 2001-02 academic year
BS	Computer Engineering	Established fall 1999
BS	Computer Science	Established fall 1992
BS	Electrical Engineering	Established fall 1986
BS	Environmental Engineering: Concentration in Water Pollution Control	Established fall 1986
BS	Information Systems	Established fall 2001
BS	Mechanical Engineering	Established fall 1990
MS	Chemical & Environmental Engineering	Established fall 1998
MS	Computer Science	Established fall 1999
MS	Electrical Engineering	Established fall 1999
MS	Mechanical Engineering	Established fall 2001
Ph.D.	Chemical & Environmental Engineering	Established fall 2003
Ph.D.	Computer Science	Established fall 1991
Ph.D.	Electrical Engineering	Established fall 1999
Ph.D.	Mechanical Engineering	Established fall 2001

A.2 Program Modes

The Mechanical Engineering undergraduate program in the Marlan and Rosemary Bourns College of Engineering is offered only in the traditional day-time mode.

A.3 Actions to Correct Previous Shortcomings

A summary of ABET Final Statement provided for the Mechanical Engineering Program, following the Fall 2000 visit, appears below:

> *Introduction*
> *Graduates of the mechanical engineering program are well prepared in both the energy and the structures and motion of mechanical systems stems of the curriculum. Members of the department's recently established Industrial Advisory Board are exceptionally supportive of the program as evidenced by their positive feedback. The mechanical engineering program has 124 full-time students, eight full-time tenure or tenure-track faculty members, one full-time lecturer, and two part-time lecturers. A dedicated and professional staff ably supports the programs and laboratories of the department.*
> *Program Strengths*
> 1. *The diverse mechanical engineering faculty is well qualified and of sufficient number to cover all curricular areas of the program including teaching students to work professionally in both thermal and mechanical systems design. They are qualified and experienced to properly guide the evaluation and development of the program. Moreover, the faculty is very well liked and respected by students and staff members.*
> 2. *The program culminates in a major, high-quality capstone design experience, and these senior design projects address real world problems from industry and are excellent examples of teamwork.*
> 3. *The students are highly qualified and are enthusiastic about the program and the department. They are well advised and monitored, including transfer students, to insure that they meet the program objectives. The students are highly regarded by the program's Industrial Advisory Board. Across all levels, students express appreciation for small class size, the availability of faculty outside the classroom, the quality of the grading process, and the overall dedication of the faculty.*
> 4. *The department enjoys constructive institutional leadership and financial support. In general, resources are sufficient to attract and support a well-qualified faculty, to acquire and maintain laboratory equipment and facilities, and to support the services necessary to meet program needs.*
> 5. *The facilities are excellent and well maintained. They are conducive to student learning and adequate to accomplish program objectives. Computing facilities are good with a systematic plan for updating hardware and software.*

In summary, there were no concerns, weaknesses, or deficiencies noted in the previous review of the Mechanical Engineering Program conducted by the EAC/ABET in Fall 2000.

At the College level, the ABET reviewers identified two Institutional Concerns:

1. Each program was found to have a weakness with respect to engineering topics, specifically criterion I.C.3. d.(3)(e), which states that the public and ABET "should be able to discern the goals of a program and the logic of the selection of the engineering topics in the program." This weakness was resolved by publication on the web page. However, it remained a concern at that time pending publication of the appropriate statements in catalogs and other publications available to the public.

2. Faculty advising was found to be a concern because the staff of the student affairs office was physically unable to see all of the undergraduates during the three-week registration period each quarter. The reviewers noted that the office has been creative in devising a plan whereby all students who need to see an advisor may do so each quarter. The College noted that new and revised advisement programs were being implemented. This concern has been resolved.

A.4 Contact Information

The Interim Chair of the Department of Mechanical Engineering is Mark Matsumoto. He will serve as the main point of contact for the visit. Akula Venkatram and Shankar Mahalingam are members of the department ABET Accreditation and Assessment Committee. They are primarily responsible for preparation of this Self-Study Report. As Chair of this Committee, Akula Venkatram will assist in the planning of the site visit. Contact information for these individuals is given below:

Mark Matsumoto, Ph.D. Professor and Interim Chair Department of Mechanical Engineering University of California, Riverside, CA 92521 Tele: (951) 827 3197 Fax: (951) 827 2899 e-mail: matsumot@engr.ucr.edu	Akula Venkatram, Ph.D. Professor and Chair of ABET Accreditation and Assessment Committee Department of Mechanical Engineering University of California, Riverside, CA 92521 Tele: (951) 827 2195 Fax: (951) 827 2899 e-mail: venky@engr.ucr.edu

B. Accreditation Summary

This section describes, in turn, our methods for advising students (B.1), our program educational objectives (B.2), our program outcomes and assessments (B.3), the program's professional component (B.4), faculty (B.5), facilities (B.6), institutional support and financial resources (B.7), and program criteria (B.8).

B.1 Students

Criterion 1 calls for the institution to evaluate student performance, advise students regarding curricular and career matters, and monitor student progress to foster success in achieving program outcomes, thereby enabling them as graduates to attain program objectives. This subsection describes the Bourns College of Engineering's steps to fulfill Criterion 1. We first provide an overview of the student population that UCR and the Bourns College of Engineering serve, and our philosophy and approach for serving them. Next, we address student advising and then describe procedures for monitoring and verifying student credits earned toward graduation. Finally, we describe the Colleges' Professional Development Milestones program, which helps students prepare for internship and career opportunities while they are undergraduates.

B.1.1 Student Population Characteristics and Implications

Table 1 summarizes the 6-year graduation rates for the three colleges within UCR that enroll undergraduates.

Table 1. Graduation rates from UCR colleges after 6 years.

College entered	College graduated from			Graduated from UCR
	BCOE	CNAS	CHASS	
Bourns Coll. of Engineering (BCOE)	**38.0%**	2.2%	22.8%	63.0%
Natural & Agricultural Sciences (CNAS)	3.1%	**30.5%**	28.8%	62.4%
Humanities & Social Sciences (CHASS)	0.9%	2.0%	**63.4%**	66.2%

The table shows that about 40% of freshmen entering BCOE graduate from the college. Figure 1, which shows the patterns of persistence in the College of Engineering since inception, indicates that we lose about 40%-50% of our students in the first two years alone. We have found that the bulk of the attrition among BCOE students occurs in the first year or two, an observation consistent with the experience of other engineering programs across the nation.

Figures 2 to 5 illustrate responses to relevant questions in the exit surveys taken by graduating seniors in 2003 and 2004. Questions Q028-Q030 on the senior exit survey asks students their level of satisfaction with their fellow students in terms of academic quality, ability to work in teams, and level of camaraderie. Question Q031 asks them how satisfied they were with the level of help in finding a permanent position. The satisfaction levels are rated numerically, with scores as follows: Very dissatisfied: 1, moderately dissatisfied: 2, slightly dissatisfied: 3, neutral: 4, slightly satisfied: 5, moderately satisfied: 6, very satisfied: 7. In each case, the responses correspond to a rating of "slightly satisfied." Responses to other questions in the survey suggest that the major contributors to this low level of satisfaction are lack of engagement with the College and inadequate mentoring during the first two years. To address this issues, we have we have taken several steps, which are discussed below.

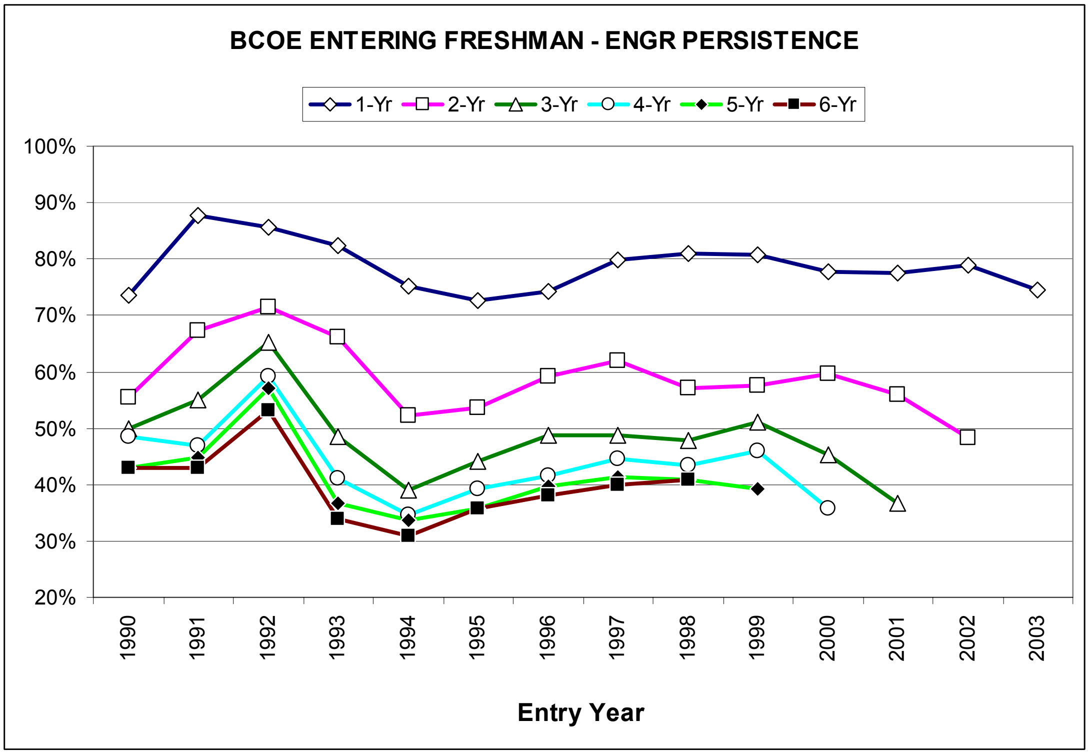


Figure 1. Persistence of entering freshmen in the Bourns College of Engineering.

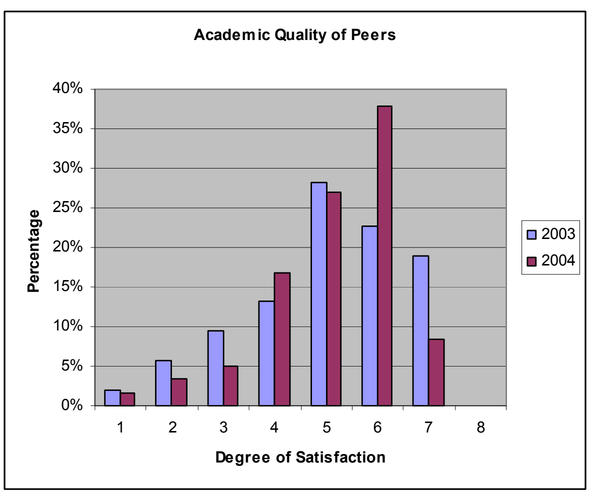


Figure 2. Student assessment of academic quality of peers.

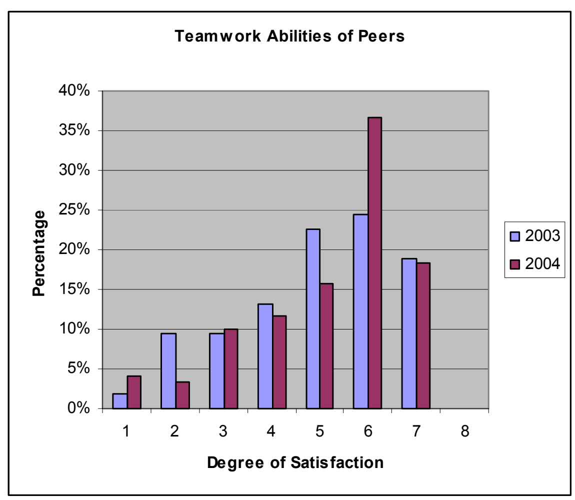


Figure 3. Student assessment of teamwork abilities of peers.

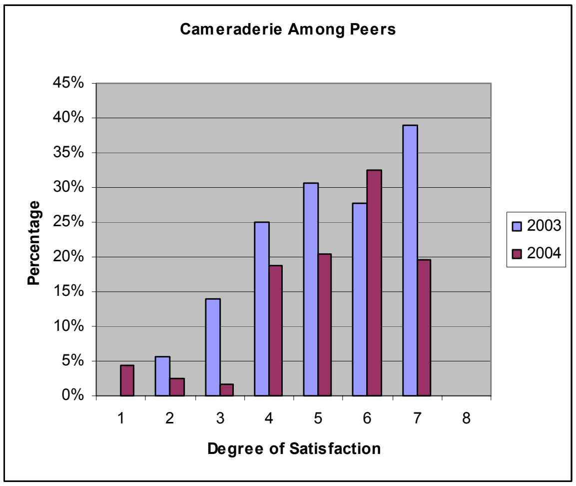


Figure 4. Student assessment of peer camaraderie.

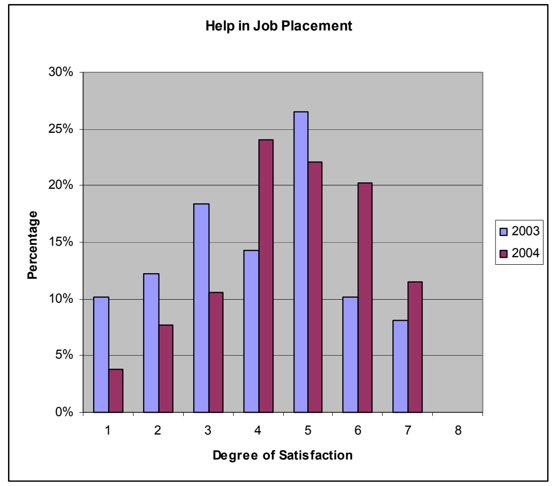


Figure 5. Student assessment of the College's helpfulness in job placement.

In 2004, the ME department introduced a series of courses, ME 1A, ME 1B, and ME 1C, to be taken during the first three quarters of the first year. These courses teach study skills, introduce students to the fundamentals of mechanical engineering, show students how to use university resources effectively, and provide familiarity with computational software such as Excel and MATLAB required in later classes. These classes also help students to come into contact with ME faculty members who can help them with social adjustment as well as academic problems. Preliminary enrollment statistics indicate that the ME 1 series has reduced the attrition rate during the first two years of school.

Based on observations made by other engineering programs that clustering of undergraduates in freshman classes improves academic performance and retention rates, the Bourns College of Engineering is working with other colleges to offer course sections that cater to engineering students. Our clustering program forms groups of freshmen and enrolls them in courses so that groups, rather than individual students, are assigned to sections. Students will see the same set of peers in all their classes, and will be able to form stronger academic and social bonds with one another. Beginning in the fall of 2007, we will cluster our students in the following courses:

- Math 5: Sections 024, 025, 027.
- Math 8A: Section 005.
- Math 9A: Sections 011, 012, 013.
- Math 9B: Sections 031, 032.
- Math 9C: Section 004.
- Chemistry 1A: Sections 031, 027.

We are working with the Registrar's office to structure the freshman registration system so that incoming engineering freshmen are automatically enrolled in courses as groups. We plan to have the system in place by the fall 2006 quarter.

Another new initiative for 2007 is the Engineering Dormitory, *Enginuity Hall*. Sharing a common residential environment can be an effective means for enhancing the development of social and academic peer relationships. We plan to make academic and professional activities an integral part of the residential experience in this hall, hosting a range of activities such as professional club activities, office hours, study groups and supplemental instruction in the residence hall.

We have been working with the Housing Services unit on campus to make the engineering residence hall option available to as many of our incoming freshmen as possible. The pilot program will be in place by fall 2006.

B.1.2 Student Advising

Student advising in the Bourns College of Engineering operates at three levels. First, staff Academic Advisors guide the students through planning, course selection, corrective action as needed, and degree check. Second, departmental faculty engage in group and individual student advising, as well as informal mentoring. Third, other resources from within the College and from the broader campus help students make good choices and advance successfully toward the degree. All of these mechanisms are covered in sections B.1.2 to B.1.4.

Students in the Bourns College of Engineering are assigned to an Academic Advisor in the Office of Student Academic Affairs based upon the year in school and/or their last name. Students are currently distributed between four sophomore through senior advisors and one freshman advisor.

Each advisor, with the exception of the Freshman Advisor, advises approximately 250 students each year. The Freshman Advisor is responsible for all new freshmen, in addition to continuing freshmen who have not yet earned enough units to achieve sophomore standing. As a result, the Freshman Advisor's caseload is larger than the others'.

The caseload system is designed so that students and Advisors have a relationship throughout the student's career. The Freshman Advisor teaches the student how to navigate the University policies and procedures as well as teaches the student how to best utilize their Advisor and Faculty mentors skills.

In the spring of the freshman year, a student meets with his or her permanent staff advisor to discuss the fall schedule and make the transition to the Sophomore – Senior caseloads. The student now works with the same advisor on all academic issues through graduation. Course scheduling, academic difficulty counseling, petitions for exceptions, and graduation applications all come to the staff Advisor. This continuity allows the student and Advisor to develop a relationship of trust which leads to better service for the student and greater insight for the Advisor on the student's needs and ambitions.

It is the Student Affairs advisor's responsibility to monitor the progress toward completion of degree requirements. All of the engineering disciplines are patterned in sample program plans which form the basis of the four-year suggested course schedules. Advisors are able to assist students with creating a personalized plan to allow for actual course enrollment to vary from the standard plan, with the required courses to be rescheduled into a later term. This becomes particularly useful for students pursuing double majors, minors, changes in program, reduced course loads due to academic difficulty or extracurricular demands (e.g. employment), and students who have changed their major into the College of Engineering from another major on campus.

The Student Affairs advisors also perform a Satisfactory Academic Progress review annually, during the summer. Each student in the advisor's caseload is reviewed for degree progress. Students are counseled about course selection and academic support services to help them achieve better grades and get back on track with their Course Plan.

Prerequisites to courses are enforced by the Student Information System in accordance with the course approval forms. Should an instructor approve enrollment on an exception basis, the Student Affairs Officers can assist the student with enrollment, given reasonable written documentation (e-mail, or note from the instructor). This documentation is then placed in the student's file.

Substitutions or waivers generally require the approval of the Associate Dean for Undergraduate Education or the Undergraduate Advisor in the major. Documentation of a substitution or waiver of a degree requirement is always included in the student's college file. Advisors are authorized to input the substitution or waiver into the Student Information System.

Technical electives required for the major are selected by the student in consultation with the faculty mentor or Undergraduate Advisor for their major. Several majors, including Computer Engineering and Electrical Engineering, have developed focus areas to allow students to concentrate their studies in one particular area.

The ABET criteria are folded into the degree requirements. The completion of core requirements is monitored by the electronic degree check. The Humanities and Social Sciences requirements are also monitored by the electronic degree check. This process uses the approved breadth list to place completed courses into the appropriate categories for both breadth and depth. The only element which must be manually monitored is the aspect of the depth requirement which necessitates that one of the two upper-division courses be from the same area as another course.

Bourns College of Engineering Program for Students in Academic Difficulty

Students in academic difficulty are monitored by the Student Affairs advisors on behalf of the Associate Dean. Upon receipt of quarterly grades, the advisors review the academic records of students who achieve less than a 2.0 to determine whether the student should be placed on Academic Probation, placed on Continued Probation, or dismissed from the University. A student in danger of being dismissed has the opportunity to submit an appeal, which is then reviewed by the Associate Dean. If dismissal procedures must be instituted, this is done by the Associate Dean.

Because the College's Academic Difficulty policy only allows for two consecutive quarters in academic difficulty before the student is dismissed from the University, a multilayered process has been established to try and retain these students.

After grades are posted for a quarter, Academic Advisors manually place holds on the registration of each student in academic difficulty to prevent him/her from making any changes to his/her registration (University regulations limit such students to 13.0 units per quarter), for the upcoming quarter prior to completing difficulty procedures. Additionally, no later than the first week of the quarter, e-mail is sent to each student in difficulty to inform him/her of his/her status. The notification clearly states what the student must do to remove registration holds and restore good standing.

Each student in difficulty is required to attend an Academic Success Workshop. Workshops are offered during the first two weeks of every quarter. The College offers a lower-division workshop for those students who have completed less than 90 units and/or no upper-division coursework. An upper-division workshop is offered for those students who are junior or seniors and well into their major having completed upper-division coursework. Approximately 80% of students in difficulty attend a workshop.

The Academic Success Workshop is designed to help students identify what it was that caused them to be in difficulty and equip them with strategies to rectify the problem and improve academic success. In the workshop, facilitators cover topics from how to identify and improve motivation to study strategies, and identify campus/college resources to facilitate the process of academic recovery. In the workshop, students are given a packet of materials to complete that includes an Academic Progress Review, Time Management Plan or Major GPA calculation (depending on class level), a Checklist that identifies various reasons why students end up in difficulty, and instructions for preparing a personal statement (essay).

If a student does not attend an Academic Success Workshop during the first two weeks of the quarter, he/she must then see an Academic Success Counselor (trained paraprofessional) to discuss all of the material covered in the workshop. The student still needs to complete all of the pieces of the packet as provided in the workshop. In addition, Success Counselors are available to all students throughout the quarter for advice.

A student must then set an appointment to meet with his/her academic advisor to discuss the various materials from the workshop and review the personal statement and checklist to further provide the student with support and strategies to resolve the issues that put him/her in academic jeopardy. The student is referred to appropriate campus resources such as the Counseling Center, Career Center, and Learning Center to meet with professionals with expertise to manage his/her personal issues surrounding academic difficulty. The student is also encouraged to visit his/her advisor prior to registration for the next quarter to discuss how things are going and plan an appropriate schedule. If the student does not complete all parts of the packet (time management plan, essay questions, etc.) the student is asked to complete the packet fully and return before the hold is removed. The advisor also reviews the student's complete grade history to be sure that the student is in a successful major choice.

Prior to registering for the subsequent quarter, a student in academic difficulty must complete a course plan and submit it to his/her academic advisor for review and approval. If the course plan is inappropriate, the student is advised to come in for guidance or to given advice as to how to better select courses and asked to resubmit.

Additionally a student must complete a follow-up assessment to gauge how helpful the workshop was in helping him/her reach his/her goals for the quarter and if the student has been able to stick to his/her plan for success.

Students who wish, or need, to change their major are encouraged to contact their desired new department for advisory information.

Additional information about the College's Academic Standing policy is available online at: http://www.engr.ucr.edu/studentaffairs/policies/acad_stand.shtml.

