UNIVERSITY of CALIFORNIA Riverside

BOURNS COLLEGE OF Engineering

Self-Study Report

Computer 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, first freshmen admitted fall 1990; effective as of fall 2002
BS	Chemical Engineering: Concentration in Biochemistry	Established fall 1986, first freshmen admitted fall 1990; 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; first freshmen admitted fall 1990; 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; first freshmen admitted fall 1989
BS	Environmental Engineering: Concentration in Water Pollution Control	Established fall 1986; first freshmen admitted fall 1990
BS	Information Systems	Established fall 2001
BS	Mechanical Engineering	Established fall 1990; first freshmen admitted fall 1994
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 undergraduate programs in the Marlan and Rosemary Bourns College of Engineering are offered only in the traditional day-time mode.

A.3 Actions to Correct Previous Shortcomings

The 2000 review expressed mentioned some shortcomings that resulted in a 2002 follow-up. The final report from that follow-up reduced the one programmatic weakness to a concern and resolved two of the three concerns expressed at the original review. Thus, two concerns remained:

- *"... that ethical, social, economic, and safety issues are included in only a few or the required courses rather than being integrated throughout the curriculum."* These topics are now explicitly addressed in CS 179, EE 175, and ENGR 180. The faculty have been encouraged to address them explicitly in other classes and to draw attention to them, e.g., when discussing Moore's Law to point out that it has a direct economic corollary, and when discussing matters of debugging/verification to note the implications regarding human safety.

- *"Based on the visit report, transcripts provided and records available, the computer engineering students who graduated in or before spring 2002 completed EE 175A/B. This course has appropriate engineering disciplinary-specific projects that meet the requirements of a capstone experience. Since no graduates have yet taken CS 179 and the course appears to be incompletely defined at this time, it is uncertain if it will contain the same level of engineering design experience. ... This concern remains until student work can be reviewed."* CS 179 has now been successfully offered more than four times per year for the past four years. Since it is offered by a broad spectrum of instructors, there remains the challenge of ensuring that it is of uniformly high quality.

At the College level, the ABET reviewers identified two Institutional Concerns in 2000:

- 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.

- 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

Department	Chair	Address	Telephone	E-mail
Computer Science and Engineering	Tom Payne	351 Engineering Building II University of California Riverside, CA 92521	(951) 827-2244	thp@cs.ucr.edu
Electrical Engineering	Prof. Roger K. Lake	343 Engineering Building II University of California Riverside, CA 92521	(951) 827-2122	rlake@ee.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

The University of California, Riverside, maintains an inclusive admissions policy and emphasizes opportunity over exclusivity. Consequently, our freshman cohort typically comprises students from a very broad range of academic, cultural, and socioeconomic backgrounds. A significant fraction (~55%) of our entering freshmen are the first in their families to go to college. There is also considerable variance within each freshman cohort in the degree of academic preparation and SAT scores.

This variance in backgrounds and preparation tends to reduce success rates both within our three colleges and from the campus as a whole. 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%

Our graduation rates are significantly lower than we would like. We have found that the bulk of the attrition among engineering freshmen occurs in the first year or two, an observation consistent with the experience of other engineering programs across the nation. In our case, poor academic preparation in high school is the most important factor influencing academic success. While the campus does support numerous programs and courses designed to address this issue, UCR's charter does not include remedial education, so it is not likely that our college or our campus can significantly influence learning outcomes in high schools.

Therefore, we have decided to focus on improving retention by identifying and addressing other issues upon which we are likely to have control. Based on the exit surveys we give to graduating seniors (see Section B.3), we have determined that lack of engagement with the College in the early years and inadequate mentoring are two such issues. In response, we have initiated programs to increase students' engagement with the engineering curriculum and the engineering faculty, as discussed below.

As is typical for undergraduate programs in engineering, our students spend the first two years of their undergraduate work completing prerequisite coursework in mathematics, the sciences, and the humanities and social sciences. Unfortunately, instructors in these areas are unfamiliar with any of the engineering disciplines, and unable to motivate or mentor our students in their early years here. Consequently, our students fail to develop a clear sense of academic direction or a sense of professional pride, having no role models or mentors, either at home or on campus.

Figure 1 shows the patterns of persistence in the College of Engineering since inception. We lose between 40% and 50% of our students in the first two years alone. Most relevant to our plans are the trends in the last five years, which shows a clear and worrisome worsening of our persistence figures.

Another consequence of this lack of engagement in the early years with the College is that our students do not appear to be building effective working relationships with their peers. They do not seem to see their peers as technically strong, or as effective partners. We see these attitudes clearly in the following summaries of responses to questions on the senior exit survey.

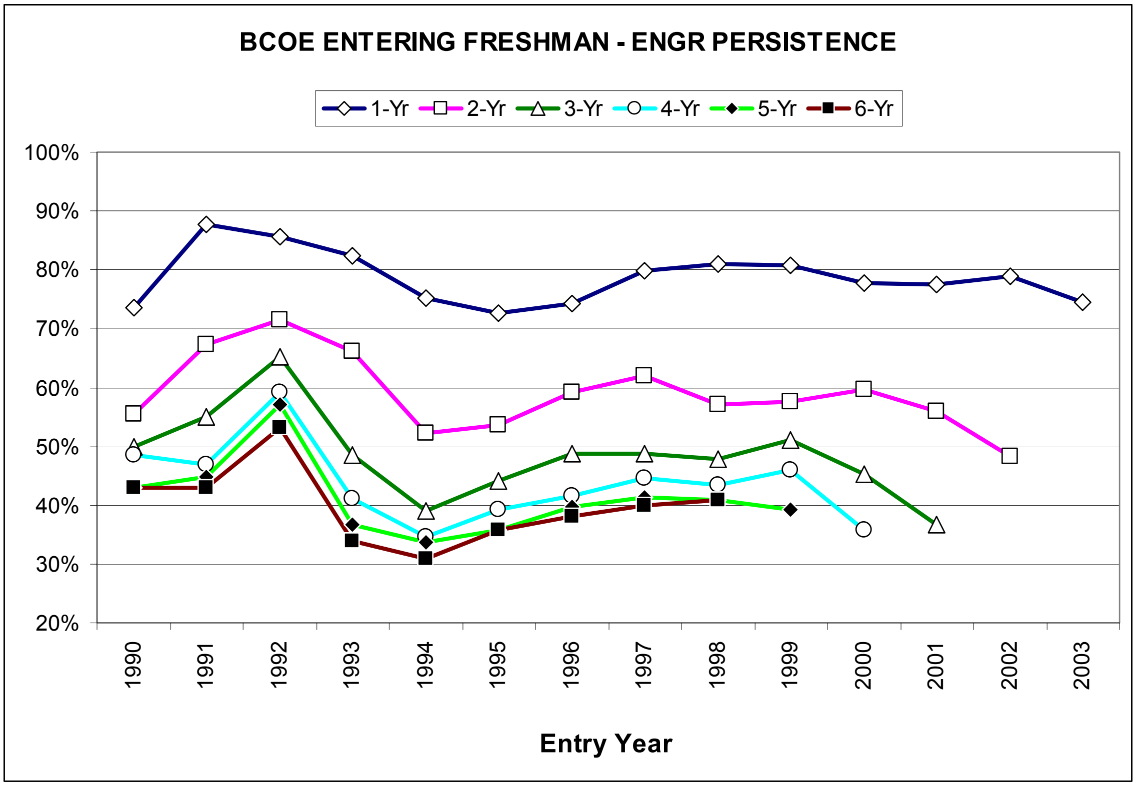

Figure 1. Persistence of entering freshmen in the Bourns College of Engineering.

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 were to be 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.

Figures 2 to 5 show the responses to question Q028-Q030. In each case, the responses correspond to a rating of "slightly satisfied." This is a surprisingly lukewarm rating, since they tend to be generally evenly matched in terms of abilities, as measured by metrics such as GPAs.

The College is addressing the deficiencies suggested by the charts in several ways. The first of these is a series of 1-unit classes intended to promote engagement with the College in the early years and to help the student's professional development in later years.

This new series of classes, numbered ENGR 1 (freshmen), ENGR 2 (sophomores), ENGR 101 (juniors), and ENGR 102 (seniors) has now been approved, and we are currently in the process of tailoring the contents of these courses to our specific needs. These courses are intended to provide our students with involvement in Professional Development activities. Activities to be performed are program-specific, and will include projects, industry overviews and interactions, involvement with professional societies and clubs, team building, career guidance, and coverage of ethics and lifelong-learning issues.

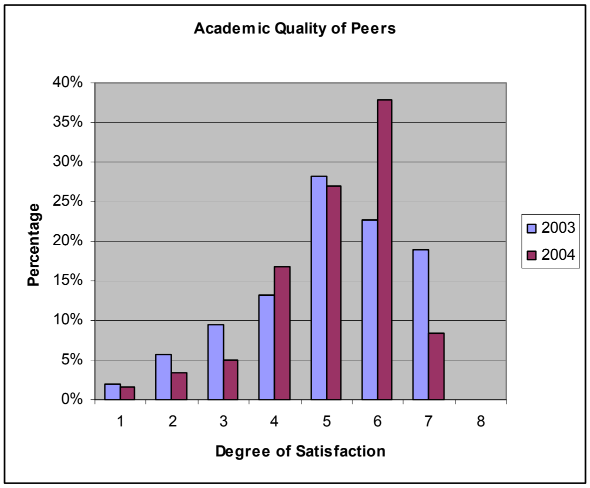

Figure 2. Student assessment of academic quality of peers.

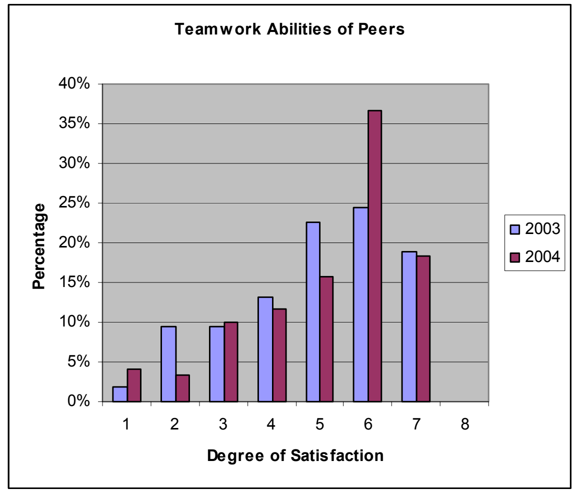

Figure 3. Student assessment of teamwork abilities of peers.

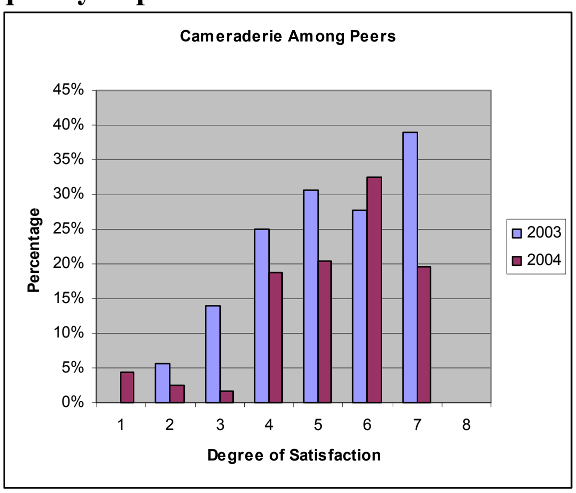

Figure 4. Student assessment of peer camaraderie.

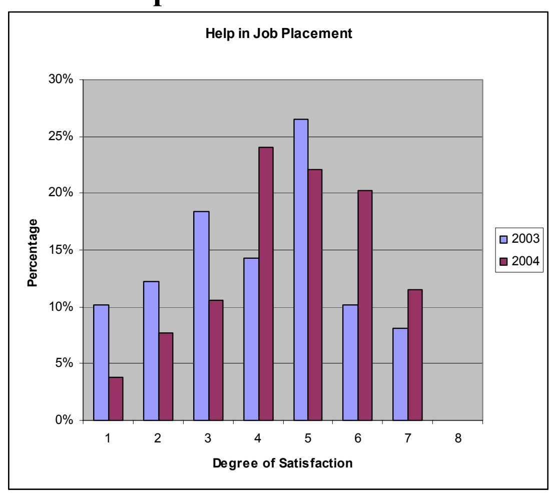

Figure 5. Student assessment of the College's helpfulness in job placement.

The specific list of topics in these courses will include the following:

- Participate in peer-group building activity.
- Understand engineering as a creative process for solving real-world problems.
- Understand current and future trends in the student's major discipline.
- Understand some analysis tools, and their use in design and practice.
- Understand the stages of development of an engineer as a professional.
- Participate in individual and group projects.
- Participate in professional clubs.
- Participate in the Career Path Milestones program.
- Understand the role and importance of ethics in the engineering profession.

- Understand the importance of engaging in life-long learning.
- Participate in industry visits.

The topics listed above will be presented in workshops and discussion-style activities. We expect that these courses will increase the degree of engagement of our students with our college, and promote academic and professional success.

To further enhance the experience of our students in their early years, we also plan to restructure the freshman-level coursework in our programs to incorporate the notion of "learning communities," intended to consolidate further the opportunities for peer-group building that the ENGR 1-102 series of courses are intended to promote.

Since engineering freshmen constitute around 10% of the entering freshman pool each year, they also tend to constitute a small fraction of the enrollments in the freshman classes. Their numbers in these early classes are greatly diluted by the preponderance of students from other colleges, so their opportunities in these crucial early years to build social and academic peer groups with colleagues from the College are also correspondingly diminished.

As a result, the social circles of our undergraduates in their later years also tend to be formed mostly of students from the other colleges, particularly from the College of Humanities, Arts, and Social Sciences, given their larger numbers on the campus. For various reasons, students from these other colleges appear to get by with significantly less work than is expected, and serve as poor role models for undergraduates in engineering. Conversations with engineering students in academic difficulty confirm this as a factor contributing to poor academic performance.

We plan to address this issue by clustering College undergraduates in freshman classes to form *Engineering Learning Communities*. Several conceptual implementations of learning communities are in use in engineering programs elsewhere, which we could use as possible models. However, since our freshmen take the bulk of their courses in the other colleges, we are working with the other colleges to develop a model for learning communities that would be most appropriate to our campus, We also intend our learning communities to work in tandem with the Professional Development and Mentoring curriculum.

In concept, 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 each other. 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 College 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.

An engineering residence hall will be an extension of the "learning communities" concept, and reinforce the benefits it is expected to yield. We plan to make academic and professional activities and 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.

The initial reactions to this concept from the parents of incoming freshmen, from our current students, and our staff have been enthusiastic. It appears likely that we will get a sufficient number of students to make the pilot program successful.

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. We seem to be on target to have a pilot program in place by this fall quarter.

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. Additionally, the Computer Science and Engineering Department has initiated an experiment with a more intensive mentoring program, which is described in Section B.5.2.

Students in the 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 275 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'. We are monitoring advisor caseloads, and plans call for the addition of another advisor and/or the addition of more support for the advising staff when the caseload reaches approximately 400.

The caseload system is designed so that students and Advisors have a relationship throughout the student's career. The Freshmen 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.

At the start of the freshman year, each student is given a four-year course plan. Students are able to check their progress relative to this plan on-line at any time. 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 fewer 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.

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 is 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.

About 80% of the students who are subject to the Academic Difficulty registration hold do agree to go through the process described above. Although we do not yet have benchmarking data, this process appears to be more effective than its predecessor, in which the student signed a "contract" to improve performance. Effectiveness is indicated either by a return to good standing in the Engineering program or successful transition to another major before the student's grade-point average is so low that remaining in the University is at risk.

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 major. 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.

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. 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.

Instructions for meeting with Faculty Mentors and contact information is provide via e-mail, posted on the College of Engineering Office of Student Academic Affairs' website and 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 respective 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.

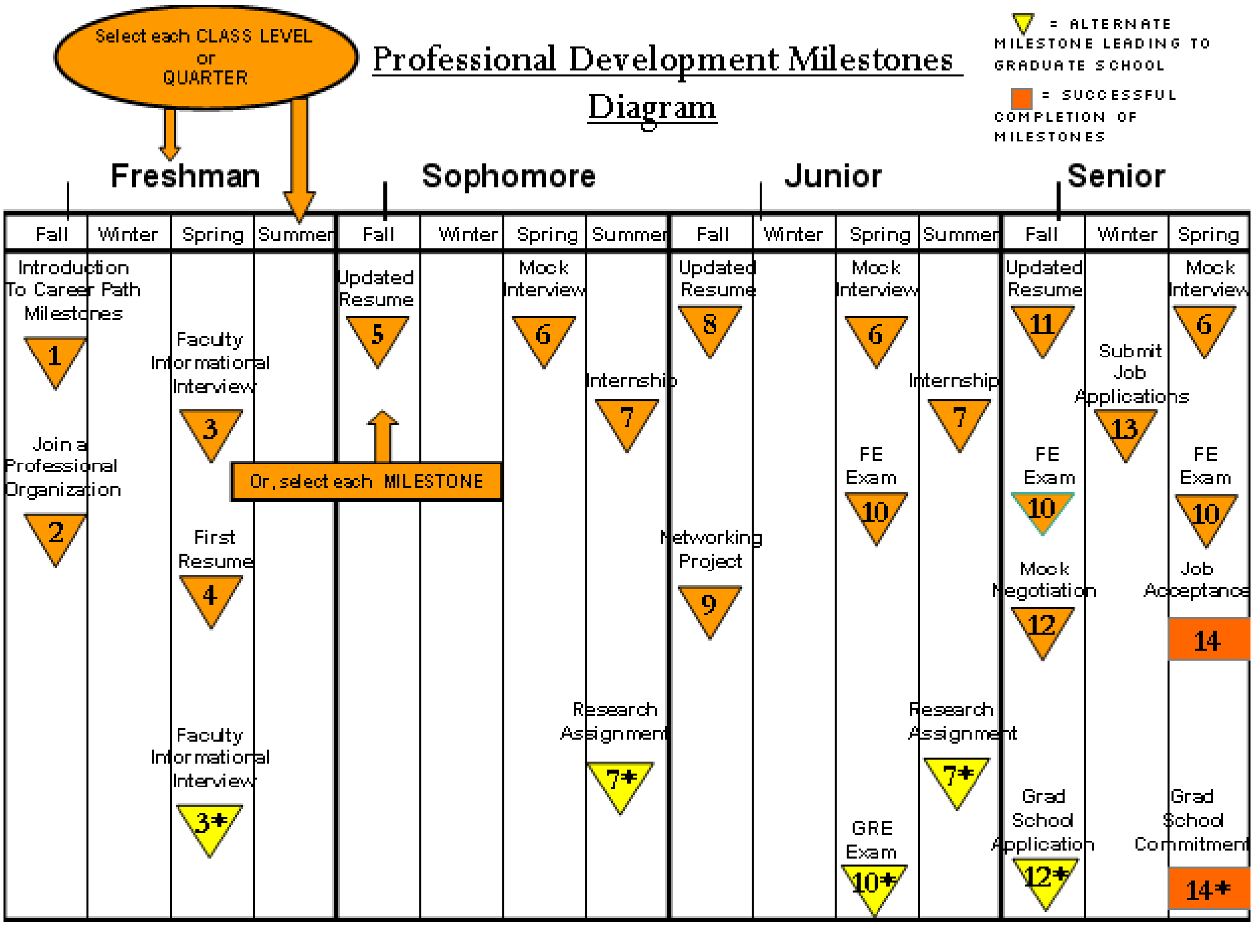

Figure 6. Diagram of key points during an undergraduate's tenure at which the Professional Development Milestones program prompts the student to take action in preparation for internships and academic or industrial career opportunities.

