San José State
UNIVERSITY

.

Program Self-Study Report

AEROSPACE 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 Aerospace Engineering* degree with the following areas of focus:

- Aerodynamics and Propulsion
- Dynamics and Controls
- Structures and Materials

A.2 Program Modes

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

A.3 Actions to Correct Previous Shortcomings

<u>A.3.1 College-Wide Cited Shortcomings and Corrective Actions</u>

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 AE Program-Specific Cited Shortcomings and Corrective actions

In the last ABET visit (1999), the following weakness was cited:

Criterion # 5 - Faculty and Criterion # 8 - Program Criteria: The Aerospace Structures course (AE114) has been taught by a part-time, adjunct faculty member, who left at the end of Spring 1998. He was replaced in Spring 1999 by another adjunct faculty member. It is not clear that the new person will be able to provide continuity and long-term stability in this area. Faculty competence in aerospace structures will be needed to meet ABET 2000 requirements.

ABET EC 2000 requires presence of full-time, competent faculty in the program. It does not break down area by area. The AE Program feels that limited use of adjunct faculty is a strength rather than a weakness. Such faculty members bring their experience and know-how to the classroom while discussing the related state-of-the-art technology and applications. The presence of three full-time, tenured / tenure-track faculty members in the program provides a strong core of experienced AE faculty members who understand the curriculum requirements. During AY 04-05 more than 80% of the FTES produced by AE courses was taught by full-time, tenured / tenure-track faculty members. All courses taught by adjunct faculty coordinated by a tenured faculty member to assure the continuity and quality of the courses.

A.4 Contact Information

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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.

[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.

B.2 Aerospace Engineering Program Educational Objectives (PEO)

The Aerospace 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

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:

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

B.2.5 Aerospace Engineering PEO

The undergraduate AE 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 AE 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 AE 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 the AE Advisory Board, employers, alumni, faculty, and students (see section B.2.9).

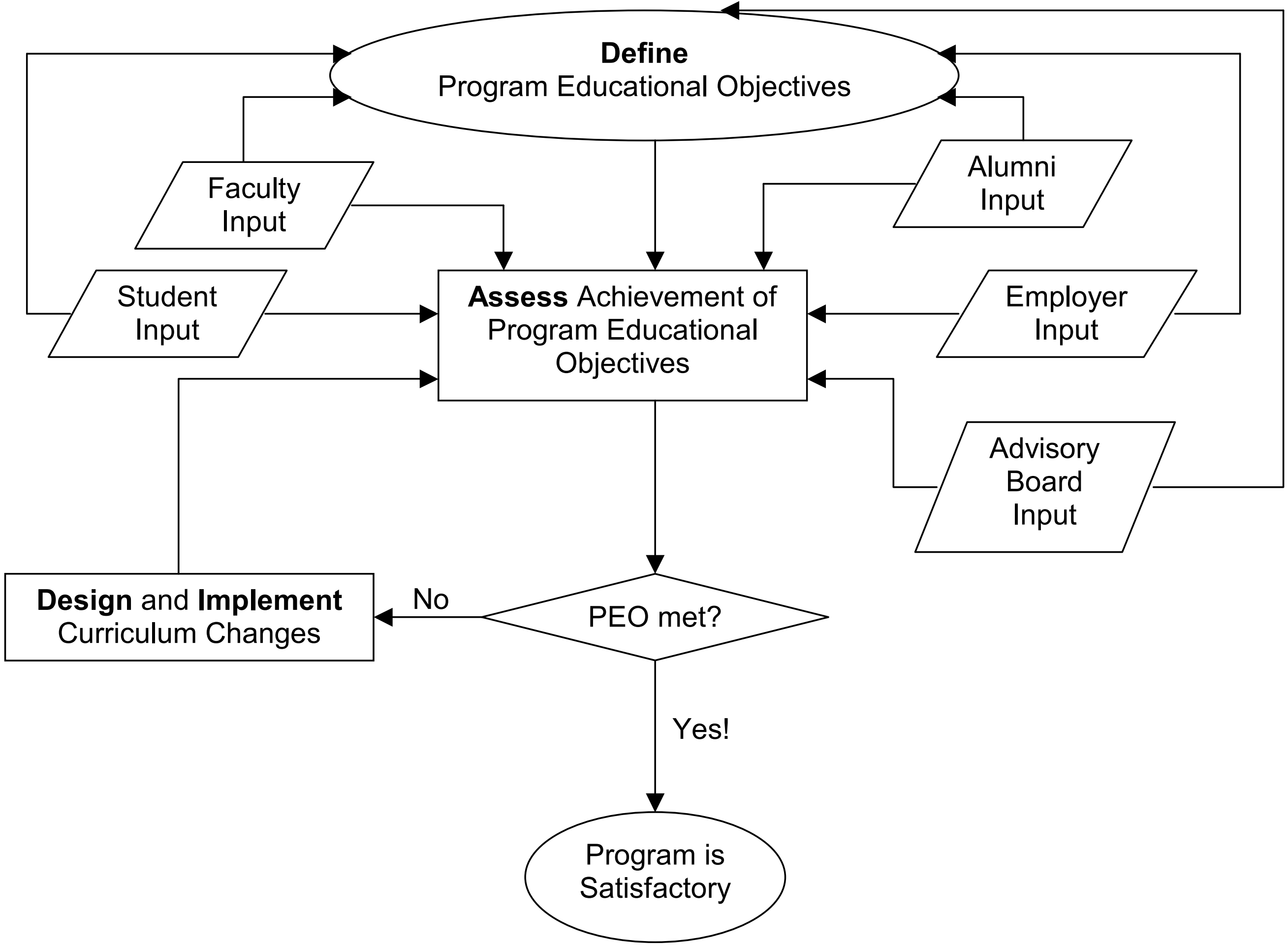

Figure B.2.1. Definition and assessment process for Program Educational Objectives.

B.2.7 Achievement of PEO

The PEO are achieved primarily through the AE 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 aerospace vehicle subsystems, 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 all their skills in a year-long aerospace vehicle design course, in which they undertake a multi-disciplinary, team-based design project of an aircraft or spacecraft subject to realistic constraints, such as economic, environmental, social, political, ethical, safety, liability, and manufacturability. Additional exposure to these issues comes through case studies, guest speakers and field trips. This course introduces students to systems-level engineering.

Students take also a minimum of two elective courses plus a capstone course that allows them to explore one aerospace 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: AIAA (American Institute for Aeronautics and Astronautics) and SAE – Aerospace Division (Society of Automotive Engineers)
- 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 (ex. SAE Aero Design West).

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 measures 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. & Ph.D. degrees	Alumni survey	Employer survey	AE Advisory Board 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, faculty were of the opinion that most of our students:

- (PEO # 1) Have adequate skills in mathematics, science, and engineering fundamentals to compete for entry-level positions but do not have adequate skills 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. Nevertheless, the faculty felt that a small percentage of our students do excel in this area.
- (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 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 provides 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, there is a need for greater sensitivity to copyright intellectual property. Although not encompassing the majority of students, the faculty have deep concern with a fraction of students that compromise academic integrity.

<u>B.2.9.2 Evaluation of the PEO through Exit Interviews</u>

Twenty-four (24) 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 an AE to compete successfully for entry-level positions in industry or entry to a graduate program?

The top seven skills mentioned are as follows:

- 67% (16) team skills
- 67% (16) communication skills (oral and written, report writing, documentation, ability to debate).
- 46% (11) technical skills, such as aerodynamics, propulsion, aircraft / spacecraft design, etc.
- 46% (11) computer / programming skills, such as CAD, CFD, FEA, MATLAB, Satellite Tool Kit, etc.
- 33% (8) lifelong learning skills, such as ability to find resources, learn new things, adapt to new learning and work environments, and conduct research.
- 29% (7) experimentation / hands-on skills (wind-tunnel, shock-tunnel, etc.).
- 17% (4) problem-solving skills.

The student responses indicate that PEO # 1, 2, and 3 are indeed valid educational objectives for the AE Program.

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

- 71% (17) of the students felt that the AE Program had prepared them adequately in the skills they identified above. The courses they identified as instrumental in preparing them for these skills were AE170 (58%), AE162 (54%), AE167 (21%), AE168 (13%), AE140 (13%), ME113 (13%), ME114 (13%), and ME120 (8%).
- 29% (7) of the students felt that the AE Program did not prepare them adequately in one or more of the skills they identified as important. Communication skills were the only skills mentioned by more than one student (2).

The student responses indicate that the AE Program achieves PEO # 1, 2, and 3.

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

On the positive side:

- 25% (6) indicated that AE was a very exciting educational experience.

- 13% (3) said they enjoyed a close relationship with AE faculty members.

On the negative side:

- 17% (4) indicated that the equipment in some of the labs is old and does not function properly. This comment was probably referred to our old smoke tunnel in the aerodynamics lab (AE162), which was replaced in Spring 2004 with a new water tunnel. The AE164 lab (shock-tunnel), although old, it is functioning properly. However, there are plans to upgrade the data acquisition system and the photo equipment.

Finally, the more common suggestions were to:

- 17% (4) hire more AE faculty.
- 13% (3) add an undergraduate CFD course because employers require it in many cases.

The Department has responded to both of these suggestions. A new faculty member will join the AE Program in the Fall of 2005 and a new undergraduate CFD course (AE169) was offered for the first time in Spring 2005.

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

Twenty (20) alumni surveys have been received through Spring 2005. The most frequent job title among the respondents was *systems engineer* (Lockheed-Martin, NASA, Honeywell, United Airlines) followed by *test engineer* (NASA, Navy) and *aeronautics / aircraft design* (Lockheed-Martin / Skunk Works)[2]. Although the number of surveys received to date is small, the types of jobs our AE graduates hold indicates that the AE Program prepares them well for these positions.

Table B.2.2 AE alumni job titles

Job Title	# of Alumni
Systems Engineer	7
Test / Instrumentation Engineer	4
Aeronautics / Aircraft Design	3
Dynamics & Controls	2
Flight Operations	1
Structural Analysis	1
Aerodynamics	1
Other engineering jobs (non-AE)	10

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

As was mentioned earlier, most of our students seek employment after graduation. Nevertheless, our alumni survey shows that 6 of the respondents (32%) were enrolled in a graduate program at the time they filled out the survey, most of them at SJSU. An additional 3 (16%) had already completed their M.S. degree[3]. One student has completed his Ph.D. degree in AE (Iowa SU, 2000) and is now an Aerospace Engineering professor at West Virginia University.

