San José State
UNIVERSITY

.

Program Self-Study Report

MECHANICAL ENGINEERING

College of Engineering
San Jose State University

June 15, 2005

A. BACKGROUND INFORMATION

A.1 Degree Titles

San Jose State University awards a *Bachelor of Science in Mechanical Engineering* degree with the following areas of focus:
- Mechanical Design
- Mechatronics
- Thermal / Fluids

A.2 Program Modes

The Bachelor of Science Degree in Mechanical Engineering is offered in a day mode.

A.3 Actions to Correct Previous Shortcomings

A.3.1 College-Wide Cited Shortcomings and Corrective Actions

In the previous ABET statement, the following deficiency applied to all programs:

Criterion #1—Students: The institution does not have in place and enforce a process that ensures that all graduating students meet all program criteria.

Both the university and the College have taken extensive actions to address this area of concern. A procedure was put in place since the last ABET visit to assure the accuracy of the graduation approval process. The key document in this process is the Major form. A Major Form specifies each and every course a student needs to complete in order to meet the major graduation requirements. Major Forms are prepared by the students, evaluated by the major advisor, and, if it is done correctly, approved by the department chair.

In the previous graduation approval process, the Records Office performed the final graduation check based on Major Forms approved and submitted by the major departments one year prior to students' graduation. Following the last ABET visit, the engineering programs inserted two extra steps into the approval process, described as follows:

1) All engineering major forms must route through the Dean's office. Dean's office's staff verifies the accuracy and completeness of the forms before forwarding them to the Records Office.

2) A graduation check is performed by the Records Office after the grades are posted at the end of the expected graduation semester. After the Records Office verifies graduation eligibility, a final clearance check is requested of the department. This final clearance check by the major department essentially eliminates any possibility for miscommunication between the major department and the Records Office.

Since the last ABET visit, the following management information system changes took place that facilitate increased accountability and compliance with course, curricula and graduation requirements:

- In 2003, the university was converted to a PeopleSoft based program. Beginning Spring 2005, this system makes a degree audit function available to students and their advisor. This degree audit report tracks students' progress toward meeting their graduation requirement. At this point, this function is used only for academic advising purposes.

- Starting Fall 2004, a real-time prerequisite check was implemented in most upper division engineering classes. This system blocks attempts to register into a course without the proper prerequisite(s).

For staff guidance, the College created a document, "Graduation Application Procedure," (Appendix III-A) that describes in detail all of the forms and procedures needed to process a student through graduation. The department staff members meet with the Records office staff every semester to discuss issues, changes, and any new policies for the graduation process. In

2003, the College conducted an audit of the system by randomly choosing ten students from each program graduating in Spring 2003. All students had met the appropriate graduation requirements.

A.3.2 ME Program-Specific Cited Shortcomings and Corrective actions

In the last ABET visit (1999), the following weaknesses were cited:

Criterion # 5 – Faculty: Of the six full-time ME faculty members, only one has competency to cover the thermal-fluids curricular area of the program.

This weakness has been resolved. At the time of the 1999 visit, only one full-time faculty member (Dr. Lambert) had specialty competence in thermal-fluids. Since then, two new ME faculty members in the thermal-fluids area were hired (Drs. Okamoto and Rhee). Dr. Lambert resigned in 2000, so presently the department has one additional full-time faculty member in this area. Moreover, Drs. Mourtos and Papadopoulos coordinate and teach the fluid mechanics (ME111) course.

Criterion # 8 – Program Criteria: The syllabus for ME130 includes two weeks of instruction in linear algebra and two weeks of instruction in statistics. The syllabus for ME120, includes three weeks of instruction in the analysis of experimental data. Based on a review of student work and course materials at the time of the visit, the coverage of these topics does not seem to be sufficient to provide the familiarity with statistics and linear algebra appropriate for a ME as required in Criterion 8.

A report was submitted describing the changes in ME120, ME130, and ME147 to ensure familiarity with statistics and linear algebra. This weakness was removed, but a concern remains until the effectiveness of these changes can be demonstrated.

A.4 Contact Information

ME Program Assessment Coordinator: Dr. Nikos J. Mourtos
Department of Mechanical & Aerospace Engineering
San Jose State University
One Washington Square
San Jose, California 95192-0087
Tel. (408) 924-3867
Fax (408) 924-3995
Email njmourtos@sjsu.edu

B. ACCREDITATION SUMMARY

B.1 Students

Criterion 1 requires that (a) students be evaluated, advised and monitored in a manner consistent with program objectives and (b) there are proper procedures for evaluating courses taken at other institutions and accepting transfer students. Student performance is evaluated through a variety of course materials and is reflected in the assigned grades for each student. Faculty members monitor each student's progress towards graduation and enforce transfer policies through mandatory advising, on a semester-by-semester basis.

B.1.1 Advising of New and Continuing Students

Students entering the program are given a brief orientation and initial advising by departmental faculty. Subsequently, continuing students must see an academic advisor at least once per semester. The Department has appointed three faculty members as student academic advisors, who receive 20% release time (one course) for this purpose. Advisors monitor progress toward the degree, ensure that students follow the published curriculum for their program, take courses (technical and general education) in the proper order, make adjustments to students' schedules as appropriate, and provide career guidance. This is particularly important for SJSU students, since most of them are working part-time. Each semester, an optional general advising group meeting occurs for making curriculum announcements and clarifications, and answering general questions on advising and degree requirements. Subsequently, students are required to see an advisor by individual appointment. A "hold" is placed on each student's record and removed only after the student has seen an academic advisor.

Students are also required to develop with the help of their advisor, an acceptable study program and document it on a "major form", normally filed 15 months prior to graduation. The Academic Advisor and the Department Chair approve the "major form" and forward it, along with the student's application for graduation to the College Dean's Office. Dean's office's staff verifies the accuracy and completeness of the forms before forwarding them to the Records Office.

Materials used to assist students in developing their plans are available on the Mechanical and Aerospace Engineering website <http://www.engr.sjsu.edu/mech/majorforms/index.htm>. There is an excellent web site as well for faculty reference in their roles as Academic Advisors: <http://www2.sjsu.edu/ugs/arb/index.html>.

The University has established a very detailed General Education curriculum that all undergraduate students must complete (see Appendix II, Exhibit II-8). Department Academic Advisors ensure that all students in the Program fulfill the University General Education requirements. In addition, students are required to consult with General Education advisors at the Assessment Center in the Office of Admissions and Records.

B.1.2 Monitoring Student Performance

Student performance is monitored at both the University and Department levels. The Office of Admissions and Records places on probation any student whose cumulative grade point average (GPA) falls below 2.0 ("C"). Students are disqualified from the major if their GPA falls below 2.0 for two consecutive semesters. Department academic advisors monitor student progress and grade performance through the accumulative checklist in the student's advising folder and the major form filed a year or more before graduation (Appendix II, Exhibit II-3).

B.1.3 Minimum Grade Requirements

To ensure that students have a good grasp of fundamental concepts that serve as the basis for more advanced design and analysis courses, students are required to earn a minimum grade of C in key communication and mathematics courses (English 1A, 1B, Technical Writing E100W, Oral Communication, Math[1] 30, 31, 32), science courses (Chemistry 1A, Physics 50, 51, 52 or 70, 71, 72) and in key engineering courses (CE112, ME101, ME111, ME113, ME130, AE162, AE165). Students who do not earn the required minimum grade in any of these courses must repeat them before registering in more advanced courses. Moreover, students need to pass the Writing Skills Test (WST) before registering in E100W and they must receive a minimum score of 6 out of 12 on their exit exam essay to receive a passing grade in the course itself. WST tests and E100W final exam papers are graded by certified instructors.

B.1.4 Characterization of College Student Population

The College student population in Fall 2004 was 3183 majors. This includes 16% women, 41% Asian, 17% White, 10% Filipino, 4% Hispanic, and 4% African-American.

The average student age is about 26. The average student load is just under 12 units, and most upper-division engineering students work part-time. Nearly all students enter from San Francisco Bay Area high schools and community colleges, and are commuting to the University. The average time to degree is extended to about 6.5 years, primarily due to taking less than a full load and working part-time.

B.2 Mechanical Engineering Program Educational Objectives (PEO)

The Mechanical Engineering Program Educational Objectives (PEO) have been developed to be consistent with the mission of (a) San Jose State University (SJSU), (b) the College of Engineering (COE) and (c) the Department of Mechanical and Aerospace Engineering (MAE).

B.2.1 SJSU Mission Statement

[1] The CSU GE Basic Skills Course graduation requirement is that engineering students must receive a "C" or better in one of the three courses, and a C- or better in the other two.

San Jose State University is a major comprehensive public university located in the city of San José and in the heart of Silicon Valley, the world's center of innovation. Its distinctive character has been forged by its long history, by its location, and by its vision - a blend of the old and the new, of the traditional and the innovative. Among its most prized traditions is a commitment to offer access to high-quality higher education to all persons who meet the criteria for admission. The result is a diverse student population whose members are from various age groups, cultures, and economic backgrounds; and a faculty dedicated to teaching and learning.

In collaboration with nearby industries and communities, this faculty and staff is dedicated to achieving the University's mission as a responsive institution of the State of California:

To enrich the lives of its students, to transmit knowledge to its students along with the necessary skills for applying it in the service of our society, and to expand the base of knowledge through research and scholarship.

The University's goals are that SJSU graduates should have:

- In-depth knowledge of a major field of study.
- Broad understanding of the sciences, social sciences, humanities, and the arts.
- Skills in communication and in critical inquiry.
- Multi-cultural and global perspectives gained through intellectual and social exchange with people of diverse economic and ethnic backgrounds
- Active participation in professional, artistic, and ethnic communities.
- Responsible citizenship and an understanding of ethical choices inherent in human development

B.2.2 Vision, Mission, and Goals of the College

Vision: *To be a leading provider of high quality, practice-oriented engineering graduates through excellence in education, research, and scholarship.*

Better the World: To achieve this vision, we intend to implement programs that will provide students an understanding of the social and economic context in which technologies are developed and used. Further, students also need to gain a firm ethical grounding, and guidance for their beneficial applications. The applications could be for social benefit, economic advancement, security, or the environmental sustainability of the world. In particular, our students need to understand the economic forces that shape the role of American engineers in today's competitive global economy.

Engineering Knowledge and Skills: Engineers develop their capabilities based on scientific knowledge and analytical methods. Our students need to acquire a solid foundation in the knowledge and methods that will prepare them for life-long learning in today's rapidly advancing world of technology. Further, in order to be competitive, our students must have superior knowledge of engineering theory and honed skills in the application of theory-to-practice. They need to master engineering topics that correspond to industry issues and trends as well as evolving global requirements.

Innovative Applications: In addition to learning engineering theory and skills, our students must have opportunities to learn innovation—a capability highly valued in today's global economy. Given its close ties to Silicon Valley industry, the College is in a unique position to focus its efforts on developing innovative applications of technologies. Innovation, defined as the development and exercise of creative processes to "see" beyond limits and boundaries, has the entrepreneurial quality of understanding and meeting customers' needs. It often occurs across disciplinary boundaries with contributing members having various functional expertise. Further, the ability to innovate contributes directly to the success of enterprises.

In summary, our vision for the College articulates our aspiration to inspire and educate our students to develop engineering capabilities as well as to understand the context in which such capabilities are used with the end goal of benefiting humanity.

Mission: *We will provide empowering educational opportunities to students for their technical, professional and social development in a competitive and dynamic global society. We will build a vibrant community of students, faculty, staff, alumni, and industry professionals through strategic collaborations with Silicon Valley, California, national and global partners.*

Goals:
(a) To be preeminent among undergraduate engineering institutions in the U.S.

- Nationally recognized for engagement with local and global industries.
- Preferred California State University campus for undergraduate engineering education.
- Nationally recognized for curriculum and quality of undergraduate experience.

(b) To have nationally recognized, professionally oriented graduate engineering programs.

- Nationally recognized for an applied technological curriculum.
- Coordinated graduate and outreach programs responsive to regional industry.
- To be the preferred partner for applied research and development
    - Initiating centers of excellence and programs.

B.2.3 MAE Department Mission

To serve society, the public sector, and private industry by

- Providing undergraduate and graduate Mechanical and Aerospace engineering education that equips students with the knowledge, modern applications and lifelong learning skills required to serve the engineering profession and industry.
- Contributing to the development and application of knowledge through faculty scholarship.
- Preparing students for the modern professional-practice environment.

B.2.4 Constituents

The MAE Department has identified the following as its constituents:

- ME and AE students.
- MAE Faculty
- Alumni of the ME and AE programs
- Employers of the ME and AE program graduates

B.2.5 Mechanical Engineering PEO

The undergraduate Mechanical Engineering Program is designed to fulfill the University, College, and Department mission described in the previous sections. It provides students with a broad understanding of basic Mechanical engineering concepts, as well as the contemporary skills required by industry. The foundation courses provide a basis for professional competence and the required knowledge to focus on a particular specialization upon graduation, either in the work environment or through pursuing advanced degrees. Courses that develop contemporary skills provide students an ability to be immediately competitive and productive as they begin their professional careers. The coursework includes extensive laboratory experiences and many opportunities for students to complete applied projects and designs.

The Mechanical Engineering PEO reflect our constituents' expectations that our graduates should have:

1. A strong foundation in mathematics, basic science and engineering fundamentals, to successfully compete for entry-level positions or pursue graduate studies in AE or related fields.

2. Contemporary professional and lifelong learning skills including hands-on laboratory experience, familiarity with computers, modern software, and information technology, to successfully compete in the local, national and global engineering market.

3. Strong communication and interpersonal skills, broad knowledge, and an understanding of multicultural and global perspectives to work effectively in multidisciplinary teams, both as team members and as leaders.

4. An understanding of the ethical choices inherent in the engineering profession to deal with issues such as public safety, honest product marketing, and respect for intellectual property.

B.2.6 Development and Evaluation of PEO

In Spring of 2003, our PEO were revised to conform to the new ABET definition, namely that PEO reflect the career and professional accomplishments of our graduates during the first several years after graduation. The input from our constituents is used for two purposes: (a) to validate the definition of our PEO, and (b) to assess the achievement of our PEO. This process is illustrated in figure B.2.1. Our PEO are revisited periodically every three years. They are evaluated and revised as necessary based on feedback from employers, alumni, faculty, and students (see section B.2.9).

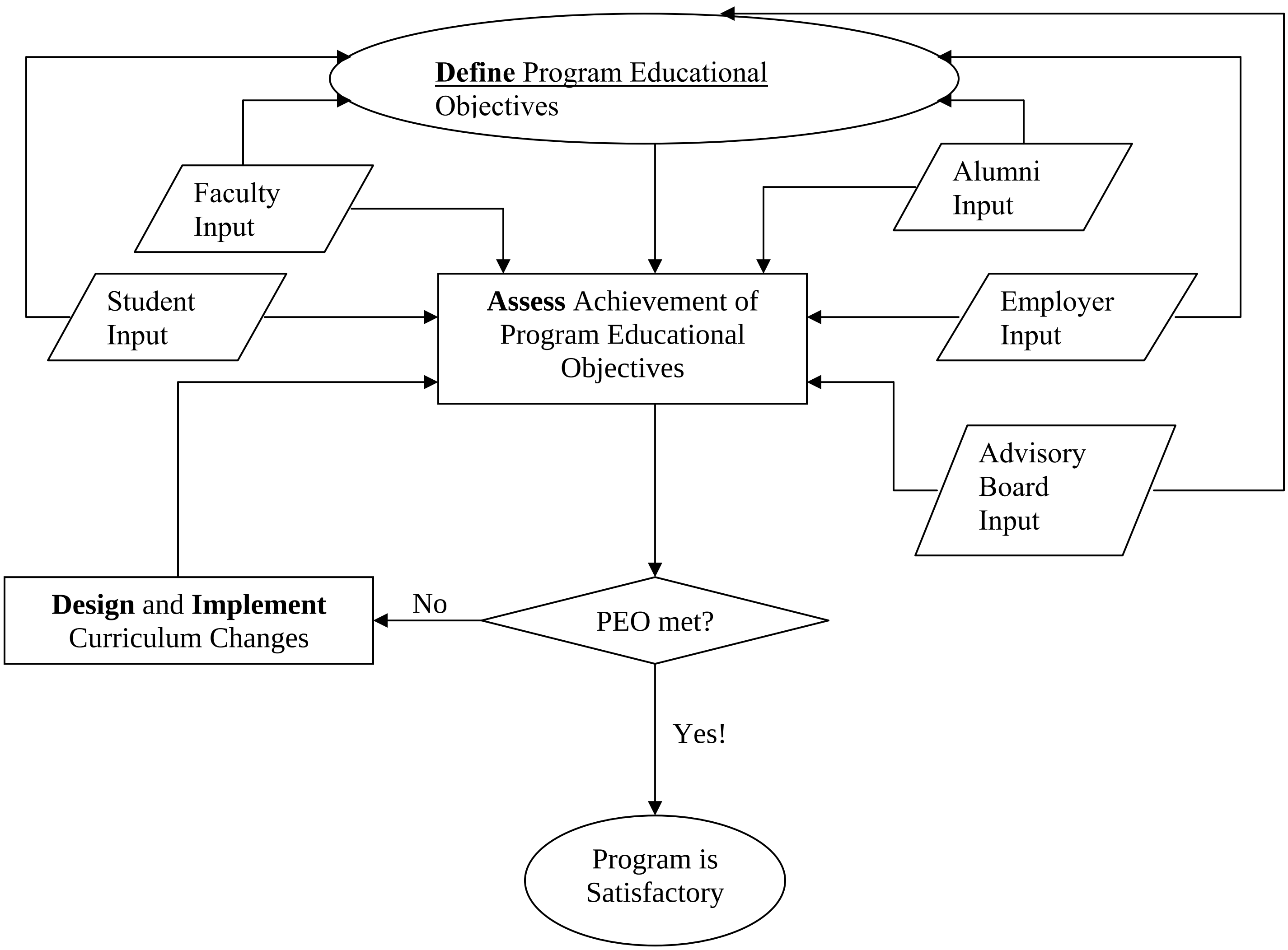

Figure B.2.1. Definition and assessment process for Program Educational Objectives.

B.2.7 Achievement of PEO

The PEO are achieved primarily through the Program curriculum, which is designed to emphasize problem solving, design skills and experiential learning (see section B.4). Building on a foundation of mathematics, science, and engineering skills, students take courses in the basic engineering disciplines (circuit analysis, statics, mechanics of materials, dynamics, fluid mechanics, and thermodynamics). In addition, they take a series of courses across the disciplines that apply engineering principles to mechanical engineering systems, emphasizing teamwork and communication skills, open-ended problems, modern software, and laboratory experiments ranging from basic measurements to systems-level experimentation. Finally, the seniors integrate their skills in a year-long mechanical engineering project, in which they undertake a team-based design subject to realistic constraints, such as economic, environmental, social, safety, liability, and manufacturability. Additional exposure to these issues comes through case studies, guest speakers and field trips.

Students take also a minimum of four elective courses plus a capstone course that allows them to explore one mechanical engineering area in more depth and develop specialized skills or focus on applications of immediate use in industry. Some electives involve considerable computer-based skills, some involve laboratory hands-on experience, some involve significant design experience, and several require oral presentations and / or written reports.

Non-curriculum mechanisms that support student achievement and growth include:

- Department-level student engineering societies: ASME (American Society of Mechanical Engineers), SAE (Society of Automotive Engineers), ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers), AFE (Association of Facilities Engineering), and Pi Tau Sigma).
- College-level student societies: AISES (American-Indian Science and Engineering Society), BASE (Black Alliance of Scientists and Engineers), MESA Engineering Program, (MEP), SME (Society of Manufacturing Engineers), SOLES (Society of Latino Engineers and Scientists), SWE (Society of Women Engineers), VESA (Vietnamese Engineering Students Association), and Tau Beta Pi (Engineering Honor Society).
- Department provision of financial, technician, and technical support for students in the senior design projects and students entering regional and national design competitions.

B.2.8 Relationship between PEO and Program Outcomes

The PEO are linked to the Program Outcomes as shown in table B.2.1.

Table B.2.1 Relationship between PEO and Program Outcomes

	Program Outcomes										
	3a	3b	3c	3d	3e	3f	3g	3h	3i	3j	3k
PEO # 1	✓	✓	✓		✓				✓		
PEO # 2		✓	✓		✓				✓		✓
PEO # 3		✓	✓	✓	✓		✓	✓	✓	✓	
PEO # 4			✓			✓				✓	

Hence, one (indirect) way to evaluate the achievement of the PEO is through the assessment of the Program Outcomes. This assessment is presented in section B.3.

B.2.9 Direct Evaluation of the PEO

Table B.2.2 shows the various tools we use to evaluate achievement of the PEO.

Table B.2.2 Measures used for PEO evaluation

	Faculty evaluation	Exit interviews	Employment data	Graduates completing M.S. degree	Alumni survey	Employer survey	ME Advisory Committee Input
PEO # 1	✓	✓	✓	✓	✓	✓	✓
PEO # 2	✓	✓	✓	✓	✓	✓	✓
PEO # 3	✓	✓	✓	✓	✓	✓	✓
PEO # 4	✓	✓	✓			✓	✓

B.2.9.1 Faculty Evaluation of the PEO

Two department meetings (April 5 and April 12, 2005) were dedicated to the evaluation of the PEO by the faculty. Each PEO was presented and faculty were asked to share their opinion on how well our students meet the PEO by the time they graduate, based on their interactions with students in their courses. A summary of the results, along with the scale used to record faculty input is shown in table B2.2

Table B.2.2 PEO Evaluation by MAE Faculty

	Average	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
PEO # 1	3.05	3	3	3	3	2.5	3	3	-	2.5	4	4	2.5
PEO # 2	3.55	3	4	3.5	4	2.5	-	3.5	-	4	3.5	4.5	3
PEO # 3	3.15	3	2.5	3	3.5	3	-	3.5	-	3	3	4	3
PEO # 4	2.67	n/a	2.5	3	3	2	-	3	-	2	2.5	3	3

5: Students truly excel in these skills!
4: Students have strong skills in this area.
3: Students have adequate skills in this area.
2: Students do not have adequate skills in this area.
1: Students do not have any skills in this area.