Bourns College of Engineering Faculty Mentoring Program

While Staff Academic Advisors in the Office of Student Affairs provide academic advising (guidance with registration, campus resources, course planning, etc.), Faculty Mentoring is a different kind of advising assistance. The Faculty Mentor's goal is to promote a strong relationship between students and professors in the department as early as the first quarter of the freshman year. Faculty Mentors are available for students to consult on matters pertaining to career planning, understanding engineering in general, and specifically for gaining a better appreciation of their majors. Mentors also provide guidance on what it takes to be successful as an engineering student, and provide suggestions to enable students to gain confidence and self-motivation.

Faculty Mentoring is an opportunity for student and faculty to interact in a less intimidating situation. The program is designed for students to gain greater insight about classes and how course material relates to post graduate goals. This is the time for students to really understand how what they do in the classroom is connected to what Engineers actually do in the real world. Faculty Mentoring helps students to clarify course guidelines, the syllabus, a specific assignment, lecture, discussion, and career goals; better understand comments on papers or assignments; improve grades by providing studying assistance; communicate about expectations; get advice on graduate study or future plans; and make suggestions for self-improvement.

Freshmen in Mechanical Engineering are required to meet with their assigned Faculty Mentor as a condition of registration every quarter of their first year of enrollment. Computer Engineering, Computer Science, and Information Systems freshmen are required to meet with a Faculty Mentor in the first quarter of enrollment as a condition of registration. Electrical Engineering majors have access to a Faculty Mentor (Advisor) but are not required to meet on a formal basis. All Bioengineering, Chemical Engineering, and Environmental Engineering majors, regardless of class level are required to meet with their assigned Faculty Mentor as a condition of registration for every quarter of enrollment.

Instructions for meeting with Faculty Mentors and contact information is provided via e-mail, posted on the College of Engineering Office of Student Academic Affairs' website and made available from each staff Academic Advisor. Students are encouraged to contact Faculty Mentors in person or by e-mail to schedule a mentoring session. Before the appointment, each student must obtain a Faculty Mentoring Confirmation slip from the department's administrative office. At the end of the meeting, the Faculty Mentor signs the confirmation slip verifying completion of the requirement. The student then brings the signed slip to the Office of Student Academic Affairs for removal of the registration hold.

B.1.3 Monitoring Student Credit-Hours

The College's Student Affairs advisors, Student Affairs Officers II, serve as both college office advisors and departmental advisors for each of the College's engineering disciplines. As departmental advisors, Student Affairs advisors discuss academic progress with students on a quarterly basis, and at additional times as changes warrant. Advising duties are split between freshmen and sophomore through senior students.

Freshman Advisor: Tara Brown

Sophomore – Senior Advisors:
A – F: Suzanne McCusker
G – K: Lisa Guethlein
L – P: Sonia De La Torre
Q – Z: Thomas McGraw

Since departmental and college advising is provided from one centralized staff, separate certification at the department level is not performed.

Once students file their Applications for Graduation (normally three weeks prior to the beginning of the graduation quarter), the Student Affairs Officer performs a preliminary degree check to assess completion of all University, College, major, and ABET requirements.

Students also have access to their own degree audit via a secure web interface. Bourns College of Engineering students are especially adept at utilizing this tool to assess their own degree progress. The audit takes the place of the preliminary as well as the final degree check that were formerly performed manually. As such, hard-copy tracking of graduation requirements is no longer done.

Upon receipt of final grades, a final degree check is performed, and students are cleared to graduate if they have satisfied all listed requirements. If the requirements are not satisfied, the student is notified by the Registrar's Office and asked to contact their College Office.

Transfer credit is honored and recognized for comparable subjects as determined by course articulation. Transfer credit is determined by faculty review. Each academic department has exclusive responsibility for the evaluation of transfer courses in its discipline, for the benefit of the campus as a whole. In each academic department, the Undergraduate Faculty Advisor is charged with reviewing any courses in their department submitted to the campus for consideration. Requests for course articulation are sent to the department by the Office of Student Academic Affairs and are accompanied by a course syllabus, course description, course name and table of contents of the text, and any lab assignments. Courses are reviewed for comparability of engineering topics, lecture material, laboratory assignments (as appropriate), and prerequisites. In this way, each academic department is of service to the campus, and consistency is maintained. Individual academic departments do articulate courses outside their own field of expertise and recognizes the existing articulation completed by faculty in the respective academic departments. This ensures transfer credit for each student is treated equitably, regardless of the student's major.

The Office of Student Academic Affairs, specifically Thomas McGraw, maintains the documentation and collection of these course articulation requests within for College of Engineering on the campus Student Information System database. The campus Articulation Officer, Thea Labrenz, serves as the manager of this database of comparable courses, which interfaces with the statewide database, ASSIST, available via the World Wide Web. The database contains all approved comparable courses for use by all campus departments and California Community Colleges, and further contributes to consistency and efficiency.

B.1.4 Professional Development Milestones

The Bourns College of Engineering Professional Development Milestones program was designed to lead students to professional success after graduation. The Professional Development Milestones parallel a student's academic path and allow a student to plan and track his/her professional development as he/she would his/her academic progress.

Earning a college degree is no guarantee of professional success. Interpersonal skills, the ability to communicate effectively, leadership qualities, internship and/or research experience, networking skills, and many other characteristics determine professional success. The Bourns College of Engineering Professional Development Milestones program allows students to gain experience and develop the skills, abilities, and characteristics that determine professional success. Among other milestones, the Bourns College of Engineering strongly encourages all students to complete at least one internship and at least one research experience prior to graduation. The Professional Development Milestones outline a plan that leads a student through each milestone and related activity as he/she makes progress toward professional success in graduate school, industry, research, academia, management, leadership, and/or many other professional endeavors.

The Professional Development Milestones program (formerly known as Career Path Milestones) is an interactive, web-based resource. The web site (http://www.engr.ucr.edu/studentaffairs/milestones/) maps actions that a student should take during each undergraduate quarter (Figure 6). Beginning in the freshman year, for example, it guides students to relevant professional organizations to join and resume-writing workshops. In the sophomore year, it connects students to resources for finding internships and research experiences. Other milestones include target dates for taking the GRE exam, revising resumes, and having mock job interviews.

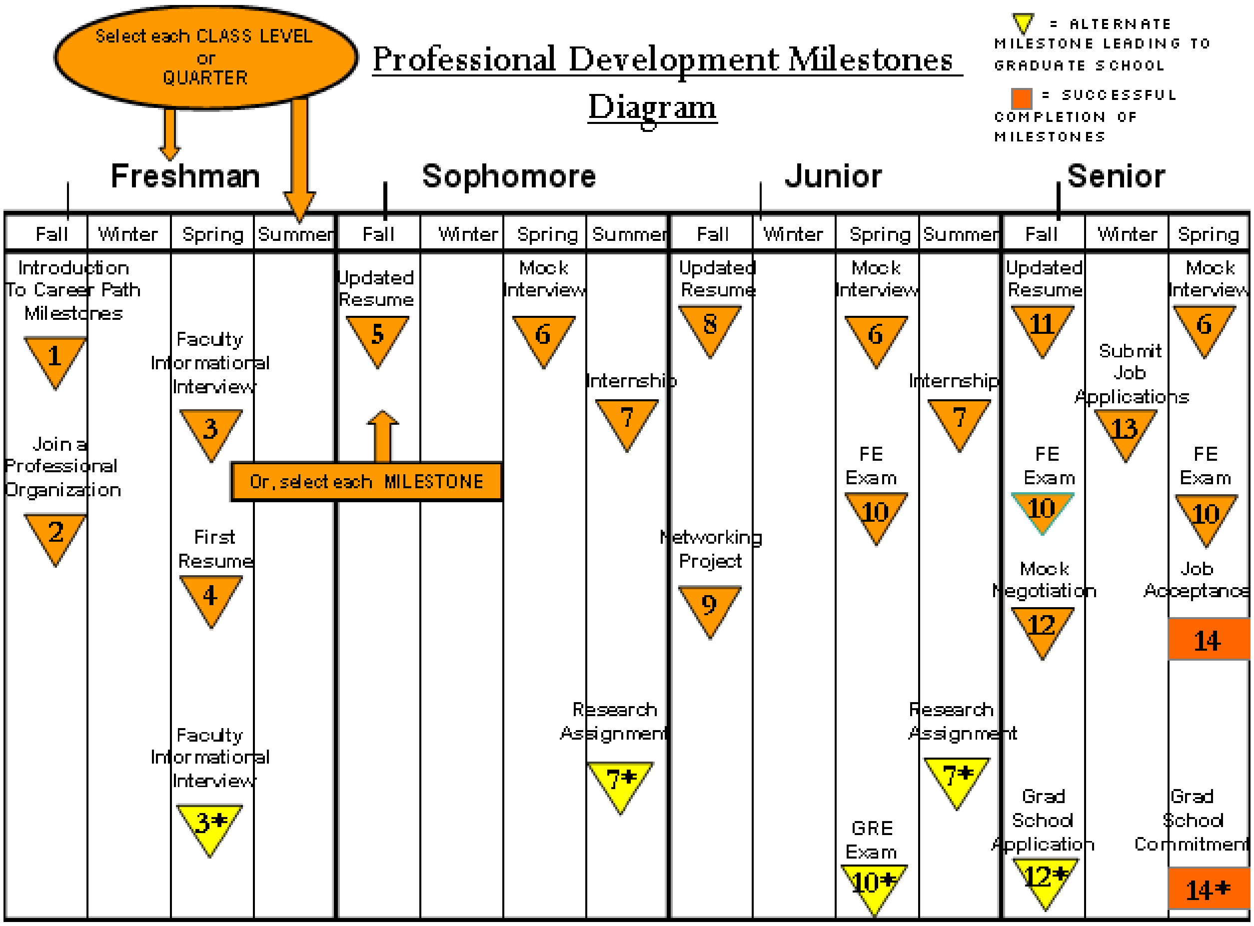


Figure 6. Diagram of key points during an undergraduate's tenure at which the Professional Development Milestones program prompts the student to take action in preparation for internships and academic or industrial career opportunities.

At this time, Professional Development Milestones is used only for Bourns College of Engineering undergraduates. It is gradually expanding to other undergraduate sequences at UCR and other institutions, and eventually can be expanded to serve graduate students.

B.2 Program Educational Objectives

This section describes the Department of Mechanical Engineering's Program Educational Objectives and their relationship to the institution's mission (Section B.2.1). Section B.2.2 lists the Department's constituencies. Section B.2.3 sets forth the processes used to establish and review the Program Educational Objectives, and B.2.4 provides a detailed analysis of the relationship between each objective and the curriculum. Section B.2.5 discusses the extent to which the Department is achieving the Program Educational Objectives and the methods for reviewing progress and making changes. Finally, Section B.2.6 describes the mechanisms we have used to determine our success in achieving the objectives, and the results that those measurements have produced.

The vision of the Department is to be nationally recognized as an innovator in both research and education in mechanical engineering. Its mission is to provide quality education, conduct strong research, foster close partnership with industry and government, and provide related service to the campus community and the community at large. The department mission is guided by a commitment to continuous improvement in the overall quality of teaching, research, and service, while adhering to the highest standard of ethics.

The formulation of the specific objectives of the undergraduate Mechanical Engineering program has been guided by the strong belief that the program should provide an equivalent of a liberal arts education for the 21st century. The program educational objectives are to:

1. **Provide students with the knowledge and skills required to enter and function in industry rapidly.**
2. **Prepare students for graduate studies by providing opportunities for undergraduate research.**
3. **Provide an education with the breadth and the intellectual discipline required to enter professional careers outside engineering, such as business and law.**
4. **Produce students with a strong sense of teamwork.**
5. **Inculcate in students the intellectual curiosity required for a lifetime of learning.**

(see http://www.me.ucr.edu/programs/ugradindex.html)

B.2.1 Relationship to University and College Missions

UCR's mission statement is as follows: The University of California, Riverside, is a research university committed to the creation and transmission of knowledge at the highest level, and to the translation of that knowledge for the public good. Our comprehensive programs and services, excellent faculty and staff, and vibrant and attractive physical environment are designed to: provide a high quality learning environment for undergraduate and graduate students; advance human knowledge and accomplishment through research and scholarship; enhance the public good through community service and initiatives; seek preeminence among U.S. research universities, recognizing UCR's quality in every area.

Superimposed over this mission are seven strategic goals articulated by Chancellor France Córdova:

1. To enhance UCR's reputational rankings: UCR will have the profile of an AAU member university.
2. To invest in areas of strength: UCR will be recognized for its distinction among all research universities in selected areas which exhibit quality and momentum.
3. To expand opportunities for learning and personal growth for all students, undergraduate and graduate: UCR will become a campus of "first choice" for applicants, and students will have a successful experience at UCR.
4. To reshape the curriculum: UCR will build on the diversity of its students and the distinction of its faculty, and connect the curriculum to the vision of UCR as an AAU institution.

5. To diversify our faculty, staff and graduate population: UCR will be a pre-eminent research university that has diversity as one of its measures of distinctiveness.
6. To build professional schools: UCR will offer expanded professional education in areas that respond to the needs of the state and region and that help to stimulate a knowledge-based economy.
7. To forge closer ties with the community: UCR will organize and coordinate with others to achieve common goals for prosperity and sustainability of the Inland Empire through technology transfer, attraction and retention of highly skilled jobs and industries, and responsiveness to regional issues

The vision and mission of the Bourns College of Engineering is to become a nationally recognized leader in engineering research and education. Our mission is to:

1. Produce engineers with the educational foundation and the adaptive skills to serve rapidly evolving technology industries.
2. Conduct nationally recognized engineering research focused at providing a technical edge for the U.S.
3. Contribute to knowledge in both fundamental and applied areas of engineering.
4. Provide diverse curricula that will instill our students with the imagination, talents, creativity and skills necessary for the varied and rapidly changing requirements of modern life and to enable them to serve in a wide variety of other fields that requires leadership, teamwork, decision making, and problem solving abilities.
5. Be a catalyst for industrial growth in the Inland Empire.

The components of the mission of the Bourns College of Engineering relevant to the undergraduate program in Mechanical Engineering are:

- To produce engineers with the educational foundation and the adaptive skills to serve rapidly evolving technology industries.
- To provide diverse curricula that will instill our students with the imagination, talents, creativity and skills necessary for the varied and rapidly changing requirements of modern life and to enable them to serve in a wide variety of other fields that requires leadership, teamwork, decision making, and problem solving abilities.
- To be a catalyst for industrial growth in the Inland Empire (see http://www.engr.ucr.edu/about/vision.shtml for complete vision and mission statement for the College).

The broad creation and transmission of knowledge in UCR's mission is consistent with the College mission to provide our students with a diverse curriculum that will engender their creativity in a rapidly changing environment. The College mission is to produce engineers who can function in technology industries. This enables translation of their knowledge for the good of the public, consistent with the University mission and the Mechanical Engineering program educational objectives. The notion of engineers working successfully in interdisciplinary teams that require technical and non-technical expertise is emphasized in the college mission and program objectives. Specifically, an ability to write technical reports and to present technical material orally with suitable visual aids is emphasized in the program experience. The program aims to offer opportunities for undergraduate research experience as a means to motivate graduates to pursue advanced graduate degrees in mechanical engineering and other fields. Thus the program educational objectives are consistent with the mission of the Bourns College of Engineering and the University of California, Riverside.

In consultation with its program constituencies identified in Section B.2.2, the Department of Mechanical Engineering has established program educational objectives. These were refined in May of 2005 and again in May 2006 in consultation with the Mechanical Engineering Department's Board of Advisors. Program faculty and lecturers have developed program outcomes following ABET established guidelines, consistent with the program educational objectives. These are highlighted in Section B.3. A rational assessment process has been established to judge the extent to which program outcomes and educational objectives have been met. Assessment results are documented and used to improve the program to ensure closure of the assessment and improvement process. Thus it is ensured that the program educational objectives are consistent with the accreditation criteria.

B.2.2 Constituencies

The stakeholders of our program are mechanical engineering undergraduate and graduate students, program faculty and lecturers, program alumni, employers in industry, and representatives from graduate schools. The Department of Mechanical Engineering has a Board of Advisors (BOA), currently comprised of 11 members representing a wide range of industries (Table 2). The primary purpose of the BOA is to provide insight and counsel to the Chair and members of the faculty in defining the future direction of the department, its curriculum and degree programs (BS, MS, and PhD), and research directions. Typically, the Board convenes once each year for a day to discuss current issues. On occasion, the Chair may also call upon Board members for individual advice and input. Areas for which the Chair seeks such counsel include, but are not limited to the following.

- Industry trends and needs
- Industry collaboration opportunities
- Centers of excellence
- Program expansion
- Industry recruitment process, internship and employment opportunities for UCR-ME students
- Consultation as stakeholder in ABET accreditation process

Given the significant industrial experience of our BOA, it serves as a vital link to the employer constituency. In addition, representatives from graduate schools are invited to special meetings focused on ABET related issues. A website is maintained at the college level to get feedback from our current students, alumni, and employer constituencies. The web address is http://www.engr.ucr.edu/abet2000/stats/

Data from this site is monitored periodically in discussions related to curriculum improvement. An overview of the mechanics of this process is discussed in Section B.2.3.

Table 2. Mechanical Engineering Department Board of Advisors, 2005-06.*

Name	Affiliation
Mr. Donald P. Antcil	Kelly Space & Technology Inc.
Dr. Thomas W. Asmus	Daimler-Chrysler AG
Mr. Wallace Brithinee	Brithinee Electric
Mr. Steve Freitas	Control Coponents Inc.
Dr. Seymour Feuerstein	The Aerospace Corporation
Dr. Herbert A. Franklin	Bechtel Technology Inc.
Mr. Gary F. Hawkins	The Aerospace Corporation
Mr. Mark Hontz	Raytheon Space and Airborne Systems
Dr. Ming Li	Alcoa Technical Center
Mr. Saroj Mandhar	The Toro Co.
Mr. Barry J. Nawa	Boeing
Mr. Thanh Nguyen	Bourns Inc.
Mr. Randy Pearson	The Toro Co.
Dr. Sanjay V. Sherikar, P.E.	Control Components Inc.
Mr. Richard Summers	Advanced Product Design Specialties
Mr. Rod Tabaczynski	Ford Motor Co.

B.2.3 Processes Used to Establish and Review the Program Educational Objectives

The current program educational objectives evolved from those set in 2000. These objectives are published in the University Catalog. A summary of the procedures adopted to review and refine the program educational objectives and our assessment methodology is presented below:

- Program educational objectives are reviewed by the program faculty annually at a department planning retreat for faculty and lecturers (September of each year).
- Stakeholders meetings were held in spring 2004 and spring 2005 in which the program educational objectives and the detailed assessment methods were reviewed and refined.
- An update of our assessment procedure and a review of our overall objectives are carried out annually as part of the agenda of Board of Advisors meetings (spring of each year).
- Program educational objectives guide our assessment process review at faculty meetings (monthly during the 9 month academic year).

In April 2003, the following text was approved for publication in the 2004-2005 UCR Catalog:

> *The design and production of machines requires a broad-based education. The Mechanical Engineering degree program at UCR has been structured to provide the necessary background in chemistry, physics, and advanced math to achieve success in the advanced engineering subjects. In addition, you will be taught the basics of Mechanical*

* Ethnic and gender diversity on our Board of Advisors is a priority. We note with deep sadness that the only woman on our Board of Advisors, Dr. Roberta J. Nichols, a member of the National Academy of Engineering, passed away in 2005.

Engineering while learning about the latest developments and experimental techniques. The goals of the Mechanical Engineering program at UCR are to:

- *provide students with the knowledge and adaptive and social skills required to enter and function in rapidly evolving industry;*
- *prepare students for graduate studies by providing opportunities for undergraduate research;*
- *provide an education with the breadth and the intellectual discipline required to enter professional careers in fields outside engineering such as business and law;*
- *produce students with a strong sense of service to the larger community they live in;*
- *inculcate in them the intellectual curiosity required for a lifetime of learning*

The Mechanical Engineering B.S. degree at UCR is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; (410) 347-7700. For more details see engr.ucr.edu/mechanical.

In May 2004, following a meeting with program stakeholders, the catalog text was modified and appears in the 2005-2006 catalog (see http://www.catalog.ucr.edu/current/me.html):

The design and production of machines requires a broad-based education. The Mechanical Engineering degree program has been structured to provide the necessary background in chemistry, physics, and advanced math to achieve success in the advanced engineering subjects. In addition, students are taught the basics of Mechanical Engineering while learning about the latest developments and experimental techniques.
The goals of the Mechanical Engineering program are to:

- *Provide students with the knowledge and skills required to enter and function in industry rapidly.*
- *Prepare students for graduate studies by providing opportunities for undergraduate research.*
- *Provide an education with the breadth and the intellectual discipline required to enter professional careers outside engineering, such as business and law.*
- *Produce students with a strong sense of teamwork.*
- *Inculcate in students the intellectual curiosity required for a lifetime of learning.*

The Mechanical Engineering B.S. degree at UCR is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; (410) 347-7700. For more details see www.me.ucr.edu.

In particular, the objectives were streamlined, the term "*social skills*" was considered redundant in the context of an ability to function effectively in industry, and the focus on a "*strong sense of teamwork*" was considered appropriate for mechanical engineering students, replacing "*strong sense of service to the larger community they live in*".

Most recently, on May 18, 2006, the Stakeholder group met to further refine the program educational objectives and cast it in an appropriate framework. Specifically, the lead in statement was modified as follows:

OLD LEAD STATEMENT: The goals of the Mechanical Engineering program are to:
NEW LEAD STATEMENT: The Mechanical Engineering program objectives are to produce mechanical engineers who:

Consistent with the restructuring of the lead in statement, the objectives were restructured after extensive discussions. These discussions focused on ensuring that the program objectives are measurable so they can be quantified effectively, enabling feedback and appropriate restructuring of course objectives. For example, participation in continuing education programs would enable quantification of an ability to engage in a lifetime of learning. Likewise, success on team projects, and the number of team projects completed on time and within budget would serve as a metric to assess an ability to work effectively in multi-disciplinary teams. The modified text appears below:
(see http://www.catalog.ucr.edu/current/me.html)

The Mechanical Engineering program objectives are to produce mechanical engineers who:

- *have the knowledge and skills to adapt to the changing engineering environment in industry*
- *are able to pursue and succeed in graduate studies have the educational breadth and the intellectual discipline required to enter professional careers outside engineering, such as business and law*
- *have an ability to work in multi-disciplinary teams*
- *engage in a lifetime of learning*

It was agreed that these objectives will form the basis for continuing assessment of the program objectives effective Fall 2006 with the beginning of the 2006-2007 academic year. Thus Section B.2.4 and others describing program objectives are based on the version prior to the May 2006 meeting.