B.2.9.5 Evaluation of the PEO through Alumni Surveys

Respondents graduated with a BSAE as early as 1989 (2) and as late as 2004 (3). Two of them had received also a BSME from SJSU. Table B.2.3 shows a summary of their responses. The majority of the respondents agreed that the skills described in the PEO are important in the work they do and that the AE Program has adequately prepared them in these skills. Statement 3-6, which pertains to an *understanding of multi-cultural and global perspectives in engineering* (PEO # 3), had the lowest agreement rating of 53% (8).

[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.
[3] The majority of our BSAE graduates who continue on to graduate school return to our department and pursue an MSAE degree.

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

		Agree	Not sure	Disagree
1-1	The AE Program has given me a strong foundation in *mathematics.*	13	2	4
1-2	A strong foundation in mathematics *is important* for the kind of work I do.	15	2	2
1-3	The AE Program has given me a strong foundation in *science* (physics, chemistry, materials, etc.).	17	1	1
1-4	A strong foundation in science *is important* for the kind of work I do.	15	1	3
1-5	The AE Program has given me a strong foundation in *engineering fundamentals.*	18		
1-6	A strong foundation in engineering fundamentals *is important* for the kind of work I do.	18		1
1-7	The AE Program has given me a strong foundation for *graduate work.*	11	7	1
2-1	The AE Program has prepared me well for *hands-on laboratory work.*	11	5	3
2-2	Hands-on laboratory work *is important* for the kind of work I do.	12	3	4
2-3	The AE Program has given me the necessary skills to work with *computers* (doing design, simulation, data acquisition and processing).	14	1	4
2-4	Computer work (design, simulation, data acquisition and processing) *is important* for the kind of work I do.	17		2
2-5	The AE Program has given me the necessary skills to *find information* and *learn on my own*.	18	1	
2-6	The ability to find information and learn on my own *is important* for the kind of work I do.	19		
3-1	The AE Program has given me good communication skills.	14	3	2
3-2	Good communication skills *are important* for the kind of work I do.	19		
3-3	The AE Program has given me good *interpersonal, team,* and *leadership skills.*	14	3	2
3-4	Good interpersonal, team, and leadership skills *are important* for the kind of work I do.	19		
3-5	The AE Program has given me a *broad knowledge* as well as *an understanding of multicultural* and *global perspectives* in engineering.	12		7
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.	10	1	3
4-1	The AE Program has given me 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.	15	1	3
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.	18	1	

B.2.9.6 Evaluation of the PEO through Employer Surveys

Only two employer surveys were received through Spring 2005. Although both of them were very positive about the AE Program the number is too small to draw any conclusions from them.

B.2.9.7 Evaluation of the PEO through Advisory Board Input

The AE Advisory Board (see appendix III-B) convened on May 20, 2005 to accomplish two objectives: (a) validate our definition of the PEO, and (b) determine whether the PEO are addressed well through the current AE curriculum and if not, make recommendations for improvements.

Table B.2.4 PEO importance rating by the AE Advisory Board

	Average	BM1	BM2	BM3	BM4	BM5	BM6
PEO # 1	**5.0**	5	5	5	5	5	5
PEO # 2	**4.2**	4	4	4	4	4	5
PEO # 3	**4.2**	5	4	3	5	3.5	4.5
PEO # 4	**4.0**	4	4	4	4	4.5	4

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.2.5 PEO evaluation by the AE Advisory Board

	Average	BM1	BM2	BM3	BM4	BM5	BM6
PEO # 1	**4.0**	4	4	4	4	4	4
PEO # 2	**4.1**	4	3.5	-	4	4	5
PEO # 3	**4.6**	5	5	-	4	4	5
PEO # 4	**4.0**	4	4	-	4	4	4

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.

The response was almost unanimous that all four PEO are important (table B.2.4) and that all four PEO are addressed well through the AE curriculum (table B.2.5). However, the Board made the following recommendations intended to further strengthen the quality of the AE Program:

a. Introduce an aircraft systems course as an elective.
b. Require linear algebra (Math 129A) of all majors.
c. Introduce an AE Seminar where guest speakers from industry will highlight the latest advances in the field as well as opportunities for employment.

B.2.10 Conclusion

In summary, all our constituents agree that the PEO defined are appropriate for our AE Program. Moreover, input from faculty, graduating seniors, alumni, and our Advisory Board confirms that the AE Program is currently achieving these objectives.

B.3 Aerospace Engineering Program Outcomes and Assessment[4]

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.

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[4] The process, data and analysis of the AE Program Outcomes can also be found at http://www.engr.sjsu.edu/nikos/aematrix.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 AE Curriculum – Outcome Relationship

Each outcome (a – k) is addressed in several courses of the AE curriculum. A subset of these courses was chosen for a thorough assessment of each outcome, as shown in Table B.3.3. This subset consists of ten (10) required courses and one elective (ME114). 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 AE Program – Outcome Matrix

	Outcomes										
	3a	3b	3c	3d	3e	3f	3g	3h	3i	3j	3k
E10	✓		A	A	✓	A	A	✓	A	✓	A
E100W						✓	C	✓	✓		
ME101	B				B			✓			
ME111	B			B	C		✓		C	B	
ME113	B			B	B		B	B	B	B	
ME120	✓	C		C			C				C
AE162	B	C	B	C	C		C	B	C	B	C
AE164	B	C		C	B		C	B	B	B	C
AE167	B				B			B	B	A	
AE170A, B	✓		C	C	✓	C	C	B	C	B	C
ME114	C	C			B		B		B	A	

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.3.3 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.3.3. 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.3.4 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 AE 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 AE 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, AE162, AE164, AE165) and 50% for all other courses.
(b) The ratings pertaining to this outcome, given by at least 70% 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 AE Program satisfies all the outcomes. As a result of our outcomes assessment, several improvements have been implemented since our last ABET visit, to ensure that AE 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, and AE164)[5].
B. Students design airplanes and spacecraft with economic, environmental, social, political, ethical, safety, liability, and manufacturability constraints (AE170A&B).
C. Team skills are taught and assessed formally (ME111, ME120, AE162, AE164 and AE170A&B).
D. Students tackle (i.e. identify, formulate, and solve) open-ended problems (ME111, ME113, ME114, AE162, AE165)[6]. Some of these problems involve integration of material from two or more courses.
E. Students research, present, and discuss in class safety, ethics, and liability issues in aerospace engineering (AE170A&B).
F. 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, AE165, AE167)[7].

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[5] 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.
[6] 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.

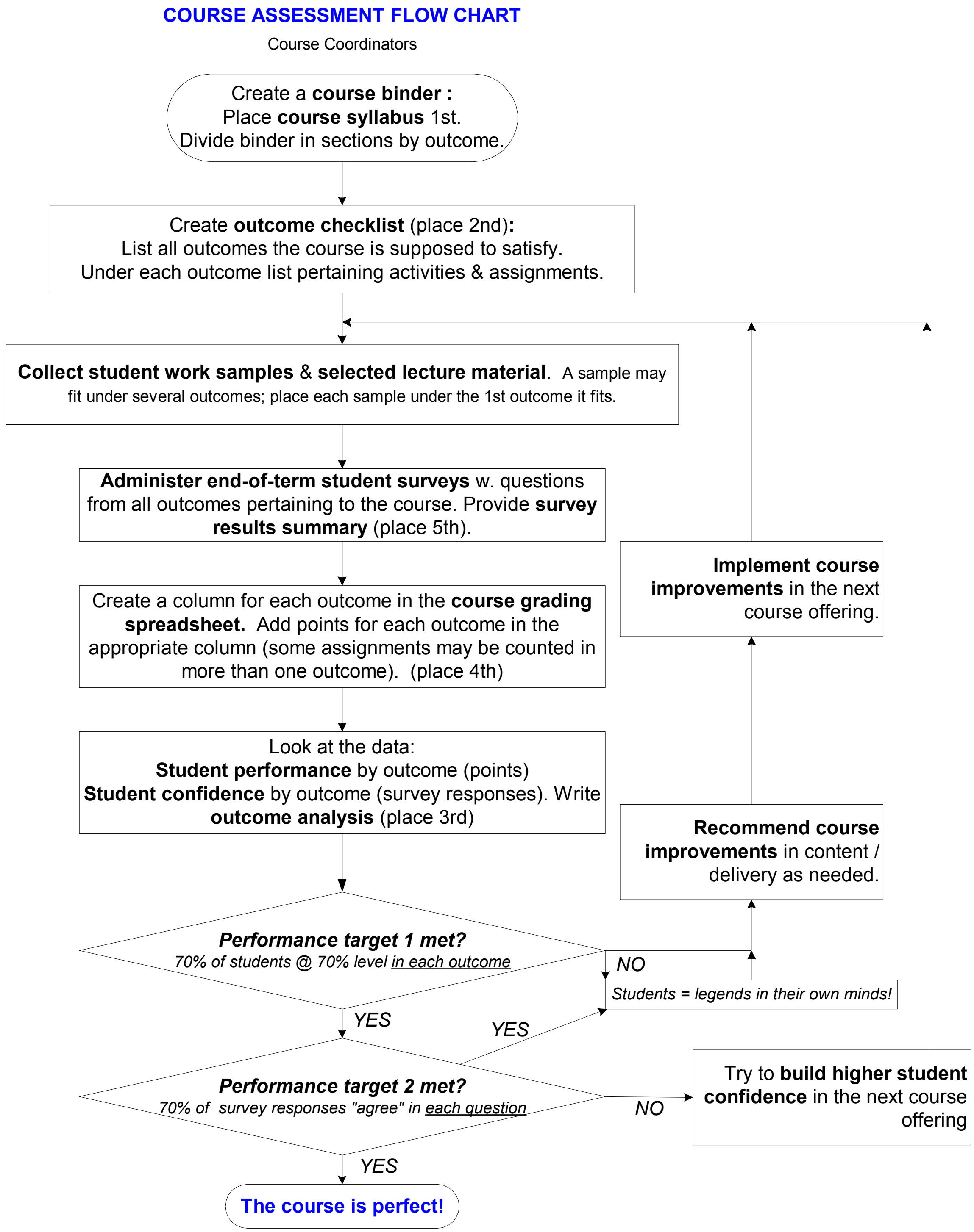

Figure B.3.1. Course assessment flow chart.

[7] DeJong-Okamoto, N., Rhee, J., Mourtos, N.J., *Incorporating the Impact of Engineering Solutions on Society into Technical Engineering Courses*, **Invited Paper,** Global J. of Engineering Education, vol.9, no. 1, 2005.