In general, the faculty felt that most of our students:

- (PEO # 1) Have adequate skills in mathematics, science, and engineering fundamentals to compete for entry-level positions, but they are less prepared in this area for graduate studies. This observation is reinforced by the fact that most of our students seek employment after graduation and only a small percentage continues their studies in graduate school.
- (PEO # 2) Are well prepared in contemporary professional and lifelong learning skills to compete in the local, national and global engineering market. They are more capable in conducting experiments and building models and applying computer skills than they are in the design of experiments, data analysis and interpretation.
- (PEO # 3) Are excellent presenters but only adequate writers. Our rigorous general education program and multicultural campus environment provide them with broad knowledge, as well as understanding of multicultural and global perspectives. They work well in teams and many of them have excellent leadership skills.
- (PEO # 4) Have a good understanding of the ethical issues that arise in their profession, however, their choices are not always ethical, especially when it comes to issues related to academic honesty and the respect of intellectual property.

B.2.9.2 Evaluation of the PEO through Exit Interviews

Thirty-nine (39) graduating seniors have been interviewed (Fall 2003 through Spring 2005). The three open-ended questions that were used in these interviews, along with a summary of the most frequent student responses, are shown below.

Question 1: What do you think are the most important skills for a ME to compete successfully for entry-level positions in industry or entry to a graduate program?

The top six skills mentioned are as follows:

- 64% (25) communication skills (oral and written, report writing, documentation, ability to debate)
- 46% (18) team / interpersonal skills
- 38% (15) project skills (ability to carry out a project, design-build-test, etc.)
- 36% (14) basic engineering science skills
- 23% (9) management / leadership / business skills / engineering economics
- 23% (9) professionalism (attitude towards responsibilities, good work ethics)

The student responses indicate that all four PEO are valid educational objectives for the ME Program.

Question 2: Do you feel that our ME program prepared you adequately in the skills you consider important? Which courses prepared you for these skills?

- Communication skills:
  - Yes = 51% (20) ME195 (13), ME120 (6), E100W (4), ME154 (4), ME157 (4)
  - No = 13% (5)
- Team / interpersonal skills
  - Yes = 31% (12) ME195 (8), ME154 (6), ME157 (5), ME106 (3)

    - No = 15% (6)
- Project skills:
    - Yes = 28% (11)   ME195 (8), ME110 (7), ME106 (3)
    - No = 5% (2)
- Basic engineering science skills
    - Yes = 31% (12)   ME113 (7), ME114 (7), ME154 (6), CE112 (5), ME111 (4)
    - No = 5% (2)
- Management / leadership / business skills / engineering economics
    - Yes = 5% (2)   ME157 (2), General Education Courses (1), ME195 (1)
    - No = 155 (6)
- Professionalism and ethics
    - Yes = 10% (4)   ME195 (2), E100W (1), ME120 (1), ME154 (1), ASME (1)
    - No = 8% (3)

The student responses indicate that the ME Program achieves PEO # 1, 2, and 3. However, the students were split on whether the Program achieves PEO # 4 (professionalism and ethics).

Question 3: Do you have any comments, positive or negative, about the ME program?

On the positive side students' top choices were:
- 33% (13) the effectiveness, responsiveness, knowledge, and availability of the faculty
- 23% (9) the overall quality of the ME Program
- 18% (7) the labs in courses such as MatE25 (1), CE113 (1), ME110 (3), ME114 (2)

On the negative side students' top concerns were:
- 15% (6) the quality of teaching from some of the faculty
- 15% (6) the inadequacy of some of the labs and college facilities

B.2.9.3 Evaluation of the PEO through Employment Data of BSME Graduates

Fifty-five (55) alumni surveys have been received through Spring 2005. The most frequent job titles among the respondents were *design engineer*, *systems engineer, and mechanical engineer*. The types of jobs our ME graduates hold indicates that the ME Program prepares them well for these positions.

Table B.2.2 ME alumni job titles[2]

Job Title	# of Alumni
Design Engineer	11
Systems Engineer	9
Mechanical Engineer	8
Consultant / Contactor	4
Project Engineer / Manager	4
Applications Engineer	3
Quality / Reliability Engineer	3
Product Development / Support Engineer	3
Other engineering jobs	17

B.2.9.4 Evaluation of PEO through M.S. Degree Completion Data

[2] Alumni were asked to indicate all the jobs they held since graduation, hence the total number of jobs shown is greater than the number of surveys received.

As was mentioned earlier, most of our students seek employment after graduation. Nevertheless, our alumni survey shows that 25% (14) of them were enrolled in a graduate program at the time they filled out the survey, 36% (5) of them in the MSME (SJSU), 36% (5) at Santa Clara University (MBA, Engineering Management), one at CSU Hayward (MBA), and the rest at other SJSU programs. Another 26% (10) of the respondents had already acquired their graduate degree (5 from SJSU, 2 from Santa Clara U., one from Stanford) at the time they filled out the survey.

B.2.9.5 Evaluation of the PEO through Alumni Surveys

Respondents graduated with a BSME as early as 1987 (1) and as late as 2004 (10). Table B.2.3 shows a summary of their responses. The majority of them agreed that the skills described in the PEO are important in the work they do. With the exception of two areas, the majority of the respondents also agreed that the ME Program has adequately prepared them in these skills. The two areas in which respondents gave very low agreement ratings were:

- Students' preparation for graduate work (statement 1-7, PEO # 1) with an agreement rating of 42% (23)
- Broad knowledge as well as an understanding of multi-cultural and global perspectives in engineering (statement 3-5, PEO # 3), with an agreement rating of 44% (24).

Table B.2.3 Summary of alumni responses on the importance and achievement of the PEO

		Agree	Not sure	Disagree
1-1	The ME Program has given me a strong foundation in *mathematics.*	43	9	4
1-2	A strong foundation in mathematics *is important* for the kind of work I do.	40	9	7
1-3	The ME Program has given me a strong foundation in *science* (physics, chemistry, materials, etc.).	49	6	1
1-4	A strong foundation in science *is important* for the kind of work I do.	50	6	1
1-5	The ME Program has given me a strong foundation in *engineering fundamentals.*	53	3	
1-6	A strong foundation in engineering fundamentals *is important* for the kind of work I do.	54	2	
1-7	The ME Program has given me a strong foundation for *graduate work.*	23	29	4
2-1	The ME Program has prepared me well for *hands-on laboratory work.*	41	9	6
2-2	Hands-on laboratory work *is important* for the kind of work I do.	46	2	8
2-3	The ME Program has given me the necessary skills to work with *computers* (doing design, simulation, data acquisition and processing).	37	7	12
2-4	Computer work (design, simulation, data acquisition and processing) *is important* for the kind of work I do.	46	2	8
2-5	The ME Program has given me the necessary skills to *find information* and *learn on my own*.	42	10	4
2-6	The ability to find information and learn on my own *is important* for the kind of work I do.	55	1	
3-1	The ME Program has given me good communication skills.	36	13	7
3-2	Good communication skills *are important* for the kind of work I do.	52	3	1
3-3	The AE / ME Program has given me good *interpersonal, team,* and *leadership skills.*	37	13	6
3-4	Good interpersonal, team, and leadership skills *are important* for the kind of work I do.	53	3	
3-5	The ME Program has given me a *broad knowledge* as well as *an understanding of multicultural* and *global perspectives* in engineering.	24	15	17
3-6	A broad knowledge as well as an understanding of multicultural and global perspectives in engineering *are important* for the kind of work I do.	36	11	9
4-1	The ME Program has given me an *understanding of the ethical choices* inherent in the engineering profession to provide for issues such as	31	14	11

	public safety, honest product marketing, and respect for intellectual property.			
4-2	An understanding of the ethical choices inherent in the engineering profession to provide for issues such as public safety, honest product marketing, and respect for intellectual property *is important* for the kind of work I do.	51	4	1

B.2.9.6 Evaluation of the PEO through Employer Surveys

Six (6) employer surveys were received through Spring 2005 from companies that have hired 14 of our BSME graduates (GE Nuclear Energy, Motion Control Engineering, ATK Thiokol, Therma Corporation, CCS Associates, and Coen Company). Although the number of surveys received is too small to draw any conclusions it is noted that all made positive comments about the mechanical engineers they have hired from SJSU. Table B.2.4 shows a summary of their responses. The majority of them agreed that the skills described in the PEO are important in the kind of work they do. Moreover, the employers who responded agreed that the ME Program adequately prepares our graduates in most of the skills described by the PEO. However, in some of the skills, such as hands-on laboratory work (statement 2-1, PEO # 2), broad knowledge / understanding of multi-cultural and global perspectives (statement 3-5, PEO # 3), and understanding of ethical choices (statement 4-2, PEO # 4)], the agreement ratings were low.

Table B.2.4 Summary of employer responses on the importance and achievement of the PEO

		Agree	Not sure	Disagree
0-1	We are very satisfied with the SJSU mechanical engineers we have hired.	6		
1-1	SJSU mechanical engineers have a strong foundation in *mathematics.*	5		
1-2	A strong foundation in mathematics *is important* for the kind of work we do in our company.	5		
1-3	SJSU mechanical engineers have a strong foundation in *science* (physics, chemistry, materials, etc.).	5		
1-4	A strong foundation in science *is important* for the kind of work we do in our company.	6		
1-5	SJSU mechanical engineers have a strong foundation in *engineering fundamentals.*	5		
1-6	A strong foundation in engineering fundamentals *is important* for the kind of work we do in our company.	5		1
2-1	SJSU mechanical engineers are well prepared for *hands-on laboratory work.*	3	2	
2-2	Hands-on laboratory work *is important* for the kind of work we do in our company.	4	1	
2-3	SJSU mechanical engineers have the necessary skills to work with *computers* (doing design, simulation, data acquisition and processing).	5		
2-4	Computer work (design, simulation, data acquisition and processing) *is important* for the kind of work we do in our company.	5		
2-5	SJSU mechanical engineers have the necessary skills to *find information* and *learn on their own*.	5		1
2-6	The ability to find information and learn on their own *is important* for the kind of work we do in our company.	6		
3-1	SJSU mechanical engineers have good communication skills.	6		
3-2	Good communication skills *are important* for the kind of work we do in our company.	6		
3-3	SJSU mechanical engineers have good *interpersonal, team,* and *leadership skills.*	5	1	
3-4	Good interpersonal, team, and leadership skills *are important* for the	5	1	

	kind of work we do in our company.			
3-5	SJSU mechanical engineers have a *broad knowledge* as well as *an understanding of multicultural* and *global perspectives* in engineering.	2	2	1
3-6	A broad knowledge as well as an understanding of multicultural and global perspectives in engineering *are important* for the kind of work we do in our company.	4		1
4-1	SJSU mechanical engineers have an *understanding of the ethical choices* inherent in the engineering profession to deal with issues such as public safety, honest product marketing, and respect for intellectual property.	3	2	
4-2	An understanding of the ethical choices inherent in the engineering profession to deal with issues such as public safety, honest product marketing, and respect for intellectual property *is important* for the kind of work we do in our company.	2		

B.2.9.7 Evaluation of the PEO through Advisory Committee Input

The ME Advisory Committee (see appendix III-B) convened on April 26, 2005 to accomplish two objectives: (a) validate our definition of the PEO, and (b) determine whether the PEO are addressed well through the current ME curriculum.

Table B.2.5 PEO importance rating by the ME Advisory Committee

	Average	BM1	BM2	BM3	BM4	BM5	BM6	BM7
PEO # 1	**5.0**	5	5	5	5	5	5	5
PEO # 2	**3.5**	3	4	4	4	4	3	3
PEO # 3	**2.2**	3	2	1	3	2	3	2
PEO # 4	**2.2**	2	2	2	3	3	2	2

How important is this PEO?
5: Very important!
4: Important.
3: I am not sure.
2: Not important.
1: Irrelevant / should not be included.

Table B.2.6 PEO evaluation by the ME Advisory Committee

	Average	BM1	BM2	BM3	BM4	BM5	BM6	BM7
PEO # 1	**5.0**	5	5	5	5	5	5	5
PEO # 2	**4.8**	4	5	5	5	5	5	5
PEO # 3	**4.2**	5	3	5	3	5	4	5
PEO # 4	**3.2**	3	3	3	3	5	3	3

How well is this PEO addressed through the AE curriculum?
5: Very well!
4: Well.
3: Adequately.
2: Not adequately.
1: It is not addressed at all.

In regards to the importance of our current PEO, the response was unanimous that # 1 is very important (table B.2.5). However, the Committee members were not sure whether # 2 was important and they seemed to agree that # 3 and # 4 are not important. In regards to how well our current curriculum addresses these objectives, the Committee found that the first three PEO are addressed very well through the ME curriculum while the last one is addressed adequately (table B.2.6).

B.2.10 Conclusion

In summary, faculty, students, and alumni seem to agree that all four of the PEO are important for our ME Program. However, from the limited number of surveys received, it seems that employers of our ME graduates do not consider an understanding of ethical choices as important for the kind of work they do. This was also confirmed through the ME Advisory Committee input, which categorized both PEO # 3 and 4 as not important.

In regards to how well the ME Program addresses the PEO, students felt that they are not getting enough training in professionalism and ethics, while faculty expressed concerns about some students' academic honesty and respect of intellectual property (PEO # 4). A large percentage of ME alumni indicated that the level of preparation for graduate work (PEO # 1) as well as for work in a multi-cultural and global environment was not adequate. The latter was also confirmed by the responses in the employer survey.

B.3 Mechanical Engineering Program Outcomes and Assessment[3]

B.3.1 General Education (GE) Contributions to Program Outcomes

The following are the General Education (GE) Program objectives:

- To develop analytical skills and reasoning powers.
- To increase the ability to communicate ideas effectively both in speaking and in writing.
- To enhance the ability to live and work intelligently, responsibly, and cooperatively in a multicultural society and an increasingly interdependent world.
- To provide a fundamental understanding of science and the natural world.
- To further knowledge and appreciation of the arts and letters.
- To promote citizenship through knowledge of the forces that shape the individual and modern society.
- To develop abilities to address complex issues and problems using disciplined analytic skills and creative techniques.

The GE goals contribute significantly to the following ABET outcomes:
(3g) Ability to communicate effectively
(3h) Broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(3i) Recognition of the need for, and an ability to engage in life-long learning
(3j) Knowledge of contemporary issues

The GE program consists of the Core, which includes such skills as oral communication, written communication, critical thinking, and math concepts; and Advanced GE, which has as prerequisites completion of Core GE and a junior-level Writing Skills Test. The four Advanced GE Areas are:
Area Z. Written Communication II (100W, known as Writing Workshop)
Area R. Earth and Environment
Area S. Self, Society and Equality in the United States
Area V. Culture, Civilization and Global Understanding

General Goals of Advanced GE: Within the Advanced Areas, students in all majors are called upon to demonstrate certain skills and competencies judged to be important to an educated person in today's society. All courses in these four Areas must build upon the skills and knowledge base of Core GE. The four Advanced GE Areas complement education in the individual majors by assuring:

- *Advanced Writing.* The 100W courses require a minimum of 8,000 words, and each of the other three Advanced Areas a minimum of 3,000 words. In both instances, "..practice and feedback.." are required; thus simply turning in an end-of-semester term paper does not satisfy the GE requirement.
- *Interdisciplinary Perspectives*. All Advanced GE courses must consider issues from different academic disciplines.
- *Application of basic skills*. All Advanced GE courses demand that students use Core GE skills (reading, writing, speaking, critical thinking, research, and math).
- *Active participation*. All Advanced GE courses require active student participation.
- *Research*. All Advanced GE courses require students to utilize library research (broadly interpreted to include contemporary electronic information sources). Class study materials must include primary sources.

---

[3] The process, data and analysis of the ME Program Outcomes can also be found at http://www.engr.sjsu.edu/nikos/mematrix.htm

Table B.3.1 summarizes the contributions of the GE program to outcomes 3g, 3h, 3i and 3j. All GE Areas include area goals and specific student learning objectives. These are listed in the condensed GE Guidelines in Appendix I-E. Table I-D XXX in Appendix I-D summarizes the GE learning objectives for ABET outcomes g, h, i , and j.. Every GE course that is certified must provide evidence that students demonstrate achievement of the learning objectives as discussed in the section on GE certification and assessment.

Table B.3.1 Contributions of GE Areas to ABET Outcomes

ABET Outcome	GE Area
(g) an ability to communicate effectively	A1 – Oral Communication
	A2 – Written Communication 1A
	C3 – Written Communication 1B
	Pass the writing skills test
	Z – Written Communication
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	B1, B2 - Science
	C1 - Arts
	C2 - Letters
	D1, D2, D3 – Social Sciences
	R – Earth and Environment
	V – Culture, Civilization and Global Understanding
(i) a recognition of the need for, and an ability to engage in life-long learning	B1, B2 - Science
	B4 – Mathematical Concepts
	C3 – Written Communication 1B
	E – Human Understanding and Development
	Z – Written Communication
(j) a knowledge of contemporary issues	D1, D2, D3 – Social Sciences

GE Course Certification and Assessment

GE courses go through a detailed planning and review process. Prior to the establishment of a new course, the faculty must submit a proposal that includes learning objectives, a syllabus, and an assessment plan. Assessment of GE student learning outcomes is based on course-specific assignments and activities rather than standardized tests. The plans typically specify which activities, assignments, and exams will be used to assess each of the General Education objectives. Occasionally a plan also includes pre-and post-tests or surveys. All Core GE courses are reviewed by area-specific General Education Advisory Panels (GEAPs), each of which is made up of six or seven faculty members from several colleges. Advanced GE courses are reviewed by the ten-member Board of General Studies (BOGS). The recommendations of the GEAPs are advisory and all final decisions are made by the Board. The GEAPs and the Board incorporate more than 80 faculty members in the review and assessment process.

Following review, the Board gives an initial certification of up to two years for approved courses. Then, based on the approved assessment plans, faculty collect data on student performance related to General Education learning objectives. The course coordinator submits a Coordinator Summary Form that summarizes assessment methods, student performance related to each learning objective, and course modifications based on the assessment aimed at improving student learning for all sections of the course that are taught. After review of the coordinator report, the Board certifies courses for up to four more years depending on the results of the two-year assessment. Certified courses are reviewed every two to four years (depending on the level of certification). When members of the Board identify concerns about how courses are meeting student learning objectives, a process is in place where course coordinators meet with Board members or with a faculty-in-residence at the Center for Faculty Development to help identify effective improvements to the course.

As of February 2004, 260 courses had been submitted for initial certification under the 1998 GE Guidelines, and 219 had been approved. Of all courses that had been submitted for continuing certification 171 were certified for 4 years, 27 for 2 years and, 15 for less than 2 years. Coordinator Summary Forms are available for review in the Office of Undergraduate Studies.

Table B.3.2 Mapping of GE learning objectives to ABET outcomes

ABET Outcome	GE Area	Learning Objectives
(3g) Ability to communicate effectively	A1	Students will be able to: • compose and deliver extemporaneous public presentations on socially significant and intellectually challenging topics; • engage in critical and analytical listening; • analyze audiences and adapt oral presentations to audiences; and • assume the ethical responsibilities of the public speaker.
	A2	Students shall write complete essays that demonstrate the ability to: • perform effectively the essential steps in the writing process (prewriting, organizing, composing, revising, and editing); • express (explain, analyze, develop, and criticize) ideas effectively; • use correct grammar (syntax, mechanics, and citation of sources) at a college level of sophistication; and • write for different audiences.
	C3	Students shall write complete essays that demonstrate the ability to: • refine the competencies established in Written Communication 1A; • use (locate, analyze, and evaluate) supporting materials, including independent library research; • synthesize ideas encountered in multiple readings; and • construct effective arguments.
	Z	Students shall be able to: • refine the competencies established in Written Communication IA and IB; • express (explain, analyze, develop, and criticize) ideas effectively, including ideas encountered in multiple readings and expressed in different forms of discourse; and • organize and develop essays and documents for both professional and general audiences, including appropriate editorial standards for citing primary and secondary sources.
(3h) Broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	B1, B2	Students should be able to: • use the methods of science and knowledge derived from current scientific inquiry in life or physical science to question existing explanations; • demonstrate ways in which science influences and is influenced by complex societies, including political and moral issues
	C1	Arts courses will enable students to: • recognize aesthetic qualities and processes that characterize works of the human intellect and imagination; • respond to works of art both analytically (in writing) and affectively (in writing or through other forms of personal and artistic expression)
	C2	Letters courses will enable students to: • recognize how significant works illuminate enduring human concerns; • respond to such works by writing both research-based critical analyses and personal responses

	D1, D2, D3	Students will be able to: • place contemporary developments in cultural, historical, environmental, and spatial contexts; • evaluate social science information, draw on different points of view, and formulate applications appropriate to contemporary social issues. • apply multidisciplinary material to a topic relevant to policy and social action at the local, national, and/or international levels.
	R	Within the particular scientific content of the course, a student should be able to: • demonstrate an understanding of the methods and limits of scientific investigation; • distinguish science from pseudo-science; and • apply a scientific approach to answer questions about the earth and environment.
	V	Students shall be able to: • compare systematically the ideas, values, images, cultural artifacts, economic structures, technological developments, or attitudes of people from different societies; • identify the historical context of ideas and cultural practices and their dynamic relations to other historical contexts; and • explain how a culture changes in response to internal and external pressures.
(3i) Recognition of the need for, and an ability to engage in life-long learning	B1, B2	Students should be able to: • use the methods of science and knowledge derived from current scientific inquiry in life or physical science to question existing explanations; • demonstrate ways in which science influences and is influenced by complex societies, including political and moral issues; and • recognize methods of science, in which quantitative, analytical reasoning techniques are used.
	B4	The mathematical concepts course should prepare the student to: • use mathematical methods to solve quantitative problems, including those presented in verbal form; • demonstrate the ability to use mathematics to solve real life problems; and • arrive at conclusions based on numerical and graphical data.
	C3	Students shall write complete essays that demonstrate the ability to: • use (locate, analyze, and evaluate) supporting materials, including independent library research; • synthesize ideas encountered in multiple readings; and • construct effective arguments.
	E	Students shall: • recognize the interrelation of the physiological, social/cultural, and psychological factors on their development across the lifespan; • use appropriate social skills to enhance learning and develop positive interpersonal relationships with diverse groups and individuals; and

	Z	Students shall write complete essays that demonstrate college-level proficiency. Students shall be able to: • refine the competencies established in Written Communication IA and IB (see pages 12 & 21); • express (explain, analyze, develop, and criticize) ideas effectively, including ideas encountered in multiple readings and expressed in different forms of discourse; and • organize and develop essays and documents for both professional and general audiences, including appropriate editorial standards for citing primary and secondary sources.
(3j) Knowledge of contemporary issues	D1, D2, D3	Students will be able to: • place contemporary developments in cultural, historical, environmental, and spatial contexts; • evaluate social science information, draw on different points of view, and formulate applications appropriate to contemporary social issues. • apply multidisciplinary material to a topic relevant to policy and social action at the local, national, and/or international levels.