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.

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 Electrical Engineering's Program Educational Objectives and their relationship to the institution's mission (Section B.2.1). Section B.2.2 lists the program's constituencies. Section B.2.3 sets forth the processes used to establish and review the Program Educational Objectives, and B.2.4 provides an analysis of the relationship between each objective and the curriculum. Section B.2.5 discusses the extent to which the program is achieving the Program Educational Objectives and the methods for reviewing progress and making changes for improvement.

B.2.1 Program Educational Objectives and Relevance to Institutional Mission

The vision of the College of Engineering is to *become a nationally recognized leader in engineering research and education*.

Its mission is to:

- *Produce engineers with the educational foundation and the adaptive skills to serve rapidly evolving technology industries.*
- *Conduct nationally recognized engineering research focused at providing a technical edge for the U.S.*
- *Contribute to knowledge in both fundamental and applied areas of engineering.*
- *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.*
- *Be a catalyst for industrial growth in the Inland Empire*.

The vision of the Computer Engineering program at UC Riverside is to provide students with the knowledge and skills needed to:

- *Pursue the two primary alternatives after graduation, which are to obtain employment in industry or pursue graduate studies.*
- *Succeed in a career involving a lifelong learning process.*
- *The curriculum is also designed to provide the breadth and the intellectual discipline required to enter professional careers in fields outside engineering such as business and law.*

This vision of the Computer Engineering program lead us to define the following Program Educational Objectives (PEOs):

- *Provide a well-rounded and balanced education through required studies in elected areas of the humanities and social sciences.*

- *Provide the broad fundamental training in the areas of engineering, mathematics, science, and statistics that will serve as the foundation on which the students' subsequent CE training will be built.*
- *Cover in sufficient depth those fundamental areas required for CE students to understand, design, and use computers and the engineered systems that contain computers.*
- *Provide extensive, relevant laboratory and hands-on experience to strengthen understanding of scientific, logical, statistical and engineering principles.*
- *Integrate the use, design, and interfacing of computers throughout the undergraduate CE program.*
- *Emphasize both oral and written communication throughout the CE curriculum.*
- *Teach students to apply theoretical knowledge to design problems common to modern computer engineering practice, using structured design methodologies and state-of-the-art tools.*
- *Allow students the freedom to mold their programs of professional specialty studies by allowing each student to choose from a broad array of technical electives.*
- *Maintain a schedule of course offerings allowing timely completion of degrees.*
- *Ensure the high-quality undergraduate education necessary for a student to progress to the MS and PhD degree level or succeed in an industrial career.*

The above mission, vision and program educational objectives are published in the college catalog and are available online at the following URLS.

- The Vision of the College of Engineering: *www.engr.ucr.edu/about/vision.shtml*
- The Computer Engineering Program Educational Objectives and the vision of the Computer Engineering *www1.cs.ucr.edu/index.php/main/education/undergraduate/cemajor/*

Both the Computer Science and Engineering Department and the Electrical Engineering Department, which jointly offer the Computer Engineering degree, consult regularly with their constituencies (see Section B.2.2), particularly their advisory boards, to review their Program Educational Objectives and update them as appropriate. Computer Science most recently updated its own objectives in 2005, and Electrical Engineering in 2006.

Naturally, the University and College of Engineering missions are much broader and more general than the Computer Engineering PEOs. However, we note that all are directed toward preparing our students to make an impact in their professional careers and all share the vision of developing leaders in industry, government, academia and society. Moreover, the PEOs articulate elements of the Computer Engineering curriculum that will enable our graduates to apply their knowledge, to communicate effectively, and to exercise creativity through problem-solving and to prepare our graduates for a variety of careers in industry, academia.

B.2.2 Constituencies

The constituencies of the Computer Engineering program are the students, faculty, employers, alumni, our Advisory Boards, and the community at large. The faculty has primary responsibility for educating the students and to effect the program's educational objectives. The current students in the program and Computer Engineering alumni are essential constituencies.

The Computer Engineering *degree program* is supported by two *departments*: Computer Science and Engineering and Electrical Engineering. Both departments have Advisory Boards (Tables 2-4). Given that a large fraction of the Advisory Board members are associated with industry, the Advisory Board servers as an important bridge to our graduates' employer constituency.

The Computer Engineering Program is particularly sensitive to the needs of employers of our students. These employers are a diverse group, including (considering only students that graduated in 2005) defense contractors such as Raytheon Space and Airborne Systems, Rockwell Collins Inc and Boeing, communication/information heavyweights such as EBAY, Hewlett-Packard, Microsoft, Verizon Wireless, Environmental Systems Research Institute and SBC Communications, financial services companies including Farmers Insurance Group, and Ameriquest Mortgage Company, and numerous start-ups such as Fetch Technologies, LunarPages (Add2Net, Inc) and ACMS inc.

Table 2. Electrical Engineering Department Board of Advisors.

Name	Affiliation
Ms. Jean M. Easum	Naval Surface Warfare Center
Dr. Hossny El-Sherief	Northrop Grumman Corporation
Mr. Robert Kelly	X-Prize Foundation
Mr. Kumaran Krishasamy	Broadcom Corporation
Dr. James Maniscalco	Northrop Grumman Corporation
Professor Argogaswami J. Paulraj	Stanford University
Dr. Ravi Rajamani	Pratt & Whitney
Mr. William Rhoades	Xerox, retired
Dr. Patrick M. Sain	Raytheon Electronics Systems
Mr. John L. Sevey	City of Riverside Public Utilities Dept.
Dr. N. Sureshbabu	Ford Motor Company
Dr. Allyson Yarbrough	The Aerospace Corporation
Mr. Ron Young	General Motors Adv. Technology Vehicles

Table 3. Computer Science and Engineering Department Board of Advisors.

Name	Affiliation
Mr. Amit Agrawal	Sony Pictures Imageworks
Mr. J. Robert Beyster	Science Applications International Corporation
Mr. Jim Cable	Peregrine Semiconductor
Dr. Michael Campbell (Board Chair)	The Aerospace Corporation
Mr. Alan Crouch	Intel Corporation
Mr. Son K. Dao	HRL Laboratories LLC
Dr. Umeshwar Dayal	Hewlett-Packard Laboratories
Professor Jean-Luc Gaudiot	University of California, Irvine
Dr. B. Bopinath	Independent
Mr. Matt Grob	Qualcomm Inc.
Mr. John Harrell	Northrop Grumman
Mr. Arman Hovakemian	Naval Surface Warfare Center
Mr. Ancle Hsu	APEX Digital
Mr. Yu-Chin Hsu	Novas Software Inc.
Dr. Anant Jhingran	IBM Almaden
Dr. Stanley J. Krolikoski	ChipVision Design Systems Inc.
Mr. Joachim Kunkel	Synopsys Inc.
Dr. James R. McGraw	Lawrence Livermore National Laboratory
Dr. Scott Morehouse	Environmental Systems Research Institute
Mr. Robert L. Payne	Philips Semiconductor
Dr. Prabhakar Raghavan	Verity Inc.
Mr. Doug Rosen	Microsoft
Dr. Emil J. Sarpa	Sun Microsystems
Mr. Anthony Sarris	Unisys Corporation
Ms. Pat Thaler	Agilent Technologies Inc.
Mr. Geoffrey O. Thompson	Nortel Networks Inc.
Dr. Douglas M. Tolbert	Unisys Corporation
Mr. Kees Vissers	Xilinx Research Inc.
Mr. Ted Vucurevich	Cadence Design Systems
Dr. Hong Wang	Intel Laboratories

Table 4. Bourns College of Engineering Council of Advisors.

Name	Affiliation
Dr. Rakesh Agrawal	Purdue University
Mr. Mark D. Beuhler	Coachella Water District
Mr. Gordon Bourns	Bourns Inc.
Mr. John Couch	Apple Computer Inc.
Mr. Jack Dangermond	Environmental Systems Research Institute
Dr. Ambuj Goyal	IBM Software Group
Dr. David A. Hodges	University of California, Berkeley (emeritus)
Mr. William R. Johnson	Johnson Machinery Corp.
Mr. David Key	Zeacom Corporation
Dr. Ron Khormaei	Hewlett Packard
Mr. Robert Krieger	Krieger and Stewart Inc.
Dr. Thomas McCann	Disney Imagineering
Dr. Kshitji Mohan	Consultant
Mr. Albert Myers	Northrop Grumman Corporation
Mr. Alan Pagnotta	Sony Electronics Inc.
Mr. William Saito	Consultant
Dr. Thaddeus H. Sandford	Boeing Integrated Defense Systems (retired)
Dr. Claudine Simson	Motorola Semiconductor Products Sector
Mr. Jon Slater	Optivus Technology Inc.
Dr. Peter Staudhammer	Alfred E. Mann Inst. of Biomedical Engr, USC
Dr. Linda Trocki	Bechtel Corporation Inc.
Dr. R. Rhodes Trussell	Trussell Technologies Inc.
Mr. Richard L. Ulmer	Unisys Corporation
Dr. Richard A. Upton	BAES Systems Advanced Information Tech.
Mr. Jacques Yeager	Yeager Bros.
Mr. Won San Yoo	RANPAC/Trans Pacific Consultants

B.2.3 Process to Establish and Review PEOs

Each department has its own process for establishing PEOs. As will become clear in this section, the processes are very similar. The Computer Engineering degree is the product of a sequence of core and advanced courses offered by the Computer Science and Engineering Department and the Electrical Engineering Department. Each department controls the process of establishing *course* objectives for its respective courses in the Computer Engineering curriculum, and the departments collaborate on establishing the PEOs for the entire program. In light of the fact that Computer Science most recently updated its PEOs in 2005 and Electrical Engineering in 2006, we expect a review of the Computer Engineering PEOs in the 2006-07 academic year.

Figure 7 presents a schematic of the process for quantitatively assessing PEOs and program learning outcomes. The process consists of two nested cycles or “loops.” The inner loop happens every quarter, and the outer loop happens every year.

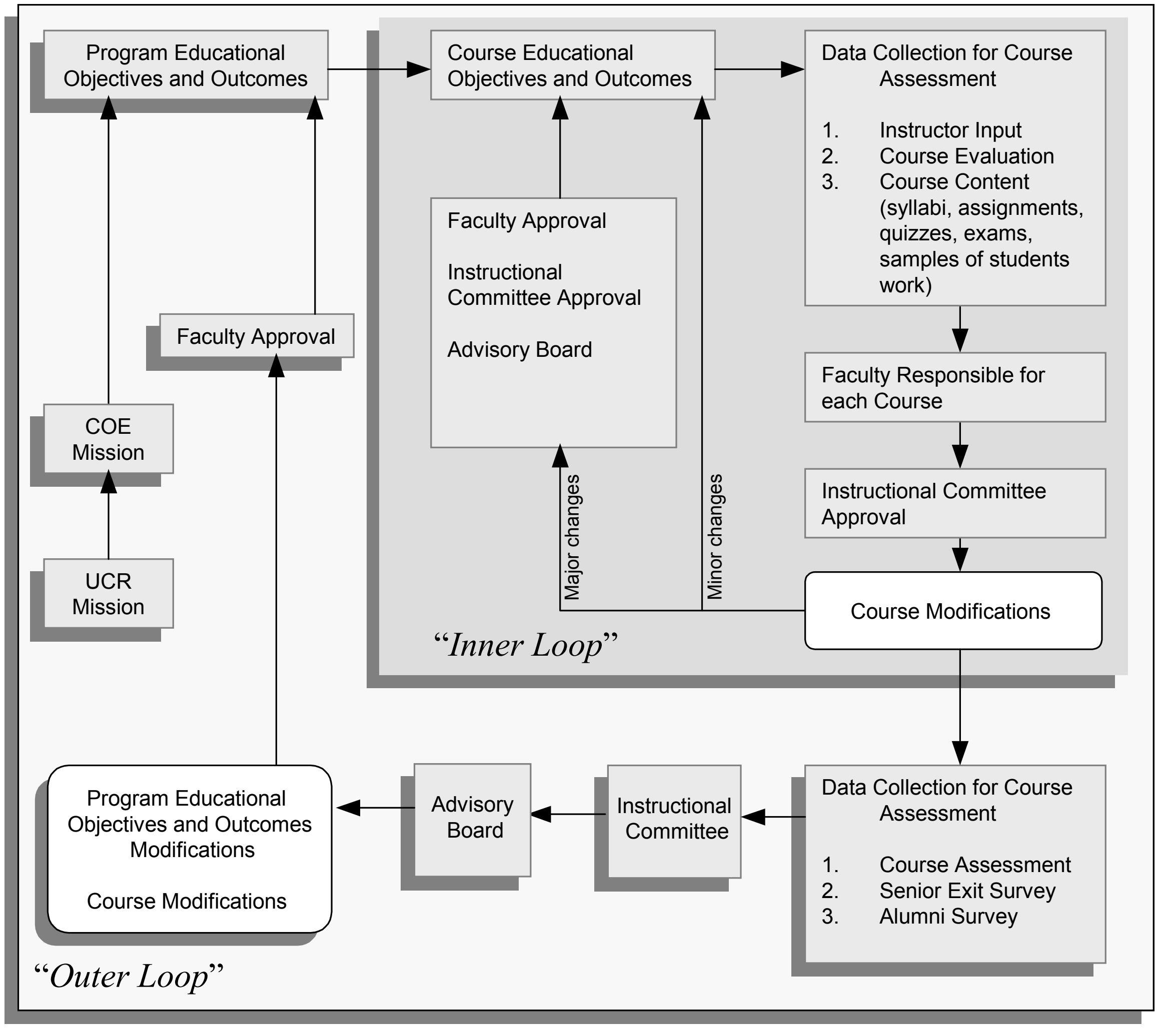

Figure 7. Process for establishment and review of PEOs.

The Inner Loop: Individual Course and Course Sequence Level

At the end of each quarter, the following data are collected:

- Grades in homework assignments, lab reports, short tests and examinations. Review of the student performance (grade received) for feedback on whether the course/program objectives are met.
- Student Evaluation of Teaching. Evaluations administered near the end of each quarter allow students to provide the instructor with anonymous feedback on the effectiveness of the course. The questions in the evaluation forms include questions relevant to the stated program objectives like "*Have you learned something you consider valuable*?"

- End-of-course student assessments/surveys. Course surveys are distributed at the end of each course. The course survey is based on the course objectives, and learning outcomes 1-11 from the course objective matrix. Students are asked how well the course learning objectives, and outcomes were achieved.

The Outer Loop: Curriculum and Program Level

At the end of each year, the following data is collected:

- Senior Exit Surveys. The survey allows the graduating seniors to rank how well the program met the objectives and outcomes. The senior Exit Surveys are distributed to the faculty and analyzed. The Undergraduate Committee then drafts an action plan for improvement.
- Board of Advisors surveys. Each year, the departments organize meetings with industry advisory boards. The Undergraduate and ABET Committees are tasked with collecting and analyzing the BOA feedback on the courses content, program objectives, etc.
- Quantitative assessment of the EE 175 and CS 179 Senior Design projects using ABET 2000-based evaluation forms.
- Alumni Surveys. These surveys are collected from the set of alumni and analyzed with the goal to determine the importance and relevance of the program objectives and outcomes, as well as their achievement.

The assessment process itself has been continually revised and improved since 2003 to incorporate more quantitative assessment elements. For example, the student Exit Surveys were originally administered in the last session of the senior design course (CS 179 or EE 175), but we realized that this allowed students to graduate without filling out a 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.

The instructor for each undergraduate course is required to keep a course file, documenting important information such as syllabus, course matrix (i.e. course objectives vs. outcomes), testing/measurement information, course assessments, report, and recommendations for future improvements. The loop is "closed" each time a new instructor teaches the course by a mechanism we call instructor "sign-on," a procedure whereby each new instructor reads and signs off on the recommendations made by the previous instructor (could be the same person) for the improvements in the course curriculum.

The information in the course files is integrated and analyzed by the CE ABET committee at the end of each academic year. Additional data obtained from the industry Board of Advisors (BOA), students, and alumni, is analyzed. Based on this analysis and in consultation with the Undergraduate Instructional Committee, recommendations may be made to the faculty for changes and/or improvements in the PEO, outcomes, or any aspect of the program. If the faculty approves, the improvement actions are then propagated forward to make the recommended changes in the EE program. We note that the assessment and improvement processes are similar for both PEO and program learning outcomes, and these two processes run in parallel. The assessment process is described in more detail in Section B.3, where we consider the program outcomes in great detail.