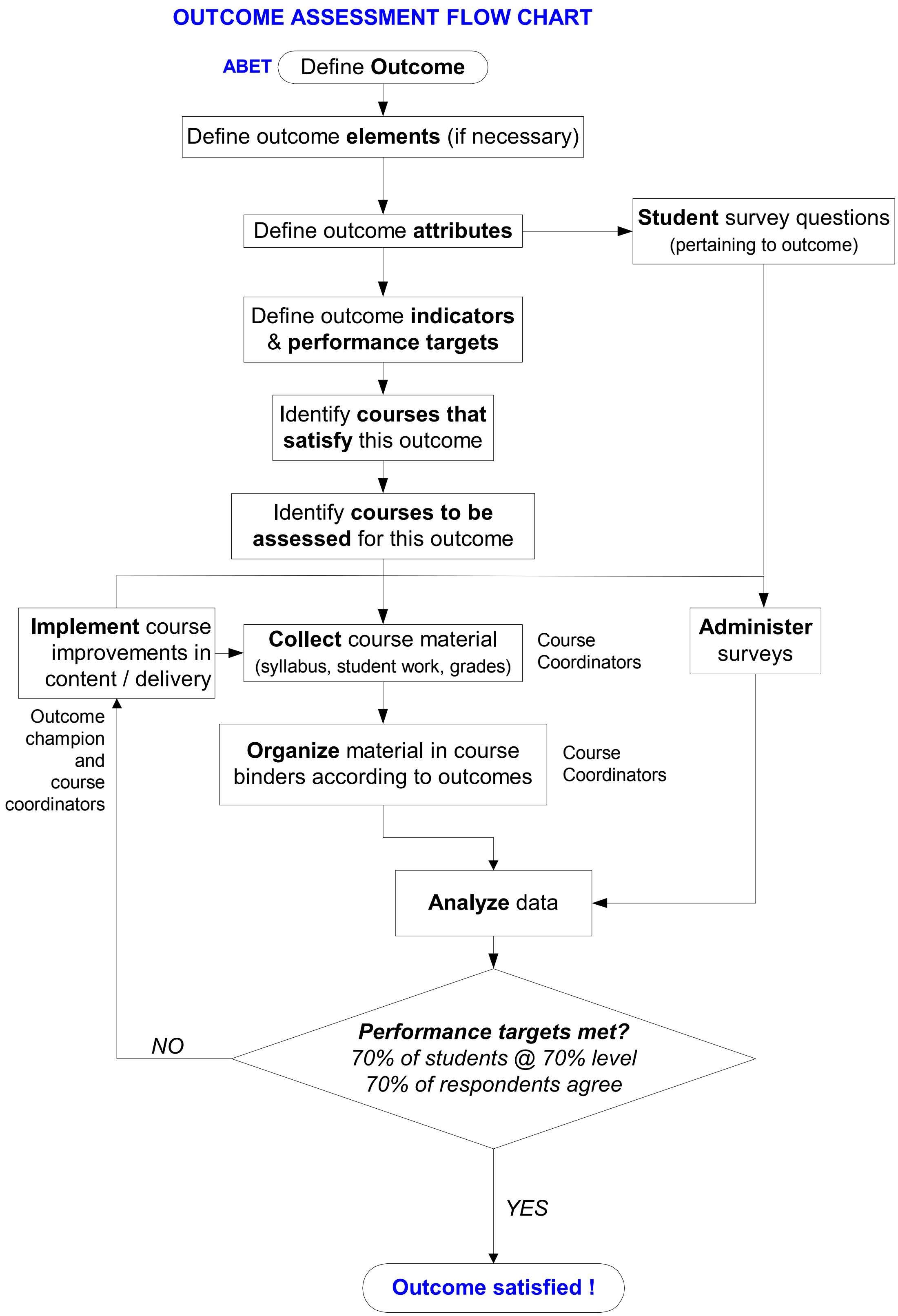

Figure B.3.2. Outcome assessment flow chart.

B.3.5 Outcome 3a

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

B.3.5.1 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: Students (a) 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, and (b) 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 (ex. 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, 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.

AE162: Aerodynamics

Course activities related to outcome 3a: Students: (a) Integrate surface pressure / shear stress distributions and use equilibrium principles to calculate aerodynamic forces / moments on 2-D bodies, (b) use Newton's 2nd law of motion and integrate the momentum flux in the wake of 2-D bodies to calculate drag, (c) integrate partial differential equations to derive the stream function and the velocity potential of a flow, (d) use the Biot-Savart law to calculate the induced velocities in the wake of a wing, (e) use potential flow theory to model the flow around aerodynamic bodies, (f) use fluid mechanics principles (boundary layers, Newton's law of viscosity, flow separation) to calculate skin friction drag of aerodynamic bodies.

Course Assessment (Spring 2003): AE162 did not meet the performance targets for outcome 3a (8 students performed below 60%).

Student Performance Summary: 23 students took the course and 21 received passing grades. The cumulative scores of these students in all the assignments and exam questions that pertain to outcome 3a was as follows: 8 students (38%) performed at 70% or better, 5 students (24%) performed between 60% and 69%, 5 students (24%) performed between 50% and 59% and 3 students (14%) performed below 50%. The class average on the 1st midterm (calculation of aerodynamic forces) was 74% and on the 2nd midterm (potential flow theory) was 75%, both of which meet the performance target. However, the class average on the final exam (airfoils, wings and boundary layers) was only 48%! Students made up some of the difference in their homework, which was extensive.

Student Survey Results: Students seem to be quite confident that AE162 increased their ability to use math and physics in the solution of engineering problems. The only exception is the use of differential equations, which is rather limited in the course.

Spring 2003 Student Survey Results (N = 18):

This course has increased my ability to:		Agree	Not sure	Disagree
3a-1	Apply mathematics in the solution of engineering problems.	17	1	0
3a-2	Apply calculus (differentiation, integration, etc.) in the solution of engineering problems.	18	0	0
3a-3	Use differential equations in the solution of engineering problems.	7	7	4
3a-6	Apply equilibrium principles and Newton's laws (including free-body diagrams) in the solution of engineering problems.	15	2	1
3a-7	Apply physics concepts (friction, thermal / fluid concepts etc.) in the solution of engineering problems.	18	0	0

Course Improvements: More example and workout problems are done in class to help students with the application of math and physics in aerodynamics, especially in potential flow theory.

AE164: Compressible Flow

Course activities related to outcome 3a: Students: (a) Use the 1st and 2nd law of thermodynamics, conservation laws from fluid mechanics (continuity, momentum and energy equations), and quasi 1-D flow theory to calculate flow properties in supersonic nozzles, diffusers, wind tunnels, and shock tubes, (b) use shock / expansion theory to calculate lift and drag coefficients of supersonic airfoils, (c) use tables and / or equations to analyze isentropic flows, flows with friction and heat addition, flow through normal and oblique shock waves, and Prandtl-Meyer flow.

Course Assessment (Fall 2004): AE164 did not meet the performance targets for outcome 3a.

Student Performance Summary: 22 students took the course and 22 received passing grades (A, B, C, and D). The cumulative scores of these students in all the assignments and exam questions that pertain to outcome 3a were as follows: 19 students (86%) performed at 50% or better and 3 students (14%) performed below 50%. The class average on the 1st midterm (1-D compressible flow, normal shocks) was 65%, on the 2nd midterm (oblique shock and expansion waves) was 68%, and on the final exam (moving shocks, linearized theory) was 41%. The performance of the students on the final exam was below the target by a significant amount. This is due to inadequate preparation on the part of the students. Students made up some of the difference in their homework, which was extensive.

Student Survey Results: Students seem to be quite confident that AE164 increased their ability to use math and physics in the solution of engineering problems.

Fall 2004 Student Survey Results (N = 19)

This course has increased my ability to:		Agree	Not sure	Disagree
3a-1	Apply mathematics in the solution of engineering problems.	18 (95%)	1 (5%)	0
3a-2	Apply calculus (differentiation, integration, etc.) in the solution of engineering problems.	13 (68%)	3 (16%)	3 (16%)
3a-3	Use differential equations in the solution of engineering problems.	13 (68%)	2 (11%)	4 (21%)
3a-7	Apply physics concepts (friction, thermal / fluid concepts etc.) in the solution of engineering problems.	19 (100%)	0	0

AE167: Aerospace Propulsion

Course activities related to outcome 3a: (a) Final exam: Students apply principles of fluid mechanics, thermodynamics and dynamics to calculate rocket performance and turbojet operational parameters. (b) Quizzes (2): Students derive turbojet cycle-relevant equations for performance parameters. Calculate rocket system configuration and performance parameters. (c) Midterms (2): Students use ideal gas dynamics equations to calculate shock waves, isentropic flow and flow with heat addition. Use thermodynamic and fluid mechanics energy/momentum relationships to calculate turbojet and rock engine operational parameters.

Course Assessment (Fall 2002): AE167 met the performance targets for outcome 3a.

Student Performance Summary: Student performance averaged 87% on the final exam, 94% in the midterms, 73% in the quizzes and 75% in the homework. Overall, 94% of the students achieved more than 70% on the combined final exam, midterms, quizzes and homework scores. All students achieved 60% or better in outcome 3a.

Student Survey Results: The average agreement in the student surveys was 80%.

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

B.3.5.2 Conclusion (Fall 2003)

Seven (7) courses were targeted for assessment of outcome 3a in the AE Program. The analysis of the data shows that AE students are given adequate opportunities to apply mathematics, science, and engineering in their required coursework. Five of these courses have met and exceeded the student performance target level (60%) for outcome 3a. In summary, the AE program satisfies outcome 3a, however, there are two issues that need to be addressed: (a) in which upper division courses[8] do students use Chemistry to solve engineering problems and how skilled are they in using Chemistry to solve 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, (b) Chemistry topics (applications) will be incorporated in ME113.

[8] Chemistry is a prerequisite to MatE25.

B.3.6 Outcome 3b

AE 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 (8):

To design an experiment, AE graduates should be able to:
3b-1 Define the goals and objectives of the experiment.
3b-2 Research any relevant theory and previously published data from similar experiments.
3b-3 Select the dependent and independent variable(s) to be measured.
3b-4 Select appropriate methods, proper range / values, the appropriate number of data points needed, and the appropriate equipment / instrumentation for measuring these variables.

To conduct an experiment, AE graduates should be able to:
3b-5 Familiarize themselves with the equipment, calibrate the instruments to be used, and follow proper procedures to collect the data, given an experimental setup.

To analyze a set of experimental data, AE graduates should be able to:

3b-6 Carry out the necessary calculations, perform an error analysis, and tabulate / plot the results using appropriate choice of variables and software.