B.3.2 ME Curriculum – Outcome Relationship

Each outcome (a – k) is addressed in several courses of the ME curriculum. A subset of these courses was chosen for a thorough assessment of each outcome, as shown in Table B.3.1. With the exception of the three capstone courses (ME157, ME182, ME190), this subset consists solely of required courses taken by all ME students. E10 is the only lower division course included in this set. Lower division courses typically prepare students at skill levels 1 or 2, while upper division courses prepare students at skill levels 3, 4, 5 or 6 of Bloom's Taxonomy in the particular outcomes they address.

Table B.3.3 ME Program – Outcome Matrix

	Outcomes										
	3a	3b	3c	3d	3e	3f	3g	3h	3i	3j	3k
E10	✓		A	A	✓	A	A	✓	A	✓	A
E100W						✓	✓	✓	✓		
ME101	B				✓						
ME106	B	B		✓			B				B
ME111	B			B	C		✓		C	A	
ME113	B			B	B		B	B	B	B	
ME114	C	C			B		B		B	A	
ME120	✓	C		C			C				C
ME147	B				✓				✓		B
ME154	✓		C	✓			✓		✓		
ME157	B		B	B	B		✓	✓	✓		C
ME182	B		B	B	B		✓	C	B	B	B
ME 195 A, B	✓		C	C	✓	C	C	B	C		C

A Skill level 1 or 2 in Bloom's Taxonomy
B Skill level 3 or 4 in Bloom's Taxonomy
C Skill level 5 or 6 in Bloom's Taxonomy
✓ Skills relevant but not presently assessed

B.3.2 Course Assessment

Figure B.3.1 shows the process for assessing each of the selected courses. ***Course coordinators*** assess their courses for the specific outcomes they address, as indicated in table B.3.1. They are responsible for ensuring that performance targets are met for each outcome in each of their courses. If the target for a particular outcome is not met, they make recommendations for improvements in that area and take responsibility for implementing these improvements in the course. If they do not teach the particular course, they coordinate the changes with the faculty who teach the course. After the implementation of the improvements, coordinators re-assess the course and re-evaluate student performance against the targets.

B.3.3 Outcome Assessment

Figure B.3.2 shows the process for assessing outcomes. For each outcome there is a designated ***outcome champion***. Champions look at the data presented in the course binders for each course assessed for their particular outcome and write a one-page evaluation on how well the ME Program produces this outcome and whether the performance targets are met. Outcome champions meet with course coordinators and instructors of the courses involved in their outcome, discuss their findings and make recommendations for course improvements. The outcome champion provides an additional level of accountability in the process, as there are always several faculty members involved in the assessment and implementation of the skills required in a single outcome. It is not just the course coordinators who must show evidence that their courses include the necessary elements to satisfy an outcome and collect / analyze data to show that performance targets are met. The outcome champion must also evaluate all this evidence collected and analyzed for individual courses and has the final word on whether the performance of the ME Program is satisfactory with regards to this outcome.

Because outcomes are rather comprehensive and difficult to assess as stated, ***outcome elements*** were extracted from each outcome. These elements represent the different abilities specified in a single outcome that would generally require different assessment measures. Moreover, we have defined ***outcome attributes*****,** i.e. student actions that explicitly demonstrate mastery of the abilities specified in an outcome element. These attributes have been defined at one of the 6 levels of Bloom's taxonomy in the cognitive domain or 5 levels in the affective domain. Two ***outcome indicators*** are used to assess student attainment of program outcomes: (a) course performance ratings based on graded student work and (b) student surveys. To satisfy Criterion 3, we have defined our ***performance targets*** as follows:
(a) The scores earned by all students, in the assignments and test questions, which pertain to a particular outcome, in each course where this outcome is measured, must be at least 60% for the required core (CE112, ME101, ME111, ME113, ME130) and 50% for all other courses.
(b) The ratings pertaining to this outcome, given by at least 60% of the students in each class surveyed, must be *"I agree"* on a 3-point scale. If these targets are met in the courses chosen for assessment of an outcome, the outcome is achieved and no further action is needed in this course. When performance targets are met, courses are assessed on a 3-year cycle. When performance targets are not met in a course, improvements are implemented and the course is assessed on a yearly basis until the targets are met.

Based on the data presented in the following sections (B.3.4 – B.3.14) the ME Program satisfies all outcomes except 3f. As a result of our outcomes assessment, several improvements have been implemented since our last ABET visit, to ensure that ME students acquire the highest possible level of the skills defined under each outcome. These improvements are listed below:

A. Students design experiments (ME113, ME114, ME120, AE162, AE164)[4].
B. Team skills are taught and assessed formally (ME111, ME120, ME195A&B).
C. Students tackle (i.e. identify, formulate, and solve) open-ended problems (ME111, ME113, ME114, AE162)[5].
D. Students study the ASME Code of Ethics and discuss in class safety, ethics, and liability issues in engineering (ME195A&B).
E. Students research, present, and discuss in class contemporary engineering applications and their impact in a global and societal context (outcomes 3h, 3j) (ME111, ME113, ME114, AE162, AE164, AE167)[6].

---

[4] Winncy Y. Du, Burford J. Furman, Nikos J. Mourtos, *On the ability to design engineering experiments*, lead paper, proceedings, 8th UICEE Annual Conference on Engineering Education, February 2005.
[5] Mourtos, N.J., DeJong-Okamoto, N., Rhee, J., *Open-Ended Problem-Solving Skills in Thermal-Fluids Engineering* Invited Paper, Global Journal of Engineering Education, May 2004.
[6] DeJong-Okamoto, N., Rhee, J., Mourtos, N.J., *Educating Students to Understand the Impact of Engineering Solutions in a Global / Societal Context*, Invited Keynote Address, Proceedings, 8th Annual UICEE Conference on Engineering Education, February 2005 (Received the Diamond Award).

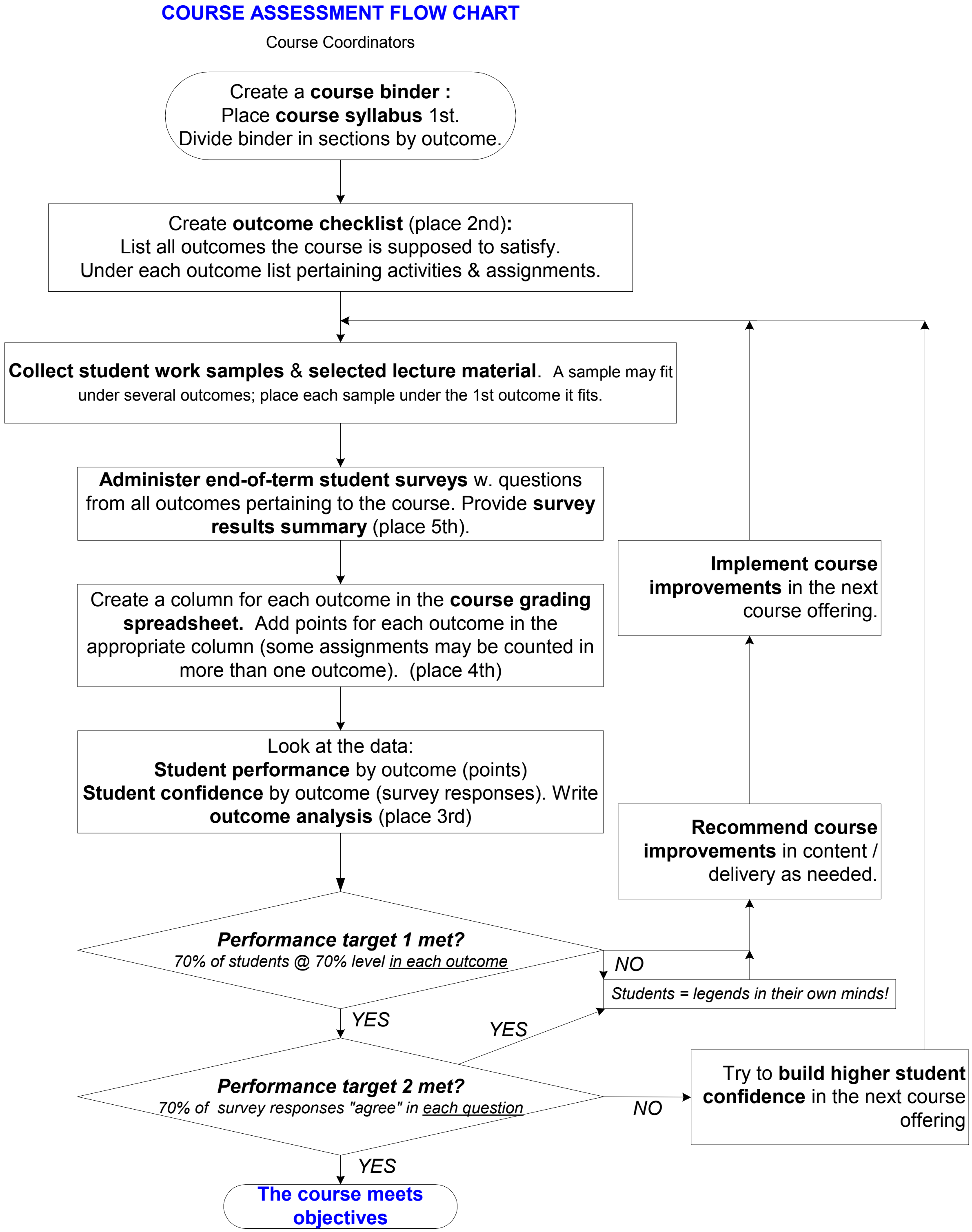

Figure B.3.1. Course assessment flow chart

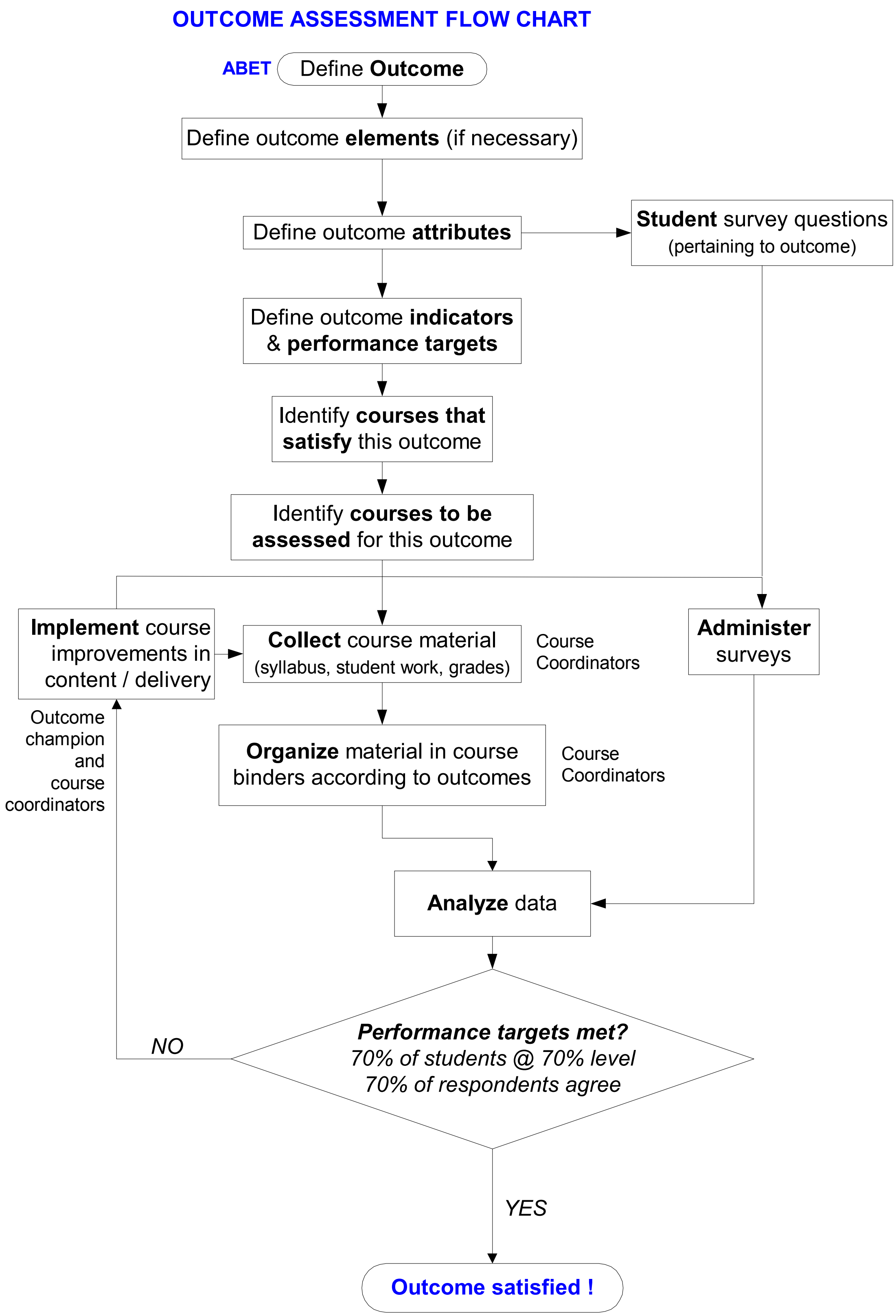

Figure B.3.2. Outcome assessment flow chart

B.3.4 Outcome 3a

ME graduates can apply mathematics, science and engineering to solve ME problems.

Outcome champion: Dr. Raymond K. Yee

Outcome elements (3): (a) ability to apply knowledge of mathematics, (b) ability to apply knowledge of science, (c) ability to apply knowledge of engineering

Outcome attributes (3): ME graduates can:
3a-1 Use math to solve ME problems.
3a-2 Use calculus (differentiation, integration, etc.) to solve ME problems.
3a-3 Use differential equations to solve ME problems.
3a-4 Use linear algebra (matrices, systems of equations) to solve ME problems.
3a-5 Use chemistry to solve ME problems.
3a-6 Use equilibrium principles and Newton's laws to solve ME problems.
3a-7 Use physics concepts (friction, thermal / fluid concepts etc.) to solve ME problems.
3a-8 Use engineering principles (ex. fluid mechanics, dynamics, heat transfer, etc.) to solve ME problems.

B.3.4.1 Summary from Supporting Courses

ME101: Dynamics

Course activities related to outcome 3a: (a) Eight homework assignments from textbook-generated problem scenarios spanning kinematics and dynamics for both point motion and rigid body motion, using force, energy, and momentum principles, (b) three in-class working sessions with four problems provided by the instructor, solved by small teams with minimal assistance from the instructor, and reviewed by the whole class, (c) three quizzes on point kinematics and dynamics, point dynamics using energy & momentum principles, and rigid body kinematics and dynamics. The quizzes include understanding given information, evaluating assumptions, answering concept questions, and performing calculations, (d) comprehensive final exam.

Course Assessment (Spring 2003): ME101 met the performance targets for outcome 3a.

Student Performance Summary: All the homework and exams tested the students' ability to apply knowledge of mathematics, science, and engineering. Therefore, an aggregate of all scores is deemed to be a suitable summary of the raw performance data. There was a total of 88 students for both class sections combined. The percentage of students who scored 70% or better ("C" level performance) was 86% (76 out of 88 students).

Student Survey Results: The student survey revealed five areas in which students feel confident that this course increased their abilities related to outcome 3a: (a) Application of mathematics in the solution of engineering problems [95% agreed]. (b) Application of calculus (differentiation, integration, etc.) in the solution of engineering problems [81% agreed]. (c) Application of linear algebra in the solution of engineering problems [67% agreed]. (d) Application of equilibrium principles and Newton's laws (including free-body diagrams) in the solution of engineering problems [98% agreed]. (e) Application of physics concepts (friction, thermal / fluid concepts, etc.) in the solution of engineering problems [88% agreed].

The greatest challenge seems to lie with differential equations, for which only 33% of the students agreed that they improved their skills in this area. The discrepancy may be a simple problem of awareness. Dynamics does involve solving differential equations. Some of the instances in class are common initial-value problems in which Newton's Second Law can be written as a differential equation relating acceleration to forces that depend on either velocity or position, and this equation must be solved to report velocity or position based on initial conditions. Applying differential equations was a part of ME101 in Spring 2003, but it is likely that the students may not have explicitly recognized that they were solving differential equations per se, as they executed its techniques (several problems were solved by separation of variables, for example).

ME111: Fluid Mechanics

Course activities related to outcome 3a: (a) Final exam and quizzes: students apply fluid statics in water tanks, use control volume techniques for mass, energy and momentum conservation in various fluid systems, and calculate skin friction and power required to move bodies through fluids. (b) Reading quizzes and final exam: students write explanations, definitions, and responses to short questions on fluid mechanics principles including fluid properties, energy and momentum, and boundary layer flow.

Course Assessment (Spring 2003): ME111 met the performance targets for outcome 3a.

Student Performance Summary: Student performance averaged 75% on the final exam, 82% on the quizzes and 67% on the reading quizzes. Moreover, 72% of students achieved more than 70% on the final exam, 85% achieved more than 70% on the quizzes, 79% achieved more than 70% on the homework but only 53% achieved more than 70% on the reading quizzes.

Student Survey Results: The average level of agreement on the student surveys was 78%.

ME113: Thermodynamics

Course activities related to outcome 3a: This course incorporates many aspects of mathematics, science and engineering in relevant engineering problems. Math topics include calculus (extensive use of integration, differentiation), differential equations (one example: Gibb's equation), and linear algebra (one assignment involving multiple equations/unknowns). Science topics include physics (force/energy balance and thermodynamic equilibrium). Although chemistry is not explicitly addressed, many topics that are covered in Physical Chemistry courses (entropy, enthalpy) are extensively covered. Engineering principles covered include the basics of thermodynamics such as conservation of mass and energy, entropy and energy, power generation and refrigeration cycles, and non-reacting mixtures. All course assignments [8 problem sets, 7 quizzes, 2 midterm exams, 3 projects, final exam] address this outcome.

Course Assessment (Fall 2002, Fall 2003): ME113 met the performance targets for outcome 3a.

Student Performance Summary: In Fall 2002 75% of the students earned at least 70% of the points in the course total. In Fall 2003 88% of the students earned at least 70% of the points in the course total. A 70% corresponded to a grade of "C-", which is the minimum passing grade in this course.

Student Survey Results: Student opinion surveys for outcome 3a were not given in Fall 2002. In Fall 2003 students felt that this course met elements of this outcome, as shown below. Of the questions that did not have 70% of the students in agreement: differential equations (3a-3) and linear algebra (3a-4) were each used in one assignment each. Perhaps this aspect of the relevant assignments can be emphasized so that students realize that they are using it. It is unclear why so many students felt equilibrium was not covered (3a-6), since the entire course uses thermodynamic equilibrium principles. Because grades indicate the students are learning the methodology for thermodynamic problems, the recommendation for the future is to emphasize these aspects of the assignments so that students realize the wide range of applicable math and science skills.

Fall 2003 Student Survey Results (N = 44):

This course has increased my ability to:		Agree	Not sure	Disagree
3a-1	Apply mathematics in the solution of engineering problems.	44	0	0
3a-2	Apply calculus (differentiation, integration, etc.) in the solution of engineering problems.	33	9	2
3a-3	Use differential equations in the solution of engineering problems.	13	14	17
3a-4	Use linear algebra (matrices, systems of equations) in engineering problems.	15	12	17
3a-6	Apply equilibrium principles and Newton's laws in engineering problems.	24	7	13
3a-7	Apply physics concepts (friction, thermal / fluid concepts etc.) in the solution of engineering problems.	38	5	1

Course improvement: The various aspects of mathematics and physics that students did not feel confident about have been emphasized more since Spring 2004.

ME114: Heat Transfer

Course activities related to outcome 3a: (a) Students use calculus, geometry, and differential equations (in addition to simpler mathematics) to solve heat transfer problems (conduction, convection, and radiation). (b) There are 60 homework problems, two exams and a quiz in the course. In addition, students solve approximately two problems per week in class and take approximately 5 ungraded quizzes that focus on theory rather than mathematical solutions. Mathematical solutions include the use of both empirical equations and direction solution of the heat conduction equation through integration and application of boundary conditions.

Course Assessment (Spring 2003, Fall 2003): ME114 met the performance targets for outcome 3a.

Student Performance Summary: Homework cannot be used to show that this outcome is met because many students do not turn in complete homework sets, resulting in low grades. However, many of them make up this work to a certain degree before the exams. The exams are where students show whether they truly understand the material or not. This being said, it would be beneficial to increase the percentage of students turning in complete homework sets. To increase the number of problems that the students work, more active and collaborative learning activities have been added to the course (Fall 2003). As can be seen below, homework grades improved significantly in Fall 2003.

Student Performance Summary

Activity	% of students with a score of 70% or better	
	Spring 2003	Fall 2003
Exams and Quizzes	70	79
Homework	31	62

Fall 2003 Student Survey Results (N = 100):

This course has increased my ability to:		Agree	Not sure	Disagree
3a-1	Apply mathematics in the solution of engineering problems.	95	5	0
3a-2	Apply calculus (differentiation, integration, etc.) in the solution of engineering problems.	92	8	0
3a-3	Use differential equations in the solution of engineering problems.	86	11	3
3a-7	Apply physics concepts (friction, thermal / fluid concepts etc.) in the solution of engineering problems.	95	5	0

ME147: Dynamic Systems Vibration and Control

Course activities related to outcome 3a: Students (a) analyze weekly homework problems, which require use of mathematics, (b) take two midterm exams on the principles of vibration and control engineering both of which require use of mathematics, (c) solve 3 short take home computer aided problems, that involve vibration and control systems analysis and design, (d) perform analytical and computer aided mathematical analysis of dynamic systems using Matlab and Simulink, (e) solve dynamic systems problems using differential equations, linear algebra, and matrix algebra.