B.2.4 Relationship Between PEOs and Curriculum

The curriculum for the Computer Engineering Program is summarized in Table 5. Course syllabi are provided in Appendix I. The curriculum meets the Program Educational Objectives in the ways described below.

Table 5. Sample course plan for Computer Engineering.

First Year

Fall quarter	Winter quarter	Spring quarter
MATH 9A, First-year Calculus ENGL 1A, English Composition CS 10, C++ Programming I ENGR 10*, Intro to CS&E	MATH 9B, First-year Calculus ENGL 1B, English Composition PHYS 40A, Physics (mechanics) BREADTH: Humanities, social science	MATH 9C, First-year Calculus ENGL 1C or ENGL 1SC*, English Composition PHYS 40B, Physics (heat/wave/sound) CS 12, C++ Programming II

Second Year

Fall quarter	Winter quarter	Spring quarter
MATH 46, Differential Equations PHYS 40C, Physics (electricity/magnetism) EE 1A/1LA, Engineering Circuit Analysis I BREADTH: Humanities, social sciences	MATH 10A, Multivariable Calculus MATH 11, Discrete Mathematics EE 1B, Engineering Circuit Analysis II BREADTH: Humanities, social sciences	MATH 111, Advanced Discrete Mathematics CS 14, Data Structures CS 61, Machine Organization BREADTH: Humanities, social sciences

Third Year

Fall quarter	Winter quarter	Spring quarter
CS/EE 120A, Logic Design CS 141, Algorithms STAT 155, Probability/Statistics for Sci/Eng BREADTH: Humanities, social sciences	CS/EE 120B, Embedded Systems EE 100A, Electronic Circuits EE 110A, Signals and Systems ENGR 180, Technical Communications	CS161/161L, Computer Architecture EE 100B, Electronic Circuits EE 110B, Signals and Systems BREADTH: Humanities, social sciences

Fourth Year

Fall quarter	Winter quarter	Spring quarter
MATH 113, Linear Algebra CS 122A/EE 128, Micro Design/Instrumentation CS 153/160, Operating Systems/Concurrent Prog. BREADTH: Biological Science	TE: Must include either EE 175 or CS 179 TE CHEM 1A/1LA or CHEM 3	TE TE TE

* Recommended but not required.
TE = Technical Elective

Provide a well-rounded and balanced education through required studies in elected areas of the humanities and social sciences.

The curriculum requires a quarter of study in World History, covering one of three time periods: the origins of civilizations (prehistory – 1500); increasing civilization interaction, including imperialism and industrialization (1500 – 1900); or modern history in the twentieth century. These courses are designed to give students an appreciation of differences and similarities in cultures and countries at various times in history, so as to better appreciate our present relationships today. This knowledge is then enhanced by more focused study in a specific area of interest. The College of Engineering has approved a subset of Humanities courses for this further study which includes offerings in Art History, Comparative Literature, Classical Studies, Creative Writing, English, Music, Philosophy, Religious Studies, or World Literature. To ensure this world study is placed in context for the engineering student, a history course related to science is also required. There are currently eight such courses from which to choose, including "The Scientific Revolution" and "Science in the Modern World."

The curriculum also requires three additional courses: one course from Economics or Political Science, one course in Anthropology, Sociology, or Psychology, and a third course either from one of the departments listed above or from Ethnic Studies. The courses are again chosen from a list of courses approved by the College of Engineering. Together, these courses offer students an understanding of the forces that shape their world, generated by individuals, small groups, political systems, economic systems or cultural heritage.

Provide the broad fundamental training in the areas of engineering, mathematics, science, and statistics that will serve as the foundation on which the students' subsequent CE training will be built.

The Mathematical foundation required for the Computer Engineering Program consists of two full years of Calculus, including three quarters of differentiation and integration with one variable, as well as a quarter each of multi-variable differentiation, multi-variable integration, and ordinary differential equations. Additionally, students take three math courses specifically designed with Computer Science and Engineering applications in mind: two quarters in Discrete Structures, and the third in Linear Algebra.

A basis in Statistics (including probability) is gained in one quarter, in a rigorous course covering probability and statistics designed specifically for the science and engineering student.

The curriculum includes a year of engineering-level Physics, including topics such as classical mechanics, thermodynamics, fluids, electricity, and magnetism, as well as a quarter of study in Chemistry and Biology.

The foundational courses more specifically tied with the major include two quarters of introduction to Electrical Engineering and four quarters introduction to Computer Science, at the conclusion of which the student will be proficient with both basic circuitry and programming.

Cover in sufficient depth those fundamental areas required for CE students to understand, design, and use computers and the engineered systems that contain computers.

CS 10 teaches the basics of high-level programming of computers, followed by CS 12 and CS 14 for more advanced programming structures and concepts.

CS 61 then shows how computers work from the ground up. Students see how machine instructions are coded and executed, and they program computers at the machine instruction level using assembly language. They learn how high-level programming constructs get translated to a series of low-level machine instructions.

EE/CS 120A provides a more in-depth introduction to the digital logic that underlies both programmable computers and custom-purpose computing circuits. Students learn to precisely capture the desired behavior of a computing circuit and to translate that behavior into a complete working digital circuit consisting of a datapath and a controller.

EE/CS 120B stresses making tradeoffs between programmable processors ("software") and custom processors ("hardware") when implementing applications. Students learn that the same application can be mapped to either type of processor, or a combination thereof, with the key differences derived noted in satisfaction of design metrics. The components needed to integrate processors, namely memories and buses, and the concepts related to storage and communication are introduced.

CS 122A not only further emphasizes tradeoffs, but introduces the important concept of capturing application behavior using computational models rather than programming languages. Those captured models are then translated to any of a variety of programming languages (such as C or VHDL). This teaches the key ideas forming FPGA (field-programmable gate array) technology, an increasingly important chip platform used in an increasing number of systems. It teaches the basic skills of low-level, real-time programming, utilizing microprocessor interrupts, timers, and other low-level, time-based items.

CS 122B emphasizes high-level real-time programming, introducing concepts related to successful programming of concurrent systems.

CS 161/161L introduces concepts of modern general-purpose computers. CS 179J has students build a challenging embedded systems project following a proven process for helping to ensure a working system at the end.

> *Provide extensive, relevant laboratory and hands-on experience to strengthen understanding of scientific, logical, statistical and engineering principles.*

With the exception of CS 150, the Theory of Automata and Formal Languages, all CS and EE courses have a laboratory component, usually one three-hour block once a week. CS 161's associated lab is so substantial that it is a distinct course with its own discussion section and grade, and CS 120A, CS 120B, CS 122A, and CS 122B have twice the number of labs as the other courses, meeting twice a week for three hours each meeting.

Having noticed in the past that students often hurried through labs in order to be able to leave early, we initiated a required attendance policy several years ago for most of the above courses. There was some grumbling during the transition, but now that full-session attendance is the norm, we have found that students spend more time trying to learn and have more success than before. They also seem more relaxed. It definitely is a better learning environment.

In 120A/120B, students work with modern Spartan-based FPGA boards from Xilix, using the latest Xilinx tools, and a popular commercial simulator tool from Aldec.

In 122A, students utilize the FPGA boards as well as 8051 microcontroller chips, programmers, and emulators from Philips. According to some surveys, the 8051 chip is the most widely-used microcontroller in the world, ensuring that students are learning on and working with industry-standard materials.

In 122B, students utilize a modern VLIW processor from Trimedia, similar to many DSP processors. They also utilize Windriver's real-time operating system and development environment. In some surveys, Windriver is the most widely used real-time development environment worldwide.

Integrate the use, design, and interfacing of computers throughout the undergraduate CE program.

Desktop computers are used in all CS and EE courses, and students will be using both Linux and Windows as appropriate throughout their studies. Furthermore, microcontrollers are used in 120B, 122A, 122B, and 179J.

Computer design is emphasized in CS 61, 120A, 120B, 122A, and 161, starting from transistors and working up to building entire microprocessors, as well as building custom processor circuits consisting of interconnected controllers and datapaths, memories, and buses.

Extensive simulation is done in 120B, 122A, and 161, using hardware description languages (HDLs). Physical implementation is done in 122A and 179J, using field-programmable gate arrays (FPGAs).

Emphasize both oral and written communication throughout the CE curriculum.

All Computer Engineering majors are required to complete or test out of a year of English composition courses. The first two quarters are general composition, and for the third quarter students have an option of taking the third general composition course or a version of the course specifically designed for science and engineering majors. In that course, students are required to create technical writing with specific attention to detail and avoidance of vagueness and generalizations. The composition courses consist of three lecture hours, and three hours of in class writing/rewriting each week, many involving oral presentations of the student's work.

In CS 120B/EE 120B students are required to give two to three oral presentations. These presentations are based on research the students do on a topic assigned by the instructor. These presentations are graded not only on technical content, but on clarity of communication, effectiveness of figure and graphs, effective use of visual aids etc. The exercise is also used as tool to teach *active listening* (Bone 98), and students are required to give at least one item of positive feedback, and one item of positive criticism to a speaker at least twice in a quarter. Similarly in CS 161 students are tasked with finding a paper on a cutting-edge topic from a range of sources, including IEEE Spectrum, and presenting it to their fellow students.

CS 122A, and 122B require students to give two five-minute presentations, on subjects of their choice having some relation to the course, during the quarter in lab. The purpose is mainly to give them practice speaking in front of a group. Students also submit well-structured written reports for every lab assignment.

CS 179J requires numerous presentations of different types, ranging from five-minute informal presentations in class, to demos of their project prototypes and final project, to a lengthier final project talk. Students also must meet weekly with groups to discuss their individual projects and provide suggestions to each other. Students also participate individually in a final interview with the instructor and TA.

Students submit reports throughout the quarter, including a project proposal, a concept tradeoff analysis, an implementation tradeoff analysis, project status, final writeup, 1-page flier, and more.

> *Teach students to apply theoretical knowledge to design problems common to modern computer engineering practice, using structured design methodologies and state-of-the-art tools.*

In CS 10 students are required to apply theoretical knowledge from physics/math to solve problems. For example, they must create a Moon Lander simulation that requires an application of inverse law of gravity and quadratic functions. In CS 161 the students are exposed to state-of-the-art tools such as the SimpleScalar, a cycle-accurate processor simulator, in the final stage of the course's project for memory hierarchy designs, so that the students are aware of the advanced technologies in computer architecture and design. In EE/CS 120A (Logic Design), students apply the logic design knowledge learned in the class to design practical logic circuits in the lab. They use the start-of-the-art Xilinx FPGA design platform for their design task. Students will apply the hierarchical design methodologies for handling large logic design problem and will learn the programming-based logic design methodologies to design today's billion transistor on a chip VLSI systems.

> *Allow students the freedom to mold their programs of professional specialty studies by allowing each student to choose from a broad array of technical electives.*

The program requires five technical electives, which students can complete from a long list of courses. In Computer Science, these courses include Software Design, Embedded Systems, Computer Graphics, Computational Geometry, Automata and Formal Languages, Compilers, Operating Systems, Concurrent Programming and Parallel Systems, Architecture, Networks, Security, Databases, VLSI Design, Artificial Intelligence, Expert Systems, Modeling and Simulation, Programming Languages, or Unix System Administration. In Electrical Engineering, the courses include Analog Integrated Circuits, Modeling and Simulation of Dynamic Systems, Communications Systems, Data Acquisition and Process Control, Automatic Control, Computer Visualization, Robotics, Computer Vision, Digital Communications, Digital Control, or Image Processing. The electives can also contain independent work on a project of individual design. This wide array of course choices allows a student not only the freedom to specialize in an area of their interest, but also the possibility of a selecting courses from widely varying arenas, in pursuit of breadth in addition to depth in their technical expertise.

Maintain a schedule of course offerings allowing timely completion of degrees.

The College maintains a suggested four year plan which may be directly followed, and would allow for program graduation in four years. A student is not required to adopt the plan exactly, and may modify the schedules to accept any number of personal circumstances or preferences, in most cases without a great deal of impact on their graduation timeline. All introductory math, physics, chemistry, biology, electrical engineering and computer science courses are offered two quarters in a row, to allow students the possibility of missing a quarter in a three-quarter series without having to wait a complete year to take the next course. As an example, Physics 40A is offered both Fall and Winter quarters, Physics 40B is offered both Winter and Spring quarters, and Physics 40C is offered both Spring and the following Fall quarters. Additionally, many of these high-volume classes are available over the summer for students making up units or working to get ahead.

The departments' course offerings for the next couple of quarters are also posted in advance, to provide students with enough information to allow individual adjustments to their plan of study without jeopardizing progress towards graduation. Students are also assigned to Undergraduate Advisors, who assist in course selection and progress towards graduation. While there is ample opportunity for students to take the core classes needed and the electives desired, the advisors ensure a level of schedule optimization students may not be able to achieve on their own.

Ensure the high-quality undergraduate education necessary for a student to progress to the MS and PhD degree level or succeed in an industrial career.

All EE classes use the professional versions of software and equipment typically used in the marketplace, making the functional skills students acquire specifically applicable to their professional futures.

B.2.5 Evaluation of the Level of Achievement of PEOs and Efforts to Improve

Evaluation of the level of achievement of the Program Educational Objectives requires data that can be used to assess how well prepared Computer Engineering graduates are upon graduation. As such, the assessment tools must focus on our students at graduation and after graduation. Consequently, the most appropriate assessment tools comprise the alumni surveys and to a lesser extent, the senior exit surveys.

The primary mechanism for student learning and achievement of program outcomes is the Computer Engineering curriculum. The curriculum has been structured to provide students opportunities to learn, practice and demonstrate the elements of our program outcomes. Thus, the assessment process is focused most intensely on the Computer Engineering plan of study. Essential to the Computer Engineering curriculum are the common College of Engineering core subjects and humanities/social sciences requirement. However, direct assessment of these courses by the Computer Engineering program is not done because these courses server a much broader audience than engineering. In addition, these courses typically include non-engineering students and are taught by faculty other than Computer Engineering faculty. Consequently, direct mechanisms to affect change in these courses are more appropriately implemented within the units that offer such courses. Thus, the processes of continuous assessment and improvement focus on Computer Engineering courses.

Course assessment input consist of, but is not limited to, for each section of the course: end-of-term course evaluations that are completed by students, average course grades for each section, discussions with the instructors who taught each section, feedback from the cognizant faculty of courses that have the assessed course as a pre-requisite requirement, and the assessment report from the previous course assessment cycle. Thus, the principal constituencies involved in the course assessment process are the faculty and the students in the Computer Engineering program. A review of the last assessment report is requested and a response on progress made on suggested actions from the previous review cycle is provided by the cognizant faculty. The cognizant faculty is asked to review and suggest changes to the information on the Course Profile forms, including changes to course topics, course objectives, course outcomes, and possibly course description (changes to course descriptions require a complete review and approval process up to the College Curriculum Committee approval). Recommendations for actions to improve the course are requested, including suggested resources that might be needed to implement the improvements.

Figure 7 (section B.2.3) shows the flowchart that describes the process for assessment for the Computer Engineering program.

The Bourns College of Engineering initiated a College-wide 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. We use a single survey tool for all alumni. It is designed to quantify the extent to which our alumni are achieving objectives common to all of the College’s degree programs; these include the ability to succeed in graduate school, the ability to succeed in industry, the ability to work in teams, the ability to apply mathematics and engineering principles on the job, and the ability to contribute to the profession through inventions and publications. 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 low – less than 10%. Going forward, we expect 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. It should be noted, however, that the survey results will always be a trailing indicator because of the long lag time between a change to the curriculum and the ability to measure what impact it has on our alumni’s success and effectiveness three to five years after graduation.

Based on the limited returns from the pilot study in 2006, we are seeing high proportions of our alumni achieving the prescribed degree objectives (Table 6). The survey, the tabulated results, and the written comments of the respondents will be available for review during the site visit.

Table 6. Results of 2006 Bourns College of Engineering alumni survey.

Metric	% of alumni answering yes
Took admissions test in pursuit of a postgraduate degree	>60
Was accepted to graduate school	~75
Plan to attend, is attending, or has attended graduate school	~70
Have completed an advanced degree	~20
Accepted a job offer within three months of graduation	>60
Accepted a position related to the engineering degree earned	80
Had a starting salary in the range of $40,000 to $60,000	50
Currently earning more than $75,000	>30
Still working in the field in which the engineering degree was earned	80
Have worked on projects with multidisciplinary requirements	70
Have worked on projects that have addressed professional and ethical concerns	60
Are required to apply mathematics and engineering principles on the job	>90
Consider the UCR education reasonably sufficient to conduct their duties	~90
Have collaborated on projects leading to patents or other types of disclosures	40
Have published in professional journals	~30

B.2.6 Evidence of Program Improvement

The senior exit surveys offer compelling evidence on program outcome achievement and improvement. Because the CE program is relatively young, we have a relatively small number of responses, 1 in 2003, 12 in 2004 and 6 in 2004. For the following analysis we will ignore the single response for 2003 and consider only 2004 and 2005. As a baseline comparison we compared our numbers against a group of six highly regarded institutions (hereafter referred to as the Select-6), University of Illinois at Chicago, Northeastern University, The University of Texas at Austin, University of Utah, University of Virginia and University of Wisconsin-Madison.

We considered six items of the survey data of most relevance to the Program Education Objectives, in particular:

- Quality of Instruction
- Quality of Course Offerings
- Breadth of Curriculum
- Computing Resources

- Team and Extracurricular Activities
- System Design and Problem Solving

The data are plotted in Figures 8 and 9. Before discussing it, we will echo two words of caution noted by the UCR CS ABET committee in presenting this data to the faculty. First, one has to be careful extrapolating trends from only two points, second, the standard deviations from these observations ranged from 0.7 to 1.84.

In general the results show both high levels of achievement of our Program Education Objectives and improvement over the time period considered. Only one item, Quality of Instruction, declined, and only by a very small amount. However it is crucial to note that our 2005 score on this item is 4.72, which is significantly higher than all the Select-6 comparison groups, which scored a *mean* of 4.33, and a *maximum* of 4.54.