B.2.4 Program Curriculum and Its Relationship to Program Educational Objectives

A detailed curriculum is presented in Appendix I. The Mechanical Engineering Program Objectives presented earlier in this section are broadly met through a curriculum that offers:

- A well-rounded and balanced education achieved through required studies in selected areas of the Humanities and Social Sciences.
- Strong training in the areas of mathematics, science, and the fundamentals of mechanical engineering that constitute the foundation of the discipline.
- Extensive laboratory and hands-on experience to strengthen understanding of fundamental principles, with opportunities for team work, written, and oral communication.
- Extensive use of computer simulation and modeling in the solution of problems and in design.
- Application of knowledge to design problems common to modern mechanical engineering practice.

- Introduction of design for manufacturability, engineering economics, and engineering ethics into the curriculum to emphasize the relationship between design, fabrication, cost, and impact on society.
- Freedom for the student to mold his or her program of professional specialty studies by allowing each student to choose from a number of technical electives, including credit for independent research, and offering a selection of senior design capstone projects sponsored by faculty and industrial sponsors.

The relationship between each educational program objective and the curriculum is discussed in some detail below.

Educational Objective 1*: Provide students with the knowledge and skills required to enter and function in industry rapidly*

In addition to basic courses in Mathematics (MATH 009A, MATH 009B, MATH 009C, MATH 010A, MATH 010B, MATH 046), Chemistry (CHEM 001A, CHEM 001B), Physics (PHYS 040A,PHYS 040B, PHYS 040C), and Biology (BIOL 003, BIOL 005A, BIOL 05LA), students acquire skills in mechanical engineering sciences (including mechanics, thermodynamics, heat transfer, materials), engineering modeling, and design. These are reinforced through two major laboratories focused on data acquisition and project based experiments. The program culminates in a capstone senior design project while training students on design methodologies, engineering economics, and engineering ethics. The concept of design, modeling, and analysis is emphasized starting with the Introduction to Mechanical Engineering (ME 001A, ME001B, and ME001C) series in the freshmen year, thereby adequately preparing our students to enter a variety of industries.

Because communication skills rank in the top three required to succeed in Industry, the ME curriculum emphasizes both oral and written communication in all the courses. A majority of lower and upper division courses incorporate a design project which requires a student to write a report and make an oral presentation. The two major laboratory courses, ME 170A and ME 170B, also require detailed reports. The capstone design course series, ME 175, stresses communication through periodic memos, reports, and oral presentations. All technical electives include a project component that emphasizes communication skills.

Educational Objective 2*: Prepare students for graduate studies by providing opportunities for undergraduate research*

The technical rigor required to pursue advanced graduate degrees in mechanical engineering and other allied fields is emphasized in our basic curriculum. Students are exposed to basic mathematical tools including applied linear algebra, solution of ordinary, and partial differential equations relevant to mechanical engineering science, thereby preparing them for advanced degrees in engineering and other technical disciplines. In addition, the curriculum allows students the explicit option to experience research under faculty supervision as a technical elective. Faculty are available to advise students about career options that include opportunities for advanced study through graduate education. Senior students with a GPA of 3.0 and above (this is the minimum required for admission to most U.S. graduate programs) are invited to an annual presentation by the Graduate Advisor to discuss graduate research opportunities.

Educational Objective 3*: Provide an education with the breadth and the intellectual discipline required to enter professional careers outside engineering, such as business and law*

Science and engineering courses discussed in the context of Educational Objective 1 provides students with disciplinary intellectual rigor required to succeed in industry or in their pursuit of advanced degrees. The ability to formulate problems, make and test assumptions, predict and solve problems enable students to branch out in to other professional areas such as business and law. In addition, the College has breadth requirements that include English composition, Humanities, Social Sciences, and Ethnicity. Thus the overall set of skills acquired, enable graduates to make contributions to society in a multitude of fields.

Educational Objective 4*: Produce students with a strong sense of teamwork*

The importance of teamwork is emphasized in the student's very first quarter (ME 001A). In subsequent quarters, students are given the opportunity to work in teams (laboratory courses ME 170A/B, and Senior Design courses ME 175A/B/C). In addition, students work in project teams in several individual courses. The program culminates with a significant team project undertaken by students as part of the senior design sequence (ME 175A/B/C) in the final year.

Educational Objective 5: *Inculcate in students the intellectual curiosity required for a lifetime of learning*

Most courses assign problems and design projects that require research and understanding of material not included in the syllabus. The program's emphasis on design provides a natural avenue that promotes intellectual curiosity. All technical elective classes expose students to state of the knowledge in those areas highlighting open questions, unsolved problems, etc. This is likely to promote the need to engage in lifelong learning.

B.2.5 Achievement of Program Educational Objectives and Program Review

The ME program has been reviewed every year since 2001 through meetings with a board of advisors, which consists of industry representatives. This group represents the industry and employer constituency of the program stakeholders mentioned in Section B.2.2. In 2004, a stakeholder group was formed. This includes members of the board of advisors, as well as other stakeholders of the program including faculty members from other UC campuses, alumni, graduate students, and current undergraduates.

The program is also continually reviewed through an online survey in which alumni and employers are sent e-mails periodically to respond to questions related to the program. These results are reviewed by faculty to make improvements in the program.

Program objectives were formulated to achieve the outcomes discussed in Section B.3. These objectives have been reviewed and modified through extensive discussions among faculty and the stakeholder group, which includes representatives from industry, faculty members from UC

San Diego and UC Irvine, UCR graduate students, and alumni. This is discussed in detail in Section B.2.3.

B.2.6 Evidence of Improved Effectiveness of the Program

Because the ME program graduated its first class in 2001, there is a relatively small pool of alumni and employers that can be surveyed to evaluate the effectiveness of the program in achieving program objectives, which refer to achievements after graduation. We have recently developed a web-based survey in which e-mails are sent to alumni and industry employers to respond to questions that can be accessed through a link in the e-mail. Because the response rate to date has been relatively small, as can be seen in the figures below, we have also used responses to senior exit survey to measure effectiveness of the program.

Objectives Assessment Conducted by Alumni

Figures 7 through 11 show the achievement of objectives as assessed by alumni responding to the on-line survey. The x-axis lists the possible scores, 1 to 5, with 5 being the best that can be assigned to the achievement of the objective. The y-axis provides the number of respondents giving each of the scores on the x-axis. For example, Figure 7 indicates that 6 out of the 11 respondents gave the achievement of objective 1 a score of 5, 3 gave a score of 4, and 1 scored it with 3, and 1 gave the objective a rating of 2.

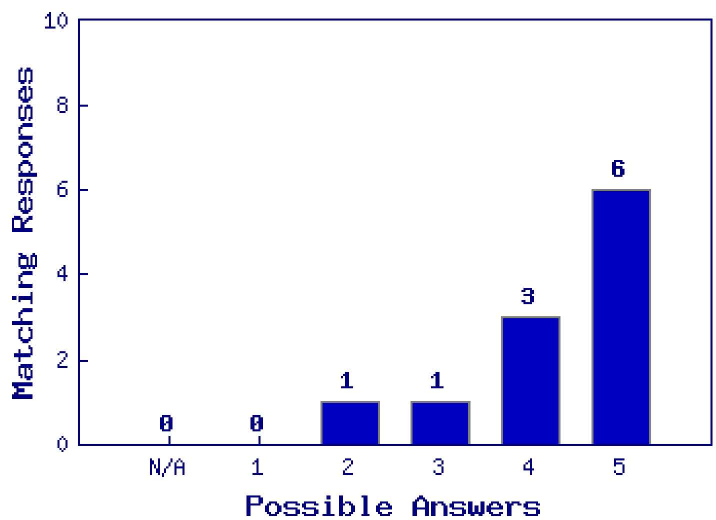


Figure 7. Alumni assessment of Objective 1: Provide students with the knowledge and skills required to enter and function in industry rapidly.

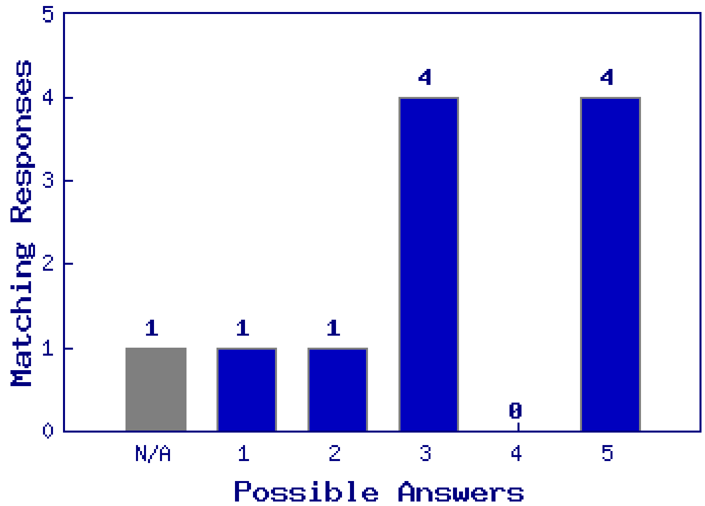


Figure 8. Alumni assessment of Objective 2: Prepare students for graduate studies by providing opportunities for undergraduate research.

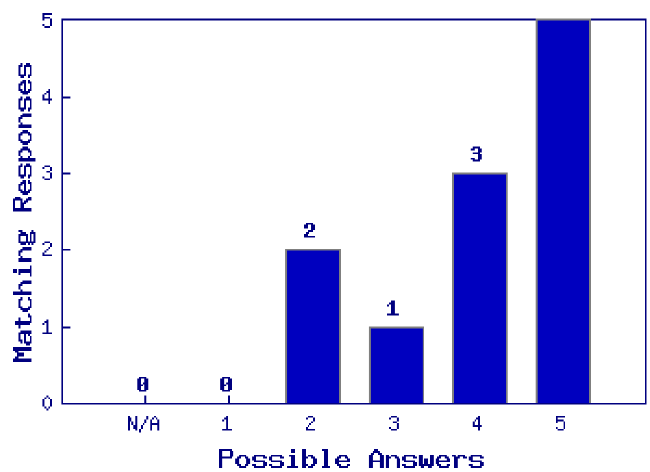


Figure 9. Alumni assessment of Objective 3:Provide an education with the breadth and the intellectual discipline required to enter professional careers outside engineering, such as business and law.

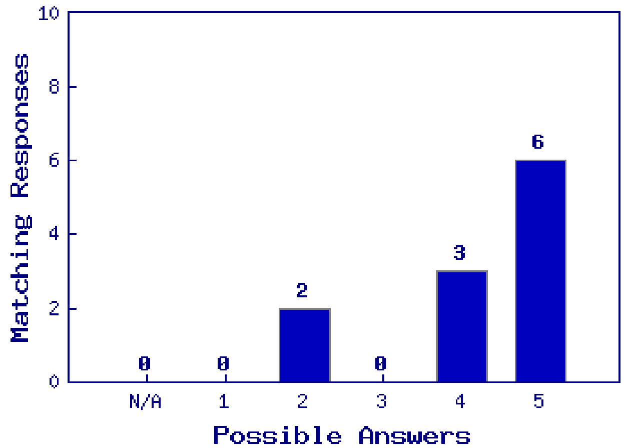


Figure 10. Alumni assessment of Objective 4: Produce students with a strong sense of teamwork.

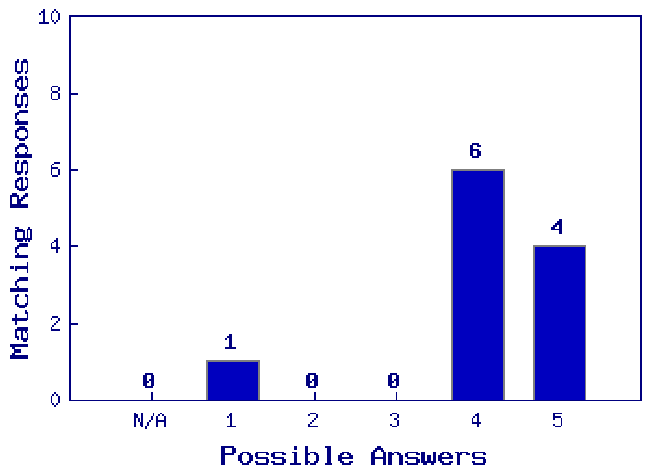


Figure 11. Alumni assessment of Objective 5: Inculcate in students the intellectual curiosity required for a lifetime of learning.

Figures 12 through 16 indicate that the ME program received high scores in four of the five objectives. The alumni are less enthusiastic about the training provided for graduate study. This will be an area for improvement when the sample size is large enough to reduce the uncertainty in the response statistics.

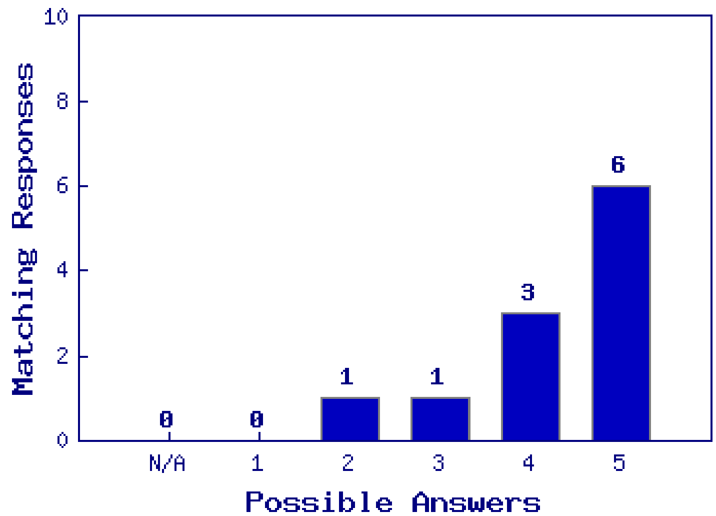


Figure 12. Alumni assessment of Objective 1: Provide students with the knowledge and skills required to enter and function in industry rapidly.

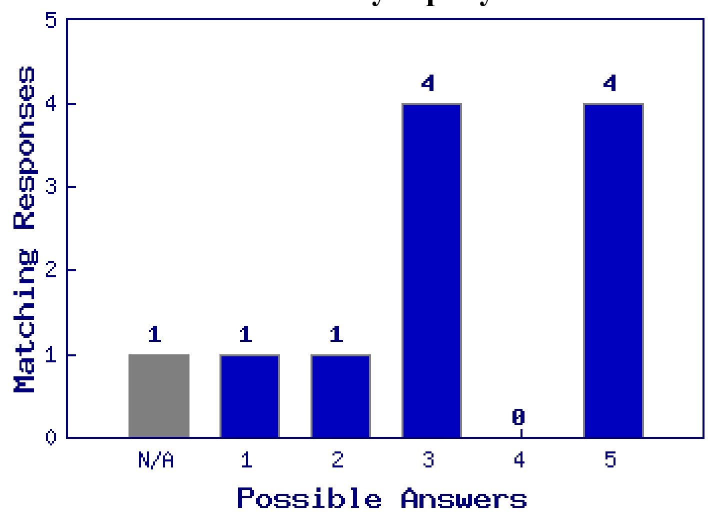


Figure 13. Alumni assessment of Objective 2: Prepare students for graduate studies by providing opportunities for undergraduate research.

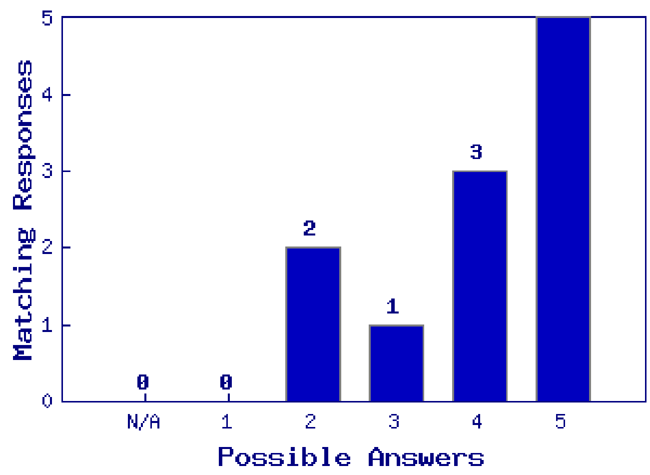


Figure 14. Alumni assessment of Objective 3:Provide an education with the breadth and the intellectual discipline required to enter professional careers outside engineering, such as business and law.

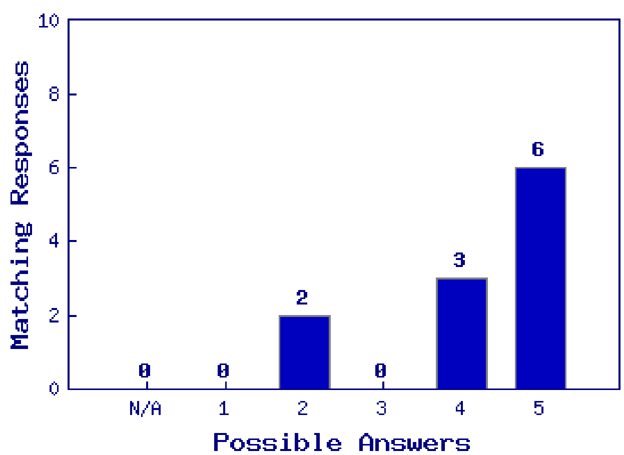


Figure 15. Alumni assessment of Objective 4: Produce students with a strong sense of teamwork.

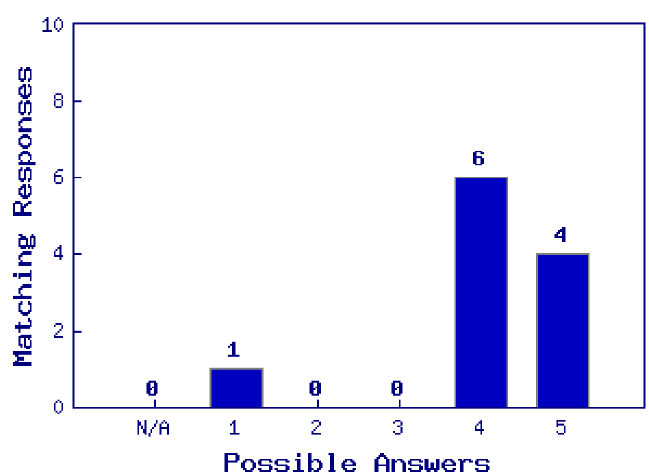


Figure 16. Alumni assessment of Objective 5: Inculcate in students the intellectual curiosity required for a lifetime of learning.

Objectives Assessment Conducted by Industry Employers

Figures 17 through 21 are the responses from industry representatives, some of whom have employed UCR students. It is clear that where they could comment on the abilities of students, they indicate that the ME program is fulfilling its objectives. Most of them are not in position to comment on the ability of UCR ME students to pursue graduate research. Although the trends indicated by the survey are promising, we need a much larger sample of responses before definite conclusions can be drawn.

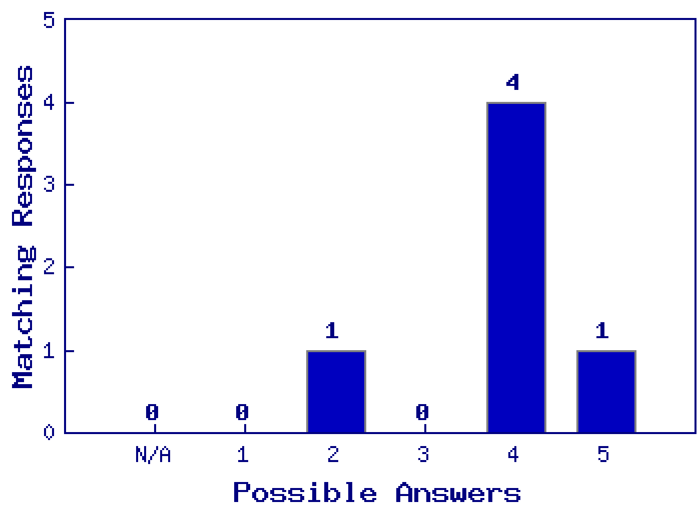


Figure 17. Industry assessment of Objective 1: Provide students with the knowledge and skills required to enter and function in industry rapidly.

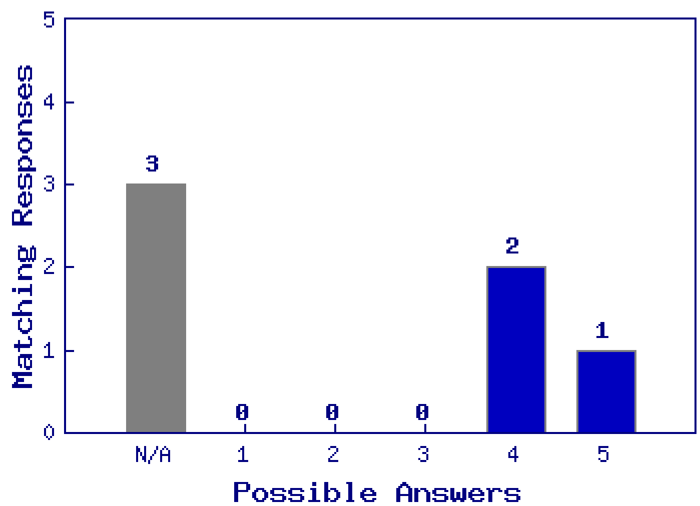


Figure 18. Industry assessment of Objective 2: Prepare students for graduate studies by providing opportunities for undergraduate research.

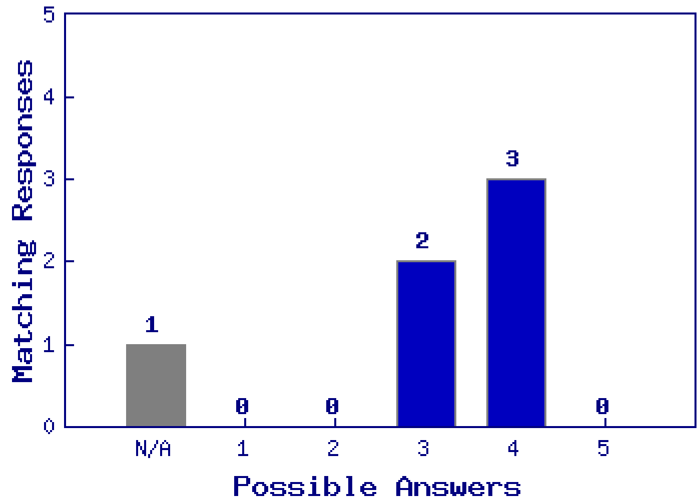


Figure 19. Industry assessment of Objective 3: Provide an education with the breadth and the intellectual discipline required to enter professional careers outside engineering, such as business and law.