Course Assessment (Fall 2002): ME147 did not meet the performance targets for outcome 3a.

Student Performance Summary: Analysis of vibratory and general dynamic systems (mechanical and electro-mechanical) using physical and engineering principles is a hard task for all the students. Fewer than 50% of the students can model rather simple, single degree of freedom vibratory systems. Most students cannot formulate complex dynamic systems (thermal/fluid, mechanical and electrical systems). Dynamic modeling of such systems is not taught in other courses. About 75% of the students can analyze dynamic systems, which closely resemble the limited vibratory and general dynamic systems studied in class. Outside of these sample problems they have difficulty formulating and analyzing even slightly complex engineering systems.

ME182: Thermal Systems Design

Course activities related to outcome 3a: (a) Development of a multi-pressure refrigeration system computer simulation. (b) Development of an electronics cooling system for a specified application. (c) Development of a combined cycle power plant computer simulation. (d) Exam questions requiring students to perform combustion analysis. (e) Each project requires an in-depth understanding of thermal-fluid fundamentals. Some example calculations / topics include, but are not limited to (i) work output from a turbine, (ii) heat transfer rates in a heat exchanger, (iii) one dimensional heat transfer networks and (iv) determination of working fluid properties.

Course Assessment (Spring 2003): ME182 met the performance targets for outcome 3a.

Student Performance Summary: The results of the student projects were excellent. All students received 70% or higher in each of the 3 projects, while 78% of them met or exceeded the 70% level at the final exam. The lower score on the final exam question indicates that additional individual scores would be helpful to gauge individual student understanding of the technical work, despite the fact that peer evaluations are factored into each students' project grade.

B.3.4.2 Conclusion (Fall 2003)

Six (6) courses were targeted for assessment of outcome 3a in the ME Program. The analysis of the data shows that ME students are given adequate opportunities to apply mathematics, science, and engineering in their required coursework. Five of these courses (4 required and one elective) have met and exceeded the student performance target level (60%) for outcome 3a. In summary, the ME program satisfies outcome 3a, however, there are two issues that need to be addressed: (a) in which upper division[7] courses do students use chemistry and how skilled are they in using chemistry to solve engineering problems, and (b) in which courses are students taught statistics and how skilled are they in applying statistics in engineering. In response to these MAE faculty have agreed on the following actions: (a) Statistics will be taught and assessed in ME130 and will be applied and assessed in ME120 and (b) chemistry topics (applications) will be incorporated in ME113.

B.3.5 Outcome 3b

ME graduates can design and conduct experiments, analyze and interpret data.

Outcome Champion: Dr. Winncy Du

Outcome Elements (4): (a) ability to design experiments, (b) ability to conduct experiments, (c) ability to analyze data, (d) ability to interpret data.

Outcome Attributes (6): ME graduates:
3b-1 Given a theoretical relationship between two variables, can choose the appropriate equipment / instrumentation, select the proper range / values of the free variable and measure the corresponding values of the dependent variable.
3b-2 Given a certain experimental setup, can familiarize themselves with the equipment, calibrate the instruments to be used, and follow proper procedures to collect the data.
3b-3 Given a set of experimental data, can carry out the necessary calculations, perform an error analysis, and tabulate / plot the results using appropriate choice of variables and software.
3b-4 Given a set of results in tabular or graphical form, can make observations and draw conclusions regarding the variation

[7] Chem1A is a prerequisite to MatE25.

of the parameters involved.
3b-5 Given a set of results in tabular or graphical form, the student can compare with predictions from theory and explain any discrepancies.

B.3.5.1 Summary from Supporting Courses

ME106: Fundamentals of Mechatronics

Course activities related to outcome 3b: Students (a) conduct 8 laboratory experiments that relate to concepts presented in lecture, (b) write 8 laboratory reports on experiments conducted that include analysis and interpretation of experimental results, and (c) design and build a mechatronics system to solve a given problem.

Course Assessment (Fall 2002): ME106 met the performance targets for outcome 3b.

Student Performance Summary: The metric for assessing student performance for outcome 3b comes from the sum of laboratory report scores divided by the total possible points. 90% of the students are achieved 70% or better as determined by this metric.

Student Survey Results: Close to 90% of the students agreed that ME 106 increased their ability to design an experiment (question 3b-1); 93% of the students agreed that ME 106 increased their ability to conduct an experiment (question 3b-2); and 84% agreed that ME 106 increased their ability to analyze experimental data (question 3b-3). With regard to observation and comparison of experimental results, 82% of the students agreed that the course increased their ability to critically observe a given set of experimental results and draw conclusions (question 3b-4); and 87% agreed that ME106 increased their ability to compare experimental results with theory from predictions and explain any discrepancies (question 3b-5).

ME120: Experimental Methods

Course activities related to outcome 3b: Students (a) conduct 6 laboratory experiments that address sensors and measurement concepts, (b) write 6 laboratory reports on experiments conducted that include analysis and interpretation of experimental results. ME120 is structured so that the first hour of class is directed teaching time, and the following two hours are devoted to conducting laboratory experiments and/or oral presentations about experimental results. There are approximately 6 directed experiments that have been designed to give students hands-on experience with various sensors and test and measurement equipment presented in lecture. Each experiment has a set of instructions that introduce the instruments and the experimental procedure. The students work mostly in pairs to perform the experiments. In addition to performing the experiment, each student must individually write a report that describes what was done and what was found.

Course Assessment (Fall 2002): ME120 met the performance targets for outcome 3b.

Student Performance Summary: Students in ME 120 meet their performance target (at least 70% achieved 70% or more) on the coursework pertaining to the outcome 3b. The performance of students in the Tuesday section is an exception however. For this section, only 40% (6 out of 15) achieved better than 70% because most students did not turn in one or more lab reports.

Student Survey Results: 67% to 92% of the students agreed that ME120 increased their ability to design an experiment (question 3b-1). 82% to 100% agreed that the course also increased their ability to conduct an experiment (question 3b-2). 100% agreed that ME120 increased their ability to analyze experimental data (question 3b-3) and draw conclusions regarding variation of the parameters involved (question 3b-4). The vast majority of students (73% to 100%) agreed that ME 120 increased their ability to compare experimental results with predictions and explain any discrepancies (question 3b-5).

Course Improvements (Fall 2003): (a) Open-ended laboratory and homework assignments have been introduced in the course. Several laboratory assignments pose a measurement challenge, such as determining the acceleration due to gravity and students are responsible for defining, carrying out, and reporting on the measurement. (b) “Design of experiment” principles are taught in the course.

ME114: Heat Transfer

Course activities related to outcome 3b: Students (a) perform 4 laboratory exercises. They conduct the lab in groups of 5-8 students. They analyze the results and write lab reports in groups of two. Lab reports include a discussion of how experimental uncertainty affects results, (b) perform one homework assignment in which they compare an experimental temperature distribution in a long fin (acquired during a class demonstration) to a distribution predicted using analytical equations. They must decide which tip boundary conditions are the most realistic. (c) Perform one computation assignment where the use the finite different method to analyze steady-state heat transfer through a two-dimensional object. They compare their results with a one-dimensional analytical solution and discuss the relative accuracy of the two methods, (d) design an experiment that will determine the thermal conductivity of an unknown metal. This is a paper design only.

Course Assessment (Fall 2002-Fall 2003): ME114 met the performance targets for outcome 3b.

Student Performance Summary: In Fall 2002 there was no design of experiments in the course. In Fall 2003 one problem was added to address this area. The results showed that students have a difficult time with open-ended problems, especially justifying their assumptions.

Activity	% of students with a score of 70% or better	
	Spring 2003	Fall 2003
four experiments exercises	90	81
finite difference lab	96	96
fin experiment	75	--
Design of experiment project	--	62

Fall 2002 Student Survey Results (N = 100):

Question Number	*This course has increased my ability to:*	Agree	Not Sure	Disagree
3b-1	Design an experiment (i.e., choose the appropriate equipment / instrumentation, select the proper range/value of the free variables to measure the corresponding values of the dependent variables).	46	43	11
3b-2	Conduct an experiment (i.e., familiarize myself with the equipment, calibrate the instruments to be used, and follow the proper procedure to collect the data).	86	11	3
3b-3	Analyze experimental data (i.e., carry out the necessary calculations, perform error analysis, and tabulate/plot the results using appropriate choice of variables and software).	97	3	0
3b-4	Critically observe a given set of experimental results in tabular or graphical form and draw conclusions regarding the variation of the parameters involved.	94	6	0
3b-5	Critically observe a given set of experimental results and choose parametric values that give best results in practical applications.	66	31	3
3b-6	Compare experimental results with predictions from theory and explain any discrepancies.	94	6	0

Fall 2003 Student Survey Results (N = 100):

This course has increased my ability to:	Agree	Not sure	Disagree

3b-1	Design an experiment (i.e., choose the appropriate equipment / instrumentation, select the proper range / values of the free variables to measure the corresponding values of the dependent variables).	84	8	8
3b-2	Conduct an experiment (i.e., familiarize myself with the equipment, calibrate the instruments to be used, and follow the proper procedure to collect the data).	81	11	8
3b-3	Analyze experimental data (i.e., carry out the necessary calculations, perform error analysis, and tabulate / plot the results using appropriate choice of variables and software).	95	5	0
3b-4	Critically observe a given set of experimental results in tabular or graphical form and draw conclusions regarding the variation of the parameters involved.	84	16	0
3b-5	Compare experimental results with predictions from theory and explain any discrepancies.	95	5	0

Course Improvements (Fall 2003): "Design of experiments" has been introduced in the form of an assignment. Students in groups of two design an experiment (on paper only) to determine the thermal conductivity of an unknown metal. Students pick appropriate equipment and instrumentation and estimate the uncertainty of their results.

B.3.5.2 Conclusion (Fall 2003)

Three (3) courses were targeted for assessment of outcome 3b in the ME Program. The analysis of the data shows that ME students are given adequate opportunities to design and conduct experiments, as well as to analyze and interpret experimental data in their required coursework. All three courses have met and exceeded the student performance target level (60%) for outcome 3b. In summary, the ME Program satisfies all the elements of outcome 3b.

B.3.6 Outcome 3c

ME graduates can design a system, component, or process to meet desired needs.

Outcome champion: Dr. Burford J. Furman

Outcome elements (3): (a) ability to design a component to meet desired needs, (b) ability to design a system to meet desired needs and (c) ability to design a process to meet desired needs

Outcome attributes (12): ME graduates can:

3c-1 Develop a flow chart of the design process
3c-2 Define "*real world*" problems in practical (engineering) terms
3c-3 Investigate and evaluate prior or related solutions for the need they are trying to address
3c-4 Develop constraints and criteria for evaluation
3c-5 Develop and analyze alternative solutions
3c-6 Choose the "best solution" considering the trade-offs between the various solutions
3c-7 Develop final performance specifications
3c-8 Communicate the results of their design orally as well as writing (sell their design)
3c-9 Build a prototype and demonstrate that it meets performance specifications
3c-10 List and discuss several possible reasons for deviations between predicted and measured design performance
3c-11 Choose the most likely reason for deviation between predicted and measured design performance and justify the choice

B.3.6.1 Summary from Supporting Courses

E10: Introduction to Engineering

Course activities related to outcome 3c: Design forms a very significant part of the course in terms of lectures, homework, projects, and exams. In particular, E10 students (a) discuss engineering design in class (4 weeks, 8 lectures), (b) perform 2 hands-on design projects and submit detailed design reports, (c) present the results of their projects (design briefings), (d) are tested on design concepts in their final exam.

Course Assessment (Fall 2002): E10 met the performance targets for outcome 3c.

Student Performance Summary (Fall 2002): Analysis of student performance in 5 out of 12 sections indicates that more than 80% of the students achieved 70% or higher, while 99% of the students achieved 50% or better on all assignments and exam questions pertaining to design. The remaining 7 sections are expected to have similar performance.

Fall 2002 Student Survey Results (N = 169):

	This course has increased my ability to:	Agree	Not Sure	Disagree
3c-1	Develop a flow chart of the design process.	74%	22%	4%
3c-2	Define "*real world*" problems in practical (engineering) terms.	80%	18%	1%
3c-3	Investigate and evaluate prior or related solutions for a need I am trying to address.	59%	38%	2%
3c-4	Develop constraints and criteria for evaluation.	72%	25%	3%
3c-5	Develop and analyze alternative solutions.	80%	18%	2%
3c-6	Choose the "best solution" considering the trade offs between the various solutions.	76%	20%	3%
3c-7	Develop final performance specifications.	66%	29%	5%
3c-8	Communicate the results of my design orally as well as in writing (sell the design).	75%	18%	7%
3c-9	Build a prototype and demonstrate that it meets performance specifications.	77%	18%	5%
3c-10	List and discuss several possible reasons for deviations between predicted and measured design performance.	62%	34%	5%
3c-11	Choose the most likely reason for deviation between predicted and measured design performance and justify the choice.	50%	45%	5%

Student survey results show that students feel confident in skills 3c-1, 3c-2, 3c-4, 3c-5, 3c-6, 3c-8, and 3c-9. However, results for skill areas 3c-3, 3c-7, 3c-10, and 3c-11 show that more emphasis can be given in explaining to students how to evaluate existing solutions to design problems, develop final specifications for their product and look for possible reasons for deviations between predicted and measured performance.

ME154: Mechanical Engineering Design

Course activities related to outcome 3c: ME154 includes design instruction and assessment on 7 homework assignments, both midterm exams, and 4 of the final examination questions. In particular, students (a) design a mechanical device (mechanism) to perform a specific task, (b) create a design solution to meet the project requirement, (c) analyze the associated mechanical components, and (d) build a prototype to verify its functionality.

Course Assessment (Fall 2002): ME154 met the performance targets for outcome 3c.
Student Performance Summary: All students scored 70% or higher on the term design project, which is a major design experience.

Student Survey Results: For the most part (questions 3c-2 through 3c-11), students felt positive that ME154 is improved their design skills.

ME182: Thermal Systems Design

Course activities related to outcome 3c: Students (a) Develop a multi-pressure refrigeration system computer simulation and use it to choose the optimum system configuration and system pressures. (b) Choose the lowest-cost electronics cooling system for a specified application. (c) Develop a combined cycle power plant computer simulation and use it to choose optimum system pressures and temperatures. Students also perform an in-depth economic analysis. System design is emphasized rather than component or process design, although the students must develop component models throughout the course.

Course Assessment (Fall 2002): ME182 met the performance targets for outcome 3c.
Student Performance Summary: All the students received 100% on all 3 projects.
Course Improvements (Fall 2003): (a) Additional individual scores have been incorporated to gauge individual student understanding of the technical work, despite the fact that peer evaluations are factored into each students' project grade. (b) The design process is discusses in class in more detail, including the different stages of design, timetables, etc. (c) One of the projects has been re-structured to be more open-ended.

ME195A&B: Senior Design Project

Course Assessment (Spring 2005): ME195 met the performance targets for outcome 3c.

Student Performance Summary: The metric for assessing student performance for outcome 3c is the average percentage earned for the end-of-semester report, the progress reports, and the technical presentations. Data from three of the four sections was available at the time of this analysis, and it shows that 100% of the students were performing above 70% on this metric. For future evaluations of this outcome, we need metrics that can more precisely assess *individual* performance on this outcome. As it stands now, outcome 3c appears to be satisfactorily met by all the students, however, the instruments comprising the metric are team-based, and consequently obscure any one individual's performance toward achieving the outcome. One suggestion toward this end would be to add appropriate questions to the Individual Performance Evaluation that the team members fill out for themselves and each of their teammates.
Student Survey Results: The results from all four sections (N = 17, 17, 11, 17 for sections 1, 2, 3, 4 respectively) of ME 195B, show that the vast majority of students agree that the course increased their ability to:

- Develop or follow a flow chart (process) to design a product. .... (76% - 94%)
- Define "real world" problems in practical (engineering) terms. .... (94% -100%)
- Investigate and evaluate prior or related solutions that may apply to the problem at hand. .... (82% - 100%)
- Develop constraints and criteria for evaluation. .... (82% - 100%)
- Develop and analyze alternative solutions. .... (88% - 100%)
- Choose the "best solution" considering the trade offs between the various solutions. .... (82% - 100%)
- Develop final performance specifications. .... (82% - 100%)
- Communicate the results of the design orally as well as in writing (sell the design). .... (88% - 100%)
- Build a prototype and demonstrate that it meets performance .... (76% - 88%)
- List and discuss possible reasons for deviation between predicted and measured performance .... (65% - 82%)
- Choose the most likely reason for deviation between predicted and measured performance .... (59% - 82%)

B.3.6.2 Conclusion (Fall 2003 – Spring 2005)

Five (5) courses were targeted for assessment of outcome 3c in the ME Program. Three of them were assessed in Fall 2003 and two in Spring 2005. The analysis of the data shows that ME students are given adequate opportunities to design mechanical engineering components and systems. All courses have met and exceeded the student performance target level (60%) for outcome 3c. In summary, the ME Program satisfies outcome 3c.

B.3.7 Outcome 3d

ME graduates can work effectively on multidisciplinary teams.

Outcome champion: Dr. Nikos J. Mourtos

Outcome elements (2): (a) ability to work effectively on a team, and (b) ability to work effectively in a multidisciplinary environment.

Outcome attributes (5): ME graduates:

3d-1 Participate in making decisions, negotiate with their partners, and resolve conflicts arising during teamwork.
3d-2 Set goals related to their team projects, generate timelines, organize and delegate their work among team members, and coach each other as needed to ensure that all tasks are completed.
3d-3 Demonstrate leadership by taking responsibility for various tasks, motivating and disciplining others as needed.
3d-4 Understand enough of the basics from other fields (ex. different branches of engineering / physical sciences, economics, management, etc.) to participate effectively on multidisciplinary projects.
3d-5 Can communicate ideas relating to ME in terms that others outside their discipline can understand.

B.3.7.1 Summary from Supporting Courses

E10: Introduction to Engineering

Course activities related to outcome 3d: Students (a) discuss team issues in class, (b) work in teams of 3-4 in two design projects, (c) work in teams to research, study, and present in class case studies on engineering ethics and failures, (d) assess their team skills using an instrument available online, (e) write peer reviews of their teammates at the end of each project based on specific criteria. Each student's project grade is calculated as the product of the team's score and the average score received in his/her peer reviews.

Course Assessment (Fall 2002): E10 met the performance targets for outcome 3d.

Student Performance Summary: Students worked well in teams, as evidenced by (a) the quality of the projects, design reports and oral presentations, (b) the peer reviews submitted, and (c) the confidence level indicated in the survey responses.

Fall 2002 Student Survey Results (N = 196):

	This course has increased my ability to:	Agree	Not Sure	Disagree
3d-1	Participate in making decisions, negotiate with my partners, and resolve conflicts arising during teamwork.	87%	10%	3%
3d-2	Set goals related to my team projects, generate timelines, organize and delegate work among team members, and coach others as needed to ensure that all tasks are completed.	86%	12%	2%
3d-3	Lead by taking responsibility for various tasks, motivating and disciplining others as needed.	75%	21%	4%
3d-4	Understand basics from other fields (ex. different branches of engineering / physical sciences, economics, management, etc.), so that I can participate effectively on multidisciplinary projects.	64%	29%	7%
3d-5	Communicate ideas relating to my discipline in terms that others outside my discipline can understand.	64%	34%	2%

ME111: Fluid Mechanics

Course activities related to outcome 3d: (a) The *"17 laws of teamwork"* are presented and discussed in class. Students work in teams of 3 to (b) solve problems in class on a daily basis, (c) solve open-ended problems and present their solutions in class, (d) research a global / societal / contemporary issue that relates to fluid mechanics, write a 2-page analysis, and present it in class. Moreover, students (e) reflect frequently on the efficiency of their teams and suggest ways to improve it, (f) write peer reviews of their teammates at the end of the semester based on specific criteria. Each student's individual grade in team assignments is calculated as the product of the team's score and the average score received in his/her peer reviews.

Course Assessment (Fall 2003): ME111 met the performance targets for outcome 3d.

Most of the teams worked well, as evidenced by (a) the quality of the research papers and presentations, (b) the peer reviews submitted, and (c) the confidence level indicated in the survey responses. The peer reviews indicated that most students worked well in their teams in class as well as outside of class (i.e. they shared the work, coached each other on the solution of problems, and resolved conflicts). The responses on the student surveys indicated a high level of confidence in the fact that ME111 improved their team skills.

Course Improvement (Spring 2004): To quantify the assessment of team skills, student peer review scores on the 7 qualities of teamwork are compared with the 60% performance target.

ME113: Thermodynamics

Course activities related to outcome 3d: Three team projects covering various aspects of thermodynamics were assigned.

Course Assessment (Fall 2003): ME113 met the performance targets for outcome 3d.

Student Performance Summary: 84% of the student projects averaged 70% or greater on the reports and calculations, which is one indication of successful teamwork. In addition, the peer evaluation form had students rate their group members in terms of commitment, leadership, responsibility, ability, communication, and personality on a scale of 1(poor) to 5(excellent). There were only 11% students (8 out of 74) that rated one of their team members with an average score of below 4/5, indicating student satisfaction with teamwork skills.

In addition, seven (7) 15-minute quizzes were administered in an interactive and collaborative format. 81% of the students scored 70% of the points on the quiz or above, indicating further evidence of successful collaboration and teamwork.

Summary of Student Surveys: At least 70% of the students agreed that this course met outcome 3d.

Fall 2003 Student Survey Results:

Teamwork: *This course has increased my ability to:*	Agree	Not sure	Disagree
3d-1. Participate in making decisions, negotiate with my partners, and resolve conflicts arising during teamwork.	44	0	0
3d-2. Set goals related to my team projects generate timelines, organize and delegate work, and coach others.	41	1	2
3d-3. Lead by taking responsibility, motivating others.	43	1	0
3d-4. Understand basics from other fields.	34	8	2
3d-5. Communicate ideas relating to my discipline in terms that others outside my discipline can understand.	33	10	1

ME182: Thermal Systems Design

Course activities related to outcome 3d: For each project, each team member performed a peer evaluation of themselves and their teammates. Each project received a baseline grade. Then the peer evaluations were used to correct that baseline up or down by as much as 15 points. The team members were assigned and varied with each project. A team leader was also assigned. Each student had a chance to be team leader once during the semester.