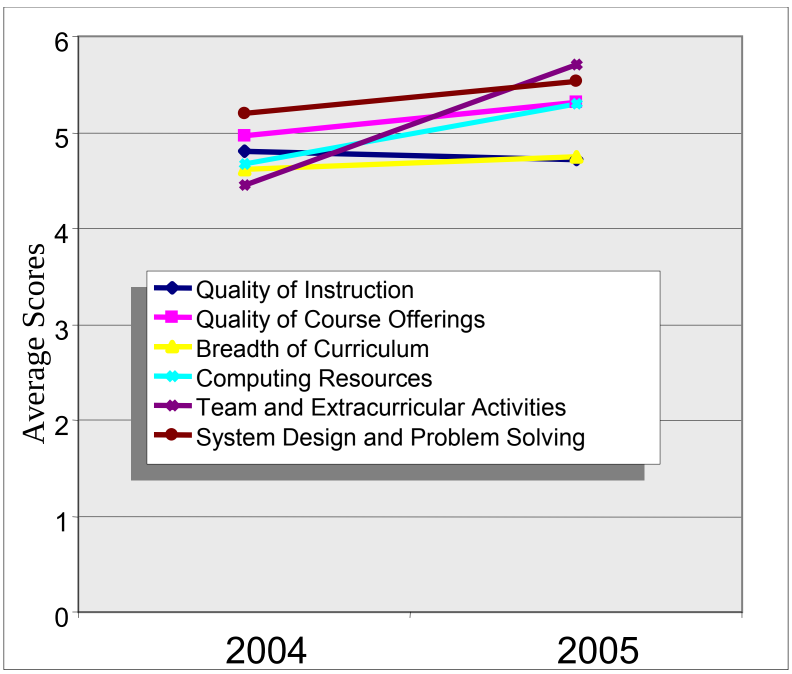

Figure 8. Program relevant data obtained from Senior Exit Surveys in 2004 to 2005.

We can see further evidence of high levels of achievement of our Program Education Objectives by comparing our scores to those of the Select-6 universities as shown in Figure 9 below.

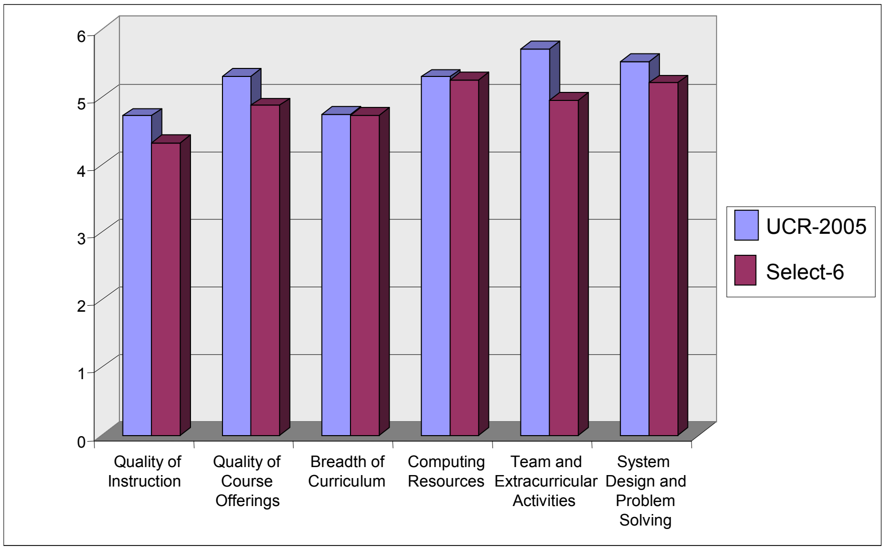

Figure 9. Program relevant data obtained from Senior Exit Surveys at UCR in 2005 compared to the Select-6 Universities. In every case our scores are better than the Select-6 Universities, in most cases significantly so.

As we will discuss in the relevant section below, these results were discussed at length by the entire Computer Science faculty for several hours on September 21, 2005, and examined for evidence the previously made program changes had been effective. While the results are generally very positive, they were also critically examined for areas were improvement could be made.

B.2.7 Improvements in Freshman Chemistry

Achievement of Outcome 1 depends heavily on coursework offered in departments not controlled by the Bourns College of Engineering. We have noticed that freshmen historically have had difficulty with the freshman series of courses in Chemistry (Chem 1A, 1B, 1C). The failure rates (D or F grade) for engineering undergraduates in Chem 1A has been around 25% or so, with undergraduates in the sciences failing at a slightly higher rate.

These courses are structured primarily as lecture courses, with 3 hours of lectures per week, and an accompanying 3-hour laboratory component, amounting to a total of 4 quarter units. These courses are large service courses, and have total enrollments of 1300+ across all sections.

An experiment was conducted by the College of Natural and Agricultural Sciences to test the effectiveness of adding an hour of discussion on overall success rates in these classes. A number of calculus-ready students were selected, and the students were divided into two groups, only one of which was required to participate in an hour-long discussion section each week.

Each Chem 1 discussion section of 20-25 students was led each quarter by one of three experienced TAs appointed by the Chemistry Department. For these discussion sections, students were required to complete homework problems assigned by the course instructor, took quizzes covering the lecture material, and participated in other appropriate activities designed to clarify lecture principles and concepts. Access to on-line practice exams was made available to students in these sections. As far as possible, students stayed in the same Chem 1D discussion section for each of the three quarters of the course.

These students also participated in mandatory workshops throughout the year given by peer mentors who were trained and supervised by the Learning Center. Workshops focused on problem-solving skills, test-taking skills, library usage, and other university acclimatization issues. These workshops taught such skills not in the abstract, but in the context of the Chem 1 course material. The students developed a sense of community with their peer mentor and other students in the group, and developed study strategies as academic partners for success in the sciences.

The results of this experiment are summarized in Table 7, which shows the failure rates (a D or F grade) for students who attended discussion sections ("participants") and those who did not ("non-participants").

Table 7. Failure rates in traditional and enhanced approaches for Chemistry 1.

	Non-participant section 1	Non-participant section 2	Participant section	Rate for Participants Only in Participant Section	Rate for Non-Participants Only in Participant Section
CHEM 1A	110/292 (37.7%)	78/306 (25.5%)	42/319 (13.2%)	4/192 (2.1%)	38/127 (29.9%)
CHEM 1B	27/169 (15.9%)	60/198 (30.3%)	23/261 (8.8%)	4/132 (3%)	19/129 (14.7%)
CHEM 1C	24/105 (22.9%)	28/161 (17.4%)	10/230 (4.3%)	1/119 (0.8%)	9/111 (8.1%)

Sections with no participants are shown as "non-participant sections." The third column ("participant section") shows the outcome for a section with between 50%-60% participants. This section had the smallest fraction of D/F grades.

A breakdown of the participant and non-participant D/F rates for the lecture-only section is shown in the last two columns. Clearly, the D/F rate for participants was by far the lowest of all the students in this course, even when compared with students in the same lecture section. Not all other variables were controlled, however. For example, the non-participants in this section included non-freshmen and some were repeating the course.

Given the clear evidence of the positive contributions that the discussion section has made to student success, BCOE has agreed to partner with the College of Natural and Agricultural Sciences to adding a discussion section to the Chem 1A/B/C courses, and test its effects on student success in a regular quarter. If the outcomes are positive, we will explore the option of making the discussion a permanent feature of the course.

B.3 Program Outcomes and Assessment

This section describes our Program Outcomes (Section B.3.1) and our assessment of them (B.3.2). Section B.3.3 presents examples of our outcome assessment, evaluation, and improvement cycle. Section B.3.4 describes evidence of program improvement made in response to the assessments. Finally, Section B.3.5 describes the materials that will be available to examiners during the site visit.

B.3.1 Program Outcomes

The program outcomes for Computer Engineering are defined as the 11 outcomes specified by ABET:

A. An ability to apply knowledge of mathematics, science, and engineering.
B. An ability to design and conduct experiments, as well as to analyze and interpret data.
C. An ability to design a system, component, or process to meet desired needs.
D. An ability to function on multi-disciplinary teams.
E. An ability to identify, formulate, and solve engineering problems.
F. An understanding of professional and ethical responsibility.
G. An ability to communicate effectively.
H. The broad education necessary to understand the impact of engineering solutions in a global and societal context.
I. A recognition of the need for, and an ability to engage in life-long learning.
J. A knowledge of contemporary issues.
K. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

We recognize that ABET offers the flexibility to alter or add to these outcomes, but for our purposes we felt that the best course was to stay within ABET's defined framework.

B.3.2 Outcome Assessment and Examples of the Improvement Cycle

The Electrical Engineering and Computer Science and Engineering departments use parallel, compatible processes for evaluating how well a course is achieving its intended objectives, and which outcomes a course is succeeding in addressing. Each course has a course file, which is maintained by the instructor(s) who teach(es) it. The file contains standard information such as the course outline, a general syllabus, course objectives, the course matrix (a mapping of outcomes per objective – see Table 8 for an example), and notations about how the course addresses design and general science.

Table 8. Course matrix for EE 160, Fiber Optic Communication Systems, taught in 2006. Each objective is rated on a scale of 0-3 for relevance to program outcomes.

Item	OUTCOME-RELATED LEARNING OBJECTIVES	OUTCOMES										
		1	2	3	4	5	6	7	8	9	10	11
1	Understand and be able to explain the physical principle for how an optical fiber guides light.	1						2			1	1
2	Be able to estimate the limitations on transmission speed and/or distance caused by fiber dispersion.	3		1		2						3
3	Understand and be able to explain the advantages, and limiting characteristics of semiconductor lasers as used in fiber-optic communications.	2	1	1				2			1	1
4	Understand and be able to explain the operating principles of semiconductor photodetectors, and the main noise sources that corrupt the detection process.	2	1	1				2			1	1
5	Be able to estimate the receiver sensitivity for P-I-N, APD, and optically pre-amplified receivers.	3		1		2						3
6	Understand and be able to explain the operating principle, advantages, and limitations of erbium doped fiber amplifiers.	2	1	1				2			1	1
7	Learn how to use basic fiber-optic test equipment for measuring optical power, optical signal spectrum, and receiver sensitivity.	1	3		3	1						3
8	Design fiber-optic communication links limited by loss and/or fiber dispersion.	3	1	3		3		1			1	3
9	Be able to write an essay on the history, and impact of fiber-optic technology on telecommunications.							3	3	2	3	
	SUBTOTALS	**17**	**7**	**8**	**3**	**8**	**0**	**12**	**3**	**2**	**8**	**16**

The course matrix assigns a score of 0 (lowest) to 3 (highest) for each course objective's contribution to each outcome. (The numerical system is based on an idea presented by Fiedler and Brent in the article "Designing and Teaching Courses to Satisfy the ABET Engineering Criteria [*Journal of Engineering Education*, January 2003]. We have adapted it significantly.) This matrix is reviewed after each quarter in which the course is taught to modify priorities or to make adjustments to how certain topics are taught or tested, as discussed in more detail below. The inputs for these decisions are student performance in the classroom, on tests, and on homework. Lower-division Computer Science courses also are evaluated at the midpoint each quarter to ensure that the course is progressing well enough to achieve its objectives.

Prior to the start of the term, each instructor prepares a syllabus, a set of eight (or more) specific *course objectives*, and a *course matrix*. Including specific course objectives is a useful tool for distilling the course curriculum, and its relationship to the program learning outcomes. In this regard, the course matrix is a key tool for quantifying the relationship between course objectives (and hence curriculum) and program outcomes.

In addition to the course matrix, another useful tool employed in the course improvement process is the *relevance matrix*, introduced in 2005 to better quantify the program outcome assessment and evaluation of each course. An example of a relevance matrix is shown in Table 9 for EE 140. The relevance matrix allows an instructor to correlate the student performance with the course objectives, and hence outcomes (e.g. the average grade for each instrument forms a "row vector" than can multiply the relevance matrix, thus obtaining a vector with each element representing the achievement of the corresponding course objective). These quantitative tools are employed, along with analysis of student exit surveys, for course assessment and evaluation.

Table 9. Relevance matrix for EE 140, Computer Visualization, taught in 2006. The course grading instruments, as shown on top row, are Labs (L), Homeworks (H), Midterm (M), Final (F), and Project (P).

	L1	H1	H2	H3	L2	H4	L3	L4	H5	L5	H6	H7	L6	M	F	P
Obj1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1
Obj2	1	0	0	1	1	1	1	1	0	0.5	0	0	0.25	0.5	0.5	1
Obj3	1	0	0	1	1	1	1	1	0	0.5	0	0	0	0	0	0.5
Obj4	0	0	0	0	0	0.25	0	0.25	0.5	0.5	1	1	1	0	0.5	1
Obj5	0	1	1	1	0	1	0	0.25	1	0.25	1	1	0.5	1	1	0.25
Obj6	0	0	0	0	0	0	0	0.25	0	0.5	0	0	1	0	0	1
Obj7	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Obj8	0.25	0	0	0	0.25	0	0.25	0.25	0	0.25	0	0	0.25	0	0	1

A course's **coverage** is a value between 0 and 1, or multiplied by 100 to serve as a percentage, showing the portion of attention given to that objective or outcome relative to all possible attention. Coverage can be applied to both course objectives and departmental outcomes. To determine coverage for a single course objective, the maximum point value for all of the questions related to that course objective is totaled. Then, that number is divided by the maximum point value sum for all the questions on the test.

An Abbreviated Example:

	Question 1	***Question 2***
Max Value	10	5
Objective 1	1	0
Objective 2	1	1
	Outcome A	***Outcome B***
Objective 1	2	3
Objective 2	1	0

Coverage of Objective 1 = (10*1) + (5*0) / (10 + 5) = .66
The result will be a statement such as: "66.00% of the points possible in the exam covered Objective 1."

To determine coverage for a single departmental outcome, the maximum point value for all the questions related to a single objective is determined, and then that number is multiplied by the relationship between that objective and the specific outcome. This value is summed for all objectives. The result is divided by the total points possible in the test *the number of objectives*: the maximum correlation between objective and outcome (3).

Coverage of Outcome A:

(Value for Objective 1 + Value for Objective 2) / (Total Val for all Questions * Number of Objectives * Maximum Correlation Value (3))

> Value for Objective 1 = [(Value for Question * Relevance to objective) summed for all questions] * Relevance to Outcome, summed for every objective = (10 * 1 * 2) + (5 * 0 * 2) = 20
>
> Value for Objective 2 = (10 * 1*1) + (5 * 1*1) = 15

(20 + 15) / (15 * 2* 3)
35 / 90 = .39

The result will be a statement such as "39% of the points possible in the Exam covered Outcome A."

Of course, to achieve 100% coverage, all questions would need to relate to all objectives, and all objectives would need to correspond completely to all outcomes. Not only is this unrealistic, it would most likely be meaningless. Instead the number must be viewed in context of the coverage of the other objectives or outcomes. Should one outcome have a coverage much lower than the others, then perhaps it needs more attention. Should one coverage be particularly high, then perhaps the focus of the class should be more evenly distributed.

The coverages can also be compared year to year, and it is hoped that they would show slightly increasing coverage rates as the course more closely targeted specific objectives or outcomes. If coverage rates remained static at what seems to be reasonable levels, that would be acceptable, however dramatic dips in coverage amounts would need attention.

The coverage rates for departmental outcomes can also be used to investigate adequate exposure to outcomes over the duration of a student's education. Of course, the number cannot be exact for any given student, but it would reflect the department's overall attention to its goals.

At the end of each course, the instructor writes the *assessment report*, including his/her recommendations for improvement. The feedback loop is "closed" when the next instructor reads the prior assessment report, and "signs-on" to the improvement actions. The instructor sign-on, introduced in 2003-2004, is a key mechanism to propagate the knowledge learned by one instructor forward to the next instructor. The results of all the course outcome assessments are integrated and fed into the outer ("global") feedback loop, along with additional data from senior exit surveys, alumni surveys, and industry board of advisors. These data are analyzed by the faculty. Thus, specific recommendations for improvement are generated for faculty review. Note the key constituencies in this process include faculty, students, alumni, and industry. The program faculty review occurs at least once every year, typically in early fall quarter. At the faculty review meeting, the recommendations made by ABET committee are discussed and voted on. If approved by the faculty, specific improvement actions are assigned by the Chair to the relevant faculty committees for implementation, thus closing the feedback loop for the program assessment, evaluation, and improvement process. An example of this process in action is given below for the 2004-2006 two year cycle.

Below we document changes made to develop and improve the CE program. Note that this is not intended to an exhaustive listing of all such improvements. Rather is it meant to be representative of the range of measures we have taken, from hiring a Career Development & Placement Officer, to improving faculty to student ratios in labs, to modifications in the curriculum.

Selected General Improvements:

- In Fall 2004 we reduced lab size by 25% (from 28 to 21), based on an analysis of student data (both exit survey data and student evaluations), advice from the undergraduate committee and feedback from our teaching assistants.
- We noted in our 2004 exit surveys that students were unhappy with the quality of career advice. After a faculty meeting of the CE faculty, it was decided the best way to address the problem was at the college level. At the time the College did have a Career Center, staffed part-time by Loreta Dalton. However the Center did not have the time, staffing, or expertise to meet the College's needs. We petitioned for more resources to be directed to career advising, and where able to revise the responsibilities of the position, reclassified it in terms of payroll title, and renamed the position to *Career Development & Placement Officer*. This position was created in November 2004 and filled by Aaron Bushong.
- Based on an analysis of student exit surveys, feedback from employers of our students (including employers that are members of our Board of Advisors) and evidence from student grades, it was noted in 2003 that many of our students had weaknesses in oral and written communication. Many corrective actions were taken, including the creation of a new course offering. However it was strongly felt that we could not "push-off" the problem into a single class. The faculty unanimously decided to integrate oral and written communication into every offering. As a concrete example, consider CS 122B. Originally students were required to write three short independent reports. The shortness of the report meant that many students abandoned any attempt at a narrative, and instead produced little more than a list of bullet points. It was decided to replace this with a single larger report. Students were clearly briefed on the faculty expectation that the report should be a high quality "stand-alone" document, with a clear structure {abstract, introduction, motivation etc}.
- Other actions to improve the program are documented elsewhere in this report. For example, the UCR CS Photorosters system (documented in B.5.2) was introduced in direct response to student feedback, and the CS&E Mentoring Program (documented in B.5.2) was introduced based on consultation with the Board of Advisors and careful examination of student exit surveys.