To interpret experimental data, AE graduates should be able to:
3b-7 Make observations and draw conclusions regarding the variation of the parameters involved.
3b-8 Compare with predictions from theory, computer simulations or other published data and explain any discrepancies.

B.3.6.1 Summary from Supporting Courses

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 ME120 met 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. All students performed better than 50%.

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). With regard to critically observing a given set of experimental results and choosing parametric values that give best results in practical applications (question 3b-5), a relatively high percentage (15% to 36%) were not sure whether the course increased their ability. This is likely due to the wording of the question and the phrase, “choose parametric values.” To date, the experimental work that students have been asked to do in the class has been mostly discovery rather than design or optimization. It makes sense then that a relatively large percentage of students would be unsure that the course increased their ability to choose parameters that would change the outcome of the experiments. The vast majority of students (73% to 100%) agreed that ME120 increased their ability to compare experimental results with predictions and explain any discrepancies (question 3b-6).

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.

AE162: Aerodynamics

Course activities related to outcome 3b: Students (a) design and perform a water tunnel experiment to study the effects of shape and angle of attack on the flow pattern around a variety of bodies and report the results. They distinguish basic flow features such as laminar and turbulent flow, attached or separated flow, etc. (b) Design and perform an experiment to study the effects of angle of attack and Reynolds number on the pressure distribution of an airfoil, analyze the data they collect, and write an extensive lab report to present and discuss their results. (c) Design and perform an experiment to study the effects of angle of attack and Reynolds number on the lift of an airfoil, analyze the data they collect, and write an extensive lab report to present and discuss their results. (d) Design and perform an experiment to study the effects of angle of attack and Reynolds number on the drag of an airfoil, analyze the data they collect, and write an extensive lab report to present and discuss their results. (e) Design and perform an experiment to study the boundary layer on a flat plate, analyze the data they collect, and write an extensive lab report to present and discuss their results.

Course Assessment (Spring 2003): AE162 did not meet the performance targets for outcome 3b (9 students performed below 60%).

Student Performance Summary: 23 students took the course and 21 received passing grades. The cumulative scores of these students in all the assignments (lab reports) that pertain to outcome 3b was as follows: (a) 8 students (38%) performed at 70% or better, (b) 4 students (19%) performed between 60% and 69%, (c) 6 students (29%) performed between 50% and 59% and (d) 3 students (14%) performed below 50%. Students in general designed the experiments well but performed poorly in several important areas that pertain to this outcome: (a) following guidelines in presenting their results and writing technical reports, (b) comparing their results with theory and published data and explaining any discrepancies, (c) interpreting experimental results and drawing conclusions.

Spring 2003 Student Survey Results (N = 19): Students seem to be quite confident that AE162 increased their ability to design and conduct experiments as well as to analyze and interpret experimental data.

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).	14	4	0
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).	16	2	0
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).	18	0	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.	16	2	0

3b-5	Compare experimental results with predictions from theory and explain any discrepancies.	17	1	0

Course Improvements (Spring 2004): There is now more in-class discussion on how to present experimental results, how to make comparisons with theory and published data as well the possible reasons for discrepancies between theory and experiment. More specific guidelines on report writing as well as on the required content for each lab report have been posted on the course website.

AE164: Compressible Flow

Course activities related to outcome 3b: Students: (a) Design and perform an experiment to calibrate the flow in the test section of a shock tunnel. They use two different models (an asymmetric wedge and a sphere) to calculate the effective values for the test section Mach number, specific heat ratio, temperature, pressure and density). They also study the effects of diaphragm pressure ratio and driver / driven gas properties on the test section Mach number. They analyze their data and write an extensive lab report to present and discuss their results. (b) Design and perform an experiment to study the hypersonic flow around a sphere. They analyze their data, compare their results with theoretical predictions and explain any discrepancies. They write a lab report to present and discuss their results. (c) Design and perform an experiment to study the hypersonic flow around a cone. They analyze their data, compare their results with theoretical predictions and explain any discrepancies. They write a lab report to present and discuss their results.

Course Assessment (Fall 2004): AE164 did not meet the performance targets for outcome 3b (5 students performed below 50%).

Student Performance Summary: 22 students took the course and 22 received passing grades (A, B, C, and D). The cumulative scores of these students in all the assignments (lab reports) that pertain to outcome 3b were as follows: 17 students (77%) performed at 50% or better and 5 students (23%) performed below 50%. A significant amount of class time was spent discussing the design of their experiment. Students designed their experiments well however, they performed poorly in several important areas that pertain to this outcome: (a) Following guidelines in presenting their results and writing technical reports, (b) comparing their results with theory and published data and explaining discrepancies between the two, and (c) interpreting experimental results and drawing conclusions.

Fall 2004 Student Survey Results (N = 19): Students seem to be quite confident that AE164 increased their ability to design and conduct experiments as well as to analyze and interpret experimental data.

This course has increased my ability to:		Agree	Not sure	Disagree
3b-1	Design an experiment (i.e., Define the goals and objectives of the experiment, research any relevant theory and previously published data from similar experiments, select the dependent and independent variable(s) to be measured, select appropriate methods for measuring these variables, select a proper range of the independent variable(s), and determine an appropriate number of data points needed for each type of measurement.).	16 (84%)	2 (11%)	1 (5%)
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).	16 (84%)	2 (11%)	1 (5%)
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).	18 (95%)	1 (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.	16 (84%)	3 (16%)	0
3b-5	Compare experimental results with predictions from theory and explain any	17	2	0

	discrepancies.	(89%)	(11%)	

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 (on paper) an experiment that will determine the thermal conductivity of an unknown metal.

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

Student Performance Summary (Fall 2002, Fall 2003): 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):

(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.3.6.2 Conclusion (Fall 2003)

Four (4) courses were targeted for assessment of outcome 3b in the AE Program. The analysis of the data shows that AE students are given adequate opportunities to design and conduct experiments, as well as to analyze and interpret experimental data in their required coursework. Two of these courses have met and exceeded the student performance target level (60%) for outcome 3b. In summary, the AE Program satisfies all the elements of outcome 3b.

B.3.7 Outcome 3c

AE graduates can design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability..

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): AE 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.3.7.1 Summary from Supporting Courses

E10: Introduction to Engineering

Course activities related to outcome 3c: 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.

AE170 A & B: Aircraft / Spacecraft Design

Course activities related to outcome 3c: Students (a) discuss airplane design in class during lectures, (b) design airplanes and write 12 detailed design reports, (c) give 4 design briefings in the course of the year, (d) respond in writing, individually to over 100 design questions and (e) participate in the SAE Aero-Design West Competition, which involves the design, manufacture and flight testing of a remotely-controlled, heavy-lift, cargo airplane. In this competition, they make an oral presentation in front of a panel of experts from industry and they are graded on their report, drawings, ability to predict their payload and finally on the performance of their airplane.

Course Assessment (Fall 2002 - Spring 2003): AE170 met the performance targets for outcome 3c.

Student Performance Summary (Fall 2002 – Spring 2003): Student performance exceeded the targets. In AE170A 5 out of 7 students performed at 85% or higher, while in AE170B and 5 out of 6 students performed at 85% or higher. All students performed at 60% or higher in both courses.

Spring 2003 AE170B Student Scores

Design Project Reports	88%	88%	88%	90%	90%	90%
Design Briefings	100%	100%	90%	100%	90%	90%
Average Peer Review Score	1.0	0.9	0.9	1.0	1.0	1.0

Fall 2002 AE170A Student Scores

Design Project Reports	92%	92%	47%	48%	90%	90%	90%
Design Briefings	97%	97%	89%	82%	80%	70%	50%
Average Peer Review Score	1.0	1.0	0.51	0.52	1.0	1.0	1.0
Design Questions	88%	73%	54%	25%	77%	87%	73%

Fall 2002 – Spring 2003 Student Survey Results: Student responses showed a high level of confidence in design skills.

Fall 2002 AE170A Student Survey Results (N = 7):

	This course has increased my ability to:	Agree	Not sure	Disagree
3c-1	Develop a flow chart of the design process.	2		5
3c-2	Define "*real world*" problems in practical (engineering) terms.	5	2	
3c-3	Investigate and evaluate prior or related solutions for a need I am trying to address.	6		
3c-4	Develop constraints and criteria for evaluation.	6	1	
3c-5	Develop and analyze alternative solutions.	4	2	1
3c-6	Choose the "best solution" considering the trade offs between the various solutions.	6		1
3c-7	Develop final performance specifications.	7		
3c-8	Communicate the results of my design orally as well as in writing (sell the design).	6		
3c-10	List and discuss several possible reasons for deviations between predicted and measured design performance.	5		2
3c-11	Choose the most likely reason for deviation between predicted and measured design performance and justify the choice.	4	1	2
3c-12	Formulate a method to validate the explanation for deviation between predicted and measured design performance.	1	2	

Spring 2003 AE170B Student Survey Results (N = 6):

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

3c-1	Develop a flow chart of the design process.	4	1	1
3c-2	Define "*real world*" problems in practical (engineering) terms.	6		
3c-3	Investigate and evaluate prior or related solutions for a need I am trying to address.	4	1	1
3c-4	Develop constraints and criteria for evaluation.	5	1	
3c-5	Develop and analyze alternative solutions.	5		1
3c-6	Choose the "best solution" considering the trade offs between the various solutions.	5		1
3c-7	Develop final performance specifications.	4	2	
3c-8	Communicate the results of my design orally as well as in writing (sell the design).	6		
3c-9	Build a prototype and demonstrate that it meets performance specifications.	4		2
3c-10	List and discuss several possible reasons for deviations between predicted and measured design performance.	5	1	
3c-11	Choose the most likely reason for deviation between predicted and measured design performance and justify the choice.	3	3	
3c-12	Formulate a method to validate the explanation for deviation between predicted and measured design performance.	2	1	3

B.3.7.2 Conclusion (Fall 2003)

Three (3) courses were targeted for assessment of outcome 3c in the AE Program. The analysis of the data shows that AE students are given adequate opportunities to design aerospace engineering components and systems. All three of these courses have met and exceeded the student performance target level (60%) for outcome 3c, hence the AE Program satisfies outcome 3c.

B.3.8 Outcome 3d

AE 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): AE 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 AE in terms that others outside their discipline can understand.

B.3.8.1 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: Thermodynanics

Course activities related to outcome 3d: Three team projects covering various aspects of thermodynamics are 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 below 4 (good), indicating student satisfaction with their partners' team 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.

Fall 2003 Student Survey Results (N = 44): Students seem to agree that ME113 improved their team skills.

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

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.