Course Assessment (Fall 2003): ME182 met the performance targets for outcome 3d.

Student Performance Summary: The only data currently available are for the third project, in which 87% of the students received 70% or higher in their peer reviews from their teammates.

Recommendation: Additional class time is needed to discuss team dynamics and individual team duties.

ME195A&B: Senior Design Project

Course Assessment (Spring 2005): ME195 met the performance targets for outcome 3d.

Student Performance Summary: The metric for assessing student performance for outcome 3d is the Individual Performance Evaluation. This evaluation addresses:

- QUALITY of work on the project
- QUANTITY of work on the project
- Level of COMMITMENT given to the project/team
- Demonstration of JOB KNOWLEDGE
- Ability to COOPERATE
- Demonstration of JUDGMENT
- ATTITUDE toward work on the project
- INITIATIVE taken on the project
- ADAPABILITY
- COMMUNICATION skill

The range of performance for students on this metric is:

Rating of 70% or higher:	78 – 100%
Rating of 60 to 70%	0 – 17%
Rating of 50 to 60%	0 – 5%
Rating of less than 50%	0%

Student Survey Results: The results from all four sections (N = 17, 17, 11, 17 for sections 1, 2, 3, 4 respectively) of ME 195B, show that the vast majority of students agree that the course increased their ability to:

- Participate in making decisions, negotiate with partners, and resolve conflicts arising in team work .... (82 - 94%)
- Set goals related to the team project, generate timelines, organize and delegate work, and coach others as needed .... (88 - 94%)
- Lead by taking responsibility for various tasks, motivating and disciplining others as needed .... (73 - 94%)
- Understand basics from other fields, so as to participate effectively on multidisciplinary projects .... (82 - 94%)
- Communicate ideas relating to ME in terms that others outside ME can understand .... (88 - 94%)

B.3.7.2 Conclusion (Fall 2003 – Spring 2005)

Six (6) courses were targeted for assessment of outcome 3c in the ME Program. Five of them were assessed in Fall 2003 and two in Spring 2005. The analysis of the data shows that ME students are given adequate opportunities to work in teams. Moreover, their survey responses and peer evaluations show that they significantly improve their team skills. All courses have met and exceeded the student performance target level (60%) for outcome 3c. In summary, the ME Program satisfies outcome 3c.

B.3.8 Outcome 3e

ME graduates can identify, formulate, and solve ME problems.

Outcome Champion: Dr. Nikos J. Mourtos

Outcome Elements (3): (a) ability to identify engineering problems, (b) ability to formulate engineering problems, (c) ability to solve engineering problems.

Outcome attributes (10): ME graduates who are problem solvers should exhibit the following attributes:
3e-1: Be willing to spend time reading, gathering information and defining the problem.

3e-2: Use a process, as well as a variety of tactics and heuristics to tackle problems.
3e-3: Monitor their problem-solving process and reflect upon its effectiveness.
3e-4: Emphasize accuracy rather than speed.
3e-5: Write down ideas, create charts / figures, while solving a problem.
3e-6: Be organized and systematic.
3e-7: Be flexible (keep options open, can view a situation from many different perspectives / points of view).
3e-8: Draw on the pertinent subject knowledge and objectively and critically assess the quality, accuracy, and pertinence of that knowledge / data.
3e-9: Be willing to risk and cope with ambiguity, welcoming change and managing stress.
3e-10: Use an overall approach that emphasizes fundamentals rather than trying to combine various memorized sample solutions.

B.3.8.1 Summary from Supporting Courses

M E111: Fluid Mechanics[8]

Course activities related to outcome 3e: (a) Homework Sets (10): Identify the given information in end-of-the chapter problems, formulate an approach to problem solution and carry out the solution to a wide variety of assigned problems spanning the student learning objectives in the course. (b) Final exam & Quizzes: Determine meaning of given information, set up the problem, identify problem type and most probable solution approach, and perform solution. All sorts of problems represented among these test products. (c) Application Notes (2): Students choose fluid mechanics applications observed in everyday life and then he/she must identify the principles that apply, derive estimated parameter values and apply the engineering formulations to solve the application. They must then compare the calculated results to what they expect or observe. (d) Several open-ended problems are presented in class, worked out in teams, and their solutions presented in class by the students.

Course Assessment (Spring 2003): ME111 met the performance targets for outcome 3e.

Student Performance Summary: Student's performance on outcome 3e averaged 83% on the homework, 78% on the quizzes combined with the final exam, and 83% on the application notes. Similarly, the percentages of students achieving the 70% level or higher are 79% on homework, 79% on final exam and quizzes and 82% on application notes, for 80% average among the products.

Student Survey Results: 76% of students agree that they achieved this outcome.

M E113: Thermodynamics[2]

Course activities related to outcome 3e: This outcome was addressed by incorporating open-ended problems into the lecture period. Here, the solution methodology is not obvious, and it is expected that the students assess the applicability of recent lecture topics to an unfamiliar problem, make and justify simplifying assumptions, obtain a solution, and judge whether it is reasonable or not. There is a range of assignments used for this class addressing this outcome. Up to seven (7) quizzes are administered; all quizzes are open-ended in nature. The exercises in the quizzes are related to the lectures, but require the students to apply principles discussed to a new situation. In addition, up to three (3) projects are assigned, and may include an open-ended design problem, a research assignment requiring a literature search and thesis, and / or web-based experiments modeling actual hardware (for comparison with idealized systems primarily covered in class.) In addition, there are occasionally open-ended problems on the midterm and final exams.

Course Assessment (Fall 2003): ME113 met the performance targets for outcome 3e.

Student Performance Summary: 81% of the students scored 70% or greater on the seven (7) quizzes and 86% scored 70% or greater on the three (3) projects.

---

[8] Mourtos, N.J., DeJong-Okamoto, N., Rhee, J., *Open-Ended Problem-Solving Skills in Thermal-Fluids Engineering*, **Invited Paper**, Global Journal of Engineering Education, vol.8, no.2, 2004.

Student Survey Results: In general, students were confident about their problem solving skills. 70% of the students agreed with most of the statements in the survey. The questions that fell marginally short of the target dealt with focusing on accuracy rather than speed (3e-6), and taking risks (3e-11).

This course has increased my ability to:	Agree	Not sure	Disagree
3e-1. Read and understand the information given about a problem.	43	1	0
3e-2. Define a problem in ways I can understand it.	42	1	1
3e-3. Research and gather information pertaining to a problem.	39	5	0
3e-4. Use a process, as well as a variety of tactics and approaches to tackle real-world problems.	35	6	3
3e-5. Monitor my problem-solving process.	35	7	2
3e-6. Focus on accuracy rather than speed.	28	11	5
3e-7. Write down ideas, create charts and figures.	39	4	1
3e-8. Be organized and systematic when I solve problems.	38	6	0
3e-9. Be flexible in my application of a problem solving strategy.	31	12	1
3e-10. Draw on pertinent subject knowledge and critically assess the quality of data.	36	7	1
3e-11. Take risks, cope with ambiguity, welcome change and manage stress.	27	14	3
3e-12. Use an overall approach that emphasizes fundamentals rather than memorized approaches.	38	5	1

ME114: Heat Transfer[2]

Course activities related to outcome 3e: (a) Lab 1 is an open-ended laboratory. Students acquire data in lab, but they must come up with their own method of calculating the thermal conductivity of an unknown material from this data. They must determine appropriate assumptions and decide which equations are most accurate. They must also determine which data is best to use to calculate the thermal conductivity based on the uncertainty of the thermocouples used to measure temperature. (b) Open-ended design of experiments project: Students design an experiment that determines the thermal conductivity of an unknown metal, taking into account experimental uncertainty. This is a paper design only. (c) In Lab 3 students use a computer and the finite difference method to analyze 2-D heat conduction. This project gives students the tools to analyze heat conduction for situations that may be too complex to accurately solve analytically. (d) Numerous homework problems require students to make assumptions and determine the appropriate process and equations to solve problems. (e) Exam problems require students to synthesize several chapters worth of information (or an entire semester for the final exam) to determine the appropriate method to attack a problem. (f) Short questions on the exams require students to synthesize information from the class to determine the causes of natural phenomena or practical design considerations. Students must know how classroom theory applies in the "real world" to answer these questions.

Course Assessment (Fall 2002-Spring 2003): ME114 met the performance targets for outcome 3e.

*Student Performance Summary***:** Student grades show excellent success on the very limited open-ended (heat conduction) lab exercise and the finite difference lab. However, students did not do as well on the final exam where they must sift through an entire semester's worth of information to choose the correct method or the more open-ended design of experiments project.

Student grades

activity	% of students with a score of 70% or better	
	Spring 2003	Fall 2003
heat conduction lab	90	--
finite difference lab	96	96
final exam	60	71
design of experiment project	--	62

Student Survey Results: Results from the F02 surveys suggested a need for stricter homework format, such as requiring figures where applicable. No significant improvement was seen in the F03 surveys in this area. However, replacing the homework grader should result in an improvement in this area. The F02 surveys also showed a need for more discussion of experimental uncertainty. While this subject is covered in detail in ME120, a discussion of experimental uncertainty and uncertainty of heat transfer correlations was added in F03, and student surveys showed an improvement. A discussion of uncertainty was included in the handout on lab report format and was emphasized to a greater degree in the lab write-ups. This topic should receive greater emphasis in the future. A new lab focusing on experimental temperature measurements and uncertainty is tentatively planned for F04.

The response to question 3e-7 most likely reflects the time limitations on exams. Students tend to confuse lack of understanding with lack of time. They'll try to work an exam problem out many different ways with no success, believing that if they just had more time they could get it. While additional exam time might illustrate to students more clearly what they do and do not know, it is very difficult to do with short class periods.

Fall 2002 student survey results

Question Number	Question	% who agree	% who aren't sure	% who disagree
3e-1	Read and understand the information given about a problem.	94	6	0
3e-2	Define a problem in ways I can understand it (build up a clear picture in my mind of the different parts of the problem and the significance of each part).	74	26	0
3e-3	Research and gather information pertaining to the problem.	80	17	3
3e-4	Use a process, as well as a variety of tactics and approaches to tackle (real world) problems.	80	20	0
3e-5	Monitor my problem-solving process and occasionally reflect upon its effectiveness.	80	20	0
3e-6	Focus on accuracy rather than speed when I solve problems.	57	40	3
3e-7	Write down ideas, create charts/figures to help overcome the storage limitations of short-term memory.	66	29	6
3e-8	Be organized and systematic when I solve problems.	91	9	0
3e-9	Be flexible in my application of a problem-solving strategy (keep options open, view situation from many different	71	26	3

	perspectives/points of view).			
3e-10	Draw on the pertinent subject knowledge and critically assess the quality and accuracy of that knowledge/data.	66	28	6
3e-12	Use an overall approach that emphasizes fundamentals rather than trying to combine various memorized sample solutions.	77	23	0

Fall 2003 student survey results

This course has increased my ability to:		% who agree	% who aren't sure	% who disagree
3e-1	Read and understand the information given about a problem.	89	11	0
3e-2	Define a problem in ways I can understand it (build up a clear picture in my mind of the different parts of the problem and the significance of each part).	92	8	0
3e-3	Research and gather information pertaining to the problem.	73	22	5
3e-4	Use a process, as well as a variety of tactics and approaches to tackle (real world) problems.	84	11	5
3e-5	Monitor my problem-solving process and occasionally reflect upon its effectiveness.	73	24	3
3e-6	Focus on accuracy rather than speed when I solve problems.	73	19	8
3e-7	Write down ideas, create charts / figures to help overcome the storage limitations of short-term memory (where problem-solving takes place).	68	24	8
3e-8	Be organized and systematic when I solve problems.	92	8	0
3e-9	Be flexible in my application of a problem-solving strategy (keep options open, view a situation from many different perspectives / points of view).	70	22	8
3e-10	Draw on the pertinent subject knowledge and critically assess the quality and accuracy of that knowledge / data.	78	19	3
3e-12	Use an overall approach that emphasizes fundamentals rather than trying to combine various memorized sample solutions.	81	19	0

Recommendations: (a) More in-class problem-solving sessions are needed where students must struggle under guidance to choose the correct solution method. (b) More open-ended homework problems where students must justify their assumptions should be added. (Note: improvement a was implemented in F03, while improvement b (will be implemented in F04)

ME147: Vibration & Control Systems

Course activities related to outcome 3e: (a) The main learning objective of this course is to teach students how to formulate and analyze dynamic systems using the laws of physics (Newton's method and Energy method). Modeling of dynamic systems (vibratory and general dynamic systems) accounts for about 1/3 of the semester. After dynamic models are developed, then analytical methods are introduced for solving simple (single degree of freedom) dynamic systems. For complex dynamic systems of higher order, systems of differential equations are solved (with the specified set of boundary and initial conditions) using computer aided numerical approaches. (b) Basic dynamic behavior of systems (transient response, frequency response, stability), and analysis and design of basic (PID) control systems are covered in the course. (c) An open-ended project was assigned to observe students' ability to formulate and design a given project (this is the take home part of this assignment).

Course Assessment (Spring 2003): ME147 did not meet the performance targets for outcome 3e.

Student Performance Summary: The students are trained to formulate single-degree and multiple degrees of freedom vibratory mechanical systems (linear and rotational). Newton’s method and the Energy method are applied for formulation. For relatively simple systems about 85% of the students learned how to identify and formulate vibratory systems of relative low degree of freedom. About 75% of the students can apply the analytical method for the initial value problems and transient / frequency responses of dynamic systems. More than 95% of the students can apply the computer-aided method for analysis of dynamic systems. Formulation of general dynamic systems other than vibratory systems is a difficult task for all senior students. Integration of knowledge from other core courses is needed to derive dynamic equations for the given systems. The students are not well prepared to do this. Many engineering principles covered in the core courses are related to the equilibrium behavior. ME147 alone cannot provide sufficient skills for the students to formulate general dynamic systems. ME130 teaches students how to solve the dynamic equations of various kinds, but not the mathematical formulation. Once the problem is identified and formulated, all students can analyze the problem using the modern engineering tools. The second midterm is a take home open-ended project. One project is to design a vibration absorber to protect a raw egg from the impact force when it is dropped from the second floor of the engineering building. Fewer than 5% of the students could identify the needed approach, formulate the system behavior and design a feasible impact force absorber.

ME182: Thermal Systems Design

Course activities related to outcome 3e: Students (a) develop a multi-pressure refrigeration system computer simulation and use it to choose the optimum system configuration and system pressures, (b) choose the lowest-cost electronics cooling system for a specified application and (d) develop a combined cycle power plant computer simulation and use it to choose optimum system pressures and temperatures. Students also perform and in-depth economic analysis.

Course Assessment (Spring 2003): ME182 met the performance targets for outcome 3e.

Student Performance Summary: All the students scored 70% or higher in all 3 projects. However, none of these projects was truly open-ended.

Recommendation: The first project should be made more open-ended.

<u>B.3.8.2 Conclusion (Fall 2003)</u>

Outcome 3e targets students' ability to identify, formulate and solve engineering problems. In general, once a problem has been identified and formulated, students are capable of solving it through application of basic principles. On the other hand, students need more training in identifying and formulating engineering problems. An effort is currently being made in ME111, ME113, ME114, ME182, and AE162 to develop open-ended problem solving skills. The data from the 5 assessed courses above show that the ME Program meets the performance targets for outcome 3e.

<u>B.3.9 Outcome 3f</u>

ME graduates understand their professional and ethical responsibilities.

Outcome Champion: Dr. Nicole DeJong Okamoto

Outcome Elements (2): (a) Understanding of professional responsibility and (b) understanding of ethical responsibility.

Outcome Attributes (5): ME graduates:
3f-1 Demonstrate knowledge of a professional code of ethics.
3f-2 Demonstrate an understanding of the impact of the profession on society and the environment.
3f-3 Demonstrate professional excellence in performance, punctuality, collegiality, and service to the profession.
3f-4 Given a job-related scenario that requires a decision with ethical implications, they can identify possible courses of action and discuss the pros and cons of each one.

3f-5 Given a job-related scenario that requires a decision with ethical implications, they can decide on the best course of action and justify the decision.

B.3.9.1 Summary from Supporting Courses

E10: Introduction to Engineering

Course activities related to this outcome 3f: Students *a)* research, present and discuss in class case studies on professional and ethical responsibility, (b) write individual reports on each case study and (c) are tested on engineering ethics in their final exam. Approximately 20% of the course grade is based on ethics assignments and ethics questions on the final exam.

Course Assessment (Fall 2002): E10 did not meet the performance targets for outcome 3f.

Student Performance Summary: In the 5 sections, taught by 3 instructors, a total of 203 students received passing grades. The cumulative scores of these students in all the assignments and exam questions that pertain to ethics were as follows: 62% of the students performed at 70% or higher, 7% performed between 60% and 69%, 11% performed between 50% and 59% and 21% performed below the 50% level. The results in the rest of the sections are expected to be similar. The student performance in this area does not meet the 70% target. One of the reasons why students have lower scores in this area is because of the writing required in the analysis of each case study. Many students answer the questions in a short, superficial way or skip the ethics assignments altogether. This issue is currently being addressed in the course by renewing the emphasis on these assignments.

E100W: Technical Writing

Course activities related to this outcome 3f: In this course, plagiarism is discussed extensively, and students are given instruction on how to site other people's work appropriately. All papers are submitted through Turnitin.com, a plagiarism prevention site. Students also examine the STC Ethical Guidelines for Technical Communicators. The students write several papers that address ethical and professional issues in assignments such as "Coral Reefs: Why and How Can You Help to Save Them, "Should the US be involved in American Samoa," and an assignment where students reflect upon ethical issues involved with importing goods manufactured under harsh working conditions.

Course Assessment: While this course clearly addresses professional and ethical responsibility to a significant degree, no data (grades or surveys) have been made available. Thus, it is not possible to determine whether student performance with regards to outcome 3f is acceptable or not.

ME195A&B: Senior Design Project

Course activities related to this outcome 3f: One of the writing assignments on ethics followed-up an in-class discussion of a case study involving the safety record of the Beechcraft V-tail Bonanza airplane. The other writing assignment asked students to reflect on the importance of ethics in engineering.
Course Assessment (Spring 2005): ME195 did not meet the performance targets for outcome 3f.

Student Performance Summary: The metric for assessing student performance for outcome 3f is the average percentage earned, which is found by combining percentages earned for quiz 2 (on Patent Law) and two writing assignments on ethics. The range of performance for students on this metric based on available data (two of the four sections) is:

Combined average of 70% or higher:	90 – 94%
Combined average of 60 to 70%	0 – 5%
Combined average of 50 to 60%	0%
Combined average of less than 50%	0 – 5%

Student Survey Results: The results from all four sections (N = 17, 17, 11, 17 for sections 1, 2, 3, 4 respectively) of ME 195B, show that the vast majority of students agree that the course increased their understanding of:

- Professional codes of ethics .... (71 - 91%)
- The importance of thoroughness, accuracy, and punctuality .... (82 - 91%)
- Plagiarism and how to appropriately cite other people's work .... (73 - 88%)

And increased their ability to:

- Identify possible effects of their designs on society through issues such as safety, reliability, recycling and disposal, and the environment .... (82 - 100%)
- Recognize the presence of an ethical dilemma .... (76 - 82%)

- Identify possible courses of action and discuss the pros and cons of each one, given a job-related scenario that requires a decision with ethical implications .... (71 - 91%)
- Decide on the best course of action and justify the decision, given a job-related scenario that requires a decision with ethical implications .... (82 - 94%)

B.3.9.2 Conclusion (Fall 2003-Spring 2005)

Based on the data available in Fall 2003, The ME Program does not satisfy outcome 3f. Although E10 and E100W spend an appropriate amount of time on engineering ethics, the low scores in E10 indicate that students do not perform well on their ethics assignments, while the lack of assessment in E100W and the lack of data and assessment in ME195A&B did not allow for any statements to be made regarding student performance in this area. Outcome 3f was assessed for the first time in ME195 in Spring 2005 and the data show that ME seniors get experience in engineering ethics and most of them perform well in their assignments. However, a small percentage of students does not meet the performance target.
Recommendation: Starting in Fall 2005, students will not receive a passing grade in the course unless they receive a passing grade in their ethics assignments.

B.3.10 Outcome 3g

ME graduates can communicate effectively

Outcome Champion: Dr. Nicole Okamoto

Outcome Elements (2): (a) Ability to communicate effectively in writing and (b) ability to give effective oral presentations.

Outcome Attributes (9): ME graduates:
3g-1 Produce well-organized reports, following guidelines.
3g-2 Use clear and correct language and terminology while describing experiments, projects, or solutions to engineering problems.
3g-3 Describe accurately in a few paragraphs a project / experiment performed, the procedure used, and the most important results (abstracts, summaries).
3g-4 Give well-organized presentations, following guidelines.
3g-5 Use visuals to convey their message effectively, when making presentations.
3g-6 Present the most important information about a project / experiment, while staying within their allotted time when making presentations.

B.3.10.1 Summary from Supporting Courses

E10: Introduction to Engineering

Course activities related to outcome 3g: Students: (a) write 2 design reports, (b) write extensively on a weekly basis, especially in assignments related to "engineering success" (lifelong learning) and "engineering ethics", (c) give 2 oral briefings on their design projects and (d) give presentations on case studies in professional and ethical responsibility.

Course Assessment (Spring 2003): E10 met the performance targets for outcome 3g.

Student Performance Summary: In general, students' writing ability is poor, primarily due to lack of language skills. On the other hand, some of the design reports are truly excellent. There are two elements that contribute to students' writing skills: (a) the 2 design reports and (b) the weekly assignments on lifelong learning and ethics. Students are given detailed guidelines on how to organize their design reports. However, instructors cannot give detailed feedback on language issues. Students seem to be better in preparing and delivering oral presentations. Overall, the students increased their ability to communicate effectively in writing and orally as indicated by (a) their design reports, (b) their oral presentations, and (c) the fairly high level of confidence in their survey responses (70% target is met in all but one skill: 3g-2).