Selected Course Specific Improvements:

- **CS 161:** In the fall quarter of 2004 a problem with CS 161 came to our attention. The student evaluations near universally complained that the workload of the course plus the lab was too high, and as a consequence the quality of the lab experience was lowered. (This claim was also supported by an analysis of course grades.) Once we had noted it, we also conducted informal interviews with students who had taken the class. We have split the course into a CS 161 with no lab, where the focus is on the concepts and the quantitative analysis, and have added a new lab-only course, CS 161L, where the focus is exclusively on the design aspect. The two courses are co-requisite and are run in tandem but the students get 50% more credit for them and two grades. The students can now focus on an end-end design of a CPU in CS 161L.
- **CS150**: After examining the course files and student feedback, we observed that students had difficulties with the formal mathematical methods. This led to several changes. Now, the proofs are covered in a more interactive, conversational style, almost always with examples that illustrate the constructions in the proofs. The textbook has also been changed. The need for better instruction in formal methods, noted in this class, was the major driving motivation for a curriculum change, expanding the requirement in discrete mathematics from one quarter to two (CS 11 and CS 111.) Since then, we observed a significant improvement in students' ability to follow this material. In the past students also complained about this class being too theoretical. After the discussion with the instructors of CS 152 (the compiler class), it was found that after taking CS 150, some of the students were not sufficiently prepared to handle topics like grammars and parsing. This motivated further changes in the course material, in particular introducing topics that cover various applications, like modeling using finite state machines, and top-down parsing. As a result, the student evaluations for this class in the "*have you learned something valuable"* category have improved significantly in the last year.
- **CS 10**: Because CS 10 (along with CS 12 and CS 14) is such an important foundational course in Computer Engineering, a special CS 10-12-14 course oversight committee was created in 2003. This committee meets at least weekly during the quarter and also holds an extensive half-day debriefing at the end of each quarter. Below we consider some changes made by the committee in the last year.
  - Feedback from the students and research on effective teaching of programming suggested that more engaging programs (especially involving graphics) would better capture the students' interest and motivate them. This was the principal factor motivating the choice of textbook, and the design of the assignment series. The current sequence of assignments used tasks students with creating a Moon Lander simulation. Based on end of quarter evaluations and instructor perception the students greatly enjoy these assignments.
  - Not all changes made in CS 10 were unqualified successes. In Fall 2005, we experimented with the pair-programming paradigm as advocated by many leading academics and companies (see www.pairprogramming.com). Our one-quarter experiment with this paradigm showed us that while some students did follow the pair-programming paradigm and benefited considerably from the experience, far too many simply used it as an opportunity to do half the work. The CS 10-12-14 course oversight committee is currently investigating techniques to incentivize students to do their fair share of the

work, and techniques to correctly and fairly assign individual (possibly distinct) grades for work completed in pairs. Until such issues are resolved our current approach is to require individual work; give the assignments just sufficient weight to incentivize the students to dedicate the necessary time to them, but not so much that they are tempted to cheat; require that they obtain satisfactory scores on at least 6 out of 8 assignments in order to pass; and follow each assignment with a proctored 30 min. test on the same material (these tests count for 15% of the course grade).

- **CS179M:** After offering CS 179M (Senior Design Project in AI) in the Spring of 2005, the instructor found that the students were not getting enough exposure to prototyping and simulation environments. Additionally, the instructor noticed that with the old grading scheme, it was difficult to tell which students in a group had contributed and which had not. Over the summer of 2004, the instructor purchased a mobile robot platform and simulator to use in the class. The Fall 2005 offering was significantly revised. Students used a simulator for initial testing of projects and then used the real robot for final implementations (often going back and forth between the two). This gave them a good sense of the importance (for speed) of simulation, but also of the drawbacks. The instructor also implemented a bi-weekly peer review system which worked well to track students. In addition to the peer reviews, students had to perform self-reviews (much like monthly progress reports in industry) which helped keep them on track. The move of much of the writing component out of 179 and into ENGR 180 helped a lot. It freed up the curriculum, allowing the changes above to be fit into the course. By noting that it was in the course objectives but that the typically projects people selected for 179 did not offer an opportunity for them to use simulations. Therefore, a project environment which naturally required (or allowed) for simulations in a useful way was found.
- **CS122B**: This course was offered in Winter 2005 and again in Winter 2006. The course was significantly revised between offerings, based on student grades, student feedback, examination of the student exit surveys, and advice from industrial contacts in leading companies. The industry is shifting more away from real-time scheduling and more into formal specification and analysis. The students are now taught state-of the art specification technique like processor network, State Chart (in more depth), Petri Net, UML, etc. Lecture material was added on Loop analysis, Power Analysis, Data Layout Analysis to reflect their increasing importance in the industry. These materials were previously only lightly covered and in a part of the course that was "presentation only" i.e. not covered by homework and examinations. The students' knowledge of these areas is now tested with several instruments. While concurrent programming is covered in CS 160 (Concurrent Programming and Parallel Systems) and also consider in CS 153 (operating systems), based on a detailed analysis of student work it was felt that its relevance to embedded and real-time systems was not fully appreciated. A lecture module and a large project using Windriver/Tornado are now used to address this. In the 2005 offering, Microblaze was only presented in lecture, in the 2006 offering students a hands-on module was added that required students to download to actual microblaze chip. Similarly a hands-on module for Tensilica was added.

Additional Minor Changes to CS 122B:

- Embedded system specification: Some of the material on real-time programming is compressed and make room for a fuller presentation on embedded system specification/analysis.
- Additional projects on state-of-the-art tools such as SystemC, Microblaze and Tensilica were added. To make room for these materials, some material on performance optimization was removed, because after careful consultation with the faculty it was found that this material was covered in CS 152.
- Consultation with industrial contacts suggests that formal verification, energy analysis, and MPSoC design are all gaining importance in embedded systems. Existing lecture materials was added to reflect this, and new lab assignments and homeworks were added to assess the students knowledge of the material.

While the faculty is pleased with the measured improvements in students knowledge, they understand that the process of continuous improvement requires a continuous cycle of revision and measurement. The responsible faculty met shortly after the 2005 offering to identify possible weaknesses in the offering and to consider how these might be addressed. While this discussion is still ongoing at the time of writing, the following items are likely changes for the next offering:

- Windriver/Tornado: Introduce even more realistic example for students to work on.
- SystemC: We are currently working on putting CoCentric System Studio (from Synopsys) online for student to work with. It is a more realistic SystemC environment and offers the possibility of co simulation, and link to implementation.
- Microblaze: Introducing hardware/software partitioning all the way to implementation for the next offering of the course.
- Tensilica: Adding Multi-Processor System On A Chip (MPSoC) design capability to this lab as Tensilica adds it to the tool suite. (Tensilica is a startup EDA company which is a leader in flexible instruction set ASIP design).
- Windriver/Tornado: The student had to write 3 reports, which is only one now. This way the lab can be run more efficiently, as a consequence, a more realistic, larger example can be added.

CS130: Our offering of CS 130 (Computer Graphics) is unique in that only one member of the faculty, Dr. Victor Zordan, has been responsible for teaching it since 2003 when Dr. Dimitrios Gunopulos offered it. As Dr. Zordan is an accomplished researcher in computer graphics he is clearly the best person to teach this class. However the CE faculty strongly believes that our program is strengthened by discussions of pedagogy and curriculum. With this in mind, even though only one person teaches this class, an informal committee meets to discuss the offering several times a quarter.

During the Fall 2004 offering it was noted that students were performing poorly on exams. The CS 130 committee met to discuss this and decided to directly poll the students to ask them why they felt that this was the case. The students nearly universally complained that there were not enough example problems done in class and that this led to poor performance on the exams. The committee suggested the following fixes, which Dr. Zordan immediately implemented:

- More worked examples of questions were made available during the during the review sessions.
- The tentative exam problems were shown to the committee and/or teaching assistants before the exam. Questions that were felt not to be representative of the course material were removed or rewritten.
- Students were given a mini review of note-taking skills.
- It was emphasized very clearly at the beginning of classes that students would need to be able to solve problems similar to the ones shown in the lecture.

The net result of these changes was that the students performed at a higher level in general, and at a *much* higher level for these on these types of problems in the midterms and on the final. In addition the student evaluations for the course indicated a much satisfaction rate.

Additional changes made to CS 130 include migrating to a more accessible text (after the committee had debated the rival merits of more than a dozen texts), replacing two smaller projects with a larger project with incremental turn-in steps (and incremental feedback). In each case the grades and student feedback were carefully examined to gauge the effectiveness of the changes.

B.3.3 Excerpts from Faculty Meetings Demonstrating Continual Review and Improvement

Below are highlights of comments from the minutes of faculty meetings between September 2002 and July 2005 that related directly to undergrad instruction for majors. Particularly relevant passages are highlighted. The original notes are available for inspection. Quoted passages are taken verbatim from the minutes, other passages are summarizations. More the 85% of the faculty meetings in this time period explicitly address undergrad instruction.

- 9/17/02: “**Check on having language/technical writing instruction for all our CS/CE students.**” Faculty urged to attend a demo of Blackboard, importance of ACM club for our undergrads. “**How to better assess the students’ acquisition of knowledge and skills.**”
- 9/22/02: Discussion of undergrad curriculum, Dr. Vahid noted “**Technical writing is critically important for our majors**” and it was agreed to add this as a requirement. Several new undergraduate courses are proposed.
- 10/07/02: Importance of reviewing lecturers’ performance… Importance of Advisory Boards feedback on our students.
- 2/4/03: The importance of technical communication skills for our majors, discussion of who should teach proposed class on technical communication

- 1/18/03: **Discussion of “scripted-base grading” to allow better archiving and review of students knowledge and skills**. A committee was appointed. The importance of technical communication skills for our majors.
- 3/18/03: Discussion of how best to help our majors move from JAVA to C++ (since many transfers students know JAVA only). A committee was appointed to talk directly to the students to garner their feedback.
- 4/22/03: **Discussion of CS 179 with respect to ABET standards**.
- 6/17/03: (one hour) **Presentation on ABET standards** by Associate Dean Dennis Rice, how can we best comply with ABET standards.
- 9/23/03: How best to retain undergraduates, how **best to measure students knowledge and skills**, ABET, revising course objectives. Importance on giving feedback to our students early on (“early on” in each class, and “early on” in academic careers). Which styles of teaching are more effective, discussion of a study that shows the usefulness of study groups, how we can implement study groups are measure their effectiveness.
- 10/8/03: Discussion on how to archive students work, discussion on the best way to monitor student progress, discussion on how best to comply with **ABET standards**.
- 12/3/03: Review and discussion of the content of various courses.
- 1/12/04: Discussion of the **ABET mandated outcomes**.
- 1/26/04: Entire meeting devoted to **ABET**. Dr. Payne notes “The College is more interested in establishing a process and culture of formalized self assessment and in documentation.”
- 2/4/04: Review and discussion of course objectives for all major offerings.
- 2/11/04: Review and discussion of undergraduate curriculum.
- 3/17/04: How best to obtain and use Advisory Boards feedback on our students.
- 5/5/04: Discussion on student morale and retention of students, discussion of teaching styles, discussion of the creation of CS&E mentoring program, discussion of policy of textbook stabilization (using a single textbook, regardless of the instructor teaching the class) discussion of **ABET** requirements.
- 9/14/04: Discussion on how to engage and motivate students, discussion on mentoring students, discussion of **ABET** requirements, Report on Assessment and Accreditation.
- 10/16/04: Discussion of **ABET** requirements, discussion of how to measure, report and understand our majors progress.
- 11/17/04: Five-year plan for CS/CE department is discussed. Goals include ABET compliance and accreditation, improving student retention, and “to ensure that the quality of our graduates is high enough to be attractive to industry leaders and to be competitive for positions in the top academic and research institutions.”
- 1/19/05: How best to use new Photorosters system to improve interaction with students [see Section B.5.2].
- 2/16/05: Discussion of our majors’ technical communication/writing skills.

B.3.4 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 generality.

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.3.5 Materials Available to Examiners for the Site Visit

Graded student work is electronically archived and will be available for review. At least one technical assistant will be available at all times to help with navigation and browsing of the data.

However we recognize that in order for the reviewers to make the best use of their time, perusing electronic data may be too slow. We have therefore set aside a room in the Engineering II building which will dedicated to Computer Engineering ABET assessment and where we will have carefully organized and indexed copies all materials:

- Course Files for every CE major offering. These will include the syllabus, and every handout, quiz, midterm, exam etc. In addition they will include all text from bulletin boards. All the course files, for three full academic cycles 2003-4, 2004-5, and 2005-6 will be available.
- Eleven outcome files, which will present the evidence for outcome assessment, improvement, and achievement, organized by outcome for clarity of presentation and analysis.
- Samples of student work from the Fall 2005 and Winter 2006 quarters will be available for all required classes.

- Access to the web-based sites for the required courses will be granted to the evaluator.
- Binders of course evaluations.
- Minutes of Faculty meetings and Advisory Committee meetings related to curriculum.
- Course assessment reports.
- Results from Senior Exit Surveys and Alumni Surveys.
- Recent “late-breaking” developments not discussed in this report.
- A tour of the teaching facilities, including the teaching labs.
- Additional information, such as faculty meeting minutes, department annual reports, ABET meeting minutes, BOA meeting minutes, and results from Senior Exit Surveys, and Alumni Surveys.
- CE faculty and staff will also be available for interviews.

Every effort will be made to provide any additional materials requested by the ABET team. Dr. Eamonn Keogh (Chair of ABET committee) and Victor Hill (System Administrator and head of technical support for ABET) will be on standby to procure any additional material at a moment’s notice.

B.4 Professional Component

UCR’s Computer Engineering curriculum is structured to ensure that our graduates satisfy our program educational objectives and achieve the competencies and abilities articulated in our program outcomes.

Mathematics and basic sciences. At the lower division: a year of calculus of a single variable, a quarter of elementary linear algebra, a quarter of differential equations, a quarter of discrete mathematics, a year of physics, and one quarter of chemistry. At the upper division: a quarter of linear algebra, a quarter of statistics, and a quarter of discrete systems.

Engineering topics. At the lower division: two quarters of introductory electrical engineering, and electrical engineering lab course, two quarters of introductory programming (typically C++), a quarter of data structures, a quarter of computer organization. At the upper division: one quarter of digital design, one quarter of embedded systems, one quarter of data acquisition or intermediate embedded and real-time systems, two quarters of electronic circuits, two quarters of signals and systems, plus five quarters or CS and/or EE technical electives from a specified list.

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 or SC). 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. In the social sciences, program students are required to take one course in economics or political science, and 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.

Major design experience. In their senior year, computer engineering students take either EE 175 or CS 179, which provide a culmination of their design curriculum and which apply the knowledge and skills acquired in their previous course work. The course pre-requisites have been established so that the students will have completed nearly all of the required courses in the Computer Engineering program prior to their capstone design experience. EE 175 is a two-quarter sequence. CS 179 is structured for students to progress from design concept to prototype within a single quarter. Examples of topics incorporated into the course include developing design specifications, ethics, liability, safety, economic concerns.

Career preparation. 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 Adequacy of Faculty Size

The curriculum is taught by 24 regular faculty and two full-time lecturers from CS&E and 18 regular faculty from EE, with an occasional course taught by an advanced Ph.D. student. Beyond the lower-division courses, most classes have enrollments in the range of thirty to sixty students.

In a typical course, faculty deliver three hours of lecture per week and hold another three office hours. In addition, the faculty supervise the TAs, who conduct three-hour supervised labs and assist students with their assignments. Course evaluations indicate that the students are senior exit surveys indicate that the students are generally pleased with their interaction with the faculty.

B.5.2 Extent and Quality of Faculty Interactions with Students

We will discuss two concrete programs that we have introduce in the last two years to improve effective interaction between students and faculty, the UCR CS Photorosters system and the UCR CS&E trial mentoring program.

Photorosters

In his book *What Matters in College*, Alexander Austin reviewed the literature on college teaching, finding the one thing that made the biggest difference in getting students involved in the under-graduate experience was greater faculty-student interaction (Austin, 1993). A prerequisite to such interaction is that the faculty and teaching assistants should learn the names of all students were possible. A professor who does not know his or her students' names may be perceived as remote, unapproachable and uninterested.

To help faculty and teaching assistants learn student names we have implemented a system called Photorosters (Figure 10). This system allows an instructor to see/print out a roster for his/her class that is augmented by recent high quality photographs.

a b

Figure 10. (a) The Photorosters system, showing all students in Dr. Keogh's Winter offering of CS 170, Section 3. (b) Response to survey of its usefulness.

While it is difficult to measure the effectiveness of Photorosters directly, we have measured the adoption rate. On March 17, 2006, we sent an email to all CS&E faculty/lecturers asking two questions: "*Have you ever used Photorosters? Y/N*" and "*Do you have any comments on Photorosters?*" Of the 17 responses, 16 affirmed using it. The following comments are representative:

- "*I use the roster mainly to learn the names of the students. It helps me when it is time to assign the grades (to take into account other factors, like class participation, etc.)*" Stefano Lonardi.
- "*I find them very useful to learn the names of my students. I guess they are also a way to discourage "extreme cheating" (i.e., the action of sending someone else in your place to take a class).*" Gianfranco Ciardo.
- "*I find that knowing names allows me to call on students in class which bolsters discussion and It gives them a more serious attitude about attendance and contributing in class (because they are not "anonymous").*" Victor Zordan.
- "*Photorosters are an extremely useful way for me to remember the names of students*.", Titus Winters.
- "*They are tremendously useful. They really help me learn students' names, which seems to create a very positive class environment*." Frank Vahid.