ME120: Experimental Methods

Course activities related to outcome 3d: Students work in teams of 2-3 to (a) carry out experiments, (b) write lab reports and (c) give oral presentations.

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

Student Performance Summary: The metric used for assessing student performance in outcome 3d is the team performance on the oral reports. All of the students achieved 70% or better in their oral reports, so we assumed that they worked well in their teams.

Student Survey Results: The analysis of the student surveys also showed that ME120 appears to be doing a good job in increasing students' ability to participate in making decisions, negotiate with teammates, and resolve conflicts arising in team work (question 3d-1, 92% - 100% agreed). A sizeable majority (67% - 85 %) agreed that the course increased their ability to set goals, generate timelines, organize and delegate work, and coach others on the team (question 3d-2).

Course Improvement (Spring 2003): To quantify the assessment of team skills, student peer review scores on the 7 qualities of teamwork are compared with the 60% performance target.

AE162: Aerodynamics

Course activities related to outcome 3d: (a) The *"17 laws of teamwork"* are presented and discussed in class. Students work in teams of 3-4 to (b) solve problems in class on a daily basis, (c) design and conduct wind-tunnel experiments, analyze / interpret experimental data and write lab reports, (d) design a wing through parametric studies, (e) research articles that discuss current aerodynamic applications and related global / societal / contemporary issues. Moreover, students (f) reflect frequently on the efficiency of their teams and suggest ways to improve it, (g) write peer reviews of their teammates 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 (Spring 2003): AE162 met the performance targets for outcome 3d.

Student Performance Summary: Student teams did not reach a high level of performance, as evidenced by their low scores on many lab reports. It is not clear whether this is due to lack of effective teamwork or inadequate time on task. The second possibility seems much more likely. The peer reviews indicated that 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). One exception to this was 2 students who, according to their teammates, did not do their share of work and missed many team meetings.

Student Survey Results: The responses on the student surveys indicated a high level of confidence in the fact that AE162 improved their team skills.

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.	18	1	0
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.	18	1	0
3d-3	Lead by taking responsibility for various tasks, motivating and disciplining others as needed.	14	4	1
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.	9	6	4
3d-5	Communicate ideas relating to my discipline in terms that others outside my discipline can understand.	11	6	2

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.

AE164: Compressible Flow

Course activities related to outcome 3d: Students: (a) Work in teams of 3 (assigned by the instructor) to solve compressible flow problems, in class as well as outside of class. (b) Discuss ways to improve their teamwork (group processing) and share their findings in class. (c) Assess their team skills by taking a test online, (d) Work in teams of 3 (assigned by the instructor) to perform a 6-hr shock tunnel experiment. (e) Work in teams to select and study three or more articles from periodicals / newspapers / magazines and the web on a current issue of interest (environment, air safety, economics, etc.) that involves high-speed aerodynamics, write a 2-page analysis on the subject, give an oral presentation in class on how high-speed aerodynamics plays a role on this issue and discuss the impact of these applications in a global / societal context. (f) Write peer reviews of their teammates at the end of each project based on specific criteria. These reviews weigh heavily when individual grades are assigned.

Course Assessment (Fall 2004): AE164 met the performance targets for outcome 3d.

Student Performance Summary: The peer reviews indicated that all but 3 students worked well in their teams in class as well as outside of class (i.e. produced good quality technical work, were committed to their projects, exhibited leadership skills, shared the responsibility for completing their projects, possessed abilities their team needed, communicated well and were easy to work with). According to their teammates, of the 3 students rated low in their teamwork two (2) did not produce good quality technical work, one (1) was not very committed to the project, all three (3) did not exhibit any leadership, one (1) did not accept responsibility for major parts of the projects, one (1) did not seem to have any abilities that could be used by the team, one (1) did not communicate well with the team, and all three (3) had some personality issues. The team performance of these students also reflected in their individual overall performance in the course.

Fall 2004 Student Survey Results (N = 19): The responses on the student surveys also indicate a high level of confidence in the fact that AE164 improved their team skills.

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.	16 (84%)	3 (16%)	0
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.	14 (74%)	4 (21%)	1 (5%)
3d-3	Lead by taking responsibility for various tasks, motivating and disciplining others as needed.	15 (79%)	3 (16%)	1 (5%)
3d-5	Communicate ideas relating to my discipline in terms that others outside my discipline can understand.	17 (89%)	2 (11%)	0

AE170 A & B Aircraft / Spacecraft Design

Course activities related to outcome 3d: Students (a) discuss team issues in class after presentation of the *"17 laws of teamwork"*, (b) work in multidisciplinary teams of 5 to 9 students that include aerospace, mechanical, computer, electrical engineers and business majors to design airplanes / spacecraft, (c) assess their team skills using an online test based on the *"17 laws of teamwork"*, and (d) write peer reviews for their teammates at the end of each semester based on 7 specific criteria. These reviews weigh heavily when individual grades are assigned.

Course Assessment (Fall 2002 - Spring 2003): AE170 met the performance targets for outcome 3d.

Student Performance Summary: Based on the results of their teamwork skills tests it appears that all students have a fairly good theoretical knowledge of what constitutes good teamwork. The peer reviews in AE170A showed that one team worked very well. The other team experienced problems with two students who (according to their peers) (a) were not willing to put enough time into the project and (b) did not have the skills to perform quality work. The negative peer reviews greatly affected these students' grades in AE170A (both received C-). However, both students performed significantly better in AE170B (one received B+, the other one A). Overall, the students increased their ability to work effectively in teams as indicated by (a) their design reports and (b) the high level of confidence in their survey responses (see exception below).

Course Improvements (Fall 2004 – Spring 2005): (a) To quantify the assessment of team skills, student peer review scores on the 7 qualities of teamwork are compared with the 60% performance target. (b) The *"multidisciplinary"* aspect of teamwork in engineering projects is now part of the aircraft design section as well. The Boeing-sponsored solar-powered UAV project involves multidisciplinary design with participation of mechanical, computer, electrical engineers and business majors in the team.

B.3.8.2 Conclusion (Fall 2003)

Eight (8) courses were targeted for assessment of outcome 3c in the AE Program. The analysis of the data shows that AE students (a) are taught how to work effectively in teams, and (b) are given adequate opportunities to practice team skills, including multidisciplinary teamwork. All of the courses assessed have met and exceeded the student performance target level (60%) for outcome 3d, hence the AE Program satisfies outcome 3d.

B.3.9 Outcome 3e

AE graduates can identify, formulate, and solve AE 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): AE graduates who are problem solvers should exhibit the following attributes:
3e-1: Are 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: Are organized and systematic in their approach to problem solving.
3e-7: Are 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: Are 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.3.9.1 Summary from Supporting Courses

M E111: Fluid Mechanics[5]

Course activities related to outcome 3e: Students solve a variety of fluid mechanics problems involving application of conservation laws (continuity, momentum and energy), some of which are open-ended and require appropriate modeling, assumptions, and discussion of the results.

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

Student Performance Summary: 42 students took the course and 39 received passing grades. The cumulative scores of these students in all the assignments and exam questions that pertain to outcome 3e were as follows: 33 students (85%) performed at 60% or better and 6 students (15%) performed between 50% and 59%. The class average on the 1st and 2nd midterms was 78%, while on the final exam it was 55%. One key element that differentiates this outcome from outcome 3a is the ability to deal with open-ended problems (ability to identify and formulate problems with minimal information given). Several examples were illustrated in class and students were given additional problems to work in teams. Students are particularly weak in this area.

	Open-Ended Problem (Rain)	
Score	Fall 2001 (N = 23)	Fall 2003 (N = 39)
60% or higher	10 (43%)	33 (85%)
lower than 60%	13 (57%)	6 (15%)

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

M E113: Thermodynamics[3]

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.

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[3]

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.

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 Fall 2002 surveys suggested a need for stricter homework format, such as requiring figures where applicable. No significant improvement was seen in the Fall 2003 surveys in this area. However, replacing the homework grader should result in an improvement in this area. The Fall 2002 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 Fall 2003, 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 Fall 2004.

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 (N = 100)

Question Number	Question	Agree	Not Sure	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 perspectives/points of view).	71	26	3
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 (N = 100)

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

AE162: Aerodynamics[3]

Course activities related to outcome 3e: (a) Students solve a variety of aerodynamics problems involving calculation of aerodynamic forces, analysis of flow fields using potential flow theory, and boundary layers. (b) Students identify and formulate open-ended problems in aerodynamics (i.e. explain what may be considered known and what needs to be found to answer the original question). These problems involve appropriate modeling of flow fields, making assumptions, and discussing the results.

Course Assessment (Spring 2003): AE162 did not meet the performance targets for outcome 3e.

Student Performance Summary: 23 students took the course and 22 received passing grades[2]. The cumulative scores of these students in all the assignments and exam questions that pertain to outcome 3e were as follows: 9 students (41%) performed at 70% or better, 7 students (32%) performed between 60% and 69%, 2 students (9%) performed between 50% and 59% and 4 students (18%) performed below 50%. The class average on the 1st midterm (calculation of aerodynamic forces) was 74% and on the 2nd midterm (potential flow theory) was 75%, both of which meet the performance target. However, the class average on the final exam (airfoils, wings and boundary layers) was only 48%! Students made up some of the difference in their homework, which was extensive. One key element that differentiates this outcome from outcome 3a is the ability to deal with open-ended problems (ability to identify and formulate problems with minimal information given). Several examples were illustrated in class and students were given additional problems to work in teams. Students are particularly weak in this area.

Student Survey Results (N = 19):

This course has increased my ability to:		Agree	Not sure	Disagree
3e-1	Read and understand the information given about a problem.	19	0	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).	17	2	0
3e-3	Research and gather information pertaining to the problem.	14	4	1
3e-4	Use a process, as well as a variety of tactics and approaches to tackle (real world) problems.	13	5	1
3e-5	Monitor my problem-solving process and occasionally reflect upon its effectiveness.	9	7	3
3e-6	Focus on accuracy rather than speed when I solve problems.	14	3	2
3e-7	Write down ideas, create charts / figures to help overcome the storage limitations of short-term memory (where problem-solving takes place).	7	8	4
3e-8	Be organized and systematic when I solve problems.	15	3	1

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).	14	3	2
3e-10	Draw on the pertinent subject knowledge and critically assess the quality and accuracy of that knowledge / data.	12	6	1
3e-11	Take risks, cope with ambiguity, welcome change and manage stress, when I solve problems.	10	4	5
3e-12	Use an overall approach that emphasizes fundamentals rather than trying to combine various memorized sample solutions.	11	7	1

Students seem to be truthful in recognizing that AE162 increased some of their problem solving skills (3e-1, 3e-2, 3e-3, 3e-6, 3e-8, 3e-9), while it did not help them as much with others (3e-4, 3e-5, 3e-7, 3e-10, 3e-11, 3e-12). Although it is unrealistic to expect improvement in all of these skills in a single course, some effort needs to be made in this direction.