E100W: Technical Writing

Course activities related to outcome 3g: E100W - Engineering Reports is an upper division technical writing course. This course is required for all engineering students. Completion of core GE and passing the Writing Skills Test (WST, a lower division college level writing test) is required prior to enrollment in E100W. Students typically take this course in their junior year. In-class writing, assessment, and feedback are carried out weekly. The COE also offers a writing clinic (E90W), open to all engineering students. This clinic was implemented in order to assist students who need basic English skills.

Course Assessment (Spring 2004 – Fall 2004): In Spring 2004, out of 287 students, 37 received less than a passing score. In Fall 2004, out of 248 students, 31 received less than a passing score. Out of the 31 receiving less than a passing score, 10 had passing grades going into the exam.

All three sections of 100W students took a pre-test the first week in class (one essay question), then the same 75 students took a post-test the week before finals. An official grader of the WST exams graded and assigned scores (1-12) on both sets. The results showed a significant improvement of the average scores (pre-test score average = 7.04, post-test score average: 8.20).

ME113: Thermodynamics

Course activities related to outcome 3g: Written communication skills are developed in this course. Oral presentation skills are not emphasized. Up to three (3) projects are assigned requiring written reports. The report format and grading follow the MAE Department guidelines.

Course Assessment (Fall 2003): ME113 met the performance targets for outcome 3g.

Student Performance Summary: 86% of the students scored 70% or higher on the 3 projects reports.

Student Survey Results: More than 70% of the students agreed that ME113 increased their written communication skills.

This course has increased my ability to:	Agree	Not sure	Disagree
3g-1. Produce well-organized reports following guidelines.	40	2	2
3g-2. Use clear and correct language and terminology when describing experiments, projects, or solutions.	35	7	2
3g-3. Describe accurately in a few paragraphs a project/experiment, procedures, and important results.	36	6	2

ME114: Heat Transfer

Course activities related to outcome 3g: (a) Proper technical memo format discussed in class, (b) students write 5 technical memoranda, including figures and appendices, for their lab reports in groups of two, (c) format, grammar, and content are edited heavily by the instructor, (d) proper homework format is discussed in class but is not enforced as strictly as technical memo format.

Course Assessment (Spring 2003-Fall 2003): ME114 met the performance targets for outcome 3g.

Student Performance Summary: Most of the points that students lose on the lab reports are due to writing problems. To help fix this problem, last year the instructor began grading lab reports rather than the lab assistant. The instructor provides significant comments on the lab reports to help students improve their writing. In addition, in Fall 2003 a more complete discussion of proper lab report format was instituted. It was placed online so that students could access it at any time. This format is used across the department.

Student grades

activity	% of students with a score of 70% or better	
	Spring 2003	Fall 2003
5 lab reports	90	81

Fall 2003 survey

This course has increased my ability to:		Agree	Not sure	Disagree
3g-1	Produce well-organized reports, following guidelines.	89	11	0
3g-2	Use clear and correct language and terminology while describing experiments, projects, or solutions to engineering problems.	86	14	0
3g-3	Describe accurately in a few paragraphs a project / experiment performed, the procedure used, and the most important results when writing abstracts or summaries.	84	16	0

ME120: Experimental Methods

Course activities related to outcome 3g: Students (a) write 6 laboratory reports on experiments conducted and (b) give at least one oral presentation on experiment conducted.

Course Assessment (Fall 2002): ME120 met the performance targets for outcome 3g.

Student Performance Summary: The metric for assessing student performance for outcome 3g comes from a combination of the student performance on laboratory reports and oral presentations. All sections showed that more than 70% of the students are achieving 70% or greater for this outcome.

Student Survey Results: ME120 appears to be very effective in increasing students' ability to produce well-organized reports (question 3g-1: 92% - 100% agreed). Similarly, there was almost unanimous agreement that the course was effective in increasing students' abilities in regards to using clear language to describe results, summarizing results, and giving well-organized and focused presentations (questions 3g-2 through 3g-6 respectively).

ME195A&B: Senior Design Project

Course Assessment (Spring 2005): ME195 did not meet the performance targets for outcome 3g.

Student Performance Summary: The metric for assessing student performance for outcome 3g consists of the average percentage earned for the oral presentations, progress reports, and end-of-semester report. The vast majority of students are performing well above 70% for this metric (data from three of the four sections).

Combined average of 70% or higher:	94 – 100%
Combined average of 60 to 70%	0%
Combined average of 50 to 60%	0%
Combined average of less than 50%	0 – 6%

Student Survey Results: According to the results of student surveys from all four sections (n=17, 17, 11, and 17 from sections 1, 2, 3, and 4 respectively) of ME 195B, the vast majority agree that the course increased their ability to:

- Produce well-organized reports, following guidelines .... (88 - 100%)
- Use clear and correct language and terminology while describing experiments, projects, or solutions to engineering problems .... (82 - 100%)
- Describe accurately in a few paragraphs a project / experiment performed, the procedure used, and the most important results when writing abstracts or summaries .... (88 - 100%)
- Give well-organized presentations, following guidelines .... (88 - 100%)

- Use visuals to convey their message effectively, when making presentations .... (76 - 100%)
- Present the most important information about a project / experiment, while staying within my allotted time when making presentations .... (88 - 100%)

B.3.10.2 Conclusion (Fall 2003)

Based on 7 courses assessed for communication skills (written and oral) the ME Program meets the performance targets for outcome 3g. However, stricter standards should be implemented in English 1A, English 1B and E100W, the last one being the most important course for teaching students technical communication skills. Students who pass E100W should be able to write much better in their reports. Other courses that follow E100W and require these skills, simply offer opportunities for reinforcement. While the standards should be high in all these courses and students should be given feedback on their reports, there is no time to teach writing in a senior design project or in other technical courses due to time limitations.

B.3.11 Outcome 3h

ME graduates have the broad education necessary to understand the impact of engineering solutions in a global / societal context.

Outcome Champion: Dr. Periklis Papadopoulos

Outcome Elements (2): (a) Ability to understand the impact of engineering solutions in a global context and (b) ability to understand the impact of engineering solutions in a societal context.

Outcome Attributes (5): ME students:
3h-1 Evaluate and describe accurately the environmental impact of various engineering products, including those they design in course projects.
3h-2 Evaluate and describe accurately environmental and economic tradeoffs of engineering products, including those they design in course projects.
3h-3 Evaluate and describe accurately the health / safety and economic tradeoffs of engineering products, including those they design in course projects.
3h-4 Take into consideration the environmental impact when designing an engineering product.
3h-5 Take into consideration the health / safety impact when designing an engineering product.

B.3.11.1 Summary from Supporting Courses

ME111: Fluid Mechanics

Course activities related to outcome 3h: Students study one or more articles from periodicals / newspapers / magazines on a current issue of interest (environment, air safety, economics, etc.) that involves fluid mechanics. They write a 2-page analysis and give an oral presentation in class on how fluid mechanics plays a role on this issue. They also discuss the impact of any fluid mechanics applications involved in a global / societal context.

Course Assessment (Fall 2002): ME111 met the performance targets to outcome 3h.

Student Performance Summary: All the students (100%) achieved the 70% performance level on the research review assignment. However, these assignments may be somewhat inadequate for their purpose.

Recommendation: Either other graded deliverables / assignments need to be introduced for outcome 3h or the standards need to be raised for assignment depth and reporting (implemented in Fall 2004).

ME113: Thermodynamics

Course activities related to outcome 3h: (a) The global and societal implications of thermodynamics are discussed in lecture, and further investigated in the assignments. Issues covered include health and safety, environmental concerns, and economic tradeoffs resulting from applications and issues such as power generation and consumption, use of refrigerants, burning of hydrocarbons, and alternative and renewable energy sources. (b) The first lecture of the semester starts with a discussion on the "Top 10 reasons to study thermodynamics". This discussion puts thermodynamics in a global and societal perspective.

(c) A research project is assigned for students to investigate a topic that is global, societal, and contemporary. A literature search is required as well as a cohesive thesis binding all three elements together. (d) Questions on problem sets, midterm and final exams address outcome 3h.

Course Assessment (Fall 2003): ME113 met the performance targets for outcome 3h.

ME113 did not satisfy outcome 3h in Fall 2002. However, several improvements were recommended and implemented in Fall 2003, resulting in the satisfactory achievement of this outcome. The research project required an in-depth look at global, societal, and contemporary effects from engineering solutions. The topics ranged from hybrid electric-gasoline vehicles, alternate fuels and energy, fuel cells, energy conservation, and liquifaction of natural gas.

Student Performance Summary: The average grade on the article and analysis was 14 out of 15 points. The average grade on the reports was 23 out of 25. The grade distribution can be found on the list of report titles. On the problem set question 20% of the students scored 70% or higher. The poor numbers are attributed to many students not turning in this assignment, or skipping the question. Homework is not a large fraction of the final grade, so perhaps lack of motivation is causing this poor result. The exam question asked students to list a global and societal impact of engineering applications discussed in class. 90% scored 70% or higher on this question.

Student Survey Results: The students felt that this course increased their knowledge of the impact of engineering solutions on a global and societal context. At least 70% of the students agreed with statements in the survey below.

Student Survey Results, Fall 2003:

This course has increased my ability to:	Agree	Not sure	Disagree
3h-1. Evaluate and describe accurately the environmental impact of various engineering products.	41	3	0
3h-2. Evaluate and describe accurately environmental and economic tradeoffs of engineering products.	34	9	1
3h-3. Evaluate and describe accurately the health / safety and economic tradeoffs of engineering products.	31	7	6
3h-4. Take into consideration the environmental impact when designing an engineering product.	37	3	4
3h-5. Take into consideration the health / safety impact when designing an engineering product.	33	6	5

ME 182: Thermal Systems Design

Course activities related to outcome 3h: (a) Each student addresses issues relating to human health and welfare, society, politics, economics, and the environment in their alternative fuel presentations. (b) Half of the exam relates to alternative and environmentally friendly power sources.

Course Assessment (Fall 2002): ME182 met the performance targets for outcome 3h.

Student Performance Summary: Student performance in this area was strong although limited to the area of alternative power sources. 96% of the students received 70% or higher in their presentations, while 87% of them received 70% or higher in the exam questions related to outcome 3h.

ME195A&B: Senior Design Project

Course Assessment (Spring 2005): ME195 did not meet the performance targets for outcome 3h.

Student Performance Summary: The metric for assessing student performance for Outcome 3h consists of the percentage of points earned on a quiz following the guest lecture given by Mr. Richard Walker, Vice-President, Emerging Countries, of the Hewlett Packard Company on April 27, 2005 (data from three of the four sections).

Average of 70% or higher:	71 – 89%
Average of 60 to 70%	0 – 19%
Average of 50 to 60%	0 – 6%
Average of less than 50%	5 – 17%

B.3.11.2 Conclusion (Fall 2003-Spring 2005)

Three courses (ME111, ME113 and ME182) were assessed for outcome 3h in Fall 2003 and met the performance targets. Hence, the ME Program satisfies outcome 3h. Two additional courses (ME195A&B) were assessed in Spring 2005 and did not meet the performance target for this outcome. Considering the nature of this outcome, it would be desirable to address and assess it in more courses to ensure more breadth of the issues discussed.

B.3.12 Outcome 3i[9]

ME students recognize the need and can engage effectively in lifelong learning.

Outcome Champion: Dr. Nikos J. Mourtos

Outcome Elements (2): (a) Ability to recognize the need for lifelong learning, and (b) ability to engage in lifelong learning.

Outcome Attributes (11): ME students who are lifelong learners:

3i-1 Are willing to learn new material on their own.
3i-2 Are capable of reflecting on their learning process.
3i-3 Participate in professional societies.
3i-4 Read articles / books outside of class.
3i-5 Are aware that to stay current in today's world, they must continue their education by attending short courses, workshops, seminars, conferences or graduate school.
3i-6 Observe engineering artifacts carefully and critically to reach an understanding of the reasons behind their design.
3i-7 Can access information effectively and efficiently from a variety of sources.
3i-8 Read critically and assess the quality of information available (ex. question the validity of information, including that from textbooks or teachers).
3i-9 Analyze new content by breaking it down, asking key questions, comparing and contrasting, recognizing patterns, and interpreting information.
3i-10 Synthesize new concepts by making connections, transferring prior knowledge, and generalizing my understanding.
3i-11 Model by estimating, simplifying, making assumptions and approximations.
3i-12 Visualize (ex. create pictures in their mind that help them *"see"* what the words in a book describe).
3i-13 Reason by predicting, inferring, using inductions, questioning assumptions, using lateral thinking, and inquiring.

B.3.12.1 Summary from Supporting Courses

E10: Introduction to Engineering

Course activities related to outcome 3i: Students: (a) Attend presentations from representatives of the student chapters of engineering professional societies on the benefits of membership and receive course credit if they join and participate in society activities, (b) become aware through class discussion, that to stay current in today's world, they must continue their education by attending short courses, workshops, seminars, conferences and/or graduate school, (c) discuss learning in the university environment as well as strategies for maximizing performance in engineering courses, (d) explore their learning styles by taking the Learning Styles Inventory and the Jung Typology Test to identify strengths and weaknesses in their learning process. They develop strategies to help them overcome weaknesses and become more balanced in their learning

[9] Mourtos , N.J. , "Defining, Teaching and Assessing Lifelong Learning Skills", Proceedings, ASEE / IEEE Frontiers in Education Conference, 2003.

approach, (e) observe engineering artifacts carefully and critically and understand the reasons behind specific designs, (f) access, read and assess the quality of information from a variety of sources as part of their work in (a) design projects and (b) case studies in engineering ethics, (g) acquire knowledge of new material (not discussed in class) related to their projects, (h) model by estimating, simplifying, making assumptions and approximations and (i) are tested on lifelong learning concepts (including modeling and estimation) in their final exam.

Course Assessment (Fall 2002): E10 met the performance targets for outcome 3i.

Student Performance Summary: In 5 sections, taught by 3 instructors, a total of 203 students received passing grades[2]. The cumulative scores of these students in all the assignments and exam questions that pertain to outcome 3i was as follows: (a) 111 students (55%) received 70% or higher, (b) 35 students (17%) received between 60-69%, (c) 25 students (12%) received between 50-59%, (d) 32 students (16%) received below 50%. Obviously, the 70% target in student performance was not met. This is not a surprise. It is frequently discussed among E10 instructors, that freshmen do not adequately appreciate the "lifelong learning" content of the course. For example, in a previous study on the effectiveness of E10[10], a large percentage of students felt they already knew how to study and prepare for exams simply because they made it successfully through high school. As a consequence, they did not care to spend any time on these topics, either in class or outside of class. The challenge here lies in finding more effective ways to convince our freshmen that they need to improve their study skills beyond the level developed in high school. However, other course assignments, which also contribute to the development of lifelong learning skills, were not included in the scoring because they were considered under different outcomes (ex. design project scores were considered under outcome 3c).

Student Survey Results: With a few exceptions the results of the student surveys did not meet the 70% target. Students show the most confidence in modeling and estimation followed by analyzing new content, synthesizing new concepts and visualizing, all of which scored 70% or higher.

Recommendation: In areas where students do not feel confident as to whether they improved their lifelong learning skills or not, instructors need to spend more time discussing the kinds of skills students are expected to demonstrate and explain how the various assignments / activities help them acquire these skills.

ME111: Fluid Mechanics

Course activities related to outcome 3i: (a) Opening handouts (discussed on the first day) indicate the breadth of fluid mechanics applications in the life sciences, physical sciences, astrophysics and geosciences, all fields of engineering and devices. A second multi-page handout lists many examples of natural and engineering flow systems in the form of questions Did you ever wonder…? As a result, students learn that there is a huge spectrum of flows in everyday life. (b) Students choose two flow applications, research information about them experientially or in various resources and submit their "application notes". (c) Students maintain journals in which they reflect every week on the course material, lecture presentation, what they learn from the homework, personal response to the material, etc. The reflection on their learning process requires change throughout the semester in discovering what is working, what isn't and making the necessary changes.

Course Assessment (Fall 2003): ME111 met the performance targets for outcome 3i.

Student Performance Summary: Student performance on the application notes averaged 83% and on the reflection journals 91% (combined average of 86%).

Student Survey Results: The agreement on the survey questions that pertain to outcome 3i averaged 73%.

ME113: Thermodynamics

Course activities related to outcome 3i: (a) One project includes a brief tutorial on library resources and information retrieval and assessment. (b) In-class quizzes require students to analyze unfamiliar problems from different points of view collaboratively in a team. (c) Applications of thermodynamic theory are heavily integrated into the course, and relevant articles and websites are available for students interested in further information. (d) A research project is assigned. Each

[10] Mourtos , N.J. , Furman, B.J., "Assessing the Effectiveness of an Introductory Engineering Course for Freshmen", Proceedings, ASEE / IEEE Frontiers in Education Conference, 2002.

student is required to find an article from a trustworthy source relevant to their group's common theme and to explain it using topics discussed in class.

Course Assessment (Fall 2003): ME113 met the performance targets for outcome 3i.

Student Performance Summary: 80% of the students received 70% or more of the points on the individual research assignment. The average score on their research project reports was 23 / 25 points. Moreover, 81% of the students scored 70% or higher on the 7 open-ended quizzes.

Student Survey Results: The majority of the students felt that ME113 increased their lifelong learning skills.

This course has increased my ability to:	Agree	Not sure	Disagree
3i-1. I was encouraged and taught how to learn new material and find information on my own.	38	4	2
3i-2. I was encouraged and taught how to reflect on my learning process and identify my strengths and weaknesses.	31	10	4
3i-5. I became aware that to stay current in today's world, I must continue my education by attending short courses, workshops, seminars, conferences or graduate school.	30	8	6
3i-6. Observe engineering applications carefully and critically.	39	5	0
3i-7. Access information from a variety of sources.	37	7	0
3i-8. Read critically and assess the quality of information available (ex. question the validity of information, including that from the internet, textbooks or teachers).	38	4	2
3i-9. Analyze new content by breaking it down, asking key questions, comparing and contrasting, recognizing patterns, and interpreting information.	37	6	1
3i-10. Synthesize new concepts by making connections, transferring prior knowledge, and generalizing my understanding.	33	8	3
3i-11. Model by estimating, simplifying, making assumptions and approximations.	38	4	2
3i-12. Visualize (ex. create pictures in my mind to help me *"see"* what the words in a book describe).	40	3	1
3i-13. Reason by predicting, inferring, using inductions, questioning assumptions, using lateral thinking, and inquiring.	39	4	1

ME114: Heat Transfer

Course activities related to outcome 3i: (a) Over half of the homework is based on conceptual and theory-based questions, and it is due before the topic that it covers is discussed in class. This forces the students to learn material on their own, and it has the added benefit of resulting in students who are much more prepared for class.

Course Assessment (Fall 2003): ME114 did not meet the performance targets for outcome 3i.

Student Performance Summary: In Fall 2003, in the second section of this class only, a new type of homework based on conceptual questions was implemented. Students in this section had a course average 4.6% higher than the other section, indicating a better understanding of the course material.

Student Survey Results: Questions 3i-1, 3i-2, 3i-6, 3i-7 and 3i-8 show a need for improvement in student confidence on the corresponding life-long learning skills.

Student Survey Results

In this course:		Agree	Not sure	Disagree
3i-1	I was encouraged and/or taught how to learn new material and find information on my own.	57	27	16
3i-2	I was encouraged and/or taught how to reflect on my learning process and identify my strengths and weaknesses.	38	46	16
This course has increased my ability to:				
3i-6	Observe engineering artifacts carefully and critically.	65	30	5
3i-7	Access information from a variety of sources.	65	24	11
3i-8	Read critically and assess the quality of information available (ex. question the validity of information, including that from the internet, textbooks or teachers).	68	24	8
3i-9	Analyze new content by breaking it down, asking key questions, comparing and contrasting, recognizing patterns, and interpreting information.	81	19	0
3i-10	Synthesize new concepts by making connections, transferring prior knowledge, and generalizing my understanding.	76	22	3
3i-11	Model by estimating, simplifying, making assumptions and approximations.	89	8	3
3i-12	Visualize (ex. create pictures in my mind to help me *"see"* what the words in a book describe).	81	14	5
3i-13	Reason by predicting, inferring, using inductions, questioning assumptions, and inquiring.	89	11	0

Recommendation: Students should be required to use the library and internet to retrieve information – such as searching for heat transfer correlations in journals or heat transfer handbooks. In addition, thermal-related seminars and workshops should be advertised to a greater degree.

ME 182: Thermal Systems Design

Course activities related to outcome 3i: Students researched in the library and the internet information on alternative fuels. Each student had to learn this technical material on their own and make a presentation in class.

Course Assessment (Fall 2002): ME182 met the performance targets for outcome 3i.

Student Performance Summary: 96% of the students received 70% or higher in their presentations indicating that they performed their literature search successfully and learned the material.

Recommendation: It is recommended that next time the course is taught, students be required to search for specific technical information (such as average heat transfer coefficients for heat sinks used in Project 2) using engineering journals via the database Engineering Village II.

ME195A&B: Senior Design Project

Course Assessment (Spring 2005): ME195 met the performance targets for outcome 3i.

Student Performance Summary: The metric for assessing student performance for outcome 3i is the percentage earned on the end-of-semester report (data from three of the four sections).

Average of 70% or higher:	100%
Average of 60 to 70%	0%
Average of 50 to 60%	0%
Average of less than 50%	0%

In order to successfully complete the senior project, most students must practice in lifelong learning skills. Most of the students learn substantial amounts of new material on their own to solve problems faced in the project.