- "*While they help with learning names, they help more with connecting students' questions in office hours with their answers on exams and homeworks. This really helps to understand their mental models of the topics.*" Christian Shelton.

There was one negative comment. Marek Chrobak said "*They are typically incomplete,*" although Dr. Chrobak did go on to say "*They are certainly very helpful though. I can finally associate names with faces*." Upon investigation we discovered that Dr. Chrobak was a very early adopter of Photorosters and the early version was necessarily somewhat incomplete. Currently the database is more than 99.5% complete.

CS&E Mentoring Program

The UCR CS&E trial mentoring program was established in Fall 2004 with the goal of improving freshmen retention rates in the computing majors – CE and CS, Several articles on engineering and CS retention emphasized the importance of personal faculty interactions with students.

An e-mail was sent on July 8, 2004, asking faculty if they would be interested in volunteering as faculty mentors for freshmen majors. Twelve CS&E faculty members volunteered. We later described the program to the EE undergraduate advisor, after which two EE faculty members volunteered also, raising the total to 14. Prof. Frank Vahid of CS&E served as the organizer of the program.

Each mentor arranged a day/time during which their meetings would take place. Incoming freshmen signed up for a mentor during the CS&E orientation on September 20, based primarily on the mentor meeting times fitting the student's schedule. Each mentor had between 8 and 15 students in his/her group. Mentors met with their students as a group. Each mentor met with his/her group four times during the Fall quarter, in the 1^{st}, 3^{rd}, 5^{th}, and 7^{th} weeks, for one hour each meeting. Students who missed a group meeting had to see the CS&E undergraduate advisor to make up the missed meeting. Students who attended the meetings received their winter quarter registration PINs on time. Those who missed meetings and did not make up those meetings had their PINs delayed.

One professor provided mentors with suggested material to cover during each meeting. That material emphasized several items:

- Helping the students to make friends with each other during the meetings.
- Providing students with inspirational data on future careers in computing.
- Providing students with practical information and tips for college success.

Students were asked to complete an evaluation form on the last meeting during the fall.

The mentoring program continued in the Winter 2005 quarter with a single meeting of the mentor with his/her group.

Internal Evaluation of the CS&E Mentoring Program

Students seemed generally pleased with the mentoring program. A summary of the evaluation forms is attached to this document. Forty-five percent said the program was useful, and another 25% said it was somewhat useful. A visual summary of student evaluation of the CS Mentoring Program. Seventy-Five students were polled. The features they liked most were:

- Study tips, time management, and test taking skills.
- Mentor resourcefulness and approachability .
- Opportunities available at UCR in the engineering field.
- Meeting new students and faculty.

The features they disliked were:

- Mandatory attendance with registration pin consequences.
- Time conflicts.
- Regular meeting times.
- Information presented too general.

We held a mentor-debriefing meeting on November 24. From the student evaluations, and the comments from mentors, we concluded the following as the key lessons learned and improvements for the future:

- We should repeat the program for new freshmen next year.
- We should have fewer meetings, two, perhaps three.
- Reducing group size would be good.
- We should definitely continue to discuss time management and test-taking skills.
- We should add discussions on choosing among the majors, and on the different research areas of our entire faculty.
- We should consider enforcement options other than delaying regpins.
- We should consider achieving mentoring using a required freshman course.

Current Status

The mentoring program was repeated in Fall 2005. Twelve of the 14 mentors agreed to continue with the program, again as volunteers. This time only two meetings were held, covering roughly the same material as last year, but covering that material more briefly. Furthermore, discussion was added about the various majors available. Prof. Marek Chrobak, the CS&E undergraduate advisor, served as the organizer of the mentor program. Materials from this year's meetings, including the agenda and handouts, can be found at:

- First meeting: http://www.cs.ucr.edu/~marek/MENTORING/MEET1/
- Second meeting: http://www.cs.ucr.edu/~marek/MENTORING/for_mentors.html

Additionally, a 2-day intensive first-week orientation for CE freshmen was organized by two faculty, Prof. Frank Vahid (CS&E) and Prof. Sheldon Tan (EE). The 2-day orientation consisted of extensive network among the freshmen, and then breakout sessions involving study habits/motivation, student clubs/organizations, balancing studying and non-studying activities, and an introduction to our lab facilities and computer accounts.

Ryan Mannion, a graduate student of Prof. Frank Vahid, developed a website to streamline the process of signing up for and switching among mentor groups (previously a huge task for the organizer), and for mentors to record mentoree participation. The website is presently at http://www.cs.ucr.edu/~mentor/. A password-protected administrative site is at http://www.cs.ucr.edu/~mentor/admin/.

The faculty discussed the mentoring program in October and agreed that it should continue. However, as attendance had been an issue for both years of the program and the use of registration PIN delays is viewed negatively by students, faculty agreed that the mentoring program should be administered through a course structure. A 1-unit engineering course entitled "Professional Development and Mentoring" is thus being introduced for next year, and will be required of all computing majors.

Grading will be satisfactory/no-credit. The course is presently going through the approval process and should be in operation and required in Fall 2006. Administering mentoring through a course may also have the benefits of providing teaching credit for professors who participate rather than relying solely on volunteerism. The course structure will utilize the http://www.cs.ucr.edu/~mentor/ website.

Summary for CS&E Mentoring Program

In summary, faculty seems to believe the mentoring program to be useful, and students seem to enjoy the program. Fine-tuning of the program must occur to make it easier to administer, to encourage better attendance, to provide appropriate credit to faculty for participation, and to better achieve the program's goals. Mentoring sophomores, juniors, and seniors may also be considered in the future.

Undergraduate Research

The Computer Science program is committed to giving opportunities to undergraduates to engage in research. The Department feels that this benefits both the faculty and students.

For the former, close interaction with undergraduates allows the faculty to understand more about the undergraduate's strengths and weaknesses, and this information can be feed back into the instructional loop. For the latter, the chance to work with world-class researchers can greatly augment the in-class instruction, and give the students a competitive edge in later admission to grad schools or prestigious employment.

The faculty takes great pains to make the students aware of research possibilities. For example:

- Several times a year faculty members give talks to the UCR ACM student chapter, discussing their research and inviting collaboration. Recent talks include Dr. Neal Young (March 2004), Dr. Eamonn Keogh (November 2004), Dr. Victor Zordan (February 2005). The current membership of the UCR ACM student is 86, and typical attendance at these talks is over 60.
- The benefits of student research are extolled in the mentoring program.
- Many faculty members prepare posters and other displays highlighting their research in visually interesting and attractive ways and place them outside their offices and labs.

Undergraduate students are encouraged to take positions as laboratory assistants. At UCR, research relationships are fostered between undergraduate students and faculty in faculty research labs and at the Center for Environmental Research and Technology. Students may volunteer, be paid through funded faculty research, through NSF Research Experience for Undergraduates awards, or through a variety of University-wide programs sponsoring undergraduate research. Specific examples of University-wide programs are listed below.

- California Alliance for Minority Participation (CAMP) – The primary goal of CAMP is to double the number of B.S. degrees granted to underrepresented students in science, engineering, and mathematics at the eight general campuses of the University of California. The primary components of CAMP at the University of California Riverside (CAMP-UCR) are a summer enrichment program for entering freshmen, peer counseling, study groups, faculty mentored research experiences, opportunities for participants to give presentations at scientific meetings, and preparation for graduate school. The program is funded jointly by the National Science Foundation and the University of California.
- Mentoring Summer Research Internship Program (MSRIP) – The goal is to prepare and encourage undergraduates from diverse backgrounds to obtain the Ph.D. degree. Students participating in MSRIP may be supported from a variety of sources, though the main funding source is the UC Office of the President. Additional funding sources include CAMP, state, and federal sources.
- Leadership Excellence through Advanced Degrees (UC LEADS) –This state-funded program is designed to attract and prepare students from a broad range of socio-economic, cultural, ethnic, racial, linguistic and geographical backgrounds to enter doctoral degree programs (preferably at UC) in math and engineering. The long-term goal is to provide students with backgrounds to prepare them to assume leadership careers in industry, government, public service and academia.
- Alliance in Graduate Education for the Professoriate (AGEP) – This is an NSF program with the goal of developing coordination of university academic outreach programs (MESA-MEP, CAMP, UC LEADS) that assist and develop students seeking careers in science and engineering.
- UCR Research for Undergraduates – In the Fall and Winter quarters, this UC program solicits, accepts, and funds proposals for undergraduate research projects conducted under faculty supervision.

Concrete Outcomes of Undergraduate Research

Perhaps the best measures of the success of undergraduate research involvement is the number and quality of papers published with undergraduates. Here are some representative papers published in collaboration with undergraduates:

- **R. Mannion,** H. Hsieh, S. Cotterell, F. Vahid. (2005) System Synthesis for Networks of Programmable Blocks. Design Automation and Test in Europe (DATE), pp. 888-893
- **Swastik Kopparty**, Srikanth Krishnamurthy, Michalis Faloutsos and Satish Tripathi (2002). *Split TCP for Ad hoc Networks*. IEEE GLOBECOM.
- **Kyle Ellrott**, Chuhu Yang, Frances M. Sladek, Tao Jiang: Identifying transcription factor binding sites through Markov chain optimization. ECCB 2002: 100-109
- Eamonn J. Keogh, **Shruti Kasetty**: On the Need for Time Series Data Mining Benchmarks: A Survey and Empirical Demonstration. Data Min. Knowl. Discov. 7(4): 349-371 (2003).
- P.C. DiLorenzo, V.B. Zordan, **D. Tran** (2004) Interactive animation of cities over time, 17th International Conference on Computer Animation and Social Agents (CASA).
- Sandeep Gupta, **Swastik Kopparty**, and C.V. Ravishankar. (2004). Roads, Codes, and Spatiotemporal Queries. PODS 2004, pp 115-124
- Victor Zordan, **Nicholas Horst** (2003). Mapping optical motion capture data to skeletal motion using a physical model, ACM SIGGRAPH Symposium on Computer Animation.
- G. Stitt, F. Vahid, **S. Nemetebaksh** (2004). Energy Savings and Speedups from Partitioning Critical Software Loops to Hardware in Embedded Systems. IEEE Transactions on Embedded Computer Systems.

B.5.3 Competence of Faculty to Cover All of the Curricular Areas

All but one of the program's 42 faculty involved in the computer-engineering program have Ph.D. degrees in EE, CS, CE, Physics, or Mathematics. Six of them do research in core areas of computer engineering: computer architecture, VLSI design, and embedded systems. One of them, Frank Vahid, has written well-received textbooks on digital design and on embedded-systems design. In addition to these core areas, faculty expertise includes the areas of operating systems, databases, compilers, theory of computation, computer performance, networking, security, artificial intelligence, coding theory, information theory, digital signal processing, machine vision, control systems, and device physics. Additional details of faculty backgrounds are available in the attached faculty resumes – see Appendix I-C.

B.5.4 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.5.5 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

The assignment of classrooms for each course is made by a joint effort between the Student Affair Office of the Bourns College of Engineering and the Scheduling Office of the Registrar Office. The Student Affair Office requests for a room from the Scheduling Office providing the enrollment for the individual class. The centralized Scheduling Office then assigns a room in different buildings on campus with the best availability to accommodate the size of the class. Special request for additional lectures, tutorials, and examinations can be made by the instructor directly. The TA office in Engineering Building Unit II (EBU II) sometimes can be used to hold additional tutorials with prior acknowledgment.

The Campus has 60 general-assignment classrooms of varying sizes, each of which is equipped with wireless Internet access, a 3000-lumen video projector connected to a networked PC, and the targets/receivers for wireless audience-response clickers. Appendix II provides more details on these resources.

B.6.2 Instructional Laboratories

Computer Science and Engineering

The Computer Engineering program is designed to provide students with extensive experience beginning in their first year of classes. Nearly all courses have an associated mandatory lab component.

There are five general purpose instructional labs located on the first floor of EBU II in rooms 127, 129, 132, 133, and 136 in which courses are scheduled that support the CE curriculum. These laboratories run CentOS Linux as their base operating system, and provide access to Windows desktop environment and applications via connection over the LAN to a Windows 2003 Terminal Server cluster. Each lab is equipped with 24 desktop PCs and with a workgroup laserjet printer, and laboratory section sizes are typically 21. Lab sections are scheduled in the range from 8 AM to 9 PM in these labs.

There is an additional computer laboratory located in EBU II 226 which provided access to the same software as other labs, but is an open lab where students can go to work at any time of the day, even if other laboratories are all scheduled for courses.

There is also a CE laboratory located in EBU II 135 that has specialized equipment including Intel IXP 1200 and 2400 network processor cards, and for specific CE courses is supplied with a range of equipment including oscilloscopes, power supplies, function generators, digital multimeters, and FPGAs. The computers in the laboratory run Linux, and so the fraction of embedded systems software that only runs under Windows and additionally requires direct hardware access is run in a virtual machine environment, currently VMWare. Lab sections are scheduled from 8 AM to 11 PM in this lab.

All of these facilities are accessible 24/7 via card access. Additionally, they are accessible on the Internet – Linux via Secure Shell or NX, and Windows via Terminal Services.

Computers, printers, and supplies for the laboratories are paid for via a course materials fee that provides approximately $25K per quarter. This fee was established in 2004 and ensures that technology refresh in the laboratories will be sustained for the foreseeable future.

Electrical Engineering

The Electrical Engineering program and the Bourns College of Engineering is built to provide students extensive hands-on experience from their sophomore year through a mandatory sophomore-level laboratory class (EE 1LA) to a number of different laboratories required by the upper-division courses, including the senior design class (EE 175A,B). Depending on the area of study chosen by the students, they are required to enroll in different laboratory classes. All laboratories require and enhance students' teamwork, communication and technical skills. The courses also introduce the students to the operational equipments used in the laboratories and give them a precious opportunity to be familiarized with the equipments.

Since EE 01LA – Engineering Circuit Analysis I Laboratory – is a requirement for the Electrical Engineering program, all students are to complete the safety orientation session as part of the course.

In particular, there are four major laboratories:

1. Circuits and Control Systems Lab located in EBUII Room 121
2. Embedded Systems and Logic Design Lab in EBUII Room 125
3. Advanced Systems and Senior Design Lab in EBUII Room 126
4. Communication and Intelligence Systems Lab in EBUII Room 128

Recently, we added two new labs on Photonic Devices and Nano-Device Characterization, corresponding to the new courses EE160 and EE136, respectively.

These labs provide excellent educational and instructional opportunities to students during their academic years at the College. There are also two non-instructional laboratories in the EBUII building: the Electronics & Prototyping Shop at EBU2 137 and the Computer Lab at EBU2 234. The Electronics & Prototyping Shop provides and maintains all the equipments and accessories used in the laboratories. The Computer Lab provides a computing environment that allows the students to access to the Internet in doing research projects or to use a number of very powerful fully-licensed software when working on assignments.

There are two other non-instructional laboratories in the EBUII building: 1) the Electronics & Prototyping Shop at EBUII 137 and 2) the Computer Lab at EBUII 234. The Electronics & Prototyping Shop provides and maintains all the equipments and accessories used in the laboratories. The Computer Lab provides a computing environment that allows the students to access to the Internet in doing research projects or to use a number of very powerful fully-licensed software when working on assignments. Table 10 indicates the different labs corresponding to different courses.

All laboratories are located at the ground floor of EBUII building. They are opened during the assigned schedule with the supervision of the TAs or are accessible with permission from the technical staff. Each laboratory occupies an area of 900 sq. ft. equally and has 16 workstations. The maximum capacity for each lab is 32 students with 2 students per workstation. Two different sections of labs are offered when the number of enrollment of the class exceeds the maximum allowable capacity in the lab.

The labs are equipped with oscilloscopes, digital multimeters, function generators, power supplies, and desktop computers, with a quantity of 16 each per lab. Each workstation has one set of the equipment listed above except for Lab 125 which only has power supplies and computers. Some fully-licensed and well-known software/tools are provided on the computers for students' use, such as Cadence, Orcad, PSpice, Matlab, and Codewarrier C Development . Students have an opportunity to gain the knowledge to utilize and manipulate the software in achieving the objectives for the certain courses.

Table 10. Laboratories utilized by EE courses.

Courses	121: Circuit & Control	125: Embedded Systems & Logic Design	126: Adv. Systems & Sr. Design	128: Comm & Intelligent Systems	137: Electronics & Proto-typing Shop	228: Nano Charact.	B234: Photonics Devices	234: Computer Lab
1AB 2	x							24 hr access
100 A/B	x							
105	x			x				
115 117				x				
120A		x						
128 134				x				
135 140				x				
132 144	x							
136						x		
141/146 152				x				
160							x	
175A/B		x	x	x	x	x		
ENG 10/ IEEE						x		

Graduate courses: 30
Undergraduate courses: 37
Discovery Seminars: 2-3
Summer courses: 4-5

The majority of the equipment was purchased for approximately $270,000 in 1998 when the program started. An estimated amount of annual costs of maintenance and upgrades is calculated to be in the range of $3-10k. Although no major upgrades had been done on the equipments, they still function well and have a lifetime of about 20 years.

B.6.3 Information Resources

Computer Science and Engineering

The Department of Computer Science and Engineering provides a comprehensive range of computing services for instructional and research purposes. The CS&E Technical Staff provide support for research and instructional labs, as well as server applications and network services. Students are provided with card access, and all labs are open for 24/7 use.

Through the Technical Staff, the Department provides support for 500 desktop machines running a comprehensive range of operating systems including Linux, Windows, and OS X. CS&E server infrastructure provides clients with remote access to their personal files and a vast range of application software via a number of mechanisms: Windows Terminal Service, secure shell, and the NX protocol. Other core network services include email, software version control, printing, authentication, name service, web, and database access.

The CS&E network infrastructure is shared with other departments in the College of Engineering. Gigabit Ethernet to the desktop is the most common client configuration, with the lowest speeds being 100 Megabits. The network core is fully redundant with 10 Gigabit connectivity internally and 20 Gigabits aggregate bandwidth between the College of Engineering LAN and the Internet core.