Recommendations: More time needs to be spent in the course to (a) discuss a general approach for open-ended problems, (b) present the solution to a few of these problems illustrating the solution approach, (c) allow students to work out several of these problems outside of class and present their results in class, so that they will receive appropriate feedback from the instructor as well as their classmates.

AE164: Compressible Flow

Course activities related to outcome 3e: Students solve a variety of high-speed aerodynamics problems involving thermodynamics, 1-D compressible flow, shock and expansion waves and linearized subsonic / supersonic flow.

Course Assessment (Fall 2004): AE164 did not meet the performance targets for outcome 3e.

*Student Performance Summary***:** 22 students took the course and all received passing grades (A, B, C, and D). The cumulative scores of these students in all the assignments and exam questions that pertain to outcome 3e were as follows: 19 students (86%) performed at 50% or better and 3 students (14%) performed below 50%. The class average on the 1st midterm (1-D compressible flow, normal shocks) was 65%, on the 2nd midterm (oblique shock and expansion waves) was 68%, and on the final exam (moving shocks, linearized theory) was 41%. The performance of the students on the final exam was below the target by a significant amount. This is due to inadequate preparation on the part of the students. Students made up some of the difference in their homework, which was extensive.

Student Survey Responses (N = 19): Students recognized that AE164 increased their problem solving skills. The only exception appears to be 3e-11. This is probably due to (a) the nature of AE164 (i.e., it does not deal with open-ended problems) and (b) the students not being clear about the particular skill.

This course has increased my ability to:		Agree	Not sure	Disagree
3e-1	Read and understand the information given about a problem.	15 (79%)	2 (11%)	1 (5%)
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).	14 (74%)	4 (21%)	1 (5%)
3e-3	Research and gather information pertaining to the problem.	17 (89%)	1 (5%)	1 (5%)
3e-4	Use a process, as well as a variety of tactics and approaches to tackle	16	2	1 (5%)

	(real world) problems.	(84%)	(11%)	
3e-5	Monitor my problem-solving process and occasionally reflect upon its effectiveness.	14 (74%)	4 (21%)	1 (5%)
3e-6	Focus on accuracy rather than speed when I solve problems.	13 (68%)	3 (16%)	3 (16%)
3e-7	Write down ideas, create charts / figures to help overcome the storage limitations of short-term memory (where problem-solving takes place).	14 (74%)	3 (16%)	2 (11%)
3e-8	Be organized and systematic when I solve problems.	18 (95%)	1 (5%)	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).	13 (68%)	5 (26%)	1 (5%)
3e-10	Draw on the pertinent subject knowledge and critically assess the quality and accuracy of that knowledge / data.	16 (84%)	2 (11%)	1 (5%)
3e-11	Take risks, cope with ambiguity, welcome change and manage stress, when I solve problems.	9 (47%)	7 (37%)	2 (11%)
3e-12	Use an overall approach that emphasizes fundamentals rather than trying to combine various memorized sample solutions.	16 (84%)	1 (5%)	2 (11%)

AE167: Aerospace Propulsion

Course activities related to outcome 3e: (a) Homework sets (7): 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, tests and 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.

Course Assessment (Fall 2002): AE167 met the performance targets for outcome 3e.

Student Performance Summary: Students' performance averaged 75% on homework, 73% on quizzes, and 87% on the final exam. Similarly, percentages of students achieving the 70% level or higher are 65% on the homework, 100% on final exam and 69% on quizzes (78% average among all the products).

Student Survey Results: 66% of the students agreed that they achieved outcome 3e.

B.3.9.2 Conclusion (Fall 2003)

Outcome 3e targets students' ability to identify, formulate and solve engineering problems. The data from the 6 assessed courses above show that once a problem has been identified and formulated, students in general are capable of solving it through application of basic principles. On the other hand, students have difficulty identifying and formulating engineering problems. These skills are emphasized in ME111, ME113, ME114, AE162, AE164, AE167. In 4 of these courses the 60% performance target has been met. Hence, the AE Program satisfies outcome 3e.

B.3.10 Outcome 3f

AE 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): AE 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.3.10.1 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: 125 students (62**%**) performed at 70% or higher, 14 students (7%) performed between 60% and 69%, 22 students (11%) performed between 50% and 59% and 42 students (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.

AE170 A & B: Aircraft / Spacecraft Design

Course activities related to this outcome 3f: Students gain significant experience in ethics, safety and liability issues related to airplane and spacecraft design through a variety of case studies (4). The students study the background information on each one of these cases and present them in class. Two of these cases (one per semester) are presented by AE student teams in joint AE / ME senior design sessions. Following a 15-minute presentation in which the AE team presents the background information on the case, students break in small groups for 10 min and discuss ethical issues raised. Subsequently, each group presents a summary of their position orally, as well as in writing, and the floor is opened for additional comments by the rest of the class. Lastly, students follow up with a homework assignment in which they answer individually key ethical questions the case study.

Course Assessment (Fall 2002-Spring 2003): AE170 met the performance targets for outcome 3f.

Overall, the aircraft design students performed well on these assignments (5 out of 7 students received higher than 70% on their reports). Their analyses of the case studies indicate that they begin to appreciate the complexities of the ethical issues encountered in aircraft & spacecraft design.

B.3.10.2 Conclusion (Fall 2003)

Four courses address engineering ethics in the AE technical curriculum. Although the performance targets were not met in E10 and there are no assessment data from E100W on this outcome, the thorough coverage of the subject in AE170 as well as the student performance on this outcome in this class, clearly demonstrate that the AE Program satisfies outcome 3f.

B.3.11 Outcome 3g

AE 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): AE 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.3.11.1 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 (F03): ME113 met the performance targets for outcome 3g.

Student Performance Summary: 86% of students scored 70% or greater on the three 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 (S03-F03): 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
five 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).

AE 162: Aerodynamics

Course activities related to outcome 3g: Students (a) write 4 lab reports, and (b) select and study one or more articles from periodicals / newspapers / magazines on a current issue of interest (environment, air safety, economics, etc.) that involves aerodynamics. They write a 2-page analysis and give an oral presentation in class on how aerodynamics plays a role on this issue. They also discuss the impact of any aerodynamic applications involved in a global / societal context.

Course Assessment (Spring 2003): AE162 did not meet the performance targets for outcome 3g.

Student Performance Summary: 23 students took the course and 22 received passing grades[2]. The cumulative scores of these students in all the assignments that pertain to outcome 3g was as follows: (a) 11 students (50%) performed at 70% or better, (b) 6 students (27%) performed between 60% and 69%, (c) 4 students (18%) performed between 50% and 59% and (d) 1 student (5%) performed below 50%. In general, students' writing ability is poor, primarily due to lack of language skills. Moreover, they do not follow the posted guidelines for report writing. On the other hand, a few of the lab reports were truly excellent. Students seem to be much better at preparing and delivering oral presentations.

Student Survey Results: Students are almost unanimous that AE162 increased their writing skills. However, they do not share the same confidence that the course increased also their presentation skills. While AE162 offers an opportunity for them to practice presentation skills, it was assumed that students already had these skills from previous courses.

This course has increased my ability to: (N=19)		Agree	Not sure	Disagree
3g-1	Produce well-organized reports, following guidelines.	19	0	0
3g-2	Use clear and correct language and terminology while describing experiments, projects, or solutions to engineering problems.	18	1	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.	17	2	0
3g-4	Give well-organized presentations, following guidelines.	9	6	4
3g-5	Use visuals to convey their message effectively, when making presentations.	11	3	5
3g-6	Present the most important information about a project / experiment, while staying within my allotted time when making presentations.	9	2	8

Recommendation: Give students more guidance on how to present more effectively.

AE 164: Compressible Flow

Course activities related to outcome 3g: Students: (a) Write an extensive lab report on the shock tunnel experiment. (b) Work in teams to select and study three or more articles from periodicals / newspapers / magazines and the web on a current issue of interest (environment, air safety, economics, etc.) that involves high-speed aerodynamics, write a 2-page analysis, give an oral presentation in class, and discuss the impact of any aerodynamic applications involved in a global / societal context.

Course Assessment (Fall 2004): AE164 did not meet the performance targets for outcome 3g (one student performed below 50%).

Student Performance Summary: 22 students took the course and all received passing grades (A, B, C, and D). The cumulative scores of these students in all the assignments that pertain to this outcome were as follows: 21 students (96%) performed at 50% or better and 1 student (4%) performed below 50%. In general, students' writing ability is poor, primarily due to lack of language skills. Moreover, they do not follow the posted guidelines for report writing. On the other hand, a few of the lab reports were very good. Students seem to be much better at preparing and delivering oral presentations.

Student Survey Responses (N = 19): Students recognized that AE164 improved their ability to communicate in writing as well as orally.

This course has increased my ability to:		**Agree**	**Not sure**	**Disagree**
3g-1	Produce well-organized reports, following guidelines.	14 (74%)	5 (26%)	0
3g-2	Use clear and correct language and terminology while describing experiments, projects, or solutions to engineering problems.	15 (79%)	4 (21%)	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.	15 (79%)	4 (21%)	0
3g-4	Give well-organized presentations, following guidelines.	17	2 (11%)	0

		(89%)		
3g-5	Use visuals to convey their message effectively, when making presentations.	17 (89%)	2 (11%)	0
3g-6	Present the most important information about a project / experiment, while staying within my allotted time when making presentations.	19 (100%)	0	0

AE170 A & B: Aircraft Design

Course activities related to outcome 3g: Students (a) write 6 design reports each semester, (b) write 4 reports on case studies in professional & ethical responsibility, (c) write one report on a contemporary issue discussed in class, (d) give 4 oral briefings on their design project, and (e) give 3 presentations on case studies in professional & ethical responsibility.

Course Assessment (Fall 2002-Spring 2003): AE170 met the performance targets for outcome 3g.

Student Performance Summary: Students' writing ability is poor, both due to lack of language skills and due to lack of knowledge on how to organize technical reports. Most reports received a failing grade when submitted. Extensive feedback was given in writing (on the reports) and orally (in meetings with students) and teams were asked to make corrections and resubmit revised versions of their reports. The revised reports were of much higher quality. Students were 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 high level of confidence in their survey responses.

Recommendation: Students should have better writing skills coming into the senior design project. This weakness needs to be addressed in E100W.