Student Survey Results: According to the results of student surveys from all four sections (N = 17, 17, 11, and 17 from sections 1, 2, 3, and 4 respectively) of ME 195B, the majority agree that the course:

- Encouraged and taught them how to learn new material and find information on their own .... (88 - 100%)
- Encouraged them to participate in professional society activities and events .... (71 - 90%)
- Made them aware that to stay current in today's world, they must continue their education by attending short courses, workshops, seminars, conferences, or graduate school .... (71 - 90%)

And increased their ability to:

- Observe engineering artifacts carefully and critically to understand the reasons behind their design .... (59 - 90%)
- Access information from a variety of sources .... (82 - 100%)
- Read critically and assess the quality of information available (ex. question the validity of information, including that from the internet, textbooks or teachers) .... (76 - 94%)
- Analyze new content by breaking it down, asking key questions, comparing and contrasting, recognizing patterns, and interpreting information .... (76 - 100%)
- Synthesize new concepts by making connections, transferring prior knowledge, and generalizing understanding.. (76 - 100%)
- Model by estimating, simplifying, making assumptions, and approximations.................................. (88 - 100%)
- Visualize .... (90 - 100%)
- Reason by predicting, inferring, using inductions, questioning assumptions, using lateral thinking, and inquiring .... (71 - 100%)

B.12.2 Conclusion (Fall 2003-Spring 2005)

Analysis of the available data for 7 courses[3], 6 of which met their performance targets, shows that the ME program satisfies outcome 3i. Some work needs to be done still in some courses to ensure that (a) performance targets are met and (b) students acquire all the necessary lifelong learning skills.

B.3.13 Outcome 3j

ME students demonstrate knowledge of contemporary[11] issues.

Outcome Champion: Dr. John Lee

Outcome Attributes: ME graduates must be able to:
3j-1 List several examples of contemporary issues related to Engineering and Technology, and articulate a problem statement or position statement for each.
3j-2 Explain what makes these issues particularly relevant to the present time.
3j-3 Suggest reasonable theories regarding the root causes of contemporary problems.
3j-4 Identify possible solutions to contemporary problems, as well as any limitations of such strategies.

B.3.13.1 Summary from Supporting Courses

ME111: Fluid Mechanics

Course activities related to outcome 3j: Students study one or more articles from periodicals / newspapers / magazines on a current issue of interest (environment, air safety, economics, etc.) that involves fluid mechanics. They write a 2-page analysis and give an oral presentation in class on how fluid mechanics plays a role on this issue. They also discuss the impact of any fluid mechanics applications involved in a global / societal context.

Course Assessment (Fall 2002): ME111 met the performance targets for outcome 3j.

Student Performance Summary: All the students (100%) achieved the 70% performance level on the research review assignment. However, these assignments may be somewhat inadequate for their purpose.

Recommendation: Either other graded deliverables / assignments need to be introduced for outcome 3h or the standards need to be raised for assignment depth and reporting (implemented in Fall 2004).

ME113: Thermodynamics

Course activities related to outcome 3j: This outcome is addressed by integration of contemporary issues in the lecture and a research project. Topics covered in lecture are updated each semester and have included global warming, power plant by-products and pollution, the recent energy crisis, alternative energy sources, refrigerant choices and the recovering ozone layer, dependence on foreign oil, and even terrorism. The research project incorporates global, societal, and contemporary issues of thermodynamics, and challenges students to find out more about current impacts and issues that we face today as a result of thermodynamic engineering.

Course Assessment (Fall 2003): ME113 met the performance targets for outcome 3j.

Student Performance Summary: The average score on the project reports was 92%.

Student Survey Results: At least 70% of the students agreed that this course improved their knowledge of contemporary issues.

Fall 2003 Student Survey Results:

This course has increased my ability to:	Agree	Not sure	Disagree
3j-1. Identify contemporary issues (ex. Alternative energy, bioethics, market and workforce globalization, mobile technology and communications, information management and security) and explain what makes them	39	3	2

[11] *A working definition of "contemporary" is "having particular relevance to the present time." In 2004, some specific examples include international conflict, terrorism, pollution, natural resources & energy conservation, urban development (traffic, housing), bioethics, market & workforce globalization, mobile technology & communications, information management & information security.*

particularly problematic or controversial in the present time.			
3j-2. Suggest reasonable theories regarding the root cause(s) of contemporary problems.	36	5	3
3j-3. Identify possible solutions to contemporary problems, as well as any limitations of such strategies.	35	6	3

ME114: Heat Transfer

Course activities related to outcome 3j: The cooling of electronics has become a constraining problem in the development of new and/or improved electronic systems. We address this issue in one lab and many homework problems. Energy conservation is addressed in several homework problems. In the Silicon Valley where SJSU is located, the cooling of electronics is an important issue. This is brought into the class through lecture and lab in many places. Students work on a number of homework problems related to this issue as well as to energy conservation. The biggest project related to a contemporary issue is the electronics cooling lab.

Course Assessment (Fall 2003): ME114 met the performance targets for outcome 3j.

Student Performance Summary: Students scored fairly well on the lab exercise, losing most of their points to writing and uncertainty analysis problems. In both Spring 2003 and Fall 2003, over 70% of students received a score of 70% or better in the electronics cooling lab assignment.

ME 182: Thermal Systems Design

Course activities related to outcome 3j: (a) Project 2 related to the cooling of electronics, which is a topic of great importance in the Silicon Valley. (b) Alternative and clean power sources receive a lot of attention in the news these days. These issues are addressed in the alternative fuel presentations. (c) Half of the exam related to alternative and environmentally friendly power sources. These issues are of special interest in California and the Silicon Valley, and thus the students were very interested.

Course Assessment (Fall 2002): ME182 met the performance targets for outcome 3j.

Student Performance Summary: Student performance in these areas was very strong. All students met the 70% performance target in project 2 and 96% met the performance target in their presentations.

B.13.2 Conclusion (Fall 2003)

A number of contemporary issues are being discussed in the 4 courses that have been assessed for outcome 3j, all of which met the performance targets. Hence, the ME Program satisfies outcome 3j.

B.3.14 Outcome 3k

ME graduates can use techniques, skills, and modern engineering tools necessary for engineering practice.

Outcome Champion: Dr. Jinny Rhee

Outcome Elements: (a) ability to use the *techniques* necessary for engineering practice, (b) ability to use the *skills* necessary for engineering practice, and (c) ability to use the *modern engineering tools* necessary for engineering practice.

Outcome Attributes: ME students:

3k-1 Use state-of-the-art technology for engineering system design, control, and analysis.
3k-2 Are skilled in web-based research.
3k-3 Use state-of-the-art software to write technical reports and give oral presentations.
3k-4 Use computer simulations to conduct parametric studies, process optimization, and 'what if' explorations.

3k-5 Use modern equipment and instrumentation in their labs.
3k-6 Are aware of state-of-the-art tools and practices used in industry through plant visits and presentations by practicing engineers.

B.3.14.1 Summary from supporting courses

ME120: Experimental Methods

Course activities related to outcome 3k: Students: (a) Use LabView software to acquire, analyze, and present experimental data. (b) Use electronic test and measurement equipment such as oscilloscopes, function generators, power supplies in experiments. (c) Use electronic calipers interfaced to Microsoft Excel to record and analyze metrology data. (d) Use various measurement equipment and sensors to quantify experimental data. (e) Use the internet to access course materials and reference materials.

Course Assessment (Fall 2002): ME120 met the performance targets for outcome 3k.

Student Performance Summary: The metric for assessing student performance for outcome 3k comes from a combination of student performance on laboratory reports and a part of the first assignment, which involved using LabView to create a virtual instrument. All sections (except Tuesday) showed that more than 70% of the students achieved 70% or greater in outcome 3k. As explained in outcome 3b, the lower performance of the students in Tuesday's section was the result of many low performing students not turning in all of their laboratory reports.

Student Survey Results: It is clear from the student survey that the vast majority (question 3k-7, 89% to 100%) agree that ME120 increased their ability to use modern equipment and instrumentation to perform experiments. It is also clear that the class increased the students' ability to use Microsoft Word, Excel, and Power Point to produce high quality reports and presentations (question 3k-2, 73% to 100% agree; question 3k-3, 91% to 100% agree). The web is used extensively in ME120. All course materials are online, and several homework problems ask students to perform web searches. The split between those who agreed with question 3k-1 and disagreed is probably due to differing skill and experience with the web. It is likely that those who had less experience with the web agreed that the course increased their ability, while those with more experience didn't feel the course significantly increased their ability.

ME 182: Thermal Systems Design

Course activities related to outcome 3k: Students in this course use (a) EES (Engineering Equation Solver) to perform the thermal system simulation for projects 1 and 3, (b) any computer program they like for project 2, and (c) Powerpoint for their presentations.

Course Assessment (Fall 2002): ME182 met the performance targets for outcome 3k.

Student Performance Summary: Students must become expert users of EES to solve Projects 1 and 3. This is an equation solver with built-in thermophysical properties that is starting to become popular in industry as well as academia. The students also proved themselves to be adept with Powerpoint. All students received 70% or higher in projects 1 and 3 and 96% of the students received 70% or higher in their project presentations.

ME106: Fundamentals of Mechatronics

Course activities related to outcome 3b: Students (a) acquire skills in web-based research, use word processing software for laboratory reports, (c) use spreadsheet software for analytical and data analysis and for presentation of results, (d) use Matlab or Excel to determine the frequency response of an RC filter, (e) use electronic test and measurement equipment such as oscilloscopes, function generators, power supplies, and multimeters, and (f) use the Basic Stamp microcontroller and the PBasic computer programming language to perform data acquisition and control functions.

Course Assessment (Fall 2002): ME106 met the performance targets for outcome 3k.

Student Performance Summary: The metric for assessing student performance for outcome 3k is an average of performance percentages for the lab reports, the term project, and for homework 8, an open-ended programming problem. 95% of the students are achieving 70% or better as determined by this metric.

Student Survey Results: It is clear from the student survey that the vast majority (Question 3k-7, 82%) agree that ME 106 increased their ability to use modern equipment and instrumentation to perform experiments. It is also clear that the class increased the students' ability to use Microsoft Word and Excel to produce high quality reports (Question 3k-2, 87% agree). There is much less agreement or even significant disagreement in regard to questions 3k-3 through 6, 3k-9, and 3k-1, however this is not surprising. The students do not give oral presentations in the class, so Power Point has not been emphasized (3k-3). The course does not delve into computer simulation (3k-4 through 3k-6). The course does not make use of state-of-the-art tools for system design or control, though some reference is made to Matlab and Excel for analysis. Being an introductory course, it does not emphasize state-of-the-art tools and practices used in industry. On occasion practicing engineers have made presentations, but not during the semester surveyed. Such presentations would be more appropriate in a follow-on course such as ME190. The web is used extensively in ME106. All course materials are online, and several homework problems ask the student to perform research on the web. The split between those who agreed with Question 3k-1 and disagreed is probably due to differing skill and experience with the web. It is likely that those who had less experience with the web agreed that the course increased their ability, while those with more experience didn't feel the course significantly increased their ability.

ME195A&B Senior Design Project

Course Assessment (Spring 2005): ME195 met the performance targets for outcome 3k.

Student Performance Summary: The metric for assessing student performance for outcome 3k is the average percentage earned by combining percentages earned on the end-of-semester report and scores on oral presentations (data from three of the four sections).

Average of 70% or higher:	95 – 100%
Average of 60 to 70%	5%
Average of 50 to 60%	0%
Average of less than 50%	0%

Student Survey Results: According to the results of student surveys from all four sections (N = 17, 17, 11, 17 from sections 1, 2, 3, 4 respectively) of ME 195B, the majority agree that the course made them aware of:

- State-of-the-art tools and practices used in industry through plant visits and presentations by practicing engineers .... (70 - 88%)

And increased their ability to:

- Perform web-based research .... (80 - 94%)
- Use Word and Excel to produce high quality technical reports .... (88 - 90%)
- Use Power Point to give high quality oral presentations .... (94 - 100%)
- Use computer simulations to perform optimization .... (71 - 100%)
- Use computer simulations to perform 'what if' explorations .... (71 - 82%)
- Use state-of-the-art technology for engineering system design, control, and analysis (59 - 93%)

<u>B.3.14.2 Conclusion (Fall 2003-Spring 2005)</u>

The data from the 5 courses assessed for this outcome confirm that the ME Program satisfies outcome 3k. ME students use many modern tools in their curriculum, including the Microsoft Suite of Word, Excel, and PowerPoint, as well Matlab, Simulink, and MathCad. In addition, the implementation of actual and virtual laboratory instruments using LabView and the Internet is covered.

B.4 Mechanical Engineering Professional Component

B.4.1 Mechanical Engineering Curriculum Design and Content

Senior Design Project: ME 195 A & B		
Thermal-Fluids	**Design**	**Mechatronics**
Capstone: ME182 Electives: ME183 ME149 ME146 AE169 AE167 AE164 AE162	Capstone: ME157 Electives: ME188 ME186 ME184 ME165 ME160 ME145 ME110	Capstone: ME190 Electives: ME192 ME187 ME136 ME189

Experimental Methods: ME120
Mechanical Design: ME154
Applied Engineering Analysis: ME130

Thermal-Fluids	Solid Mechanics	Dynamics & Controls	Electronics & Electromechanics
ME114 ME113 ME111	CE113 CE112 CE99 MatE25	ME147 ME101	ME106 EE98

Engineering Fundamentals: E10 (Introduction to Engineering), ME20 (Design & Graphics), ME30 (Computer Applications), E100W (Engineering Reports)
Science: Physics 70 (Mechanics), Physics 71 (Electricity & Magnetism), Physics 72 (Atomic Physics), Chemistry 1A (General Chemistry)
Mathematics: Math 30 (Calculus I), Math 31 (Calculus II), Math 32 (Calculus III), Math 133A (Differential Equations)

Figure B.4.1 ME Curriculum Design

The ME curriculum is vertically integrated as shown in Figure B.4.1. Foundational engineering sciences (thermal-fluids, solid mechanics, dynamics & control, electronics & electromechanics) build upon mathematics, science, and basic engineering skills. Two additional required courses give students advanced mathematics (ME130), experimentation (ME120), and mechanical design (ME154) skills. The curriculum concludes with both a synthesis of engineering skills in the senior design project, as well as a concentration focusing in one of three specialization areas: thermal-fluids, design, or mechatronics. Students may focus in one area or mix and match electives, however, they must take at least one of the 3 capstone courses.

Table I-1 (Appendix I) shows the ME curriculum in detail along with the categories of the professional component each course satisfies. Table I-2 in the same appendix shows the Course and Section Size Summary for AY 2004-2005. Course syllabi for all technical courses are presented in Appendix I-B. Course Binders (available at the site visit) with sample assignments, exams and student work allow for an assessment of each course.

General Education: The ME curriculum includes 33 semester units of GE courses, consistent with a detailed plan established by the University. Courses in written and oral communication, humanities, and social science provide a broad exposure to issues that affect today's society. In particular, the junior level technical writing course (E100W) requires students to analyze and discuss the environmental impact of engineering processes, products, and systems.

Mathematics and Basic Sciences *(requirement = 1 year / 32 units):* The ME curriculum includes 33 units of mathematics and basic sciences: five math courses (Calculus I, II, III, Differential Equations, Applied Engineering Analysis), three physics courses (Mechanics, Electricity and Magnetism, Atomic Physics) and a course in General Chemistry.

Technical Curriculum (requirement = 1.5 years or 48 units of engineering topics that include engineering sciences and engineering design): The ME curriculum includes 72 units of engineering topics, 15 of which are lower division and 57 are upper division. All upper division courses emphasize engineering problem solving through mathematical and physical modeling, while some of them include open-ended problems (ME111, ME113, ME114, ME147, ME154, AE162, AE164, AE167 among others) and computer modeling / simulations (AE164, AE169, ME113, ME114, ME160, ME165 among others), and design (ME110, ME145, ME154, ME157, ME160, ME165, ME182, ME188, ME189 among others). The capstone course in each concentration requires system-level synthesis of stem-based skills.

Experimentation / Product Testing: The ME curriculum includes here are 8 required laboratory courses (Phys.70, Phys.71, Phys. 72, Chem.1A, MatE25, ME106, ME120, ME114, CE113) and 4 elective laboratory courses (AE164, ME145, ME110, ME192). In these courses students are taught how to design and perform experiments that meet specific objectives. Moreover, they are taught to analyze, interpret, and present their data in formal laboratory reports and oral briefings.

<u>B.4.2 Preparation for Engineering Practice</u>

Breadth and Depth: The ME Program provides graduates with an understanding of the basic principles and applications of all 3 disciplines: thermal-fluids, mechanical design and mechatronics, so that they will be able to work in any of the 3 fields. In order to prepare for work in any of the specific disciplines of ME, students are required to take courses in each of the main engineering science disciplines – fluid mechanics, thermodynamics, heat transfer, dynamics & control, strength of materials, circuits and mechatronics. This foundation of engineering sciences is then applied in more discipline-specific courses, as students choose a stem to specialize, by selecting a capstone course and four electives from that particular area. Some breadth is allowed in the elective choices in that some electives can be chosen across stems and also from other engineering, math or science programs.

Design throughout the Curriculum: Engineering design is distinguished from engineering science in 3 ways. First, it involves open-ended problems that require many assumptions and have multiple solutions. Several courses prepare students to develop open-ended problem solving skills[5] (ME111, ME113, ME114, AE164, AE167 among others). Second, it requires the synthesis of principles from many different fields (ME195A&B). Third, it requires critical thinking to check the validity of assumptions and evaluate the various design solutions.

Design is first introduced at the freshman level in E10, where students participate in 3 comprehensive design projects. In each of these projects, they work in teams to design a product that meets certain specifications. They present their results in written as well as in oral reports. In all 3 of these projects, students have to build a product and test it to verify its performance. Examples of such projects include the design and manufacture of a cup to keep coffee hot for as long as possible (using limited materials) and the design of a rubber-powered airplane for maximum range and endurance.

Design activities are integrated throughout the ME curriculum (ME110, ME145, ME154, ME157, ME160, ME165, ME182, ME188, ME189), not only to serve as a link between theory and practice but also to emphasize the many problems encountered in building and testing a prototype. Students use current tools (AutoCAD, Working Model, EES, Flotherm, Solidworks, ProE, COSMOS, ProMechanica) and practices in completing the various design projects. They typically work in teams and present their final designs in written as well as oral reports. For example, students synthesize a mechanical device to perform a desired task using graphical and analytical methods and use various failure criteria to guard against yielding, fracture and fatigue failures (ME154). Students are also introduced to the ME design process, which includes identification of a need, specification and requirements, conceptual design, evaluation of concepts, product design, design for manufacturing and ease of assembly, cost and human factors and design or select (from catalogs) various machine components, such as mechanical springs, contact bearings, brakes and clutches, gears, shafts, and motors (ME157). They analyze structural safety and cost-effectiveness using the Finite Elements Method (ME160) and design / build 3-D solid models of engineering products (ME165). Finally, in ME195A&B, students integrate knowledge and skills from previous courses to design, build and test a full scale ME product. This provides the students with diverse practical design experience and exposure to many design issues and solutions covering different areas of ME.

Senior Design Project: The major culminating design experience comes in the two-semester senior project (ME195A&B). Students integrate thermal-fluids, mechanical design, and mechatronics while considering cost, ease of construction and implementation. The iterative nature of design, as well as the need for compromise is stressed throughout the project. Students are given opportunities to work on industry-sponsored projects or participate in professional society design competitions, such as the ASME Old Guard competition[12] and Human-Powered Vehicle, the SAE Mini-Baja, etc.

B.4.3 ME Program Review

The MAE and COE Curriculum Committees, the MAE Department faculty, and the ME Advisory Board all participate in reviewing the ME curriculum for relevance, adherence to Program Educational Objectives, and fulfillment of the professional component. In addition, the COE Physics, Chemistry and Calculus Task Forces work closely with their respective departments to ensure that the math and science topics covered are appropriate for engineering students and

In summary, the ME curriculum meets the ASME Program Criteria and the ABET 2005 Criteria for the professional component. Materials that will be available at the site visit to show achievement of Criterion 4 will include:
- Course journals including samples of student work in all engineering and science courses
- Exit interviews with graduating seniors
- Student transcripts
- Summary of alumni and employer survey results
- Senior design projects

B.5 Faculty

B.5.1 Faculty Competency and Size

Appendix I-A, Tables 3 and 4 give an analysis of the qualifications, activity levels and workload of full-time and part-time faculty within the Department. Appendix I-C gives the resumes of all full-time and part-time faculty. The Department has eleven full-time tenure-track faculty members and one FERP-active (Faculty Early Retirement) faculty. All of the full-time faculty hold Ph.D. degrees in their respective subject areas. Four are registered professional engineers, and nearly all have had two or more years of industrial experience. The size of the faculty is nominally adequate to cover all of the curricular areas in the program (as well as responsibilities to the students, the College of Engineering, the University and the profession). All the ME disciplines in the program – thermodynamics / heat transfer, fluid mechanics, mechanical design, manufacturing / mechatronics are represented on the current faculty.

Experienced practicing engineers are used as lecturers to teach specific courses. Many of these lecturers have had a sustained affiliation with the University and the Department, and have been active in updating the curriculum and the laboratories. The lecturers bring an additional element of professional practice and on-the-job realism to classroom instruction. The faculty has excellent educational credentials, extensive industrial experience, and are from a diverse set of academic and professional backgrounds.

B.5.2 Faculty as Innovative Teachers

Several members of the faculty have been awarded College, University, and National awards for the quality of their teaching. The faculty has been active in experimenting with alternative teaching styles, and have participated in many COE professional-development seminars addressing innovations in teaching and learning. In addition, several faculty have received SJSU and NSF grants for curriculum and laboratory development.

---

[12] ME students have received 1st place awards in the past 3 years.

B.5.3 Faculty Involvement with Students

The faculty maintains a close association with students through advising and counseling, classroom contact, and extra-curricular activities, and continues a close relationship with alumni. Through research, consulting, and participation in local societies, the faculty helps students to obtain internship employment, summer jobs, undergraduate research experience and full-time jobs upon graduation.

B.5.4 Faculty Professional Development and Interactions with Industry

Faculty interaction with industry is considered to be good to excellent. The faculty enjoys this relationship, in particular, through the Senior Design Project program. Members of the ME Program Advisory Committee are also involved in providing a review of curriculum and laboratory facilities. In addition to the Advisory Committee members, local professional society representatives, normally affiliated with industry, provide mentoring, guidance, as well as substantial funding and equipment support. These industry representatives also provide a significant level of support in faculty professional development as they give lectures and offer short courses.

B.6 Facilities

Table B.6.1 provides a summary of the laboratory facilities used for instruction by the MAE Department. All labs are furnished with electronic locks to allow students to enter the labs on an as-needed basis. The Department's current equipment and instrumentation is in good to excellent condition. Several National Science Foundation Instrumentation Laboratory Initiative (NSF/ILI) grants and generous industry equipment donations have resulted in equipping the laboratories with modern tools and instrumentation.