Electrical Engineering

The integrated network in the Bourns College of Engineering offers one of the nation's most advanced computing environments to the faculty, staff and students of the College. The network provides ultra-performance workstations for educational purpose in course-related research and project.

The fully-integrated network maintains 189 desktop workstations in 6 computing labs that are open to all engineering students. All of these labs are accessible to students 24 hours a day, 7 days a week. Windows XP, 2003 Server, Linux, Unix, and Solaris are all supported operating systems. It also allows the students to access many course-related applications and centralized personal folders, e-mails, printers, and other services on the network. People can also reach their personal servers or common shared folders on the network from any other workstation off campus.

The network operates on the TCP/IP protocol with a connecting speed ranging from 100 to 1000 megabits per-second and some Power Over Ethernet (POE). All the switches in the building are connected at 1 gigabit fiber connection. Connection between the Bourns College of Engineering and Engineering Unit II buildings are based on 10 gigabit fiber and 10 gigabit wide-area-network (WAN) link. Wireless Ethernet is available in student lounges, offices, labs, and other locations in the College of Engineering buildings.

The computing environment of the College is fully combined with a broader group of networks that ties the entire country and the globe together. The students of the Bourns College of Engineering have the privilege of taking advantage of the state-of-the-art technology in advancing their learning endeavor and research experience at the University.

B.6.4 Opportunities to use Modern Engineering Tools

Computer Science and Engineering

An extensive range of free open-source software is provided under the Linux operating system, including compilers, interpreters, and simulators that are used in CS&E courses, as well as proprietary software for specific courses such as Maya and Renderman for graphics courses and Xilinx, Cadence, and Synopsys software for embedded-systems courses. Windows Terminal Servers provide remote timeshared access to software such as Aldec Active HDL for embedded-systems courses and a wide range of Microsoft software including, such as, Visual Studio 2005.

Electrical Engineering

Some fully-licensed and well-known software/tools are provided on the computers for students' use, such as Cadence, Orcad, PSpice, Matlab, and Codewarrier C Development . Students have an opportunity to gain the knowledge to utilize and manipulate the software in achieving the objectives for the certain courses.

B.6.5 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.

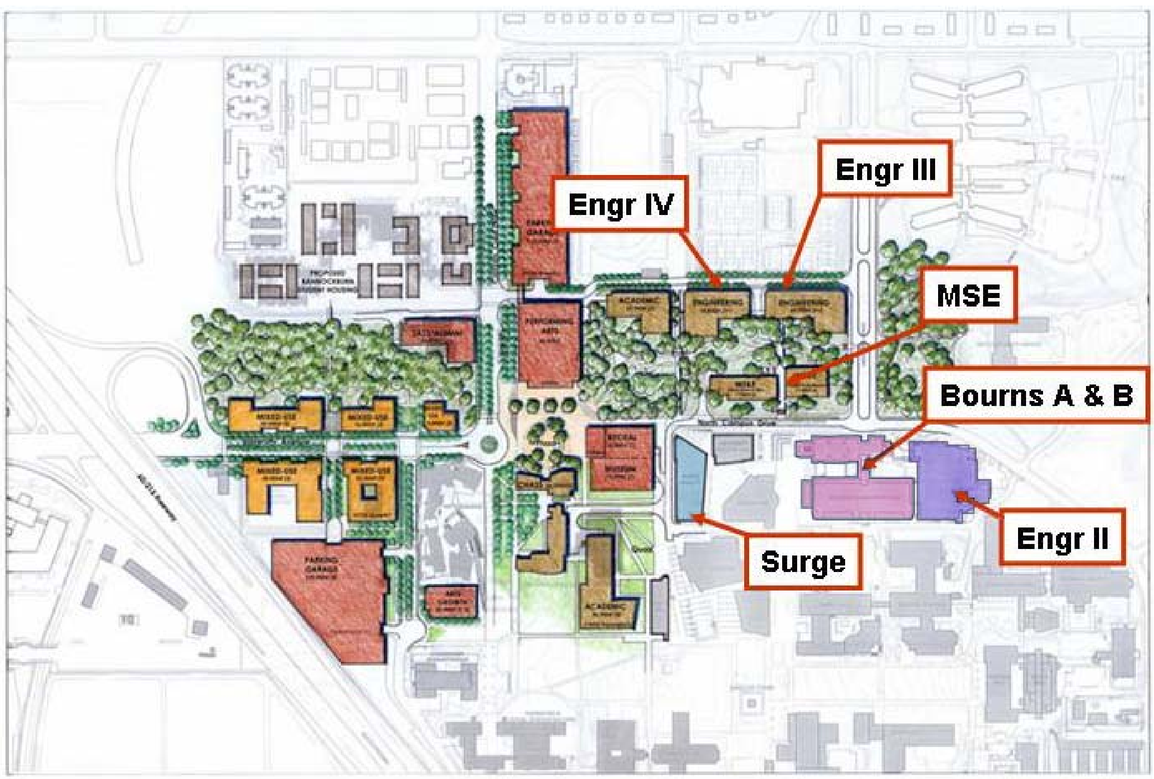

Figure 11. Locations of Bourns Hall (existing) and Engineering II (existing), with the planned Materials Science and Engineering (MSE) Building (2008) and future Engineering III and Engineering IV locations. Surge was the temporary home of the Computer Science and Engineering Department before Engineering II opened in the summer of 2005. The College now has no offices or labs in Surge.

The University's plan calls for the opening of a Materials Science and Engineering Building in 2008 (Figure 11). 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.

B7. Institutional Support and Financial Resources

The University, Campus and College provide a good balance of central leadership and support for the missions and goals of the Computer Engineering degree program. 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 Executive Vice Chancellor'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 1. 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 Facilities and Equipment

Computer Science and Engineering

The CS&E department operates on a budget of approximately $90,000 per fiscal year. This excludes salary and benefits for permanent employees (faculty, administrative and technical staff) and provisional academic personnel such as lecturers, teaching assistants and adjunct professors. In addition to this allocation, CS&E established lab fees in 2005, which provide roughly $25,000 per quarter towards replacement of equipment in instructional labs. Additional funds are requested and justified to the Dean on an as needed basis

Electrical Engineering

The EE department operates on a budget of approximately $84,600 per fiscal year. This excludes salary and benefits for permanent party employees (faculty, administrative and technical staff) and provisional academic personnel such as lecturers, teaching assistants and adjunct professors. Additional funds are requested and justified to the Dean on an as needed basis. Currently, neither the department nor the College offer any scholarships, stipends, fellowships, gifts, etc. to undergraduate students, although scholarships are available from research centers (such as CE-CERT).

B.7.4 Support Personnel and Institutional Services

Computer Science and Engineering

Computing support is provided by the CS&E full-time and part-time technical staff. Part-time staff consists of graduate or undergraduate students selected for expertise with the curriculum, as well as multiple operating systems and programming languages, and for additional factors such as maturity, leadership, and industry experience. Contract and grant post-award administration, course proposals and updates, TA and Reader assignments, travel, purchasing, and general administrative assistance is provided by full-time staff and part-time student assistants within the department.

Electrical Engineering

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 program has a designated Undergraduate Advisor (currently Dr. Balandin) to oversee curricular matters and to offer advice on curricular issues.

College Support

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. The College has developed a Professional Development 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 and manage lab instruction 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 College Office also supports the departments by managing contract and grant pre-award submissions, academic personnel and recruitment, and course scheduling.

B.8 Program Criteria

Computer Engineering students gain knowledge of probability and statistics from Statistics 155; of differential and integral calculus from Mathematics 9A, 9B, and 9C; of basic science from Physics 40A, 40B, and 40C and from the required Chemistry course; of computer science from the many required Computer Science courses; of the engineering science necessary to analyze and design complex electrical and electronic devices, software, and systems containing hardware and software components from the required computer science and electrical engineering courses; and of discrete mathematics from Math/CS 11 and 111. That these computer-engineering graduates learned the corresponding subject matter from these courses is demonstrated by their successful performance in courses for which these are prerequisites and from the outcomes discussed in B.3.

C. References Cited

Austin, A. W. (1993). What matters in college?: Four critical years revisited. San Francisco: Jossey-Bass.

Bone, D. (1988) The Business of Listening. Los Altos, CA: Crisp Publications, Inc.

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 Quarter	Course (Department, Number, Title)	Category (Credit Hours)				
		Math & Basic Science	Engineering Topics*		Hum. & Soc. Sci.	Other
			Engrg Science	Engrg Design (✓)		
1; Fall	MATH 1A – First Year Calculus	4		( )		
	ENGL 1A – Beginning Composition			( )	4	
	General Elective– Biological Science	4		( )		
	CS 10 – C++ Programming			( )		4
1; Winter	MATH 9B – First Year Calculus	4		( )		
	PHYS 40A – General Physics	5		( )		
	ENGL 1B – Intermediate Composition			( )	4	
1; Spring	MATH 9C – First Year Calculus	4		( )		
	ENGL 1C – Applied Intermediate Composition			( )	4	
	PHYS 40B – General Physics	5		( )		
2; Fall	CS/MATH 11 – Finite Mathematics	4		( )		
	PHYS 40C – General Physics	5		( )		
	MATH 46 – Differential Equations	4		( )		
	EE 1A/1LA – Engineering Circuit Analysis I		4	( )		
2; Winter	MATH 10A – Calculus of Several Variables	4		( )		
	CS/MATH 111 – Finite Mathematics	4		( )		
	CS 12 – C++ Programming II			( )		4
	EE 1B – Engineering Circuit Analysis II		4	( )		
	General Elective – H&SS			( )	4	
2; Spring	MATH 10B – Calculus of Several Variables	4		( )		
	MATH 113 – Linear Algebra			( )		4
	CS 14 – Data Structures			( )		4
	CS 61 – Assembly Language Programming			( )		4

TABLE I-1 (Continued)
BASIC-LEVEL PROGRAM

Year; Semester or Quarte	Course (Department, Number, Title)	Category (Credit Hours)				
		Math & Basic Science	Engineering Topics*		Humanities & Social Sciences	Other
			Engrg Science	Engrg Desig (✔)		
3; Fall	CS/EE 120A – Logic Design		5	( )		
	CS 141 – Algorithms		4	( )		
	STAT 155 – Probability & Statistics fo Engineers	4		( )		
	General Elective – H&SS			( )	4	
3; Winter	CS 120B– Embedded Systems		5	( )		
	EE 100A – Electronic Circuits		4	( )		
	EE 110A – Signals & Systems		4	( )		
	General Elective – H&SS			( )	4	
3; Spring	CS 161/161L – Computer Architecture		6	( )		
	EE 100B – Electronic Circuits		4	( )		
	EE 110B – Signals & Systems		4	( )		
	ENGR 180 – Technical Communications			( )		3
4; Fall	CS 180 – Software Engineering		4	( )		
	CS 122A/EE 128 – Micr Design/Instrumentation		4	( )		
	EE 141 – Digital Signal Processing		4	( )		
	General Elective – H&SS			( )	4	
	General Elective – H&SS			( )	4	
4; Winter	CS 153/160 – Operatin Systems/Concurrent Programming		4	( )		
	Technical Elective		4	( )		
	Technical Elective		4	( )		
	Chemistry Elective	4		( )		
4; Spring	Technical Elective		4	( )		
	Technical Elective		4	( )		
	Technical Elective		4	( )		
	General Elective – H&SS			( )	4	
OVERALL TOTAL FOR DEGREE (EQUIVALENT SEMESTER CREDITS)*		34	57.3		24	5.3
PERCENT OF TOTAL		28	48		20	4
Must satisfy one set	Minimum semester credit hours	32	48		16	
	Minimum percentage	25	37.5		12.5	

* The technical elective options include CS 130, CS 161, CS 168; EE 102, EE 107 (to be renumbered to EE 133, effective Fall 2000), EE 117, EE 128, EE 140, EE 144, EE 146, EE 150, EE 151, EE 152, and CS/EE 143. Design content is discussed in XII.D.

Note: The Humanities, Social Sciences, and Biological Science elective options are included in Volume II, Appendix B and discussed in Volume II, Section XII, P.

TABLE I-2
Course/Section Summary 05F – 06S

Course No.	Title	No. of Sections Of offered in Current Year	Avg. Section Enrollment	Type of Class (1)			
			Enrollment	Lecture	Lab.	Recit.	Other (Specify)2
CS 10	Introduction to Computer Science for Science, Math and Engineering I	7	53	X			
CS 10	Introduction to Computer Science for Science, Math and Engineering I	18	21		X		
CS 11	Introduction to Discrete Structures	3	7	X			
CS 11	Introduction to Discrete Structures	5	5			X	
CS 12	Introduction to Computer Science for Science, Math and Engineering II	4	40	X			
CS 12	Introduction to Computer Science for Science, Math and Engineering II	9	18		X		
CS 14	Data Structures	3	39	X			
CS 14	Data Structures	6	20		X		
CS 61	Machine Organization & Assembly Language Program	3	46	X			
CS 61	Machine Organization & Assembly Language Program	9	15		X		
CS 100	Software Construction	2	15	X	X		
CS 111	Discrete Structures	2	23	X			
CS 111	Discrete Structures	3	15			X	
CS 120A	Logic Design	3	17	X			
CS 120A	Logic Design	5	11		X		
CS 120B	Introduction to Embedded Systems	3	24	X			
CS 120B	Introduction to Embedded Systems	6	12		X		
CS 122A	Embedded System Design	1	21	X	X		
CS 122B	Embedded System Design	1	13	X	X		
CS 130	Computer Graphics	1	27	X			
CS 130	Computer Graphics	2	13		X		
CS 133	Computational Geometry	2	15	X	X		
CS 141	Algorithms	3	25	X			
CS 141	Algorithms	5	15		X		
CS 150	Theory-Automation & Formal Languages	3	20	X			
CS 150	Theory-Automation & Formal Languages	4	15		X		
CS 152	Compiler Design	3	26	X			
CS 152	Compiler Design	5	15		X		
CS 153	Design of Operating Systems	3	27	X			
CS 153	Design of Operating Systems	6	14		X		
CS 160	Concurrent Programming & Parallel Systems	*					

CS 161	Design & Architecture of Computer Systems	3	29	X			
CS 161	Design & Architecture of Computer Systems	5	17			X	
CS 161L	Laboratory in Design & Architecture of Computer Systems	3	29	X			
CS 161L	Laboratory in Design & Architecture of Computer Systems	5	18		X		
CS 162	Computer Architecture	1	8	X	X		
CS 164	Computer Networks	2	37	X			
CS 164	Computer Networks	4	19		X		
CS 165	Computer Security	1		X			
CS 165	Computer Security	3			X		
CS 166	Database Management Systems	1	25	X			
CS 166	Database Management Systems	2	12		X		
CS 168	Introduction to Very Large Scale Integration Design (VLSI)	*					
CS 170	Introduction to Artificial Intelligence	1	53	X			
CS 170	Introduction to Artificial Intelligence	3	18		X		
CS 171	Introduction to Expert Systems	*					
CS 177	Modeling and Simulation	1	6	X	X		
CS 179 (E-Z)	Project in Computer Science	6	13		X	X	
CS 180	Introduction to Software Engineering	1	42	X			
CS 180	Introduction to Software Engineering	2	21		X		
CS 181	Principles of Programming Languages	*					
CS 183	Unix System Administration	1	42	X			
CS 183	Unix System Administration	2	21		X		
CS 193	Design Project	10	1				Research 25%, Individual Study 25%, Lab 50%
EE 001A	Engineering Circuit Analysis I	3	41	X			
EE 01LA	Engineering Circuit Analysis I Lab	5	22		X		
EE 001B	Engineering Circuit Analysis II	2	32	X			
EE 001B	Engineering Circuit Analysis II	3	21		X		
EE 100A	Electronic Circuits	2	26	X			
EE 100A	Electronic Circuits	3	17		X		
EE 100B	Electronic Circuits	2	26	X			
EE 100B	Electronic Circuits	3	17		X		
EE 105	Modeling and Simulation of Dynamic Systems	1	50	X			

EE 105	Modeling and Simulation of Dynamic Systems	2	25		X		
EE 110A	Signals and Systems I	2	55	X			
EE 110A	Signals and Systems I	3	18		X		
EE 110B	Signals and Systems II	2	30	X			
EE 110B	Signals and Systems II	3	20		X		
EE 115	Introduction to Communication Systems	1	60	X			
EE 115	Introduction to Communication Systems	2	30		X		
EE 120A	Logic Design	3	13	X			
EE 120A	Logic Design	5	8		X		
EE 120B	Introduction to Embedded Systems	3	13	X			
EE 120B	Introduction to Embedded Systems	6	7		X		
EE 128	Data Acquisition, Instrumentation & Control	1	40	X			
EE 128	Data Acquisition, Instrumentation & Control	2	20		X		
EE 132	Automatic Control	1	46	X			
EE 132	Automatic Control	2	23		X		
EE 133	Solid-State Electronics	1	53	X			
EE 133	Solid-State Electronics	2	26		X		
EE 134	Digital Integrated Circuit Layout	1	47	X			
EE 134	Digital Integrated Circuit Layout	2	24		X		
EE 135	Analog Integrated Circuit Layout and Design	1	32	X	X		
EE 140	Computer Visualization	1	5	X	X		
EE 141	Digital Signal Processing	1	77	X			
EE 141	Digital Signal Processing	3	26		X		
EE 144	Introduction to Robotics	1	9	X	X		
EE 146	Computer Vision	1	13	X	X		
EE 150	Digital Communications	1	13	X		X	
EE 151	Introduction to Digital Control	1	9	X	X		
EE 152	Image Processing	1	26	X	X		
EE 175A	Senior Design Project	1	74				Consultation
EE 175A	Senior Design Project	4	19		X		
EE 175B	Senior Design Project	1	74				Consultation
EE 175B	Senior Design Project	4	19				Design & Proto-typing 100%