B.3.11.2 Conclusion (Fall 2003)

Based on 9 courses assessed for communication skills (written and oral) the AE 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.3.12 Outcome 3h

AE 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): AE students:
3h-1 Evaluate and describe accurately the environmental impact of various engineering products, including those they have designed in course projects.
3h-2 Evaluate and describe accurately environmental and economic tradeoffs of engineering products, including those they have designed in course projects.

3h-3 Evaluate and describe accurately the health / safety and economic tradeoffs of engineering products, including those they have designed 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.3.12.1 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 F03, 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.

Fall 2003 Student Survey Results (N = 44):

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

AE162: Aerodynamics

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 aerodynamics. They write a 2-page analysis and give an oral presentation in class on how aerodynamics plays a role on this issue. They also discuss the impact of any aerodynamic applications involved in a global / societal context.

Course Assessment (Spring 2003): AE162 met the performance targets for outcome 3h.

Student Performance Summary: 23 students took the course and 22 received passing grades[2]. The cumulative scores of these students in the assignment that pertains to outcome 3h was as follows: (a) 18 students (77%) performed at 70% or better, (b) 3 students (14%) performed between 60% and 69%, and (c) 1 student (5%) did not do this assignment.

Student Survey Results (N = 19):

This course has increased my ability to:		Agree	Not sure	Disagree
3h-1	Evaluate and describe accurately the environmental impact of various engineering products.	9	4	6
3h-2	Evaluate and describe accurately environmental and economic tradeoffs of engineering products.	10	3	6
3h-3	Evaluate and describe accurately the health / safety and economic tradeoffs of engineering products.	7	3	9
3h-4	Take into consideration the environmental impact when designing an engineering product.	10	2	7
3h-5	Take into consideration the health / safety impact when designing an engineering product.	9	2	8

Although student performance on the single assignment that pertained to this outcome exceeded the 70% target, the responses on the student surveys show that students were ambivalent about certain issues. However, this was expected as some students chose and researched topics that addressed environmental issues (ex. sonic boom in supersonic flights), some chose and researched topics that addressed economic issues (ex. laminar flow wings and fuel efficiency), and some chose and researched topics that addressed safety issues (ex. wake turbulence and airline safety) related to aerodynamics. The idea was that all the students would be exposed to all the issues through the presentations and the discussion that followed each presentation.

AE 164: Compressible Flow

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

Course Assessment (Fall 2004): AE164 met the performance targets for outcome 3h.

Student Performance Summary: All students in the course performed at 70% or better in the assignment that pertains to outcome 3h. The topics students selected for their research papers and presented in class were (a) vehicle design for sonic boom reduction, (b) making space tourism affordable, (c) affordable access to space and its effect on the ozone layer, (d) helicopter noise, (e) economic feasibility of supersonic transports, (f) supersonic business jets, (g) jet contrails and their effect in global warming, and (h) engine efficiency of supersonic aircraft. These topics addressed environmental and economics issues related to high-speed aerodynamics. All the students were exposed to all the issues listed above through the class presentations and the discussion that followed each presentation.

Student Survey Results: Students were not surveyed on outcome 3h.

AE167: Aerospace Propulsion

Course activities related to outcome 3h: Students research / review one international and one environmental topic - approved by the instructor - and write a polished summary of the issues involved in each.

Course Assessment (Fall 2002): AE167 met the performance targets for 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 Fall 2004).

AE170 A & B: Aircraft Design

Course activities related to outcome 3h: Students: (a) Evaluate and describe the environmental impact of their proposed airplane designs (ex. air pollution, noise pollution, sonic boom). (b) Discuss safety issues related to their proposed airplane designs (ex. controlled flight into terrain, pilot decision-making and weather).

Course Assessment (Fall 2002 - Spring 2003): AE170A&B met the performance targets for outcome 3h.

Student Performance Summary: Students researched several references and gathered information regarding the environmental impact of their proposed airplane designs. Both teams addressed air and noise pollution as well as energy consumption. One team addressed also the sonic boom problem because their airplane was supersonic. The supersonic team did a very thorough job on addressing their issues. Both teams addressed safety issues related to their proposed airplane designs. One team discussed controlled flight into terrain, pilot decision-making, weather, loss of control, survivability, and runway incursions because these issues were more relevant to their general aviation airplane. The other team discussed safety issues related to the Concorde, which (a) was an aging airplane – now no longer in service – and (b) had difficulty replacing worn parts because the assembly line had been closed several years ago.

Student Survey Results:

3h-1	Evaluate and describe accurately the environmental impact of various engineering products.	3	2	1
3h-2	Evaluate and describe accurately environmental and economic tradeoffs of engineering products.	3	2	1

3h-3	Evaluate and describe accurately the health / safety and economic tradeoffs of engineering products.	3	2	1
3h-4	Take into consideration the environmental impact when designing an engineering product.	5		1
3h-5	Take into consideration the health / safety impact when designing an engineering product.	4	1	1

Only half the students showed confidence in their survey responses related to this outcome 3h. The reason for this may be that the questions did not mention *"airplanes",* which is what the students designed in this course.

Recommendations: (a) Additional class time will be spent discussing issues related to questions 3g-1, 3g-2, and 3g-3. (b) The wording of the questions will be changed to reflect more accurately the course content. (c) The activities in the spacecraft design section related to outcome 3g need to be assessed. [Improvements (a) and (b) were implemented in AY 03-04].

B.3.12.2 Conclusion (Fall 2003)

All of the 7 courses assessed, met the performance targets for outcome 3h. Hence, the AE Program satisfactorily addresses this outcome. Some fine-tuning is needed to ensure that all AE students are knowledgeable on a variety of global and societal issues by the time they graduate.

B.3.13 Outcome 3i[9]

AE 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): AE 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.

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

B.3.13.1 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 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.

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[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.

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 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.

AE 162: Aerodynamics

Course activities related to outcome 3i: (a) 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 approach. (b) Observe aerodynamic artifacts carefully and critically and discuss the reasons behind specific designs. (c) Select and study one or more articles from periodicals / newspapers / magazines on a current issue of interest (environment, air safety, economics, etc.) that involves aerodynamics. They write a 2-page analysis and give an oral presentation in class on how aerodynamics plays a role on this issue. They also discuss the impact of any aerodynamic applications involved in a global / societal context. (d) Take responsibility to study 3-D Potential Flow Theory on their own and demonstrate their knowledge by solving assigned problems. Interaction with the instructor, as well as with other students is encouraged but no lectures are given on this topic. (e) Write a 2-page reflection on their learning process at the end of the semester discussing their strengths and weaknesses, highlights and challenges in the course, and applications of the material. (f) Learn how to use Sub2D by studying the manual on their own and completing several assignments on potential flow, airfoils, wings and ground effect. (g) Model various flow fields by making simplifying assumptions and approximations.

Course Assessment (Spring 2003): AE162 did not meet the performance targets for outcome 3i (one student performed below 50%).

Student Performance Summary: 23 students took the course and 22 received passing grades[2]. The cumulative scores of these students in all the assignments that pertain to this outcome was as follows: (a) 19 students (86%) performed at 70% or better, (b) 2 students (9%) performed between 50% and 59% and (c) 1 student (5%) performed below 50%. Many students wrote excellent end-of-the-semester reflections on the course (class average 86%), while the ones who studied 3-D potential flow theory on their own and turned in the homework did an excellent job (class average = 67% including 6 students who got zero because they did not do this assignment). Moreover, students were able to learn Sub2D on their own and exceeded the 70% target in 2 out of the 3 Sub2D assignments (Sub2D scores were not included in this outcome). Lastly, students did a very good job on their research papers.

Student Survey Results (N = 19): Student responses indicate that AE162 improved significantly most of their lifelong learning skills.

In this course:		Agree	Not sure	Disagree
3i-1	I was encouraged and taught how to learn new material and find information on my own.	16	1	2
3i-2	I was encouraged and taught how to reflect on my learning process and identify my strengths and weaknesses.	This question was not included in the S'03 survey		
3i-3	I was encouraged to explore my learning style preferences and taught how to develop strategies to overcome any weaknesses in my learning process.	This question was not included in the S'03 survey		
3i-4	I was encouraged to participate in professional society activities and events.	9	6	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.	15	1	3
	This course has increased my ability to:			
3i-6	Observe engineering artifacts carefully and critically.	13	5	1
3i-7	Access information from a variety of sources.	14	4	1
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).	10	9	0
3i-9	Analyze new content by breaking it down, asking key questions, comparing and contrasting, recognizing patterns, and interpreting information.	12	7	0
3i-10	Synthesize new concepts by making connections, transferring prior knowledge, and generalizing my understanding.	10	7	2
3i-11	Model by estimating, simplifying, making assumptions and approximations.	17	1	1
3i-12	Visualize (ex. create pictures in my mind to help me *"see"* what the	16	1	2

	words in a book describe).			
3i-13	Reason by predicting, inferring, using inductions, questioning assumptions, using lateral thinking, and inquiring.	14	4	1

AE 164: Compressible Flow

Course activities related to outcome 3i: Students: (a) Observe artifacts related to course topics (ex. rocket nozzles, jet engines, etc.) carefully and critically and discuss the reasons behind specific designs. (b) Work in teams to select and study three or more articles from periodicals / newspapers / magazines and the web on a current issue of interest (environment, air safety, economics, etc.) that involves high-speed aerodynamics, write a 2-page analysis, give an oral presentation in class, and discuss the impact of any aerodynamic applications involved in a global / societal context. (c) Write a 2-page reflection on their learning process at the end of the semester discussing their strengths and weaknesses, highlights and challenges in the course, and applications of the material.

Course Assessment (Fall 2004): AE164 met the performance targets for outcome 3i.

Student Performance Summary: The cumulative scores of all the students in the course in all the assignments that pertain to outcome 3i exceeded the 50% target. Many students wrote excellent end-of-the-semester reflections on their learning experience in the course and did an excellent job on their research papers related to global / societal / contemporary issues.

Student Survey Responses (N = 19): Student responses indicate that AE164 improved significantly their lifelong learning skills.