Table B.6.1 Department instructional laboratory facilities

Location / Name	Courses Served	Current Status	Adequacy of Instruction	No of students served annually	Area (ft^2)	Director
E107 – Aerodynamics	ME111, AE162 AE170A,B	Excellent	Excellent	215	1357	Mourtos
E111 – Product Design	ME154, ME157, ME195A,B	Good	Good	180	1600	Yee
E113 – Energy Conversion & Heat Transfer	ME113, ME114	Good	Good	200	1600	Rhee
E114A – Electronics Cooling	ME114, ME145, ME146, ME195A,B	Good	Good	224	1800	Okamoto
E115 – Microsystem Fabrication Technology	ME189, ME196Q, ME195A,B	Good	Good	220	1600	Barez / Hsu
E125 – Mechatronics Engineering	ME106, ME190, ME195A,B	Good	Good	160	1800	Furman
E125A – Acoustics & Precision Measurements	ME145, ME149, ME195A,B	Good	Good	110	1800	Furman
E133 – Engineering Measurements	ME 120	Good	Good	120	2000	Furman
E135 – Process Control	ME187, ME190, ME195A,B	Good	Good	75	2360	Wang
E137 – Computational Fluid Dynamics	AE169 AE110 AE170A,B	Adequate	Good	40	400	Papadopoulos
E164 - Gas Dynamics	AE164 AE170A,B	Adequate	Adequate	60	1800	Mourtos
E192 – Robotics & Manufacturing	ME192, ME195A,B	Good	Good	45	3200	Du
E213 – Multimedia Computer Lab	Several ME courses	Excellent	Excellent	150	1600	Agarwal
E215 – Computer Lab	All MAE students	Excellent	Excellent	800	1600	Agarwal
E217 – Product Reliability	ME145, ME196R	Good	Good	85	1600	Barez

The MAE Department maintains an ME clubroom that serves as the headquarters for the student chapters of ASME, AFE (Association for Facilities Engineering), ASHRAE (American Society of Heating; Refrigeration, & Air Conditioning Engineers), and ΠΤΣ (ME Honor Society). The clubs are invited to maintain their own web pages linked to the Department web page. The ASME chapter maintains a fairly large lending library.

The engineering building contains 15 lecture rooms shared by all engineering programs. The classroom capacities are listed in the following table. Overflow lecture sections are scheduled in other facilities on campus through the Academic Scheduling Office.

Table B.6.2 COE classroom capacities

Room #	Capacity	Room #	Capacity	Room #	Capacity
232	40	331	100	341	100
301	40	337	70	343	100
303	40	338	30	395	35
327	30	339	70	401	40
329	70	340	50	403	40

The College of Engineering also manages a 210-seat auditorium (E189), several meeting rooms (E247, E335, E285, E287), and an open study area on the third floor. The auditorium is regularly used for professional presentations, symposiums, and occasionally, for large class lectures and exams. The meeting rooms are used for faculty and staff meetings and events.

The College's Engineering Computing Systems group manages eight computer laboratories as listed in the following table. These laboratories are exclusively for COE students, faculty, and staff use. These computers are loaded with programs including Matlab, AutoCAD, Unigraphics, ProModel, Visual Studio, Minitab, Pspice, ProEngineer, C compiler, word processing, spreadsheet and web browser. These labs primarily support engineering common courses such as programming and writing classes. The open laboratories (E390 and E305) are available five days a week on a walk-in basis. Wireless Internet access is available in the most of the Engineering Building.

Table B.6.3 COE computer laboratories

Room #	No. of PCs	Usage
E333	30	Engineering classes using multimedia presentation or cooperative learning
E390	25	Open Lab
E391	25	Engineering core writing and programming classes such as: E10, E100W, CmpE46, ME20, and ME30.
E392	25	Engineering core writing and programming classes such as: E10, E100W, CmpE46, ME20, and ME30.
E393	25	Engineering core writing and programming classes such as: E10, E100W, CmpE46, ME20, and ME30.
E394	25	Engineering core writing and programming classes such as: E10, E100W, CmpE46, ME20, and ME30.
E405	27	Open Lab
E407	25	Engineering core writing and programming classes such as: E10, E100W, CmpE46, ME20, and ME30.

Engineering students can also take advantage of the computer lab located in the Student Union (adjacent to the Engineering Building) and computing services in the King Library. The Student Union computer lab has one hundred computer stations managed by the Associated Students Computer Services Center. The lab supports major operating systems (Windows, Linux, and Macintosh) and provides DVD and CD burners, high-speed Internet access, and document scanning capability. The King Library provides the following computer resources to all SJSU students:

- Laptop checkout for students (80 laptop computers and 20 tablet computers)
- Four (4) computer classrooms (total of 123 computers)
- Reserve-a-computer with office software & internet access (208 computers)
- Research information computers with Internet access (51 computers)
- Library catalog computers for quick look-up (27 computers)
- Personal laptop computer connections (180 ports)

B7. Institutional Support and Financial Resources

B.7.1 Financial Resources

The primary financial resource for the College is the state-supplied general fund allocated by the University. The Dean of the College allocates the College's general fund to each program, primarily based on the program's student enrollment as measured by the number of its Full-Time Equivalent Students (FTES). The general fund supports the program's basic operating needs: faculty and staff salaries, supplies and services, and equipment requisitions. The College also receives a significant amount of financial support from three major external sources: funds from Extended Studies, contracts and grants, and donations and gifts. Funding from these sources supports college-wide initiatives for faculty and student development.

General Fund

The University establishes the College's general fund allocation. The University assigns a FTES (full-time equivalent students) target and a Student-Faculty Ratio (SFR) to each college. Historically, the College of Engineering has been assigned an SFR of approximately 17.5, which is considerably less than that assigned to the College of Humanities and the Arts, for example. This lower SFR assignment is in recognition of the fact that engineering programs, because of their heavy emphasis on laboratory and project work, require a lower SFR than those disciplines whose courses are taught almost entirely in lecture mode. The assigned FTES and SFR are translated into the number of Full-Time Equivalent Faculty (FTEF). The difference between the FTEF and the number of tenure-track faculty members determines the number of full-time equivalent non-tenure-track lecturers, whose average salary is budgeted at $45,708 per academic year. The total faculty salary allocation is the sum of the actual salaries of tenure-track faculty and the budgeted amount for full-time equivalent lecturers. In addition to the faculty salary allocation, the University allocates a higher percentage of funding for equipment requisitions and maintenance to the laboratory-based disciplines such as engineering.

The annual budget allocation for each program is made by the Dean of the College with assistance from the Associate Deans and the College's budget analyst. For the most part, the allocation is made by formula, especially in the areas of supplies, services, and travel. The formulas are based on each program's fraction of the College's FTES. Travel allocations, however, are based on the number of tenure-track faculty in each program. The $45,708 funding for hiring a full-time equivalent lecturer is generally inadequate. However, this problem is mitigated by the fact that the College has been able to tap into a vast pool of practicing engineering professionals in Silicon Valley, who don't rely on teaching as a primary source of income.

Funds from Extended Studies

Funds from Extended Studies are derived from two sources: Open University and Off-Campus programs. Through the Open University program, non-matriculated students may be permitted, on a space-available basis, to take a regular course being offered. The Off-Campus programs include degree programs offered on company sites and the Rose-Orchard site which is managed by the College of Business. The net revenue from the Extended Studies programs has been approximately $300K per year for the last several years. A portion of the net revenue is distributed to the academic programs which contribute to the teaching of the programs. The remaining funds are used for supporting activities that would otherwise not be funded. Examples are travel expenses for faculty to present papers at professional meetings, expenses for hiring and recruiting new faculty members, start-up packages for new faculty, and matching support for equipment grants.

Contracts and Grants

The College also derives support from the return on indirect charges collected by the San Jose State University Foundation in connection with contracts and grants. The funding distributed to the College, which is used to support research-related activities, is divided into three equal portions: one-third goes to the Dean, one-third to the principal investigator's department, and one-third to a research account controlled by the principal investigator. Over the past five years the funds available to the Dean, departments, and principal investigators have been approximately $50K - $60K each per year. In addition, grants for supporting instructional materials and laboratory development typically include budgets for lab equipment or computers.

Donations and Gifts

The College receives significant donations and gifts from our industry partners and individual contributors. These contributions take the form of equipment donations and cash grants. For instance, the College received an average of $1.5 million in cash gifts per year over the last five years from friends, alumni, and Silicon Valley companies such as AMD, Applied Materials, Atmel, Cadence, Cisco, IBM, Intel, Lam Research, Lockheed Martin, Maxim Integrated Products, National Semiconductor, Rockwell Collins, Solectron, Synopsys, and Xilinx. Major contributors of laboratory and instructional equipment are Agilent Technologies, Applied Materials, Atmel, Cadence, Cisco, HP, Intel, Novellus, and Xilinx.

Another significant financial source for the College is the interest income generated from the College's endowment funds. Currently, the College has endowment funds of about $7.3 million dollars that support faculty development and hiring, student scholarships, and student co-curricular programs.

B.7.2 Instructional Support

Funding from the general fund allocated to the academic programs is used primarily to support their basic needs. Such funding, however, is inadequate to provide the high-quality educational programs needed by our students. The additional support provided by the College to the departments is funded by the general fund held by the Dean at the College level, special funds provided by the University, and external financial resources described in the previous section. The additional support covers four main areas: endowed chairs and faculty development, student scholarships, student support and co-curricular programs, and technical support.

B. 7.2.1 Endowed Chairs and Faculty Development

Acquiring teaching resources and supporting faculty development are a high priority in the College of Engineering. Currently, the College has two endowed chairs: the Pinson Chair, and the Charles W. Davidson Chair in Construction Management which is earmarked for the Department of Civil and Environmental Engineering. The goal of the Pinson Chair is to help programs to develop new curricular areas. For instance, in AY 1999/2001 Pinson Chair Tom Boag helped develop the microelectronics process engineering program in the Department of Chemical and Materials Engineering. In AY 2001/03 Anthony Chan with the Department of Electrical Engineering helped develop the network engineering program. For AY 2003/05, Russell Smith with the Department of Computer Engineering has assisted in the development of the software engineering program. These Pinson chairs have extensive industry experience which is critical in their developing new curriculum at the College. In the area of faculty development, the College provides sabbatical leave opportunity, reduced teaching load for new faculty members, and faculty development grants.

<u>Sabbatical leave</u>
The purpose of sabbatical leave is to benefit the University, its students, and its programs through the professional development of the faculty. Sabbatical projects include scholarly and professional activities, activities which enhance a faculty member's pedagogical and professional competencies, and projects which contribute significantly to the development of a discipline or curricular area. Faculty can either take a one-semester sabbatical with full pay or a two-semester sabbatical with half pay. The number of awards given to the engineering faculty is typically between three to five annually.

<u>Reduced teaching load for new faculty members</u>

It is the College's policy to assist new faculty members to develop their teaching repertoires and initiate research programs by reducing their teaching loads by one-half during their first year and by one-quarter during their second year. This policy pertains to all faculty members newly hired as assistant professors. More experienced faculty members also receive some initial release-time support depending on their needs and qualifications. The College also has a 1:2 matching policy to provide assistance to faculty members who secure external grants to reduce their teaching loads. If a faculty member secures external funding sufficient to reduce his/her teaching load by two courses, the College provides a third course reduction.

Faculty development grants

Faculty development grants provide a way to advance the faculty's career aspirations and the College's objective of becoming a premier undergraduate engineering educational institution by recognizing, promoting, and supporting faculty's research achievements and excellence in teaching. The research and teaching goals are mutually supportive with research providing vitality and vision in technical issues and teaching providing focus for research and a channel for dissemination of knowledge gained in research efforts. Since 2002, the College has offered the Engineering Research Development Grant and the Teaching Development Grant to the faculty of the College of Engineering. These two grant programs are entirely supported by external funding.

The Engineering Research Development Grant provides support to enable, to initiate, or to coordinate research efforts of the faculty members and their departments. Faculty members are encouraged to collaborate on project proposals and pursue team-oriented projects. The Engineering Teaching Development Grant is intended to support faculty efforts in curricular development, assessment, and improvement for subjects aligned with departmental priorities as well as enhancing students' learning effectiveness. The funding level of both development grants has been about $90K per year with one course release time budgeted at $5K.

In addition to the College's faculty development grants, the University offers two faculty grant programs: the CSU Research Grant and Professional Development Grant. The CSU Research Grant offers funding for "seed" money or summer fellowships. "Seed" money ($5k) is for testing promising ideas and obtaining preliminary results prior to seeking external support. "Seed" money can be used for research, clerical assistance, equipment, software, or travel which is essential to the project. Summer fellowships ($7,500) are awarded in whole-month increments to faculty members at their regular monthly rate of pay. The grants fund the time needed by the faculty to initiate, continue, or complete research projects. The funding level for engineering awards has been about $20K per year for the past five years.

The Professional Development Grant supports professional development for faculty, staff, and students. Categories for which funds may be used include participating in training/education programs, conferences, hiring student assistants, travel, software, equipment and supplies. Staff and student organizations are also eligible to apply. The total grant awards for engineering faculty have been about $36K per year for the past several years.

B. 7.2.2 Student Scholarships

The College started the Silicon Valley Engineering Scholarship program in 2001 by offering scholarship awards to top incoming students. The funding is provided by Silicon Valley companies and individual supporters. In addition, the Silicon Valley Engineering Scholarship recipients have opportunities for summer internships with sponsoring companies. The sponsoring companies include Applied Materials, Atmel, Cadence, Lam Research, Lockheed Martin, National Semiconductor, Rockwell Collins, and Solectron. The typical scholarship award is $20K per student at $5K per year for a four-year period. There have been 25 scholarship recipients since 2001. In addition, the College, in collaboration with Hewlett-Packard Company, has an HP Scholar program targeting underrepresented minority engineering students. The HP Scholar program provides each student not only financial assistance, but also a support program of mentoring, advising, and internship.

B. 7.2.3 Student Support and Co-Curricular Programs

The College, in collaboration with the departments, has provided student advising in the areas of General Education and transfer evaluations. Further, special advising has been offered to underrepresented minority students and students on academic probation. Taking advantage of its location in Silicon Valley, the College has been proactive in developing co-curricular programs that complement students' classroom learning.

B. 7.2.3.1 Student Support

The College of Engineering funds two student advising and support units: the Engineering Student Advising Center and the MESA Engineering Program. The Engineering Advising Center, established in Spring 2005, provides General Education advising, new student advising, and special advising for students on academic probation. The goal of the MESA Engineering Program is to increase the number of engineering graduates entering the engineering profession from groups with low eligibility rates in college admissions. Engineering students can also take advantage of the services provided by the University Academic Services including free tutoring and various study skills workshops. A detailed description of these support units is presented in Appendix II Section B.10 Non-academic Support Units.

B. 7.2.3.2 Co-Curricular Programs

Co-curricular programs have been an integral part of the educational experience that the College offers its students with the goal of providing opportunities to students to learn about the context and domain of current and future engineering practices. There are three on-going programs sponsored by the College: Co-op Project Course, Global Technology Initiative, and Silicon Valley Leaders Symposium.

Co-op Project Course (ENGR 197)

This course is designed to provide students practical work experience with innovative technology companies in Silicon Valley. Students are also taught to further their communication and interpersonal skills as practiced in a professional setting. This course is coordinated jointly by an engineering faculty member and an industry instructor, and is in collaboration with the University Career Center. The Career Center assists students in obtaining internship positions with local companies.

Global Technology Initiative (GTI)

With an increasingly globalized technical workforce, the College established the Global Technology Initiative (GTI) in 2004 with a goal of providing our students a global perspective. The focus is on technology and business developments in the Asia-Pacific region, which has strong links with Silicon Valley. The Initiative is funded by a one-million-dollar endowment supported by industry leaders with strong ties to Silicon Valley and the Asia-Pacific area. Each year this funding supports about 25 students and three faculty members on a two-week all-expense-paid study-tour to Asia. For instance, in summer 2004, 25 engineering students and four faculty members visited a variety of technology enterprises as well as educational and research institutions in China and Taiwan. They witnessed first-hand the advancement of the high tech industry in that region and the high level of interconnectedness of Taiwan's and China's businesses with those in Silicon Valley. This study program also included significant components in pre-trip acculturation and post-trip dissemination of lessons learned. Assessments indicate that many students change their study and career plans because of their own trip experience or lessons learned from their classmates who went on the study tour.

Silicon Valley Leaders Symposium

Each Thursday the College invites an industry or technology leader to campus to speak on topics of importance to engineering faculty and students: emerging technologies, business practices, and industry trends. This is the College's Silicon Valley Leaders Symposium. Further, the Symposium provides an opportunity for our faculty and students to interface with industry leaders and learn from their insights and experience. The following two tables list the speakers and their topics presented in the last two semesters.

Fall 2004 Silicon Valley Leaders Symposium

Speaker	Title	Presentation
Dr. Regis McKenna	Marketing consultant	Total Access: New Marketing Strategies
Dr. Court Skinner	Director of Research, National Semiconductor	Staying Out Of the Box
Mr. G. Dan Hutcheson	CEO and President, VLSI Research, Inc.	Innovation in Semiconductor Technology
Mr. Sridhar Vajapey	Senior Director, Sun Microsystems, Inc.	Changing the Design Trends – Chip Multithreading

Dr. Aram M. Mika	Vice President, Advanced Technology Center, Lockheed -Martin	Future Trends in Space Technology
GTI Scholars	GTI Scholars	2004 Summer Study Tour of China and Taiwan
Mr. Harry Blount	Senior Vice President, Lehman Brothers	The Current State of the IT Industry: Liquid Data
Mr. Richard Walker	Vice President, Emerging Countries, Hewlett-Packard Company	Globalization, Its Impact at HP and the Implications for Business/University Partnerships

Spring 2005 Leading Technology Symposium

Speaker	Title	Presentation
Mr. Jen-Hsun Huang	President and CEO, NVIDIA	The Digital Media Era – Challenges and Opportunities
Dr. Lee Galbraith	KLA-Tencor	The End of Moore's Law? And What Comes Next?
Mr. Young K. Sohn	Group President, Agilent Technologies	The Changing Face of the Worldwide Semiconductor Industry, and the Growing Needs for Innovation
Dr. Kris Pister	Founder and CTO, Dust Networks	Wireless Sensor Networks: From Smart Dust to Commercial Products
Mr. Hong Liang Lu	CEO and Chairman, UTStarcom, Inc.	B to 4B: The Future of Telecommunications Market
Mrs. Jeanette Horan	Vice President, Silicon Valley Lab, IBM	Shattering the Past: A New Era in Technology
Mr. Russell Hancock	President & CEO, Joint Venture: Silicon Valley Network	Building the Next Silicon Valley
Dr. Aart J. de Geus	CEO& Chairman, Synopsys	From the Garage to the Globe
Mr. Edward W. (Ned) Barnholt	Chairman Emeritus, Agilent Technologies	Silicon Valley as a Global Leader: What's Next?
Mr. John P. Daane	President, CEO, and Chairman, Altera Corporation	Keeping Innovation Alive in Silicon Valley

B.7.2.4 Technical Support

The College provides technical support to all its academic programs in two areas: computer/networking and machine shop. The computer/networking support is provided by the Engineering Computing System group and the Central Shop provides design and fabrication services. The responsibilities and staffing of these two units are described in detail in Appendix II, Section B.10 Non-academic Support Units.

B.7.3 Challenges

A continuing problem for the College is the generally low faculty salaries. On an absolute scale faculty salaries may not be unreasonably low, but because of the very high cost of housing in Santa Clara County, attracting and retaining high-quality faculty has become a great challenge. Administrators both at the University and CSU System Office have been made aware of this issue, but faculty compensation throughout the System is a contentious issue, so the particular difficulties of engineering and other high market-rate disciplines have not received the attention they require. The problem is compounded by the fact that the State of California experienced a deep recession in the past four years, which badly eroded support for the universities in the state. Against this background of deteriorating financial support from the state, the College has experienced an enrollment drop for the past two years in its two largest programs, Electrical Engineering and Computer Engineering programs. Since the funding from the University is based on FTES, reduced College's FTES translate into a lower-level funding for the College.

In view of the inadequate state funding for the College to develop its programs, the College has been more aggressive in generating revenues from external sources for the past two years. For instance, the number of revenue-generating Off-Campus programs has increased from five to nine. The annual cash gifts of about $1.5 million dollars have increased. Nevertheless, the College has a potential for generating higher-level gifts if it has staffing support in fundraising. Recognizing such a need, the University recently hired a Development Officer to support the College's fundraising efforts. This individual is assisting the Dean in formulating a development plan for the College to expand its industry partnerships and alumni support.

B.8 Mechanical Engineering Program Criteria

B.8.1 Curriculum Program Criteria

The ME program must demonstrate that graduates have (the courses that cover each topic are shown in parenthesis):

- *Knowledge of chemistry* (Chem1A[13]) *and calculus-based physics* (Phys70, 71, 72[14]) *with depth in at least one.*
- *Ability to apply advanced mathematics through multivariate calculus and differential equations* (Math30, 31, 32, 133A, ME130[15]). ME130 (Applied Engineering Analysis) treats engineering applications of ordinary and partial differential equations, as well as linear algebra.
- *Familiarity with statistics and linear algebra* (ME120, ME130). ME120 (Experimental Methods) introduces students to probabilistic and statistical methods in the context of experimental design and data analysis.
- *Ability to work professionally in both thermal and mechanical systems areas including the design and realization of such systems* (ME111, ME113, ME114, MatE25, CE99, CE112, CE113, ME154). In addition to the required courses listed, students often need to integrate thermal/fluid and mechanical design in their senior design projects (ME195A&B).

B.8.2 Faculty Program Criteria

The program must demonstrate that faculty members responsible for the upper-level professional program are maintaining currency in their specialty area.

The faculty information in Table I-4 clearly shows that all the full-time and part-time faculty who teach upper division courses are current in their area of specialization. The full-time faculty stay current in various ways, such as research in their disciplines, interaction with industry on projects, participation in professional societies, and publishing.

[13] This course is 5 semester units.
[14] The physics sequence is a total of 12 semester units.
[15] The math sequence includes 13 units of calculus and differential equations plus 3 units of applied engineering analysis.