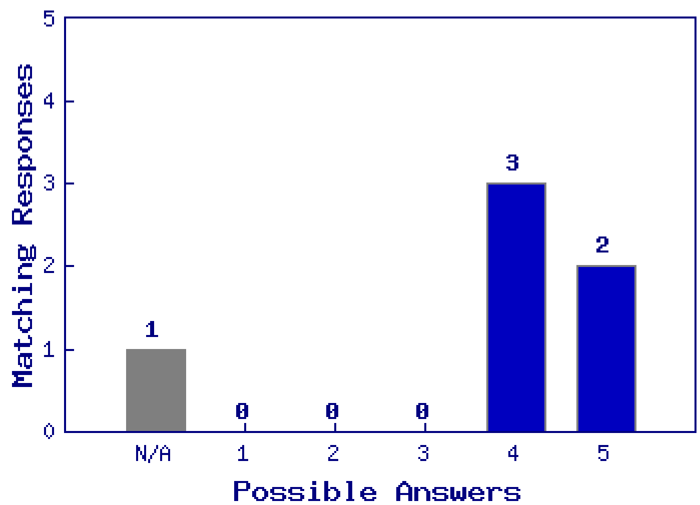


Figure 20. Industry assessment of Objective 4: Produce students with a strong sense of teamwork.

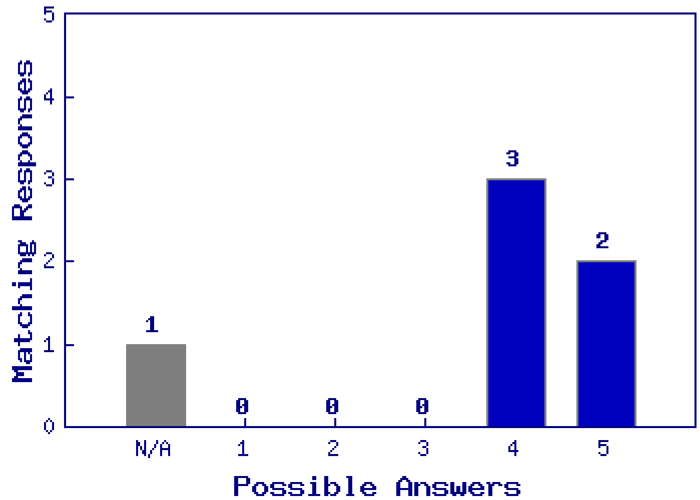


Figure 21. Industry assessment of Objective 5:Inculcate in students the intellectual curiosity required for a lifetime of learning.

Objectives Assessment through the College Alumni Survey

The Bourns College of Engineering initiated an alumni survey (not to be mistaken with the senior exit survey) in 2006 to begin tracking how well our graduates are achieving our program objectives. The College has approximately 600 alumni who graduated between 2000 and 2003, and who thus are in that "window" of interest to ABET – three to five years after completion of the bachelor's degree. Currently, we use a single survey for all alumni. This survey includes questions designed to address the objectives of the individual programs in the College. The results from the survey will be analyzed by the ME program to evaluate the achievement of program objectives described in sections B.2.4 and B.2.5.

The current methodology begins with an e-mail message from the dean to the target alumni, followed by a second e-mail containing the actual survey. College staff then follow up by phoning those who do not respond.

The response to the alumni survey so far has been less than 10%. We plan to increase the response rate by (1) working with UCR's alumni relations office to improve our contact database and (2) making more contacts via phone or a web-based interface. Since each alumnus will be in the survey "window" for three years and the overall population is relatively small, we are confident of obtaining data on a very high percentage of alumni at least once in the five years after graduation. This will provide us with good, quantifiable data on the performance of our alumni with respect to our program objectives.

Table 3 illustrates the limited returns from the pilot survey in 2006. The survey, the tabulated results, and the written comments of the respondents will be available for review during the site visit.

Table 3. Results of 2006 Bourns College of Engineering alumni survey.

Metric	**Objective Addressed**	**% of alumni answering yes**
Took admissions test in pursuit of a postgraduate degree	Educational Objective 2	>60
Was accepted to graduate school	Educational Objective 2	~75
Plan to attend, is attending, or has attended graduate school	Educational Objective 2	~70
Have completed an advanced degree	Educational Objective 2	~20
Accepted a job offer within three months of graduation	Educational Objective 1	>60
Accepted a position related to the engineering degree earned	Educational Objective 1	80
Had a starting salary in the range of $40,000 to $60,000	Educational Objective 1	50
Currently earning more than $75,000	Educational Objective 1	>30
Still working in the field in which the engineering degree was earned	Educational Objective 3	80
Have worked on projects with multidisciplinary requirements	Educational Objectives 4, 5	70
Have worked on projects that have addressed professional and ethical concerns	Educational Objectives 4, 5	60
Have collaborated on projects leading to patents or other types of disclosures	Educational Objectives 4, 5	40
Have published in professional journals	Educational Objective 5	~30

Outcomes Assessment through Senior Exit Survey

In view of the small sample size of alumni responses, the effectiveness of the ME program has also been measured through achievement of outcomes through surveys conducted by an independent private organization. The surveys were generally given to seniors at the end of the senior design class, when they were in the best position to provide a critique of the education they received at UCR. The survey involved about 72 questions, out of which about 30 could be related to the program outcomes that a graduate should demonstrate:

1. an ability to apply knowledge of mathematics, science and engineering
2. an ability to design and conduct experiments, as well as analyze and interpret data
3. an ability to design a system, component, or process to meet desired needs with realistic constraints such as economic, social, political, ethical, health and safety, manufacturability, and sustainability
4. an ability of function on multidisciplinary teams
5. an ability to identify, formulate, and solve engineering problems
6. an understanding of professional and ethical responsibility
7. an ability to communicate effectively
8. the broad education necessary to the understand the impact of engineering solutions in a

global, economic, environmental, and societal context
9. a recognition of the need for and an ability to engage in lifelong learning
10. a knowledge of contemporary issues
11. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

We have experimented with different means of administering the senior exit survey. We now administer it through the Office of Student Academic Affairs. Students must complete the exit survey whey they file their applications for graduation. Graduation applications are not accepted without the survey. This assures 100% participation in the survey.

Figure 22 illustrates the scores assigned to these questions by seniors at the end of the spring quarters in 2003, 2004, and 2005.

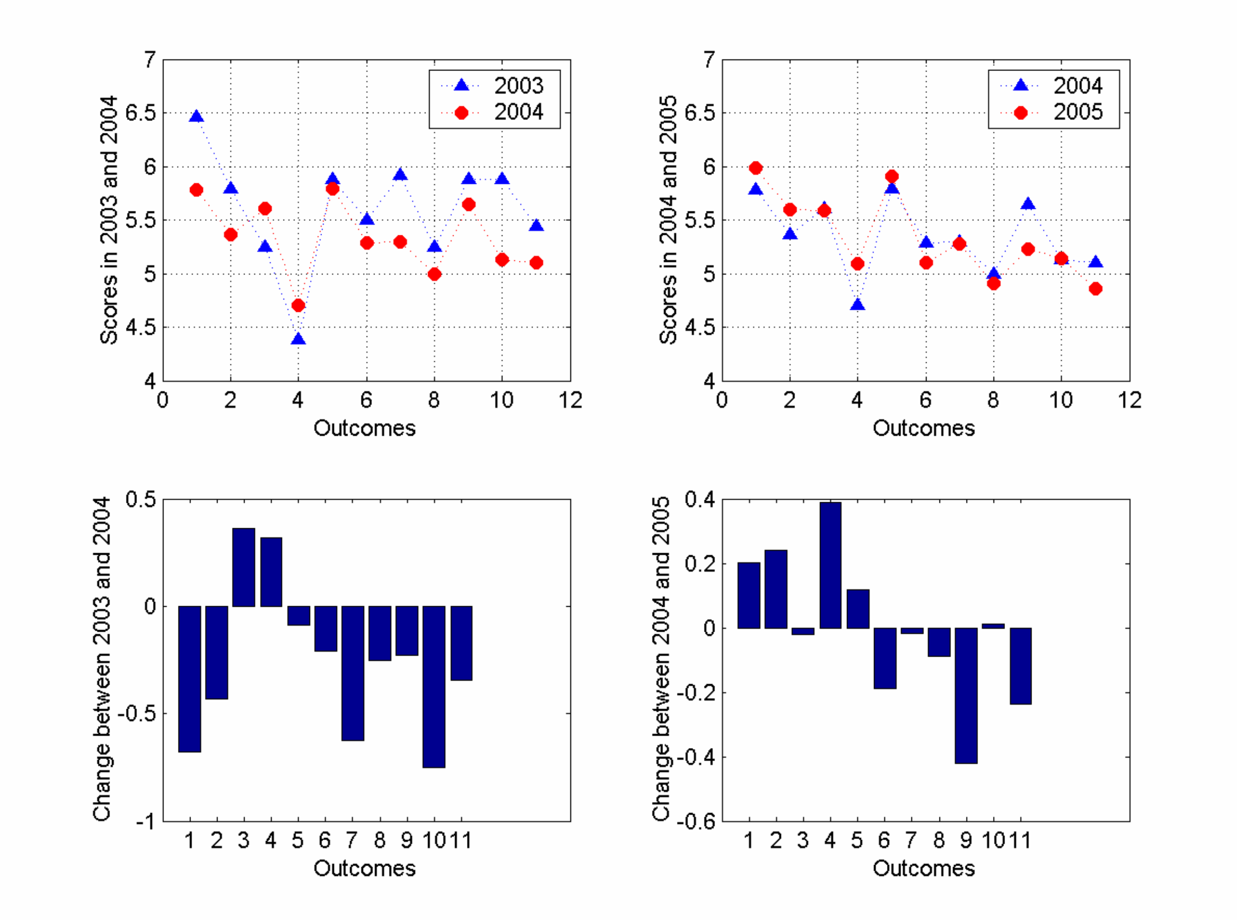


Figure 22. Changes in assessment of program outcomes obtained through surveys taken by seniors in 2003, 2004, and 2005. The x-axis lists the outcomes, 1 to 11. The top panels show the scores, ranging from 1 to 7, given by the students to each of the outcomes. The bottom panels show the differences in scores between successive years.

The figure shows that the survey scores are correlated in the sense that when a certain outcome is given the lowest score in a certain year, it is also given the lowest score in succeeding years.

High scores are similarly correlated. It is not surprising that students rate themselves highly relative to outcome 1, which is the ability to apply knowledge of mathematics, science, and engineering. Outcome 5, related to the ability to identify, formulate, and solve engineering problems, is given high scores. Students feel that their education has stressed outcome 9, which is the recognition of the need for and an ability to engage in lifelong learning. They do not feel that they have adequate skills in functioning in multidisciplinary teams, related to outcome 4. Surprisingly, the scores for outcome 6, related to the ability to use modern engineering tools, are relatively low. This could be related to the questions in the survey that were correlated to outcome 6, which are:

1. Satisfaction with availability of computers in the engineering school.
2. Degree that engineering education enhanced ability to use modern engineering tools.
3. Advising/computing-satisfaction with: remote access to engineering school's computer network.
4. Degree that laboratory facilities allowed use of modern engineering tools.
5. Satisfaction with: training to utilize Engineering School's computing resources.

Four out of the five questions are related to access to computers and training, and thus miss the intent of outcome 6. However, it is clear that students would like improvements in computing facilities. In response, the ME department has added an additional computer laboratory with 30 new machines (see Section B.6.3) to accommodate the rapidly growing student population.

The left panel of the figure compares survey scores obtained in 2003 and 2004. Eight graduating seniors participated in the 2003 survey. In general, these students were very satisfied with their educational experience, and they rated UCR higher than the comparison institutions in the majority of the issues addressed in the 72 questions of the survey. The scores in 2003 were higher than those in 2004 for the majority of the questions.

The survey conducted in 2004 was taken by a larger group of 24 graduating students These students indicated that they had acquired most of the ABET 1 through 11 outcome skills through their education at UCR. Their rating of their skills was higher than those of the six institution comparison group,[†] for outcomes 1, 3, 5, 6, 8, 9, 10, and 11. They rated themselves lower than the comparison group for outcome 2: ability to design and conduct experiments as well as to analyze and interpret data. They were also not convinced that their education enhanced their ability to function in multidisciplinary teams (outcome 4), communicate in written form, and identify engineering problems. Students were not satisfied with several issues not directly related to the ABET skills. These included opportunities for interaction with practitioners, practical experience with undergraduate curriculum, academic advising by faculty, engineering program's extracurricular activities, availability of courses in major, number of companies recruiting on campus, and quality of teaching in differential equations.

[†] The six peer institutions were selected by UCR and analyzed by the same surveying company, EBI. The peer institutions were not the same every year. Since 2001, the peer group has included the University of Connecticut, the University of Delaware, and the University of Wisconsin-Madison every year. Other institutions that have been part of the peer group over the years have included the University of Illinois at Urbana-Champaign, the University of Illinois at Chicago, the University of Notre Dame, the Massachusetts Institute of Technology, Stanford University, the University of Rhode Island, the University of Houston, and the University of Texas-Austin.

It is clear that the students feel that they have acquired most of the 1 through 11 outcomes specified by ABET. The differences in the responses between the 2003 and 2004 senior groups could be related to class size. It is possible that the smaller class in 2003 was provided with more individual attention by faculty members. However, even the larger 2004 group rated UCR higher than the comparison group in most of the issues considered important by ABET.

B.3 Program Outcomes and Assessment

This section describes our Program Outcomes (Section B.3.1) and their relation to the Program Educational Objectives (B.3.2). Section B.3.3 describes our process for evaluating outcomes, as well as the process by which the assessment results are applied to further develop and improve the program. Section B.3.4 describes changes that we have made to the program in response to the assessments. Finally, Section B.3.5 describes the materials that will be available to examiners during the site visit.

Figure 23 depicts the system used by the ME program to "foster the systematic improvement in the quality of engineering education that satisfies the needs of constituencies in a dynamic and competitive environment" (from Criteria for Accrediting Engineering Programs, ABET, EAC, November, 2004). The yellow boxes refer to the processes used in the system, while the blue boxes refer to the "objects" that these processes operate on.

Course objectives are formulated to yield course outcomes, which in turn produce program outcomes. The program outcomes are designed to foster attainment of program objectives.

The outcomes are ***assessed*** to produce qualitative and quantitative measures of performance. These measures are then ***evaluated*** against metrics. We have not yet established absolute metrics to evaluate assessment results. In the interim, we have evaluated these results by quantifying year to year changes in measures of their relative importance in the curriculum and student performance in achieving them. The calculation of these measures is discussed in Section B.3.3.

Evaluation of results from outcomes assessment leads to the ***modification*** of a variety of components of the educational process to improve the effectiveness of attaining program outcomes and objectives. The processes illustrated in Figure 23 are carried out by a stakeholder group consisting of faculty members, graduate and undergraduate students, alumni, faculty members from other schools, industry representatives, and employers.

Through discussions with the stakeholders of the department, the Department of Mechanical Engineering identified and adopted the program outcomes consistent with Criterion 3 of the Engineering Accreditation Criteria; specifically, no additional outcomes were added. The list of outcomes is provided in Section B.3.1.

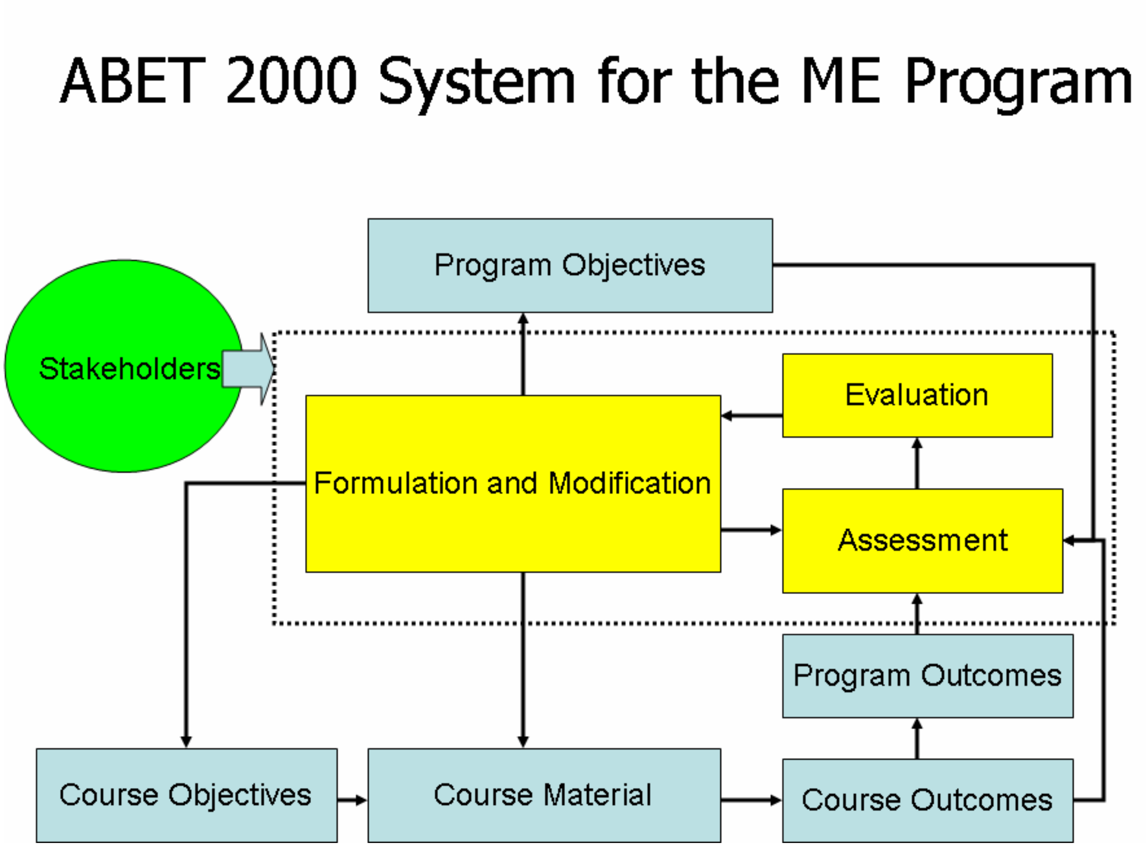


Figure 23. Mechanical Engineering Department's system to make continuous improvements in the ME program to achieve objectives formulated by stakeholders.

B.3.1 Program Outcomes

Graduates of the Mechanical Engineering program must demonstrate:

1. an ability to apply knowledge of mathematics, science and engineering
2. an ability to design and conduct experiments, as well as analyze and interpret data
3. an ability to design a system, component, or process to meet desired needs with realistic constraints such as economic, social, political, ethical, health and safety, manufacturability, and sustainability
4. an ability of function on multidisciplinary teams
5. an ability to identify, formulate, and solve engineering problems
6. an understanding of professional and ethical responsibility
7. an ability to communicate effectively
8. the broad education necessary to the understand the impact of engineering solutions in a global, economic, environmental, and societal context
9. a recognition of the need for and an ability to engage in lifelong learning
10. a knowledge of contemporary issues
11. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

B.3.2 Relation between Program Outcomes and Educational Objectives

Several discussions were conducted, both formally and informally, among members of the stakeholder group to establish consistency between program objectives and program outcomes. The current set of objectives is the result of a meeting of the stakeholder group held in May 2004. The group believed that the objectives should be relatively small in number, stated as simply as possible, avoid overlap among them, and most importantly be consistent with the attainment of program outcomes. As indicated in Section B.2.3, following a meeting with our stakeholders in May 2006, a new set of educational objectives were created by essentially rephrasing the ones established in May 2004. However, it was agreed that the May 2004 version will continue to be in place until the AY 2006-2007 academic year. Accordingly, the current set of objectives is:

1. ***Provide students with the knowledge and skills required to enter and function in industry rapidly.***
2. ***Prepare students for graduate studies by providing opportunities for undergraduate research.***
3. ***Provide an education with the breadth and the intellectual discipline required to enter professional careers outside engineering, such as business and law.***
4. ***Produce students with a strong sense of teamwork.***
5. ***Inculcate in students the intellectual curiosity required for a lifetime of learning.***

The program outcomes are related qualitatively to program objectives through the "influence" matrix shown in Figure 24.

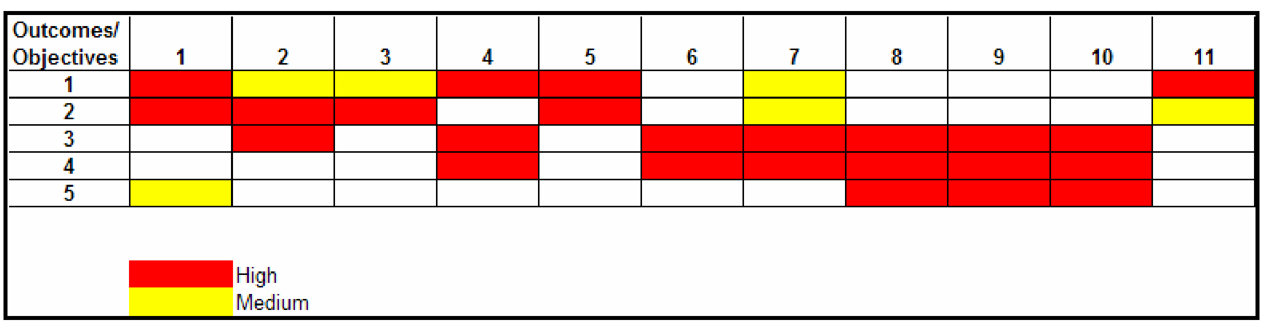


Figure 24. The role of the 11 program outcomes, shown in the column headings, in achieving the 5 program objectives, which appear as row headings.

The strength of the relationship between objectives and outcomes is classified as either high or medium. The stakeholder group felt that translating these categories into numbers could be misleading. On the other hand, it was important to make sure that the program outcomes fostered the attainment of program objectives by being related to as many objectives as possible; every outcome influences at least two of the objectives. Note that the "non-technical" outcomes 8, 9, and 10 are closely tied to objectives 3, 4, 5. The "technical" outcomes, 1 to 5, are designed to foster the attainment of objectives 1 and 2.