*** Courses not offered in the 05-06 Academic Year**

Table I-3. Faculty Workload Summary
Computer Science and Engineering Faculty

Faculty Member (Name)	FT or PT (%)	Classes Taught (Course No./Credit Hrs.) Fall 05	Winter 06	Spring 06	Total Activity Distribution[2] Teaching	Research	Other[3]	
Laxmi Bhuyan	100	203A	213	161	30	50	20	Buyout
Marek Chrobak	100	215	150		40	40	20	Ugrad Advisor
		111						
Michalis Faloutsos	100	260	240	164	40	40	20	Instruction Comm
		302/1	302/1	302/1				TA Oversight
Brett Fleisch	100							on leave to NSF
Dimitrios Gunopulos	100	236	133		40	40	20	Sabbatical W/S
		179						
Harry Hsieh	100	220	122.2	269	40	40	20	
Tao Jiang	100							Sabbatical FWS
Vana Kalogaraki	100	253	153		40	40	20	
		179						
Eamonn Keogh	100		205	235	40	40	20	ABET Comm
Srikanth Krishnamurthy	100	164	260	257	30	50	20	Buyout
Stefano Lonardi	100	234	218	150	40	40	20	
Mart Molle	100	204	177	179	40	40	20	Grad Advisor
Walid Najjar	100			260	40	40	20	
		161L/2	161L/2	161L/2				
				203B				

Thomas Payne	100		152	201	20	20	60	Chair
Teodor Przymusinski	100	152	180	152	40	40	20	search comm.
		287/1	287/1	287/1				colloquium
Chinya Ravishankar	100	165	255		30	40	30	Assoc dean
Vassilis Tsotras	100	166			40	40	20	Sabbatical W/S
Frank Vahid	100	122A	!20B	179	40	40	20	
		61						
Jun Yang	100	161	161		40	40	20	
		203A						
Victor Zordan	100	130	260	134	40	40	20	
Christian Shelton	100	179M	170	272	40	40	20	
Neal Young	100	141	141	141	40	40	20	
			260					
Guru Parulkar	100				40	40	20	on leave to NSF
Gianfranco Ciardo	100	260.3	237		30	40	30	Assoc Chair
		150						
Brian Linard	100	12.1	61	61	100	100	100	
		12.2	12.1	12.1				
		6	6	6				
Kris Miller	100	10.1	10.1	10.1	100	100	100	
		10.2	10.2	10.2				
		10.3	5	5				
Jason Villarreal	50	100	21	100	50	50	50	
Victor Hill	11			183				
Ann Gordon-Ross	50	14	14	14	50	50	50	

Titus Winters	50	153	179	153	50	50	50	
Brian Gratton	22	120B		120B	33		33	
Doug Tolbert	11		245			33		
Y.C. Hong	0				0	0	0	
Essia	12.6			12.2			50	

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-3. Faculty Workload Summary
Electrical Engineering Faculty

Faculty Member (Name)	FT or PT	Classes Taught (Course No./Credit Hrs.)	Total Activity Distribution: Teaching		Research		Other		Other service (if applicable)
			Term	Year	Term	Year	Term	Year	
Balandin, Alexander	FT	EE 116 (4 units)	30%						
Barth, Matt	FT	ENGR 92 (1 unit), EE 128 (4 units)	37%						
Beni, Gerardo	FT	EE 1A (3 units), EE 143 (4 units)	60%						
Bhanu, Bir	FT	EE 240 (4 units)	30%						
Chen, Jie	FT	EE 110A (4 units)	30%						
Dumer, Ilya	FT	EE 115 (4 units)	30%						
Farrell, Jay	FT	EE 237 (4 units)	30%						
Hackwood, Susan[1]	PT (10%)	N/A	0%				90%		See footnote
Hua, Yingbo	FT	EE 141 (4 units), EE 226 (4 units)	60%						
Korotkov, Alexander	FT	EE 201 (4 units)	30%						
Lake, Roger	FT	EE 208 (4 units)	30%						
Liang, Ping	FT	EE 210 (4 units)	30%						
Liu, Jianlin	FT	EE 133 (4 units)	30%						
Lyubomirsky, Ilya	FT	EE 1B (4 units)	30%						
Ozkan, Mihri	FT	CEE 200 (4 units)	30%						

[1] 90% Governor's appointment as Director of the California Commission on Science and Technology.

Roy Chowdhury, Amit	FT	EE 241 (4 units)	30%						
Tan, Xiang-Dong	FT	EE 120A (5 units)	30%						
Tuncel, Ertem	FT	EE 260 (4 units)	30%						
Xu, Zhengyuan	FT	EE 215 (4 units)	30%						
El-Sherief, Hossny[2]	PT	None offered this quarter.	0%		0%		100%		See footnote
Fonoberov, Vladimir[2]	PT	None offered this quarter.	0%		100%		0%		See footnote
Fu, Peilin[2]	PT	EE 1A (3 units)	33%		67%		0%		See footnote
Giles, Dan[2]	PT	EE 10 (2 units)	25%		0%		75%		See footnote

[2] For all part-time Adjunct faculty and Lecturers, the percentages in the "Other" category represent time spent through their regular employment outside of the university

Table I-4. Faculty Analysis
Computer Science and Engineering Faculty

Name	Rank	FT/ PT	Highest Degree	Institution from which Highest Degree Earned & Year	Years of Experience: Govt./ Industry Practice	Years of Experience: Total Faculty	Years of Experience: This Institution	State in which Registered	Level of Activity (high, med, low, none): Professional Society (Indicate Society)	Level of Activity: Research	Level of Activity: Consulting/ Summer work in Industry
Laxmi N. Bhuyan	Professor VIII (OS)	FT	Ph.D.	Wayne State University, 1982		24	5		Association for Computing Machinery (ACM), (Fellow, 2000); Institute of Electrical and Electronic Engineering (IEEE), (Fellow, 1998); American Association of Advancement in Science (AAAS), (Fellow 2002)	H	L
Marek Chrobak	Professor IV (OS)	FT	Ph.D.	Institute of Math, Polish Academy of Sciences, 1984		22	19		Association for Computing Machinery (ACM); Institute of Electrical and Electronic Engineering (IEEE); SIGACT; EATCS	H	**N**
Gianfranco Ciardo	Professor II (OS)	FT	Ph.D.	Duke University, 1989	10	17	2		Member, ACM (SIGMETRICS) Senior Member, IEEE (Computer Society)	H	**N**
Michalis Faloutsos	Associate Professor II (OS)	FT	Ph.D.	University of Toronto, 1999		7	7		Member Inter-Domain Multicast Routing Group (IDMR) of Internet Engineering Task Force (IETF); Member of the Engineering Chamber of Greece	H	**N**

Brett Fleisch	Associate Professor IV (OS)	FT	Ph.D.	University of California, LA, 1989		17			Association for Computing Machinery (ACM); Institute for Electrical and Electronics Engineers (IEEE); Computer Society Institute of Electrical and Electronics Engineers ; USENIX Society	H	**N**
Dimitrios Gunopulos	Professor I (OS)	FT	Ph.D.	Princeton University, 1995						H	**N**
Harry Hsieh	Assistant Professor IV (OS)	FT	Ph.D.	University of California, Berkeley, 2000		6			Institute of Electrical and Electronics Engineers (IEEE), since 1993	H	**N**
Tao Jiang	Professor V (OS)	FT	Ph.D.	University of Minnesota, 1988		18			Member Association for Computing Machinery (ACM, IEEE, IEEE Computer Society; Online Science Advisory Board (SAB); Editorial Board, International Journal of Foundation of Computer Science, 1999 - 2005; Editorial Board, Journal of Combinatorial Optimization, 2000 - Present; Editorial Board, Journal of Computer Science and Technology, 2000 - present; UC Life Science Informatics (LSI) Task Force, 2000 - 2002;Editorial Board, BMC Bioinformatics, 2001 - Present; Editorial Board, Journal of Bioinformatics and Computational Biology,	H	**N**

									2002 - present;		
Vana Kalogeraki	Assistant Professor III (OS)	FT	Ph.D.	University of California, Santa Barbara, 2000		6			Member of ACM Member of the Object Management Group (OMG)	H	**N**
Eamonn Keogh	Assistant Professor V (OS)	FT	Ph.D.	University of California, Irvine, 2001					Association for Computing Machinery (ACM); SIGMOD; SIGKDD; AAAI	H	**N**
Srikanth Krishnamurthy	Associate Professor II (OS)	FT	Ph.D.	University of California, San Diego, 1997					IEEE Communications Society; Association for Computing Machinery (ACM) - Sigmobile	H	**N**
Stefano Lonardi	Assistant Professor IV (OS)	FT	Ph.D.	Purdue University, West Lafayette, 2001		5			Association for Computing Machinery (ACM), since 1994; IEEE Computer Society, since 1994; Upsilon Pi Epsilon Honor Society, since 1997; Phi Kappa Phi Honor Society, since 2000; International Society for Computational Biology, since 2001	H	**N**
Mart Molle	Professor V (OS)	FT	Ph.D.	University of California, Los Angeles, 1981		25			Association for Computing Machinery (ACM); Institute of Electrical and Electronics Engineering (IEEE); Editorial Board, ACM/IEEE Transactions on Networking	H	**N**

Walid Najjar	Professor II (OS)	FT	Ph.D.	University of Southern California, 1988		18			Association for Computing Machinery (ACM); Institute of Electrical and Electronics Engineers (IEEE); IEEE Computer Society; Editorial Board, Parallel Computing, Theory and Applications, February 2002 - present	H	**N**
Guru Parulkar	Professor III (OS)	FT	Ph.D.	University of Delaware, 1987		19				H	**H**
Thomas Payne	Associate Professor IV (OS)	FT	Ph.D.	University of Notre Dame, 1967		39			Sigma Xi; Association for Symbolic Logic; Association for Computing Machinery (ACM); Mathematics Association of America; American Mathematical Society	L	**L**
Teodor Przymusinski	Professor VI	FT	Ph.D.	Institute of Math, Polish Academy of Sciences, 1974		32			American Association for Artificial Intelligence; Association for Logic Programming	H	**N**
Chinya Ravishankar	Professor III (OS)	FT	Ph.D.	University of Wisconsin, Madison, 1987		19			Senior member Institute of Electrical and Electronics Engineers (IEEE); Member of the Association for Computing Machinery (ACM)	H	N
Christian Shelton	Assistant Professor II (OS)	FT	Ph.D.	Massachusetts Institute of Technology, 2001		5			Member, ACM	H	N

Vassilis Tsotras	Professor III (OS)	FT	Ph.D.	Columbia University, NY, 1991		15			Institute of Electrical and Electronics Engineers (IEEE); Association for Computing Machinery (ACM); Sigma XI; Associate Editor, IEEE Transactions on Knowledge and Data Engineering, 9/2002 - 9/2004; Associate Editor, Very Large Databases Journal, 9/2003 - 9/2009	H	N
Frank Vahid	Professor II (OS)	FT	Ph.D.	University of California, Irvine, 1994		12			IEEE Computer Society; Association for Computing Machinery (ACM)	H	N
Jun Yang	Assistant Professor III (OS)	FT	Ph.D.	University of Arizona, 2002		4			IEEE member ACM Member	H	N
Neal Young	Associate Professor III (OS)	FT	Ph.D.	Princeton University, 1991		15			Phi Beta Kappa, ACM SIGACT	H	N
Victor Zordan	Assistant Professor III (OS)	FT	Ph.D.	Georgia Institute of Technology, 2002		4			ACM Member; ACM Siggraph Member; Golden Key National Honor Society	H	N
Brian Linard	Lecturer	FT	Ph.D.	University of Melbourne, 1979	8	5	5			N	N
Kris Miller	Lecturer	FT	BS	University of California, Riverside, 2001		3	3		Member, IEEE	N	N
Toby Gustafson	Lecturer	FT	MS	University of California, Riverside, 1991	15	15	15			N	SR. Software Engineer at Tyrell Software
Kara Dodge	Lecturer	PT	MS	University of Michigan, 2001	5	?	1			N	H

Bonnie Graham	Lecturer	PT	BA	University of California, San Diego, 1990	16	4	1			N	H
Sharon Burton	Lecturer	PT	BS	University of California, Riverside, 1988	10	8	1			N	H
Doug Tolbert	Lecturer	PT								N	H
Brian Grattan	Lecturer	PT	MS	University of California, Riverside, 2002	7	?	?		Member, IEEE	N	H

Electrical Engineering Faculty
Tenured

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) in:		
					Gov't./Industry Practice	Total Faculty	This Institution		Professional Society (Indicate Society)	Research	Consult/Smr. Work in Industry
Balandin, Alexander	Professor	FT	Ph.D.	University of Notre Dame, 1997	0	7	7	N/A	IEEE: Med. Amer.Physics Soc.: Med. Electrochem. Soc.: Med. Int'l. Thermoelec. Soc.: Med. ASEE: Med. SPIE: Med. MRS: Med.	High	Low
Barth, Matthew	Professor	FT	Ph.D.	UC Santa Barbara, 1989	1	11	11	N/A	IEEE: High Trans. Rsch. Board: High Air& Waste Mgmt. Assoc.: Med.	High	Low
Beni, Gerardo	Professor	FT	Ph.D.	UC Los Angeles, 1974	10	20	13	N/A	AAAS: Low Amer. Phys. Soc.: Low	Low	None

Bhanu, Bir	Professor	FT	Ph.D.	University of Southern California, 1981	8	16	14	N/A	IEEE: High AAAS: Med. Int. Assoc. Pattern Recog.: SPIE: Med. Assoc. Comp. Machinery: Med. Amer. Assoc. for Artificial Intell.: Med.	High	Med.
Chen, Jie	Professor	FT	Ph.D.	University of Michigan, 1990	0	12	12	N/A	IEEE: Med. Control Syst. Soc.: Med.	High	None
Dumer, Ilya	Professor	FT	Ph.D.	Institute for Problems of Information Transmission Russian Academy, 1981	7	10.5	10.5	N/A	IEEE: High	High	None
Farrell, Jay	Professor	FT	Ph.D.	University of Notre Dame, 1989	9.5	12	12	N/A	IEEE: High	High	Low
Hackwood, Susan	Professor	PT (10%)	Ph.D.	DeMontfort University, England, 1979	3	21	16	N/A	IEEE: Med.	Low	None
Hua, Yingbo	Professor	FT	Ph.D.	Syracuse Univ., 1988	0	5	5	N/A	IEEE: High	High	None
Korotkov, Alexander	Associate Professor	FT	Ph.D.	Moscow State Univ., 1991	0	6.5	6	N/A	IEEE: High Amer. Phys. Soc: Med. SPIE: High.	High	None
Lake, Roger	Associate Professor	FT	Ph.D.	Purdue University, 1992	8	6	6	N/A	IEEE: Med.	High	None
Liang, Ping	Associate Professor	FT	Ph.D.	University of Pittsburgh, 1987	0	18	14	N/A	IEEE: Med.	Med.	Med.

Untenured

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) in:		
					Gov't./Industry Practice	Total Faculty	This Institution		Professional Society (Indicate Society)	Research	Consult/Smr. Work in Industry
Liu, Jianlin	Assistant Professor	FT	Ph.D.	UC Los Angeles, 2003	0	3	3	N/A	IEEE: Med. Amer. Phys. Soc.: High	High	None
Lyubomirsky, Ilya	Assistant Professor	FT	Ph.D.	Mass. Inst. Tech., 1999	4.5	3	3	N/A	IEEE: High Optical Soc. Amer.: Med.	High	None
Ozkan, Mihrimah	Assistant Professor	FT	Ph.D.	UC San Diego, 2001	3	5	5	N/A	IEEE: High Mater. Res. Soc.: High Optics Soc. Amer.: Med. Biomed. Engr. Soc.: Med. Int'l. Soc. BioMEMS & Biomed. Nanotech.: High	High	None

Roy Chowdhury, Amit	Assistant Professor	FT	Ph.D.	Univ. Maryland College Park, 2002	1	3	3	N/A	IEEE: High	High	None
Tan, Xiang-dong (Sheldon)	Assistant Professor	FT	Ph.D.	Univ. of Iowa, 1999	5.5	5	4	N/A	IEEE: High Assoc. Comp. Machinery: Med. ACM SIGDA: Med.	High	Low
Tuncel, Ertem	Assistant Professor	FT	Ph.D.	UC Santa Barbara, 2002	0	3	3	N/A	IEEE: High	Med.	None
Xu, Zhengyuan (Daniel)	Assistant Professor	FT	Ph.D.	Stevens Institute of Technology, 1999	5	7	7	N/A	IEEE: High	High	None

Table I-5. Note that the Computer Engineering program is a joint effort of the Department of Computer Science and Engineering and the Department of Electrical Engineering.

Table I-5. Support Expenditures
Bourns College of Engineering – Department of Computer Science & Engineering

	1	2	3	4
	2004	2005	2006	2007
Fiscal Year	(prior to previous year)	(previous year)	(current year)	(year of visit)
Expenditure Category				
Operations[1] (not including staff)	199,522.49	269,545.22	182,733.61	
Travel[2]	71,667.41	91,242.61	72,864.65	
Equipment[3]				
Institutional Funds	111,340.88	8,854.36	71,635.47	-
Grants and Gifts[4]	26,801.13	8,854.36	-	-
Graduate Teaching Assistants	766,157.16	785,543.11	942,475.66	
Part-time Assistance[5] (other than teaching)	80,820.57	118,358.36	93,310.49	

Table I-5. Support Expenditures
Bourns College of Engineering – Department of Electrical Engineering

	1	2	3	4
	2004	2005	2006	2007
Fiscal Year	(prior to previous year)	(previous year)	(current year)	(year of visit)
Expenditure Category				
Operations[1] (not including staff)	303,749.99	306,598.50	269,637.97	
Travel[2]	51,698.34	78,142.45	83,256.13	
Equipment[3]				
Institutional Funds	394,013.10	403,941.63	33,333.57	
Grants and Gifts[4]	329,328.07	57,076.23	50,471.79	
Graduate Teaching Assistants	236,015.65	273,177.04	255,103.63	
Part-time Assistance[5] (other than teaching)	15,259.17	21,077.05	31,672.32	

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