B.3.3 Assessment of Program Outcomes

Program outcomes are assessed through quantitative and qualitative techniques. The quantitative methods depend on student performance in courses while the qualitative techniques are based on surveys. We first describe the method based on student performance.

Every course in Mechanical Engineering lists a set of objectives that are designed to ensure that students completing the class will have the knowledge and skills to perform a specific set of tasks related to course content. These course objectives are linked to program outcomes using the objective-outcome matrix presented by Fiedler and Brent in "Designing and Teaching Courses to Satisfy the ABET Engineering Criteria (*Journal of Engineering Education*, January 2003).

Relationship of course to program outcomes: As an example, the contribution of ME 118 (formerly ENGR 118) to program outcomes (1) – (11) is summarized in the objective-outcome matrix , shown in Figure 25. The objectives are linked to program outcomes using a number on a scale of 1 to 3 to denote the strength of the relationships. Student performance in the course is evaluated through fulfillment of course objectives. This performance in achieving course objectives is translated into performance in achieving program outcomes using the mapping scheme of the objective-outcome matrix. The mechanics of the process are described next.

When examinations, homework or quizzes are set, the faculty member or the teaching assistant assigns a set of numbers to each one of the problems to link the relevance of the problem to each of the course objectives. This set of numbers is then scaled by the average of student scores for each problem to obtain measures of the degree of achieving course objectives. A manual (http://www.engr.ucr.edu/abet2000/repository/ABET%20Users%20Manual-ME.doc) describing the procedures used in obtaining these achievement scores is available to faculty members and teaching assistants. New teaching assistants are given an hour of instruction on these procedures before every quarter.

Figure 26 provides details on how student grades are translated into outcome weights and efficiencies. To explain the process, we have considered a course with 4 objectives and 5 outcomes. The course matrix is shown in the lower left corner of the figure. The table in the top left corner provides the weights assigned to each of the objectives in the assignments named in the rows. Each entry corresponds to the sum of the weights, ranging from 0 to 3, assigned to objectives for the problems in the assignment. For example, the entry 12 for HW 1 might correspond to 4 problems in which objective 1 was assigned a weight of 3. The same 4 problems could have the following distribution of weights for objective 2: 3, 2, 0. 0. The sum of these weights corresponds to the entry 5 for HW 1. The last column of the Table, titled 'Weights,' is the relative weights assigned by the instructor to the components of the course, named in the rows. For example, the Final Exam is assigned 0.5 or 50% of the total class grade, while the Mid-Term is assigned 20% of the final grade.

	ME 118 Engineering Modeling and Analysis											
	Objective-Outcome Matrix											
Objective Addresses Outcome: 1-Slightly 2-Moderately 3-Substantially												
	Outcome Related Learning Objectives	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5	Outcome 6	Outcome 7	Outcome 8	Outcome 9	Outcome 10	Outcome 11
Objective 1	Manipulate data sets using MATLAB and explore their properties using MATLAB plotting routines		2			1		2				3
Objective 2	Formulate mechanistic models for simple systems	3	1	1		3						2
Objective 3	Solve model equations using commonly used numerical methods	2	1			1		1	1			3
Objective 4	Fit models to data	1	2			1		2				2
Objective 5	Work in team to develop model for a complete system by integrating components	2		2	3	2	1	2			1	2
Objective 6	Evaluate model with data and improve formulation based on evaluation results	2	2		1	2						2
Objective 7	Write report summarizing results from the application of the model and make an oral presentation summarizing model formulation and major results				2	2		3	2		1	2

Outcome 1	An ability to apply knowledge of mathematics, science, and engineering
Outcome 2	An ability to design and conduct experiments, as well as analyze & interpret data
Outcome 3	An ability to design a system, component, or process to meet desired needs
Outcome 4	An ability to function on multidisciplinary teams
Outcome 5	An ability to identify, formulate, and solve engineering problems
Outcome 6	An understanding of professional and ethical responsibility
Outcome 7	An ability to communicate effectively
Outcome 8	The broad education necessary to understand the impact of engineering solutions in a global and
Outcome 9	A recognition of the need for and an ability to engage in lifelong learning
Outcome 10	A knowledge of contemporary issues
Outcome 11	An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Figure 25. Example of the relationship between course objectives and program outcomes, in this case for ME 118, "Mechanical Engineering Modeling and Analysis."

Weights

	Obj 1	Obj 2	Obj 3	Obj 4	Weight Distribution
HW1	12	5	6	4	0.100
Mid-Term	14	12	10	1	0.200
Project	12	2	5	4	0.200
Final	2	5	8	6	0.500

Relative Weights

	Obj 1	Obj 2	Obj 3	Obj 4
HW1	0.044	0.019	0.022	0.015
Mid-Term	0.075	0.065	0.054	0.005
Project	0.104	0.017	0.043	0.035
Final	0.048	0.119	0.190	0.143
Sumwt	0.272	0.219	0.310	0.198

Efficiency

	Obj 1	Obj 2	Obj 3	Obj 4
HW1	0.700	0.650	0.800	0.900
Mid-Term	0.700	0.600	0.750	0.900
Project	0.600	0.760	0.550	0.750
Final	0.600	0.660	0.780	0.660

Course Matrix

	Outcome1	Outcome2	Outcome3	utcome	Outcome5	Objective Measures: Eff	Wt
Obj 1	3	1	1	3	1	0.644	0.272
Obj 2	3	1	2	1	0	0.649	0.219
Obj 3	3	2	2	1	1	0.744	0.310
Obj 4	1	0	2	1	1	0.700	0.198

Weighted Course Matrix

	Outcome1	Outcome2	Outcome3	Outcome4	Outcome5
Obj 1	0.091	0.030	0.030	0.091	0.030
Obj 2	0.094	0.031	0.063	0.031	0.000
Obj 3	0.103	0.069	0.069	0.034	0.034
Obj 4	0.040	0.000	0.079	0.040	0.040
	0.327	0.130	0.241	0.196	0.104

Outcome Weight	0.327	0.130	0.241	0.196	0.104
Outcome Efficiency	0.684	0.698	0.693	0.674	0.698

Figure 26. Process used to relate student grades to outcome weights and efficiencies.

The top right table, titled 'Relative Weights,' normalizes the entries in 'Weights' table as follows. Each entry in 'Weights' is divided by the sum of the entries in the row, and multiplied by the entry in the last column of the row to yield the corresponding entry in 'Relative Weights'. Each entry in 'Relative Weights' can be interpreted as the contribution of a component of the course to each objective. For example, the mid-term contributes 7.5% to objective 1 and 6.5% to objective 2. The sum of all the entries in the table equals unity or 100%. The sum of the rows in a column, corresponding to an objective, represents the weight attributed by the course to the objective. In this example, objective 1 has a relative weight of 0.272, objective 2 has a relative weight of 0.219, objective 3 has a relative weight of 0.310, and objective 4 has a relative weight of 0.198. These relative weights sum to unity.

The 'Efficiency' table in the middle of the figure summarizes the performance of students in each of the components of the course. For example, in HW 1, each entry corresponds to the average of the student grades in problems related to each of the objectives. Assume that in the 4 problems that are assigned a weight of 3 for objective 1, the average student grades are 60%, 80%, 75%, and 65%. Then the weighted average grade in problems addressing objective 1 is $(3\times0.60+3\times0.80+3\times0.75+3\times0.65)/12= 0.70$. The entry of 0.66 for the 'Final' row suggests that in problems addressing objective 4, the average student grade is 66%.

The 'Eff' column between the bottom two tables corresponds to the scores obtained by students in the course content addressing each of the objectives. Each entry in the column is a weighted score obtained by performing a vector multiplication of each column in the 'Relative Weights' table with the corresponding column in the ‘Efficiency’ table, and then normalizing by the weight assigned to the objective. For example, the first entry is obtained as follows:

$$(0.7\times0.044+ 0.7\times0.075+0.6\times0.104+0.6\times0.048)/0.272=0.644.$$

The ‘Wt’ column reproduces the ‘Relwt’ numbers below the ‘Relative Weights’ table. So we now have the weights assigned to each of the course objectives and the performance (Efficiency) of students in course content addressing these objectives.

The two columns ‘Wt’ and ‘Eff’ are measures related to course objectives. These measures are now mapped to outcomes using the ‘Course Matrix’ discussed earlier. Before this mapping can be done, the matrix is normalized using the same steps as that used to construct the ‘Relative Weights’ matrix, shown in the top right of the figure. Each entry in the Course Matrix is divided by the sum of the entries in each row, and then multiplied by the ‘Wt’ entry in the row. Each entry in the ‘Weighted Course Matrix’ corresponds to the contribution of a particular objective to an outcome. For example, the contribution of objective 1 to outcome 1 is 0.091. The sum of all the entries is unity, and the sum of each column corresponding to an outcome corresponds to the weight assigned to the outcome by the course in setting homework, exams, and projects. Note that outcome weights are not pre-assigned, but are the result of the educational activities of the class.

The last step of the process is calculating the weighted efficiency in achieving the outcomes. Each Outcome Efficiency is obtained by vector multiplication of the column corresponding to the outcome in the ‘Relative Course Matrix’ by the ‘Eff’ vector and normalizing by the outcome weight.

The tables shown on the right side of Figure 26 are generated by TAs and faculty members through manual entry and Excel spreadsheets. The calculations that yield the objective and outcome weights and efficiencies are performed using a MATLAB code by a student assistant, who is responsible for organizing the course data. A graphical representation of the output from the code is presented in Figure 27.

The primary products of the procedure are 1) the relative weights assigned by course activities to program objectives and outcomes, and 2) measures of the degree of achievement of the objectives and outcomes. At the end of each course, students also fill out surveys that provide subjective assessments of achieving course objectives and outcomes. These surveys ask students to make comments on how course can be improved.

This procedure used to assess achievement of program outcomes ensures that faculty members and teaching assistants are constantly aware of program objectives and outcomes.

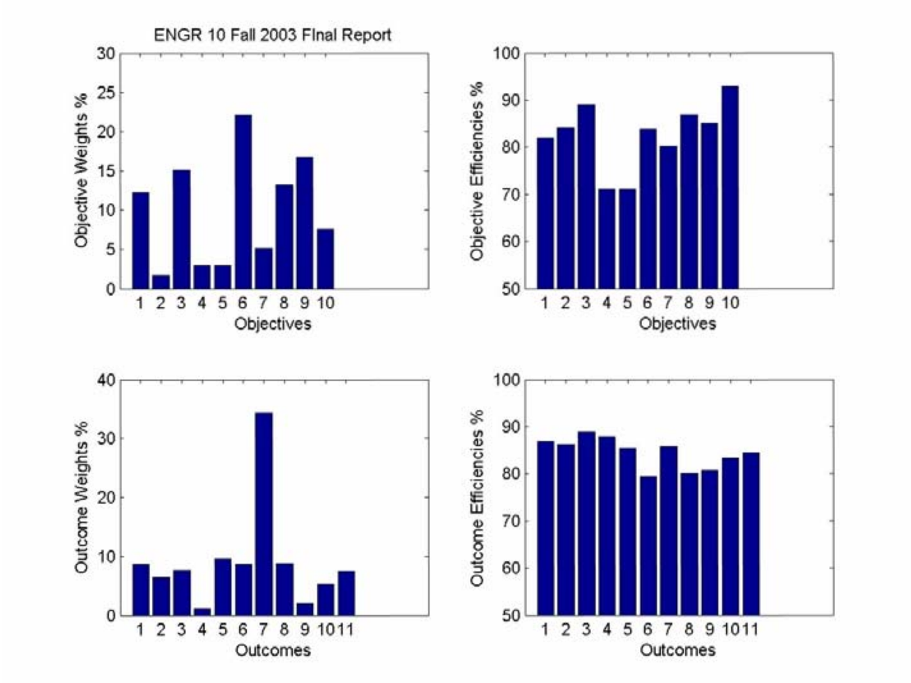


Figure 27. Example of assessment results for ME 10, Statics.

In summary, the assessment process results in:

1. Relative weights assigned to outcomes by each course in the ME program.
2. Grade based measures of degree of achievement of course objectives and outcomes.
3. Survey based measures of degree of achievement of course objectives and outcomes.
4. Comments from students on course deficiencies and possible improvements in course.

This information is used by faculty members to improve the course. Faculty members also rely on formal teaching evaluations conducted by the University.

To ensure that the information generated by the assessment procedures is used to modify courses to achieve program objectives and outcomes, faculty members are asked to make specific suggestions, which are included in the course file. The faculty member who teaches the course the next time is then asked to respond to these suggestions in writing, and relate improvements to these suggestions if possible.

Because every course results in relative weights and achievement scores for the same set of program outcomes, the course statistics can be combined to provide a composite picture of the entire program, which can be then related to the ME program objectives. Figure 28 shows the outcome weights resulting from educational activities in the courses taught during 2003-2004. There is a similar table for outcome efficiencies, which can be combined with the table of weights (Figure 28) to produce outcome weights and outcome efficiencies for the program as a whole.

2003-2004 School Year Outcome Analysis											
	Weights										
Course	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5	Outcome 6	Outcome 7	Outcome 8	Outcome 9	Outcome 10	Outcome 11
ENGR 10 (Fall)	8.63	6.47	7.64	1.15	9.63	8.62	34.38	8.74	2.02	5.25	7.47
ENGR 118 (Fall)	29.58	14.31	2.92	1.61	9.76	0.20	2.76	0.33	1.07	0.36	37.10
ENGR 118 (Spring)	23.31	16.29	1.18	1.41	19.08	0.00	3.29	1.41	1.35	0.71	31.97
ME 9 (Winter)	5.19	14.59	16.34	1.11	9.60	1.11	19.43	5.46	2.55	8.53	16.10
ME 10 (Fall)	14.93	5.75	4.59	5.75	13.76	1.17	10.34	10.34	11.51	5.75	16.10
ME 10 (Winter)	47.96	0.00	0.00	0.00	15.04	0.00	0.00	0.00	0.00	0.00	36.99
ME 10 (Spring)	49.12	0.00	0.00	0.00	13.61	0.00	0.00	0.00	0.00	0.00	37.28
ME 14 (Spring)	19.82	0.48	10.26	0.00	1.94	0.00	0.00	0.00	34.15	33.34	0.00
ME 100A (Fall)	23.15	8.36	6.44	3.73	14.82	2.14	8.70	4.15	11.70	4.23	12.57
ME 100A (Winter)	20.39	6.66	8.48	6.58	12.83	3.04	7.71	4.39	10.44	4.95	14.52
ME 100B (Winter)	14.22	17.19	17.19	7.57	9.62	0.85	5.01	12.58	1.14	5.01	9.62
ME 103 (Winter)	27.40	12.37	12.37	0.00	32.25	1.62	0.00	10.75	0.00	0.00	3.24
ME 103 (Spring)	33.33	11.11	11.11	0.00	33.33	0.00	0.00	11.11	0.00	0.00	0.00
ME 110 (Fall)	18.00	0.00	5.00	0.17	29.13	21.89	5.31	13.31	2.50	2.19	2.50
ME 115A (Winter)	51.21	0.00	0.00	0.00	45.65	0.00	0.00	0.48	0.00	0.00	2.67
ME 115B (Fall)	10.59	11.75	15.56	8.60	7.93	7.63	6.04	7.58	6.87	9.43	8.03
ME 116A (Spring)	39.61	0.00	1.22	0.82	40.31	0.00	4.54	0.00	0.00	1.22	12.28
ME 116B (Fall)	17.65	8.82	17.65	3.35	17.65	0.00	5.75	8.82	8.82	5.75	5.75
ME 117 (Spring)	18.62	10.60	15.71	0.00	15.82	2.40	0.00	10.07	1.15	5.49	20.14
ME 120 (Spring)	8.62	10.96	10.68	9.12	10.28	7.77	7.77	7.77	7.89	8.61	10.53
ME 121 (Fall)	30.56	0.00	4.82	1.80	20.10	0.00	1.61	0.00	0.00	0.00	41.11
ME 122 (Winter)	27.38	3.27	12.43	2.02	18.70	1.51	1.95	1.70	2.13	0.85	28.07
ME 130 (Winter)	12.60	6.47	10.20	6.60	13.19	5.33	9.41	5.15	8.41	8.37	14.29
ME 133 (Spring)	11.48	11.18	9.67	11.73	10.42	4.47	4.77	6.55	9.29	10.22	10.22
ME 136 (Winter)	61.21	22.09	9.68	1.82	1.82	1.55	1.82	0.00	0.00	0.00	0.00
ME 153 (Fall)	41.93	0.00	1.37	0.69	11.95	0.69	0.69	5.85	20.73	6.22	9.89
ME 170A (Spring)	15.51	23.92	8.63	7.07	7.87	8.25	13.68	15.08	0.00	0.00	0.00
ME 170B (Fall)	15.30	15.30	15.30	9.39	7.65	0.00	0.00	7.65	7.65	14.11	7.65
ME 175A (Fall)	9.00	0.00	5.95	19.00	5.95	0.00	26.25	4.98	3.96	9.96	14.95
ME 175B (Winter)	0.00	0.00	7.86	36.67	7.86	0.00	26.67	2.62	5.24	5.24	7.86
ME 175C (Spring)	6.79	0.00	6.55	30.57	6.55	0.00	18.47	4.45	4.37	8.90	13.35

Figure 28. Weighting (%) of Mechanical Engineering courses with respect to outcomes.

The program can also assessed in terms of achieving program outcomes by conducting a survey of senior students during the senior design course. Several questions in this survey are directly related to program outcomes.

The following section discusses how each of the outcomes is addressed in the ME undergraduate program.

Outcome 1: An ability to apply knowledge of mathematics, science and engineering

The majority of the ME courses are designed are designed to address this outcome, as reflected in Figure 26, which lists the weights assigned by the courses to each of the outcomes. In 2003-2004, the overall program assigned a weight of 23% to this outcome. ME 10, Statics, is the first course that emphasizes the application of science and mathematics to engineering problems. Other foundational courses, such as ME 115A, B and ME 116A, B, offered in the junior year also focus on applications of mathematics and basic science.

Outcome 2: An ability to design and conduct experiments, as well as analyze and interpret data

ME 118 (called ENGR 118 in 2003-2004) teaches methods to formulate empirical and mechanistic models to explain data. This includes the application of statistics to the analysis of data. Students also become comfortable with using MATLAB, which is ideally suited for data analysis and interpretation. ME 170A provides the fundamentals of experimental techniques used in engineering. ME 170B requires students to design and conduct experiments to achieve stated goals. It also combines experiments drawn from both the thermal and the mechanical sciences to ensure that students appreciate the need to integrate their knowledge in solving engineering problems. It is offered in the senior year after the students have a thorough grounding in the topics required to design the experiments. Outcome 2 has a weight of about 7.7% in the overall ME program for 2003-04.

Outcome 3: 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 and health, manufacturability, and sustainability

This is a relatively important outcome which was assigned a weight of 8.3% in 2003-04 in the ME program. Design is emphasized in most courses including those offered in the junior year. In these classes, students work in teams to design a system or component to meet specifications, write a report, and make an oral presentation. For example, in ME 118, students worked in groups of three to design the major features of a hybrid automobile to meet specified performance characteristics such as gas mileage and time to reach 60 mph. The capstone design courses, ME 175A, B, and C, and the laboratory courses ME 170A and ME 170B pay special attention to ethical, health and safety concerns in design. Courses such as ME 117 and ME 136 stress environmental concerns. ME 175 A, B, C also requires consideration of economics and manufacturability, and sustainability issues.

Outcome 4: An ability to function on multidisciplinary teams

Although design teams in classes consist almost exclusively of mechanical engineering students, students are expected to work in areas that cross disciplines. For example, in ME 133, students in a team specialize in electronics to design an electro-mechanical system. Students in ME 170A work in teams to prepare technical memos and technical reports, while understanding the basics of data acquisition, using electronic equipment, and data analysis. The scope of the projects included in the capstone course, ME 175ABC, requires students to learn and apply knowledge outside traditional mechanical engineering. For example, students are currently designing a wastewater treatment system, which requires them to understand bacterial degradation of waste. The ME program has assigned a relative weight of 5.8% to this outcome.

Outcome 5: An ability to identify, formulate, and solve engineering problems

This important outcome, with a relative weight of close to 15.3%, is emphasized in the majority of the courses in the ME curriculum.

Outcome 6: An understanding of professional and ethical responsibility
The introductory courses in mechanical engineering, such as ENGR 10 (replaced by ME 1A, 1B, and 1C) deal with professional and ethical responsibility in all activities related to being a student as well as a practicing engineer. ME 175A, the first in the senior design course series, has several lectures devoted to ethics and professional responsibility. A discussion on ethics and responsibilities is covered in several classes, ex: in ME 115A. In 2003-2004, the ME curriculum dealt with this outcome in 2.6% of the course content.

Outcome 7: An ability to communicate effectively
Students are required to write design reports and make oral presentations in several courses. The capstone design course, ME 175ABC, emphasizes this outcome. The relative weight assigned to this outcome was 7.3% in 2003-04.

Outcome 8: The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
Lectures and discussions in ENGR 10 (now in ME 1A) and ME 175A deal explicitly with this outcome. Several technical electives deal with this outcome. ME 136, an elective on the environmental impact of energy production, emphasizes the need to understand the impact of engineering on society. In ME 117, the societal and economic impact of prescribed burning as a tool to manage forest fuels is discussed. In ME138, students learn to identify cutting-edge research in the field of transport phenomena in living systems, and to present that orally. A general knowledge of the contemporary applications of optics and lasers is presented in ME 180. ME156 introduces students to fundamental concepts of macro- and nano-scale mechanical testing of a variety of engineering materials. The relative weight of this outcome in the curriculum was 5.5% in 2003-04.

Outcome 9: Recognition of the need for and an ability to engage in lifelong learning
Most courses assign problems and design projects that require research and understanding of material not included in the syllabi. This is likely to promote the need to engage in lifelong learning. The relative weight of this outcome in the curriculum during 2003-04 was 5.3%.

Outcome 10: Knowledge of contemporary issues
Several courses assign problems and design projects that require students to be aware of contemporary issues. For example, students in ME 136, were asked to write a short paper on global climate change. In ME 117, students are asked to write a position paper on a hydrogen based economy. In ME 118 (formerly ENGR 118), the design project involved hybrid automobiles, which have become popular with the rise in oil prices. In ME156, students learn about failure process in materials and its relevance to materials for integrated circuits and microelectro mechanical systems (MEMS). The relative weight of this outcome in the curriculum was 5.3%. Most senior design projects are sponsored by industry giving students an opportunity to be engaged in contemporary technological and other issues.

Outcome 11: Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
This important outcome, with a relative weight was 13.9% in 2003-2004, is emphasized in all courses. Modern engineering requires an appreciation of modeling, software tools, and experimental techniques. Freshmen are introduced to CAD software (Solid Works) in ME 1B.

ME 1C provides skills in Excel and MATLAB. ME 9 introduces students to engineering design through Solid Works. ME 18 and ME 118 provides instruction on modeling using MATLAB. ME 170A and ME 170B provide thorough grounding in modern experimental techniques and experimental design, and enables student to master a state-of the art data acquisition software LABVIEW. The knowledge and skills acquired in these classes are integrated in the senior design project conducted in the ME 175 series.

Figure 29 shows the distribution of the weights assigned to the outcomes and the performance in achieving them as measured by student grades. The right panels of the figure show the changes in these two statistics between 2003-2004 and 2004-2005.

We see that the outcome weights for the overall ME program changed by less than 2% between 2004 and 2005. The performance, as measured by student grades, increased by an average of 4 points over this time period, which indicates that faculty members became more aware of the need to tailor problems to objectives. The next section discusses the evaluation of the assessment of outcomes, and the changes made in response.

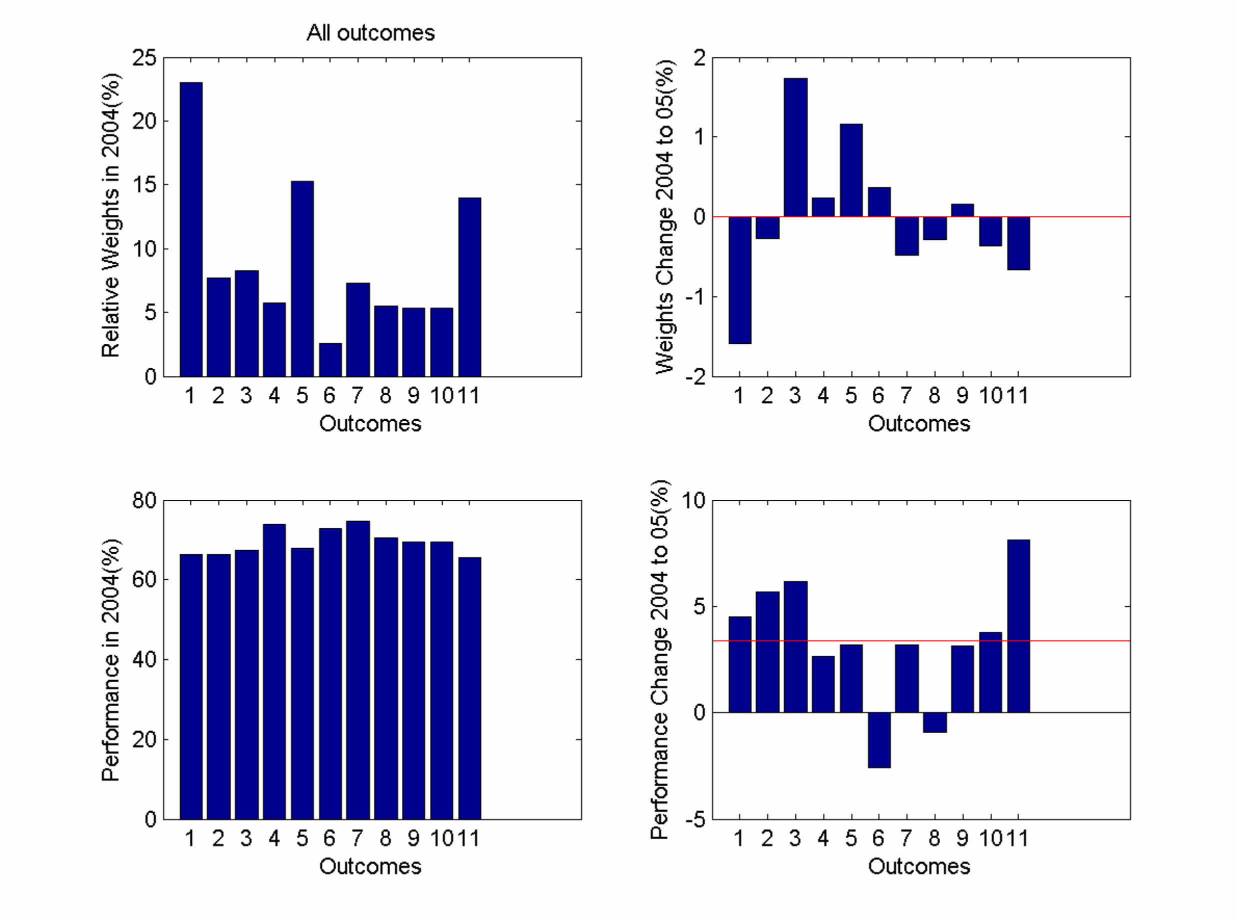


Figure 29. Left panels show distribution of outcome weights and performance in 2003-2004 as a function of outcomes shown on the x-axis Right panels show the changes that occurred in 2004-2005.

B.3.4 Changes in the ME Educational Program in Response to Outcome Evaluation

Although outcome evaluation did not provide explicit information on student attrition, it became clear that close to half of the students entering the ME program were dropping out of the program by the junior year. There were several reasons for this relatively high attrition rate. One of them was that students had little contact with the ME faculty during the first two years at UCR. Thus, they lacked guidance from ME faculty who have a vested interest in helping them to overcome problems facing students making the transition from a high school to a much more demanding university environment. The second reason arises from a situation that is unique to UCR: among the UC schools, UCR admits the highest percentage of students who are the first members of their family to go to college. Such students need extra help in managing the independence granted in the university environment. To help students to get through the first two years of college, the ME department introduced a series of courses, ME 1A, ME 1B, and ME 1C, to be taken during the first three quarters of the first year. These courses teach study skills, introduce students to the fundamentals of mechanical engineering, show students how to use university resources effectively, and provide familiarity with computational software such as Excel and MATLAB required in later classes. These classes also help students to come into contact with ME faculty members who can help them with social adjustment as well as academic problems. Preliminary enrollment statistics indicate that the ME 1 series has reduced the attrition rate during the last two years.

In response to evaluation of assessment of courses related to computation and modeling, the ME program made changes in these courses. Before 2004, all students were required to take a computer science course that taught C++. It was believed that this provided them with the programming background to take ENGR 118, which introduces students to engineering modeling and analysis using numerical methods. Students were expected to learn MATLAB, the primary programming language used in the class, on their own in view of their familiarity with C++. It tuned out that students could not make the transition from C++ to MATLAB as easily as we thought possible, and thus did not achieve the modeling objectives of the class. It became a class in MATLAB applied to numerical methods. This problem was addressed in 2004 by splitting ENGR 118 into two classes: a 2-unit ME 18 that focused on MATLAB, and a 4-unit ME 118 that concentrated on engineering modeling. The first of this experiment has had its teething problems. Student comments and performance in class indicates that ME 18 did not provide the required background in MATLAB programming. The instructor teaching ME 18 for the first time introduced students to the applications of MATLAB before the students had a strong grounding in the MATLAB language. Since then, the syllabus has been modified to stress the language rather than the applications.

The ME program has made other changes to the curriculum to reflect the current multidisciplinary nature of mechanical engineering. Chemistry 1C, the third chemistry course in the curriculum, has been replaced by Biology 5A, a course on fundamentals of molecular biology. Thus, ME students now take two courses in Biology, which better prepares them for the increased emphasis on biological applications in mechanical engineering. In order to integrate the thermal and fluid sciences, the ME department has combined the second courses in the thermal/fluid sciences course series into a single transport phenomena course. Specifically, students will now take ME 135 instead of, ME 115B (fluid mechanics), ME 116B (heat transfer), and, ME 100B (thermodynamics). These courses can now be taken as electives for students who want to specialize in these topics.

The changes in course statistics between 2003 and 2004 stratified according to the importance of outcomes in courses are illustrated in Figure 30. The bar heights in the left panels correspond to averages over the top 10 courses where the courses have been ranked by the weights they have assigned to the outcomes. For example, the relative weight of 40% for outcome 1 has been obtained by averaging over the 10 courses with the highest weights for outcome 1. These courses emphasize outcome 1 more than the others do. Note that in 2004-05, the weight of outcome 1, which focuses on the purely technical aspects of engineering, has been reduced. The weights attributed to the non-technical outcomes, 7, 8, and 9, have increased between 2004 and 2005. In general, the performance of all outcomes, except 8, increases between 2004 and 2005.

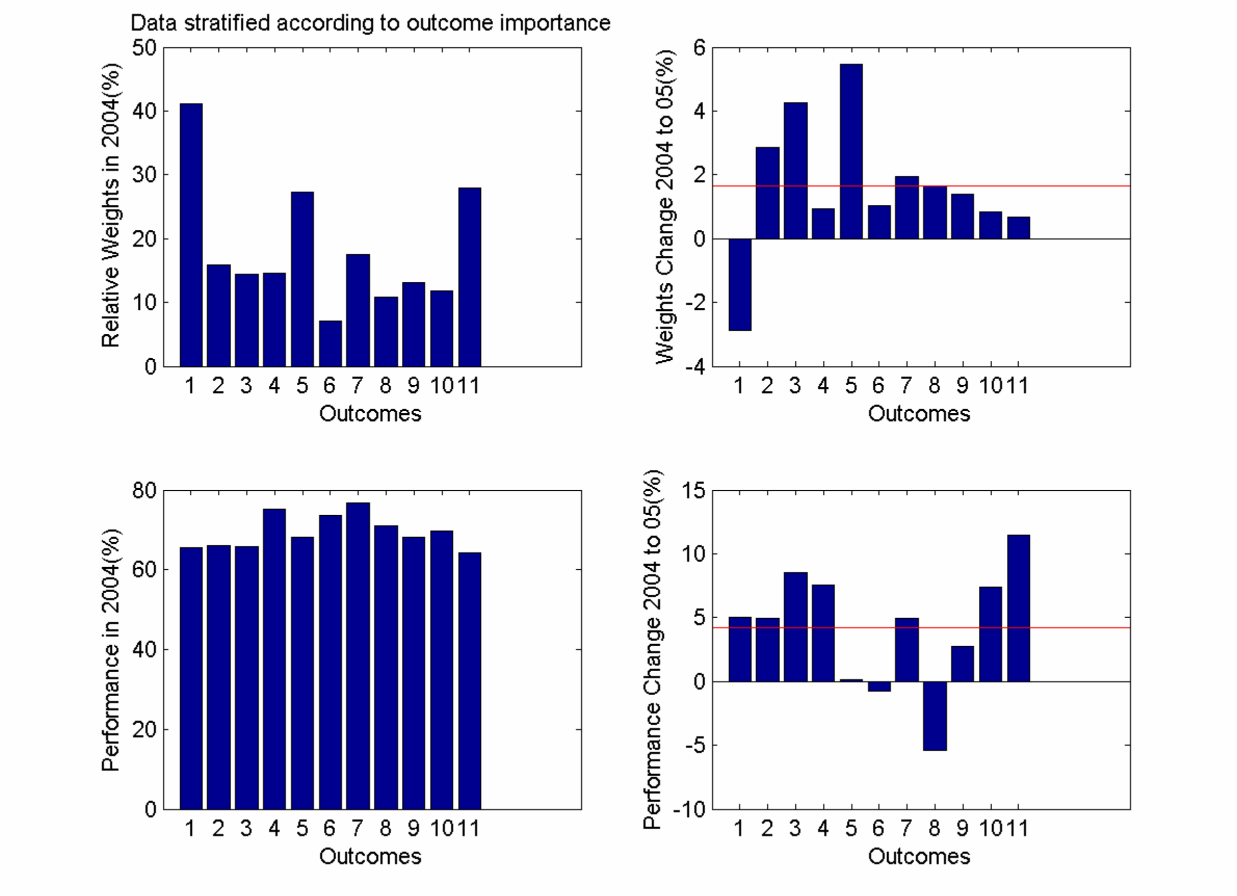


Figure 30. Distribution of weights and performance stratified according to the importance given to outcome. See text for explanation.

The evaluation of the senior exit surveys, discussed in Section B.2.6, indicated the need to improve the ME program in the following areas:

1. Ability to design and conduct experiments as well as to analyze and interpret data. Note that even in this area, the students rated UCR between 5.17 and 5.58 (in 2004) which

differ from the means of the comparison group by less than one half of the standard deviation of the population: There is no statistical difference between UCR scores and those of the comparison group.

2. Mathematical skills.
3. Ability to function in multidisciplinary groups.
4. Communication in written reports. Here the UCR scores are not statistically different from the comparison group.

Although UCR students do not give low scores to their ability to design and conduct experiments, the replacement of STAT 155 by STAT 100 A during 2004-2005 was designed to improve their experimental and data analysis skills. STAT 155 focused on the theory underlying Probability and Statistics, and thus paid little attention to the data analysis required in experimental work. STAT 100A, on the other hand, addresses practical statistics and data analysis methods. Feedback from students indicates that the course material is more relevant to the data analysis they encounter in their laboratory classes.

The students already take 24 credits in mathematics including a course in differential equations. The faculty believes that the students' perception of weakness in mathematics is related to the fact that mathematics is not applied to engineering problems in their math courses. We have addressed this issue by splitting ENGR 118 into ME 18 and ME 118. In ME 18, offered in the sophomore year, students are taught numerical methods using MATLAB, which in turn is taught in a new course called ME 1C. This allows us to devote ME 118 to application of mathematics and numerical methods to engineering problems. This should go a long way in making students more comfortable with applying mathematics.

Scores for outcomes 1 to 5 generally improved between 2004 and 2005. However, it is clear that the curriculum needs to give more attention to the non-technical aspects of the education as embodied in outcomes 6 to 10. In response, ME 175A has been revised to focus on ethics and professional responsibility.

B.3.5 Other Outcome Analysis Mechanisms

The College and the campus also perform assessments to evaluate student expectations and performance. At the campus level, the most significant assessment tool is the UC Undergraduate Experience Survey, or UCUES. This is a uniform questionnaire, which is administered at all UC campuses. Each campus also is able to add its own questions. The questionnaire is administered every two years, although there is some discussion of converting to an annual format. While UCUES does not enable us to compare our student responses directly with those of non-UC campuses, it does provide a basis for comparison with all of the other UCs with undergraduate programs (note that UC San Francisco has no undergraduate programs).

UCR also conducts an annual senior survey. This survey is not particularly valuable for assessing engineering outcomes because of its breadth.

The campus has developed a single relational database (200 fields) to answer queries on student performance and trends, with longitudinal information. There is tiered access to different levels of detail; this protects the privacy of the students for whom data are gathered. As the database is populated with new information, it should be a valuable resource for providing information on the performance of engineering students in non-engineering courses and for evaluating their overall experiences.

The Bourns College of Engineering will begin to administer a new assessment tool in the fall of 2006. All incoming freshmen will receive a questionnaire designed to explore their expectations. In the fall, a second questionnaire will examine how well the actual experience matched the expectations.

B.3.6 Material Available to ABET Examiners during Visit

The ME department will provide the following materials for review during the visit by the ABET Examiners:

1. Course files, which will include syllabi, textbook, lectures notes, homework assignments, mid-term and final examinations, and examples of student work in homework and examinations. Each file will also include a course matrix, and summary of student performance in achieving objectives and outcomes.
2. Files organized in terms of outcomes. These files will include course material relevant to each outcome, assessment of student performance and survey responses, and descriptions of modifications in courses to improve performance in achieving outcomes.
3. Minutes of meetings and discussions held by faculty and stakeholder groups to formulate course objectives and modify program in response to assessment process.
4. Survey forms used to measure attainment of course objectives and outcomes.
5. Alumni survey questionnaires and results.
6. Laboratory manuals describing experimental procedures.
7. Health and safety manuals used in laboratories.
8. Equipment lists.
9. University evaluations of teaching by faculty members.

B.4 Professional Component

The Mechanical Engineering program is structured to provide the necessary background in mathematics and basic sciences (chemistry, physics, and biology) with the intent of preparing our graduates for the 21st century. It includes a general education component consistent with the college and university requirements for the B.S. degree. Tables I-1 and I-2 in Appendix I list the Mechanical Engineering courses and present details on the course and section size.

Students learn the basics of mechanical engineering including design and modeling through lecture classes, laboratory classes, technical electives, and a major capstone design project spanning three quarters in the senior year. These three components are consistent with the program outcomes listed in Section B.3.1 and the program educational objectives discussed in Section B.2. The unique aspect of the program is that students are introduced to the process of design, and modeling in the freshmen year itself through a three quarter sequence of 1 unit classes ME 1A, B, C. Thus the process of creating a design based on specifications is a theme that is carried through other mechanical engineering classes in the sophomore and junior years, culminating in a major capstone design project in the senior year. Specific details are provided below:

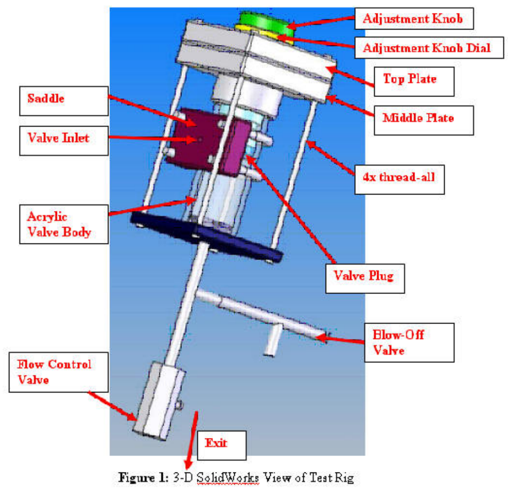
(a) Mathematics and basic sciences: The ME program requires 6 quarters of basic mathematics (MATH 9A, MATH 9B, MATH 9C, MATH 10A, MATH 10B, and MATH 46) starting from introductory calculus of one variable to advanced calculus of several variables and ordinary differential equations. In addition a basic course in statistics (STAT 100A) prepares program students with the fundamentals of probability, distributions, and hypothesis testing concepts. Required chemistry classes (CHEM 1A, CHEM 1B) provides an introduction to basic principles of chemistry including appropriate laboratory training designed to reinforce these principles. Program students are also required to take three quarters of general physics (PHYS 40A, PHYS 40B, and PHYS 40C) covering Newtonian and particle physics, rigid body motion, heat, sound, electricity, magnetism, including laboratories illustrating the experimental foundations of physical principles and applications of these principles. A unique aspect of the program is that students are required to take two quarters of biology (BIOL 3, BIOL 5A, and BIOL 5L) covering human physiology, cell, and molecular biology, including experimental methods relevant to these topics. These courses prepare students to obtain a broad understanding of biological principles to enable them to function effectively in industry that requires mechanical engineers to work in biomedical companies to design and engineer appropriate solutions.

(b) Engineering topics: Program freshmen enroll in a 3-quarter sequence of Mechanical Engineering classes (ME 1A, B, C). In addition to enabling them to make a successful transition from high school to college, students are engaged with the faculty, and are exposed to engineering design (ME 1A), solids modeling using SOLIDWORKS (ME 1B), and computational modeling using MATLAB (ME 1C). The theme of design and modeling is thus introduced early and reinforced throughout the four years. In the sophomore year, students learn about engineering graphics and design (ME 9), foundations of mechanics through statics (ME 10), programming concepts, and elementary numerical methods using MATLAB (ME 18). Students also take a lecture and a laboratory class in electrical circuits, learning about network concepts, operational amplifiers, and network analysis (EE 1A, 1LA). Core concepts in mechanics – dynamics (ME 103), fluid and solid mechanics (ME 115A, ME 110), thermodynamics (ME 100A), heat transfer (ME116A), properties of engineering materials (ME 114) are covered in the junior year. In addition students learn to analyze linear systems and controls (ME 120), and carry out kinematic analysis and design of mechanisms (ME 130). Students are taught the essentials of developing mathematical models for engineering systems (ME 118), and receive a broad-based introduction to experimental techniques in mechanical engineering focusing on data acquisition utilizing LABVIEW software (ME 170A). In addition students learn to work in teams, prepare technical memos, and write technical reports. In the senior year, students work on fluid mechanics experiments measuring head losses in pipes and fittings, and airfoil design and testing in a wind tunnel. Heat transfer experiments focus on fundamentals of conduction, convection as well as radiation. Students perform experiments on automotive engines and perform an energy balance; determine material properties through stress-strain experiments on different materials; and do static and dynamic force measurements on climbing ropes as part of a broad-based introduction to experimental techniques in mechanical engineering. Students are given a problem whose solution requires them to design and conduct experiments to measure parameters of the system under consideration. Most experiments are designed to illustrate the close relationship among material from courses that the students have already taken. For example, an experiment might involve both knowledge of fluid mechanics and heat transfer. All these experiments are performed in ME 170B. In addition, students get additional opportunities to write technical reports. Program students have the opportunity to select up to four technical electives to provide specialized training in their areas of interest within the field of mechanical engineering. Over the last two to three years, the number of technical elective offerings has increased with the addition of new program faculty. In 2005, faculty voted to approve up to one technical elective course (4 units) to include supervised research in a faculty member's research laboratory. Students are required to write a detailed technical report at the end of this course (ME 190) summarizing the research methodology and findings.

Finally, students are engaged in a 3-quarter-long senior design project course (ME 175 A, B, C). In ME175A, they learn about engineering economics and engineering ethics as part of design methodology so that they understand the impact of engineering solutions in a global, economic, environmental, and societal context, consistent with program outcome (h). Students develop design specifications, examine alternate design strategies, model and analyze designs using modern computing tools, and learn to rapid prototype in ME 175B. Design iteration, followed by further analysis, building of a prototype, and testing against design specifications is carried out in ME 175C. Students work in teams, learn to develop schedules, prepare and present preliminary designs in oral and poster formats. Approximately two-thirds of the projects are sponsored by industry and the rest are sponsored by program faculty. Design project sponsors from 2003-2006 include Control Components Inc., Brithinee Electric, Guidant Corporation, Union Pacific Railroad, Concorde Battery Corporation, AMA Plastics, Pacific Plastics Technology Inc., Freedom Innovations Science and Technology, The Toro Company, etc. (Figure 31). In addition to course instructors, project sponsors meet with student groups to mentor and advice at various stages of the course. A formal oral presentation to which faculty and sponsors are invited occurs at the end of the third quarter. This is accompanied by a detailed written technical report and a website that illustrates their solutions.

(c) General education: Program students have a breadth requirement consistent with the college requirements and approved by the University. It provides a framework for students to realize their potential as individuals and contributing members of society. In the area of English composition, students have to complete a sequence of three quarter long courses culminating in applied intermediate composition (ENGL 1A, B, C). This course addresses the function of writing in a range of contemporary situations, including that of the academy, from a critical and theoretical perspective. Strategies for personal and public writing in a multicultural context are emphasized. In humanities, students are required to take one course in World History, one course in one of the areas of fine arts, literature, philosophy, or religious studies. Additional course requirements are described in Appendix I. In the area of social sciences, program students are required to take one course in economics or political science, one from anthropology, psychology, or sociology. Finally, students are required to take one course that deals with general concepts and issues in the study of race and ethnicity in California and the United States.

a



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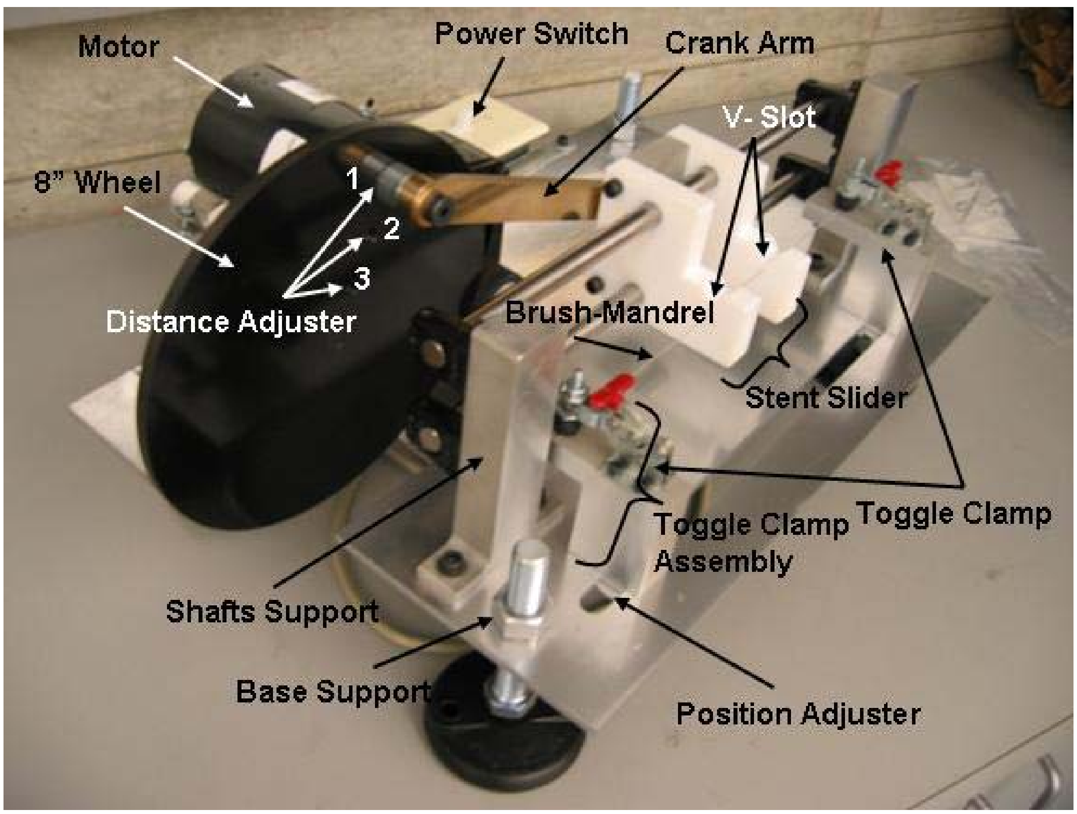

c

Figure 31. Examples of academic year 2004-05 academic year projects: (a) a rotary sprinkler design, sponsored by Toro;; and (b) cavitation test loop, sponsored by CCI Valve; (c) a coating overflow removal tool for stents, sponsored by Guidant Technologies.

Appendix II lists the professional engineering societies and other relevant student organizations that help students build professional skills and networks. The Appendix also describes the Career

Center, whose services include assistance with resume preparation, interviewing skills, internships, and placement. The Career Center's mock interview service is conducted in conjunction with student professional societies, including the Society of Women Engineers and the IEEE. In 2005, companies that provided interviewers for this program were Fleetwood Enterprises, Kroger, and Raytheon. In 2006, participating companies were Ambryx Biotechnology, the City of Riverside, Fleetwood, Kroger, and Luminex.

B.5 Faculty

B.5.1 Faculty Description and Qualifications

Faculty expertise in the department spans the three broad sub-disciplines of mechanical engineering: fluid and thermal science (TF), mechanics and materials (MM), information computation and design (ICD). The expertise of its lecturers includes these areas and in addition they bring expertise in the areas of heat transfer, controls, mechanical design, and mechatronics. All of the faculty and lecturers have the highest academic degrees (Ph.D.s) in their fields earned from the most prestigious universities in the United States. All of the department faculty members are very actively engaged in scholarly research, consistent with the mission of the department, college, and University. In addition to being actively engaged in teaching undergraduate and graduate students, members of the department faculty supervise research of graduate students pursuing M.S. and Ph.D. degrees, and provide research opportunities to undergraduate students in their research laboratories. Faculty is active in conducting research, publishing research papers in the leading journals in their fields of expertise, attending technical conferences, and generating extra mural funding for research from various local, state, federal, and industrial agencies. Currently faculty receive funding from the National Science Foundation (NSF), National Institute of Health (NIH), United States Department of Agriculture (USDA), Army Research Office (ARO), U.S. Navy, American Society for Lasers in Medicine and Surgery, Lawrence Livermore National Laboratory (LLNL), California Air Resources Board (CARB), California Institute for Energy Efficiency (CIEE), UC-MEXUS, Bourns Inc., Raytheon, Dyncorp, and Aeptec, among others.

Faculty members also are very actively engaged in providing service to the department, college, campus, and the University of California. Examples in 2005-2006 AY include Dean of the College (Dr. Abbaschian), member of the College Executive Committee (Dr. Venkatram), Chair of the Department (Dr. Mahalingam), Chair of Department Graduate Program Committee and Graduate Advisor (Dr. Aguilar), Chair of Department Undergraduate Committee and Undergraduate Advisor (Dr. Xu), Chair of the Department Faculty Search Committee (Dr. Stahovich), and Chair of ABET Accreditation and Assessment Committee (Dr. Venkatram). In addition as part of their service contributions and professional development, they serve as editors and on editorial boards of major journals, review papers and proposals, organize and participate in conferences, etc. While faculty members perform research, teaching, and service, the primary contributions of lecturers is teaching and service. Table I-3 in Appendix I provides a Faculty Workload Summary for the 2005-2006 AY. Summary curriculum vitae for all faculty members and lecturers are provided in Appendix I.C.

The Department of Mechanical Engineering currently has 13 faculty members, 2 full-time lecturers, and 2 part-time lecturers. Three of the lecturers are also employed in local industry.

Three of the faculty members have significant industrial experience and several more are actively engaged in research sponsored by industry. The faculty is comprised of 5 full professors, 2 associate professors, and 6 assistant professors. Their research expertise spans TF, MM, and ICD. In addition, faculty expertise includes the fields of bioengineering (BIO), and nanotechnology (NT). In terms of research expertise, the department has 2-3 faculty members with expertise in bioengineering (BIO), 2 in ICD, 5 in TF, 6 in MM, and 1-2 in NT. The faculty body is diverse, including 1 woman and 2 Hispanics, and their Ph.D. degrees range from mechanical engineering, materials science, engineering and applied science, to theoretical and applied mechanics. The award year of their Ph.D. degrees range from 1971 to 2004.

The program faculty is extremely competent at teaching and is fully engaged in all curricular matters pertaining to the undergraduate program. ME faculty teach 4 courses over three academic quarters. Assistant Professors teach 3 courses during this period until they achieve tenure. Faculty members are expected to teach a minimum of one undergraduate course per year; more often they teach at least two and in some cases, they teach four undergraduate courses. Faculty members with significant administrative (ex: Dean, Chair, Graduate Advisor) and other major service responsibilities teach a reduced load. Given the breadth of faculty and lecturer expertise, all required and elective courses in mechanical engineering including all lecture and laboratory courses are covered by the program instructors. Faculty are accessible to students in class, in teaching laboratories, during office hours, and via e-mail at all other times. Faculty are very active in encouraging and supervising research carried out by undergraduate students in their research laboratories. Students can earn up to 4 units of technical elective credit for research. Students interact with the faculty member, their graduate students and visiting researchers, learn to operate equipment, design experimental apparatus, work with computer modeling tools, acquire and analyze data, etc. The research experience culminates in a written report. Approximately half the members of the program faculty serve as faculty mentors to program freshmen; offering career counseling, providing guidance for academic and professional success, and encouraging students to pursue internship and/or research opportunities. All program freshmen are required to meet with their faculty mentors for a one-on-one mentoring session at least once every quarter. Faculty is thus actively engaged in ensuring student retention in the program.

Faculty and lecturers are involved in various student clubs in the department and college. Examples include: American Society of Mechanical Engineers (ASME) Advisor (Dr. Sawyer), Faculty Mentor for Society of Automotive Engineers (SAE) sponsored mini Baja Competition (Dr. Xu), Advisor for Society for Hispanic Professional Engineers (SHPE) (Drs. Aguilar and Garay), and Mentor for ME students in the Society of Women Engineers (SWE) (Dr. Wang).

As part of the department's vision to continuously improve the program by offering a variety of technical electives and engaging in cutting edge research in premiere areas, the department envisions a target faculty size of approximately 20 faculty members by 2008. To this end, faculty recruitment is a major initiative. The areas targeted include BIO, ICD, TF, and MM in that order based on the current research and teaching needs in the department. This is consistent with the 2004-2008 five-year plan developed by the department faculty.

B.5.2 Faculty Currency in Their Fields

Faculty members have resources from initial complements, “various donors” funds, and contract and grant awards to travel to meetings and conferences in their disciplinary areas or in engineering education. Some additional funds are available from the College, the campus, and the Faculty Senate. These resources are sufficient to assure that professors are able to maintain currency in their fields.

B.5.3 UCR Scholarship of Teaching Series

The UCR Office of Instructional Development has established a Scholarship of Teaching lecture series for faculty and instructor to enhance the quality of teaching throughout the campus. Presentations highlight

- The effective use of current and emerging instructional methodologies and technologies.
- Strategies for the introduction of active learning, peer to peer learning, and collaborative approaches in teaching.
- Pedagogical approaches to enhance student engagement and optimize student learning outcomes.
- Effective approaches to teaching and learning in and outside of the classroom.
- The engagement of teaching community in the collaborative, scholarly examination of their practice as teachers.
- The development of assessment tools to measure student learning outcomes.
- The development of a campus culture of evidence regarding our academic programs.

Some lectures are presented by faculty or administrators from UCR, and some by outside presenters. Many deal with new teaching resources and technologies available for use at UCR. For a complete list of all topics presented in the 2005-2006 academic year, please see http://www.oid.ucr.edu/OIDSpeakerSeries.html.

B.6 Facilities

B.6.1 Classrooms

Instructional classrooms are provided by the University and the College of Engineering and centrally administered by the campus. Typically, a tentative list of course offerings is prepared in the spring quarter for the following academic year. This list is developed by the Chair of the department of Mechanical Engineering with input from Chairs of the departmental Undergraduate and Graduate Program Committees, and in coordination with program advisors in the College Student Affairs Office. Multiple-quarter offerings of key courses are decided upon at this stage, based on previous year's demand and projections for the upcoming academic year. In addition, number of discussion section offerings for each course is determined. Most classrooms offered by the campus and the college are media-equipped, facilitating computer and Internet access for the classroom instructor.

B.6.2 Machine Shop

The ME department has an excellent machine shop (nearly 4100 sq ft) that allows the construction of most of the laboratory equipment. For example, we were able to develop our own dynamometer facility based on an 80 horsepower Volkswagen engine. A well-trained, full-time junior development engineer maintains the machine shop, and assists students in building prototypes for their senior design projects. This shop, built in 1997-1998, is hosted by the ME department and in addition to providing service to ME students, it provides service to faculty research laboratories in ME, the college, and the campus. The space is divided into (a) Engine and assembly area (b) Wood and sheet metal shop, and (c) Heavy machine tools, and (d) Supervisor cabin.

Major equipment in the machine shop includes: Robofil 300 wire EDM machine, two-axis milling machine, three-axis milling machine, two conventional milling machines with digital readouts, a 12"x20" Monarch tool-room lathe, two 12"x30" Lions lathes, 20"x60" Lions lathe, hydraulic surface grinder, end mill and drill sharpeners, hydraulic press, diamond grinder, 1hp pedestal grinder,3/4hp grinder/buffer, 16" disc sander, 6" disk and belt sander, 20" drill press, 48" foot shears, notcher, 48" pan and box brake, 48" form roller, table saw, radial-arm saw, 6" planer, universal grinder, horizontal cut-off saw, vertical metal cutting saw, abrasive cut-off saw, two surface plates, wire feed MIG welder, square wave TIG welder, spot welder, gas welder/cutter, and more than four hundred miscellaneous tools and supplies.

The machine shop is normally open 8 to 5 on weekdays. During peak demand for senior design project assembly, manufacturing and assembly of components for the SAE sponsored mini Baja competition, the shop is open additional hours. In all cases, activities in the shop are supervised by the junior development engineer in charge. Access to machines in the shop is provided to students who are willing to undergo training (provided by the shop supervisor) that includes a safety workshop.

B.6.3 Computing Laboratories

Two computing laboratories are dedicated to program students. Room B207 located in Bourns Hall is a 1671 square feet facility that includes 40 networked computers and a networked printer. Room B238 is a 2038 sq ft facility that was acquired in 2006 to keep pace with growth in the program enrollment. It houses 30 additional computers and a networked printer. B238 is open 24/7 for all ME students. Courses that require computer use during class time are scheduled in B207. At all other times, the lab is open to all ME students. The computers run Windows XP and have most recent versions of MATLAB, SOLIDWORKS, MS-OFFICE, VISUAL STUDIOS, AUTOCAD and other various engineering applications. Each lab is also equipped with LANSCHOOL – a software program that enables monitoring of all computers with an ability to broadcast material from the instructor's computer. This facilitates class room instruction and is conducive to effective learning of software tools.

B.6.4 Experimental Laboratories

A 1733 sq ft laboratory (B213AA) used mostly for instruction associated with ME 170A. It houses 10 computing stations that include computers equipped with LABVIEW software for data acquisition and analysis, generators, DC power supplies, digital multimeters and oscilloscopes for signal generation, measurement, acquisition, analysis and display. The lab also houses the following additional equipment for performing basic instrumentation, data conversion, filtering, amplification and typical mechanical engineering measurements such as temperature, pressure, strain and vibration including strain gauges, strain gauge beams and holders, accelerometers, model 355 flow meter, gas regulator, high-pressure gas supplies, pressure gauges, thermocouples, thermistors, infrared thermometer, pressure transducers, water baths, blowers, air speed indicator, stirring hotplates, resistance decade box, Mettler Toledo AB104 analytical balance, Mettler Toledo AB104 topload balance, and 110V transformer, various resistors, capacitors and operational amplifiers.

In addition to equipment for data acquisition, B213AA houses a Mechatronics laboratory used mostly for instruction associated with technical elective ME133. The equipment includes:

1. GE-FANUC 23 point Programmable Logic Controllers (IC200UAL006 PLC), 10 each.
2. GE-FANUC Proficy Logic Developer software, 10 each.
3. PLC Nano/Micro/Programming Cable for interface between PLC and PC.
4. Many 18 DIP Microcontrollers (PIC16F84).
5. Micro Engineering Lab USB programmer with accessories (2 copies).
6. Micro Engineering Lab PIC Basic Pro compiler (2 copies).
7. Micro Engineering Lab integrated development environment (IDE) windows software.
8. Many electronics components (micro switches, 4 MHz microprocessor crystals, LED, Transistors, Power Transistors, Logic components (AND, OR, NAND, NOR), Motorola LS7084 chip for optical encoder interface, and operational amplifiers).
9. 10 each NI data acquisition board NI DAQ PCI-6221.
10. 10 each robotics experiments (each includes 5 arms, 2 DC motors, 2 optical encoders, and 2 power amplifier).
11. 10 each pneumatic experiments (each includes 1 linear potentiometer, 1 optical encoder, 1 pneumatic actuator, and power amplifier).

A 977 square foot laboratory (B164) used primarily for instruction associated with ME 170B. Major equipment includes:

1. 4 personal computers for data analysis.
2. A small wind tunnel.
3. Thermal radiation apparatus consisting of black aluminum plate with thermocouples, anodized steel and aluminum plates with thermocouples, polished steel and aluminum plates with thermocouples, freestanding thermocouple, Linear Laboratories C-1700 Radiometer, thermocouple temperature readout, Vernier calipers, power supply unit, anemometer, hand held thermometer.
4. Instron Universal testing machine supplied with computer, Vernier calipers, sample specimens of aluminum, plain carbon steel, stainless steel, and nylon.

5. Rope testing apparatus consisting of static rope, dynamic rope, support rope and pulley arrangements, weights for calibration, strain gage with computer, DBK-43 strain gage card, and ruler.
6. Accelerometer and accelerometer tilt table supplemented with power supply unit, cantilever beam with strain gages mounted, weights, spring, Vernier calipers, digital millimeter, meter stick, balance, stand, computer with DBK-12 multiplexer card and DBK-43 strain gage card, three-option expansion card cable, beaker, trough, and washers of 1¼'', 2'' and 2½'' diameter.
7. Hot-ball anemometer consisting of brass and aluminum spheres with K-type thermocouples attached, chromel-alumel thermocouple, thermocouple card (DBK-19). Supplemental equipment includes alcohol-in-glass thermometer, stirrer, beakers, heater, blower, ring stand and clamp for suspending thermocouple, hand held anemometer, thermocouple extension wire, and digital voltmeter.
8. (8) 3-point and 4-point configuration attachments for bending testing, in-house built apparatus for undamped and damped vibration testing, an in-house built apparatus for dynamical tensile testing.
9. A photoelasticity system for characterizing stress concentrations in engineering structures via polarization modulation.

Available teaching equipment for ME 180 includes one set of photoelastic polariscope, one 2-mW He-Ne laser, 2 linear polarizers, 2 quarter wave plates, one integrating sphere, and 8 pairs of safety goggles. These are located in the Nano Mechanics and Materials Laboratory (see Section B.6.6).

<u>A 1022 sq ft teaching lab (B162)</u> shared with the department of Chemical and Environmental Engineering department. Relevant equipment utilized for instruction in ME170B includes:

1. Armfield Multi-Pump test rig model C3-00 supplemented hook and point gauge, thermocouple, and stopwatch
2. Armfield fluid friction apparatus, model C6, supplemented with thermocouple, stopwatch, Vernier caliper, sudden contraction, sudden expansion, ball valve (fully open), globe valve (fully open), gate valve (fully open, ½ open), Venturimeter, 90 degree elbow, smooth pipe 17.5 mm diameter, and rough pipe 17.5 mm diameter.

B.6.5 Design Studio

In 2005, the program acquired a 2665 sq ft space (B265) for design studio. Although the studio setup is in its preliminary stages, it is currently a room available to students working on capstone design projects. It provides space for assembly, preparation of posters, and discussions. In addition, the studio is used for instruction in ME 1A.

B.6.6 Research Laboratories

In addition to several computing laboratories supervised by faculty, the department has several major experimental research laboratories. These include:

(a) Laboratory of Transport Phenomena for Biomedical Applications

(b) Laboratory for Advanced Materials Processing and Synthesis
(c) Biomaterials and Nanotechnolgy Laboratory
(d) Laboratory for Environmental Flow Modeling
(e) Smart Tools Laboratory
(f) Nano Mechanics and Materials Laboratory

Although these laboratories are used by faculty and graduate students for their research, program students have access to these laboratories for carrying out directed research and earning technical elective credit (ME190).

B.6.7 Accommodating Future Growth

Bourns Hall is approximately 15 years old and provides more than 100,000 square feet of office, classroom, and wet laboratory space for the Bourns College of Engineering. Engineering Building II is one year old and has 98,177 assignable square feet of office, classroom, and dry lab space. These two buildings are ample to accommodate the College faculty, staff, and students at this time.

The University's plan calls for the opening of a Materials Science and Engineering Building in 2008 (Figure 32). This building is designed at 76,940 square feet, including laboratory, office, and classroom space. Laboratory facilities will include a larger clean room nanofabrication facility than the one currently available in the B-wing of Bourns Hall. The building site currently is a recreational field across the street from Bourns Hall.

Formal plans for Engineering III and Engineering IV are not yet in place. Engineering III could be ready for occupancy as early as 2012.

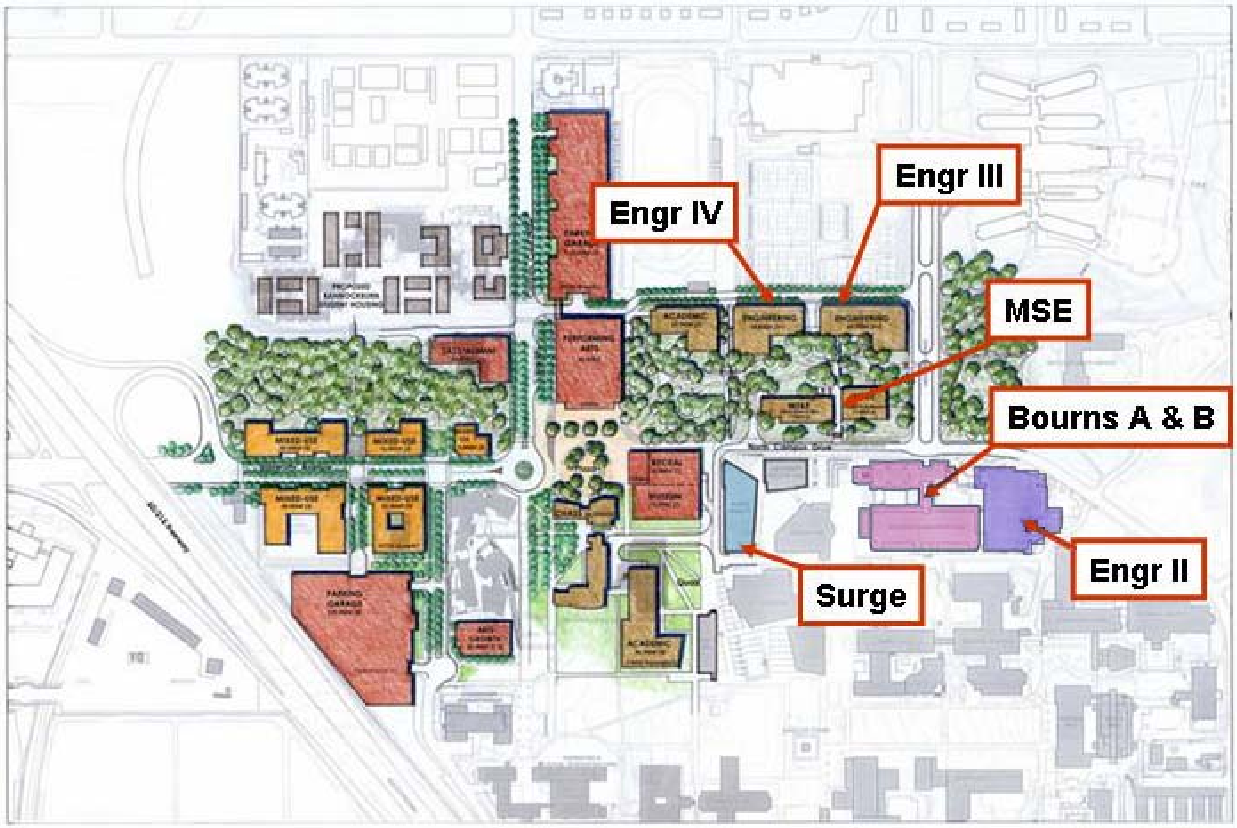

Figure 27. Locations of Bourns Hall (existing) and Engineering II (existing), with the planned Materials Science and Engineering (MSE) Building (2008) and future Engineering III and Engineering IV locations. Surge was the temporary home of the Computer Science and Engineering Department before Engineering II opened in the summer of 2005. The College now has no offices or labs in Surge.

B.7 Institutional Support and Financial Resources

The University, Campus and College provide a good balance of central leadership and support to enable the program to achieve its missions and goals. As articulated in Section B.6, our students have access to excellent facilities within the Department and the Campus. Support for these facilities, including the requisite staffing support is described. below.

B.7.1 Budget Processes

The University of California, Riverside has a multi-step budget development process. The major steps in the annual process are:

February:	Campus Budget Call Letter is distributed and meetings held with academic units to discuss faculty renewal models
March:	Comprehensive Planning Documents are submitted to the Executive Vice Chancellor
April:	Individual unit hearings with senior UCR management

May: Input and feedback from Faculty Senate Committee on Planning and Budget to EVC
June: Final unit budgets announced

In response to the February Budget Call Letter, the Dean's Office in the Bourns College of Engineering requests budget proposals from each academic department in the College. These proposals include undergraduate and graduate student projections, course load information, staffing requirements and needs for additional supply, travel and miscellaneous expenses. Any additional resources requested are presented in the context of departmental Five-Year Plans. In this way, departments demonstrate their progress in attaining Five-Year goals and request the resources required for the next year to maintain that progress. In most cases, departmental current year (Permanent) budgets are the starting points for the next fiscal year's budgets. UC Permanent Budget resources do not have expiration dates and are used to fund long-term commitments from the University. In addition to Permanent funds, departments can request Temporary funds from the Dean's Office either during the budget proposal cycle or during the fiscal year for exceptional (one-time) expenses. The Dean's Office evaluates annual departmental funding requests and submits a combined budget proposal from the College in late March to the EVC's Office. After the final College budget is announced in June, any additional resources approved are allocated to the departments beginning the start of the fiscal year, July 1st. Temporary funding requests approved during the fiscal year are allocated at the time of approval or are reimbursed to departments after expenses are incurred. Each department is responsible for monitoring its expenses and projected ending balances during the fiscal year.

B.7.2 Faculty Professional Development

Faculty professional development funds are provided to assistant professors as part of their faculty start-up packages. The University has a normal sabbatical program to maintain faculty currency. In addition, the Academic Senate provides travel assistance grants, and the campus provides grants to support innovative teaching. Also, funds area available to all faculty from their faculty support accounts, which are funded by a number of activities including a (small) portion of indirect costs generated by grants and contracts.

B.7.3 Maintenance and Operation of Facilities and Equipment

The Bourns College of Engineering provides one-time equipment funds annually to upgrade and acquire equipment. In addition, the College provides facilities to house and operate the equipment. A detailed description of these facilities and the list of current equipment is provided in Sections B.6.2-B.6.6. A brief recent history of funding is provided below:

In the current year (2005-2006), the College provided $73,000 for the program to acquire (1) Computers, printers, tables and chairs for a new computing laboratory (B238) described in Section 6.3, (2) National Instruments Strain Gage Equipment, (3) Programmable logic controllers and miscellaneous electronic components for the Mechatronics laboratory (ME133) described in Section 6.4, and (4) safety supplies for ME180 lab students.

In 2004-2005, the program received $45,275. These funds were used for software license for SOLIDWORKS, acquisition of 14 computers to replace computers used for instruction in

ME170A, motors/controllers/amplifiers for senior design projects course (ME175A, B, and C), a used metal evaporator, and polishing turntables for materials processing associated with ME156.

In 2003-2004, the College provided $68,300 for the program. Out of this pool, $20,000 was used to purchase a rapid prototyping equipment (cost: $75,000) that is located in the Smart Tool Laboratory (see Section B.6.6). This is an example of equipment that is used for both research and undergraduate student instruction.

The capstone senior design projects course is funded by the department. Over the last three years, we have been successful in getting industry sponsors to contribute $2,500 - $3,500 per project to help offset departmental expenditures towards this course. The companies that have made contributions include CCI Valve, The Toro Company, Brithinee Electric,

B.7.4 Support Personnel and Institutional Services

The program is supported by full time departmental staff, part-time student assistants, teaching assistants, readers, and graders as needed to support individual courses and program administration. The College provides Student Advisors who interact with program students, monitor academic progress, enable registration, and direct them to appropriate services on campus for tutoring, career counseling, etc. Tutoring service is provided at the Learning Center and in the student dormitories (free for students living on campus). The College has developed a Professional Milestones Program to enable each program student to prepare for internships, job interviews, and research opportunities. The College provides funds to support teaching assistants, graders, and readers, assigned based on course enrollment and need for laboratory supervision. Teaching Assistants conduct discussion sessions in which students are exposed to additional problems and concepts to reinforce material covered in lectures, and to enable students to complete course assignments. All instructors and teaching assistants maintain posted office hours for assisting students outside scheduled classes. The program has a designated Undergraduate Advisor (currently Dr. Xu) to oversee curricular matters and to offer advice on curricular issues.

B.8 Program Criteria

The ABET program criteria for mechanical engineering is incorporated into the program outcomes via outcomes 1-11 listed in Section 3.1.

As discussed in Section 4, program students are required to undertake courses in Chemistry, Physics, Mathematics, and Biology ensuring that graduates have knowledge of chemistry, biology, and calculus based physics including multivariate calculus and differential equations. Course objectives in basic mechanical engineering courses ME10, ME103, ME110, ME100A, ME115A, ME116A utilize multivariate calculus, differential equations, and linear algebra concepts from a mechanical engineering professional perspective. Program students also learn basic statistics, and the course objectives in ME18, ME118 ensures basic competence in linear algebra. The program curriculum is designed to ensure that graduates can work professionally in both thermal and mechanical systems. This is achieved via course objectives in ME100A, ME100B, ME115A, ME115B, ME116A (thermal systems) and ME103, ME110, ME120, and

ME130 (mechanical systems). Mechanical and thermal system concepts including an ability to design such systems is covered through program objectives in a major laboratory course ME170B.

Appendices

- Appendix I – Additional Program Information
  - IA – Tabular Data for Program
  - IB – Course Syllabi
  - IC – Faculty Curriculum Vitae

- Appendix II – Institutional
  - IIA – Background Information Relative to the Institution
  - IIB – Background Information Relative to the Engineering Unit

Appendix I

IA. Tabular Data for Program

Table I-1
Course Requirements of Curriculum
Basic-Level Program

Year; Semester or or Quarter	Course (Department, Number, Title)	Category (Credit Hours)				
		Math & Basic Science	Engineering Topics*		Hum. & Soc. Sci.	Other
			Engrg Science	Engrg Design (✓)		
1; Fall	MATH 9A –First Year Calculus	4		( )		
	ENGL 1A – Beginning Composition			( )	4	
	ME 1A – Intro to Mech. Engineering		1	(x)		
	General Elective – H&SS			( )	4	
1; Winter	MATH9B – First Year Calculus	4		( )		
	ME 1B – Intro to Mech. Engineering		1	(x)		
	PHYS 40A – General Physics	5		( )		
	ENGL 1B – Intermediate Composition			( )	4	
1; Spring	MATH 9C – First Year Calculus	4		( )		
	ME 1C – Intro to Mech. Engineering		1	( )		
	PHYS 40B – General Physics	5		( )		
	ENGL 1C – Applied Intermediate Composition			( )	4	
2; Fall	MATH 10A – Calculus of Several Variables	4		( )		
	CHEM 1A – General Chemistry	4		( )		
	General Elective – H&SS			( )	4	
	PHYS 40C – General Physics	5		( )		
2; Winter	MATH 10B – Calculus of Several Variables	4		( )		
	CHEM 1B – General Chemistry	4		( )		
	STAT 100A – Intro to Statistics	5		( )		
	ME 9 – Engineering Graphics and Design		2	(x)		2
2; Spring	MATH 46 – Intro. to Ordinary Diff. Equations	4		( )		
	ME 10 – Statics		4	( )		
	ME 18 – Intro to Engineering Computations		2	( )		
	EE 1A/1LA – Circuit Analysis/Circuits Lab		4	( )		
	General Elective – H&SS				4	

Table I-1 (Continued)
Basic-Level Program

Year; Semester or Quarter	Course (Department, Number, Title)	Category (Credit Hours): Math & Basic Science	Engineering Topics*: Engrg Science / Engrg Design	Humanities & Social Sciences	Other
3; Fall	ME 100A – Thermodynamics		4 ( )		
	ME 103 – Dynamics		4 ( )		
	ME 114 – Properties of Materials		4 ( )		
	BIOL 5A/5LA – Intro. to Cell & Molecular Biology	4	( )		
3; Winter	BIOL 3 – Organisms in their Environment	4	( )		
	ME 110 – Mechanics of Materials		4 ( )		
	ME 115A – Fluid Mechanics		4 ( )		
	ME 118 – Engineering Modeling		4 ( )		
3; Spring	ME 116A – Heat Transfer		4 ( )		
	ME 120 – Dynamic Systems		4 ( )		
	ME 130 – Mechanical Design		4 ()		
	ME 170B – Experimental Techniques		4 ( )		
4; Fall	Technical Elective[1]		4 ()		
	ME 175A – Senior Design Project		2 (x)		
	ME 170B – Mechanical Engineering Lab		4 (x)		
	General Elective – H&SS		( )	4	
4; Winter	ME 175B – Senior Design Project		3 (x)		
	Technical Elective[1]		4 ()		
	Technical Elective[1]		4 ()		
	General Elective – H&SS		()	4	
4; Spring	ME 175C – Senior Design Project		2 (x)		
	Technical Elective[1]		4 ()		
	General Elective – H&SS		( )	4	
TOTALS-ABET BASIC-LEVEL REQUIREMENTS		68	91 (12)	36	6
OVERALL TOTAL FOR DEGREE (EQUIVALENT SEMESTER CREDITS)*		39.36	60.7 (12)	24	4
PERCENT OF TOTAL		31	47 ( )	19	3
Must satisfy one set	Minimum semester credit hours	32	TOTAL = 48 (16)	16	
	Minimum percentage	25	TOTAL=37.5 (12.5)	12.5	

Table I-2. Course and Section Size Summary

Course No.	Title	No. of Sect. Offered in Current Year	Avg. Section Enrollment	Type of Class			
				Lecture	Lab.	Recit.	Other
ME 1A	Introduction to Mechanical Engineering	4	33		X		
ME 1B	Introduction to Mechanical Engineering	5	30		X		
ME 1C	Introduction to Mechanical Engineering	5	25		X		
ME 9	Engineering Graphics and Design	2	40	X			
ME 9	Engineering Graphics and Design	3	27		X		
ME 10	Statics	2	84	X			
ME 10	Statics	6	28			X	
ME 18	Introduction to Engineering Computation	2	26	X			
ME 18	Introduction to Engineering Computation	3	17		X		
ME 100A	Thermodynamics	2	26	X			
ME 100A	Thermodynamics	3	17			X	
ME 100B	Thermodynamics	1	33	X			
ME 100B	Thermodynamics	2	17			X	
ME 103	Dynamics	2	20	X			
ME 103	Dynamics	3	13			X	
ME 110	Mechanics of Materials	1	53	X			
ME 110	Mechanics of Materials	2	26			X	
ME 114	Properties of Engineering Materials	1	54	X			
ME 114	Properties of Engineering Materials	2	27			X	
ME 115A	Fluid Mechanics	2	35	X			
ME 115A	Fluid Mechanics	3	23			X	
ME 115B	Fluid Mechanics	1	27	X			
ME 115B	Fluid Mechanics	2	14			X	

ME 116A	Heat Transfer	1	58	X			
ME 116A	Heat Transfer	2	29			X	
ME 116B	Heat Transfer	1	23	X		X	
ME 117	Combustion and Energy Systems	1	19	X		X	
ME 118	Mechanical Engineering Modeling & Analysis	1	53	X			
ME 118	Mechanical Engineering Modeling & Analysis	3	18			X	
ME 120	Dynamic Systems	1	53	X			
ME 120	Dynamic Systems	2	26			X	
ME 121	System Dynamics and Control	1	51	X			
ME 121	System Dynamics and Control	2	25			X	
ME 122	Vibrations	1	38	X		X	
ME 130	Kinetic Analysis and Design of Mechanisms	1	60	X			
ME 130	Kinetic Analysis and Design of Mechanisms	2				X	
ME 131	Kinetic Synthesis of Mechanisms	*		X	X		
ME 133	Introduction to Mechatronics	1	9	X	X		
ME 135	Transport Phenomena	*		X		X	
ME 136	Environmental Impacts of Energy Production and Conversion	1	18	X		X	
ME 137	Geophysical Fluid Mechanics	*		X		X	
ME 138	Transport Phenomena of Living Systems	1	12	X		X	
ME 153	Applied Finite Element Methods	1	24	X		X	
ME 156	Mechanical Behavior of Materials	1	30	X	X		

ME 170A	Experimental Techniques	2	25	X			
ME 170A	Experimental Techniques	3	17		X		
ME 170B	Experimental Techniques	1	20	X			
ME 170B	Experimental Techniques	2	14		X		
ME 174	Machine Design	*		X		X	
ME 175A	Senior Design Project	1	49	X	X		
ME 175B	Senior Design Project	2	24	X	X		
ME 175C	Senior Design Project	2	24	X	X	X	
ME 180	Optics and Lasers in Engineering	1	30	X	X		
ME 190	Special Studies	9	1.3				100%; Individual study under faculty supervision

* Course not offered in 2005-06

Table I-3. Faculty Workload Summary
(Mechanical Engineering)

Table I-3. Faculty Workload Summary
(Mechanical Engineering)

Faculty Member (Name)	FT or PT (%)	Classes Taught (Course No./Credit Hrs.) 2005-2006 F-Fall 2005, W-Winter 2006, S-Spring 2006	Total Activity Distribution[2]		
			Teaching	Research	Other[3]
Abbaschian, Reza	FT	None	0%	15%	85% (Dean - BCOE)
Aguilar, Guillermo	FT	F-ME138/4, W-ME115A/4, S-ME116A/4	35%	50%	15 %
Garay, Javier	FT	F-ME1A/1, W-ME278/4, ME1A/1, S-ME170A/4	35	50	15%
Jiang, Qing	FT	F-ME103/4,S-ME120/4, ME290/4	30%	60%	10%(sabbatical, Winter)
Mahalingam, Shankar	FT	F-ME1C/1,S-ME1C/1, ME117/4	25%	25%	50% (ME Chair)
Ozkan, Cengiz	FT	F-ME272/4, W-ME110/4, S-ME156/4	35%	50%	15%
Princevac, Marko	FT	F-ME170B/4, W-ME290/4, S-ME115A/4	35%	50%	15%
Stahovich, Thomas	FT	F-ME175A/2, W-ME103/4, S-ME175C/3, ME231/4	40%	35%	25%
Vafai, Kambiz	FT	F-ME100A/4, ME240A/4, W-ME100B/4,S-ME116B/4	40%	40%	20%
V. Sundararajan	FT	F-ME200/4, W-ME175B/3, S-ME175C/3	35%	50%	15%
Venkatram, Akula	FT	W-ME118/3, ME136/4	20%	50%	30%(sabbatical, Winter)
Wang, Junlan	FT	F-ME266/4, W-ME261/4, S-ME180/4	35%	50%	15%
Xu, Guanshui	FT	F-ME153/4, ENGR 92/1, W-ME18/2, S-ME18/2, ME290/4	40%	35%	25%
Lecturers:					
John Dougherty	PT	W-ME122	10%		90% (non-UCR employ)
Salah Feteih	PT	ME133, ME130, ME121			
Ram Hariharan	FT	F-ME10/4, ME114/4, ME115B/4, W-ME9/4, ME100A/4, ME170A/4, S-ME9/4, ME130/4, ME170B/4	100%	0	0
James Sawyer	PT	ME1B,C, ME10, ME121, ME175B,c	100%	0	0

1. Indicate Term and Year for which data apply.
2. Activity distribution should be in percent of effort. Faculty member's activities should total 100%.
3. Indicate sabbatical leave, etc., under "Other."

Table I-4. Faculty Analysis
(Mechanical Engineering)

Name	Rank	FT or PT	Highest Degree	Institution from which Highest Degree Earned & Year	Years of Experience			State in which Registered	Level of Activity (high, med, low, none)		
					Govt./ Industry Practice	Total Faculty	This Institution		Professional Society (Indicate Society)	Research	Consulting /Summer Work in Industry
Abbaschian, Reza		FT	Ph.D.	Berkeley, 1971			1		High (ASM, TMS)	Low	Medium
Aguilar, Guillermo		FT	Ph.D.	UCSB, 1999		3	3		Medium	High	Low
Garay, Javier		FT	Ph.D.	UCDavis, 2004		2	2		Low	High	Low
Jiang, Qing		FT	Ph.D.	CalTech, 1989		16	8		Low	High	Low
Mahalingam, Shankar		FT	Ph.D.	Stanford, 1989	2	17	6		Medium (ASME, The Combustion Institute)	High	Low
Ozkan, Cengiz		FT	Ph.D.	Stanford, 1997	4	5	5		Medium (ASME)	High	Low
Princevac, Marko		FT	Ph.D.	Arizona S, 2003		2	2		Low	High	Low
Stahovich, Thomas		FT	Ph.D.	MIT, 1995			3		Medium (ASME)	High	Low
Vafai, Kambiz		FT	Ph.D.	Berkeley, 1980			6		High (AAAS, ASME, AAAS, AAUP)	High	Low
V. Sundararajan		FT	Ph.D.	Berkeley, 2000		2	2		Low	High	Low
Venkatram, Akula		FT	Ph.D.	Purdue, 1976	12		13		Medium (ASME, AWMA)	High	Low

Wang, Junlan		FT	Ph.D.	UIUC, 2002		3	3		Low	High	Low
Xu, Guanshui		FT	Ph.D.	Brown, 1994	3	8	8		Low	High	Low
Lecturers:											
Dougherty, John		PT	Ph.D.	UCLA, 1995	22	9	9	CA	Medium (AIAA)	Low	High
Feteih, Salah		PT	Ph.D.	Stanford, 1990	10	10	4	CA	Medium (AIAA, IEEE, ASME, ION)	Low	High
Hariharan, Ram		FT	Ph.D.	Purdue, 1993	0	13	13		Low	Low	None
Sawyer, James		FT	Ph.D.	Purdue, 1996	10	8	8	CA	Medium (ASME, ASEE, SPE)	Low	High

Instructions: Complete table for each member of the faculty of the program. Use additional sheets if necessary. Updated information is to be provided at the time of the visit. The level of activity should reflect an average over the current year (year prior to visit) plus the two previous years.

Table I-5. Support Expenditures

Fiscal Year	1 2004 (prior to previous year)	2 2005 (previous year)	3 2006 (current year)	4 2007 (year of visit)
Expenditure Category				
Operations[1] (not including staff)	256,855.05	242,512.70	321,625.36	
Travel[2]	44,175.86	68,290.89	81,794.31	
Equipment[3]				
Institutional Funds	486,115.08	162,536.05	85,636.04	
Grants and Gifts[4]	51,647.15	25,290.45	43,718.22	
Graduate Teaching Assistants	143,135.82	161,745.03	243,605.04	
Part-time Assistance[5] (other than teaching)	8,281.45	14,140.76	28,571.89	

IB. Course Syllabi

In Appendix I.B., *Course Syllabi*, provide standard descriptions for courses used to satisfy the mathematics and basic sciences, and engineering topics required by Criterion 4. The format should be consistent for each course, must not exceed two pages per course, and, at a minimum, contain the information listed below:
Department, number, and title of course
Designation as a 'Required' or 'Elective' course
Course (catalog) description
Prerequisite(s)
Textbook(s) and/or other required material
Course objectives
Topics covered
Class/laboratory schedule, i.e., number of sessions each week and duration of each session
Contribution of course to meeting the professional component
Relationship of course to program outcomes
Person(s) who prepared this description and date of preparation

IC. Faculty Curriculum Vitae

In Appendix I.C., provide current summary curriculum vitae for all faculty members with the rank of instructor and above who have primary responsibilities for course work associated with the program. Include part-time and adjunct faculty members. The format should be consistent for each curriculum vita, must not exceed two pages per person, and, at a minimum, contain the information listed below:

Name and Academic Rank
Degrees with fields, institution, and date
Number of years of service on this faculty, including date of original appointment and dates of advancement in rank
Other related experience--teaching, industrial, etc.
Consulting, patents, etc.
State(s) in which registered
Principal publications of last five years
Scientific and professional societies of which a member
Honors and awards
Institutional and professional service in the last five years
Professional development activities in the last five years