In this course:		Agree	Not sure	Disagree
3i-1	I was encouraged and taught how to learn new material and find information on my own.	18 (95%)	0	1 (5%)
3i-2	I was encouraged and taught how to reflect on my learning process and identify my strengths and weaknesses.	15 (79%)	3 (16%)	1 (5%)
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.	17 (89%)	2 (11%)	0
This course has increased my ability to:				
3i-6	Observe engineering artifacts carefully and critically to understand the reasons behind their design.	16 (84%)	2 (11%)	1 (5%)
3i-7	Access information from a variety of sources.	13 (68%)	6 (32%)	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).	16 (84%)	3 (16%)	0
3i-9	Analyse new content by breaking it down, asking key questions, comparing and contrasting, recognizing patterns, and interpreting information.	17 (89%)	2 (11%)	0
3i-10	Synthesize new concepts by making connections, transferring prior knowledge, and generalizing my understanding.	15 (79%)	3 (16%)	1 (5%)
3i-11	Model by estimating, simplifying, making assumptions and approximations.	17	2 (11%)	0

		(89%)		
3i-12	Visualize (ex. create pictures in my mind to help me *"see"* what the words in a book describe).	14 (74%)	5 (26%)	0
3i-13	Reason by predicting, inferring, using inductions, questioning assumptions, using lateral thinking, and inquiring.	16 (84%)	3 (16%)	0

AE167: Aerospace Propulsion

Course activities related to outcome 3i: Students research / review one international and one environmental topic - approved by the instructor - and write a polished summary of the issues involved in each.

Course Assessment (Fall 2002): AE167 met the performance targets for outcome 3i.

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 3i or the standards need to be raised for assignment depth and reporting (implemented in Fall 2004).

AE170 A & B: Aircraft Design

Course activities related to outcome 3i: Students: (a) Observe airplanes carefully and critically and understand the reasons behind specific designs. (b) Access information from a variety of sources (internet, books) to answer design questions and do their projects. (c) Read critically and assess the quality of information available before using it in their design assignments. (d) Routinely acquire knowledge of new material, not discussed in class. Learn to analyze new content by breaking it down, asking key questions, comparing and contrasting, recognizing patterns, and interpreting information. (e) Synthesize new concepts (ex. performance constraint analysis) by making connections, transferring prior knowledge, and generalizing their understanding in the process. (f) Model by estimating, simplifying, making assumptions and approximations (ex. estimate required wing area and thrust needed to meet mission specifications, assume realistic values for various parameters, etc.). (g) Reason by predicting, inferring, using inductions, questioning assumptions, using lateral thinking (ex. area ruling in the design of supersonic airplanes), and inquiring.

Course Assessment (Fall 2002 – Spring 2003): AE170A&B met the performance targets for outcome 3i.

Student Performance Summary: Most of the lifelong learning skills defined in this outcome are inherent in open-ended, design projects. Nevertheless, the students were given an additional assignment to practice lifelong learning skills. Seven (7) sets of design questions were posted on the course website and each student had to individually search several references, including the worldwide web, for answers. Moreover, the students were tested on these questions during their oral presentations. The scores on this assignment ranged from 73% to 88% for the 5 students who did well on their projects and from 25% to 54% for the two students whose teammates complained that they did not pull their weight on the project. Overall, the students increased their lifelong learning skills as evidenced by (a) their work on their projects, (b) their output on the design questions, and (c) the confidence level shown in their survey responses.

Student Survey Results: With the exception of 3i-3 (participation in professional societies), student responses indicated a very high level of agreement in the fact that the course increased their lifelong learning skills.

Recommendation: (a) Students should participate in professional society activities as part of the course. (b) The activities related to outcome 3i in the spacecraft design section need to be assessed.

B.13.2 Conclusion (Fall 2003)

Analysis of the available data for 9 courses[3] shows that the AE 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. However, these skills are emphasized and assessed in the senior design course and the results show that most AE students graduate with the necessary attributes to become lifelong learners.

B.3.14 Outcome 3j

AE students demonstrate knowledge of contemporary[11] issues.

Outcome Champion: Dr. John Lee

Outcome Attributes: AE 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.3.14.1 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 23 / 25 points.

Fall 2003 Student Survey Results: At least 70% of the students agreed that this course improved their knowledge of contemporary issues.

[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.

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 particularly problematic or controversial in the present time.	39	3	2
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

AE162: Aerodynamics

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

Course Assessment (Spring 2003): AE162 met the performance targets for outcome 3j.

Student Performance Summary: Student performance on the single assignment that pertained to this outcome exceeded the 70% target.

Student Survey Results: The responses on the student surveys show that students were ambivalent about certain issues. This occurred because students were unable to find topics / articles that connected aerodynamics with contemporary issues as defined in the first statement (3j-1) of the survey. As a result, there appears to be some disjoint between class activities and cognitive awareness of the four outcome attributes. On the other hand, as was mentioned in the analysis for outcome 3g, students discussed in their research papers safety, environmental, and economic issues related to aerodynamics. If the definition is expanded to include safety, environmental, and economic issues, then AE162 did contribute to outcome 3j.

Recommendation: Survey questions need to be updated to provide closer correlation between outcome attributes and learned abilities. The assignment described above should be modified to contain the language used in the outcome attributes.

AE 164: Compressible Flow

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

Course Assessment (Fall 2004): AE164 met the performance targets for outcome 3j.

Student Performance Summary: All students in the course performed at 70% or better in the assignment that pertains to outcome 3j. The topics students selected for their research papers and presented in class were (a) vehicle design for sonic boom reduction, (b) making space tourism affordable, (c) affordable access to space and its effect on the ozone layer, (d) helicopter noise, (e) economic feasibility of supersonic transports, (f) supersonic business jets, (g) jet contrails and their effect in global warming, and (h) engine efficiency of supersonic aircraft. These topics addressed environmental and economics issues related to high-speed aerodynamics. All the students were exposed to all the issues listed above through the class presentations and the discussion that followed each presentation.

Student Survey Results: Students were not surveyed on outcome 3j.

AE167: Aerospace Propulsion

Course activities related to outcome 3j: Students research / review one international and one environmental topic - approved by the instructor - and write a polished summary of the issues involved in each.

Course Assessment (Fall 2002): AE167 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 3j or the standards need to be raised for assignment depth and reporting (implemented in Fall 2004).

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.

AE 170 A & B: Aircraft / Spacecraft Design

Course activities related to outcome 3j: Students researched several references and gathered information regarding the environmental impact of their proposed airplane designs. Both teams addressed air and noise pollution as well as energy consumption. One team addressed also the sonic boom problem because their airplane was supersonic. Overall, however, student experience in contemporary issues was rather limited in the course.

Course Assessment (Fall 2002-Spring 2003): AE170 met the performance targets for outcome 3j.

Student Performance Summary: All students performed higher than the 70% target level in the assignment related to outcome 3j.

Recommendations: (a) A larger variety of issues needs to be addressed in class discussions and student reports, in addition to the ones mentioned above. Magazine and newspaper articles that discuss airplane design in light of the new challenges we are facing in the 21st century (energy conservation, terrorism, international conflict, globalization, etc.) will be presented and discussed in class throughout the year.

<u>B.14.2 Conclusion (Fall 2003)</u>

A number of contemporary issues are being discussed in the 8 courses that have been assessed for outcome 3j, all of which met the performance targets. Hence, the AE Program satisfies outcome 3j.

<u>B.3.15 Outcome 3k</u>

AE 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: AE 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.3.15.1 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 did not meet 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.

AE162: Aerodynamics

Course activities related to outcome 3k: Students (a) Use a wind tunnel with DAS, a water tunnel, and a smoke tunnel to perform a variety of aerodynamic / hydrodynamic experiments. (b) Use Sub2D to analyze a variety of flow fields. (c) Perform library and web-based research for several assignments. (d) Use MS Word 2000 to write their lab reports and research papers and MS PowerPoint to prepare their oral presentations.

Course Assessment (Spring 2003): AE162 did not meet the performance targets for outcome 3k.

Student Performance Summary: 23 students took the course and 22 received passing grades[2]. The cumulative scores of these students in all the assignments that pertain to this outcome was as follows: (a) 11 students (50%) performed at 70% or better, (b) 6 students (27%) performed between 60% and 69%, (c) 4 students (18%) performed between 50% and 59%, (d) 1 student (5%) performed below 50%. In general, students did very well in 2 out of the 3 Sub2D assignments (class average was 71%, 74%, and 20% respectively). On the other hand, although they became familiar with the use of the wind tunnel and its DAS, their lab reports were not as good (see discussion in outcome 3b).

Student Survey Results (N = 19):

This course has increased my ability to:		Agree	Not sure	Disagree
3k-2	Use modern equipment and instrumentation to perform experiments.	12	4	3
3k-3	Perform web-based research.	11	5	3
3k-4	Use Word and Excel to produce high quality technical reports.	18	1	0
3k-5	Use Power Point to give high quality oral presentations.	4	1	14
3k-6	Use computer simulations to conduct parametric studies.	13	0	6
3k-7	Use computer simulations to perform optimization.	13	3	3
3k-8	Use computer simulations to perform 'what if' explorations.	13	4	2
3k-9	Use state-of-the-art technology for engineering system design, control, and analysis.	7	5	7

Recommendations: (a) Invite speakers from industry to discuss current practices. (b) Visit industrial sites and / or airplane museums. (c) Require the use of PowerPoint in oral presentations. (d) Introduce at least one design assignment using modern software. [Improvements (b), (c) and (d) were implemented in Spring 2004]

AE164: Compressible Flow

Course activities related to outcome 3k: Students: (a) Use a shock tunnel with DAS to perform gas dynamics experiments. (b) Acquire skills in library and web-based research. (c) Use MS Word 2000 to write their lab reports and research papers and MS PowerPoint to prepare their oral presentations. (d) Listen to guest speakers from the aerospace industry (Fall 2004 speaker: Burt Rutan).

Course Assessment (Fall 2004): AE164 met the performance targets for outcome 3k.

Student Performance Summary: All the students in the course earned 50% or higher in the cumulative scores of the assignments that pertain to outcome 3k.

Student Survey Results (N = 19): In general students agreed that AE164 increased their competence with modern tools. The course does not normally include plant visits. On the other hand, one guest speaker should meet this requirement, especially if the speaker is Burt Rutan.

In this course I became aware of:		Agree	Not sure	Disagree
3k-1	State-of-the-art tools and practices used in industry through plant visits and presentations by practicing engineers.	8 (42%)	6 (32%)	5 (26%)
This course has increased my ability to:				
3k-2	Use modern equipment and instrumentation to perform experiments.	13 (68%)	3 (16%)	3 (16%)
3k-3	Perform web-based research.	15	2 (11%)	2 (11%)

		(79%)		
3k-4	Use Word and Excel to produce high quality technical reports.	17 (89%)	0	2 (11%)
3k-5	Use Power Point to give high quality oral presentations.	19 (100%)	0	0

AE 170 A & B: Aircraft / Spacecraft Design

Course activities related to outcome 3k: Students: (a) Use the Advanced Aircraft Analysis program throughout the year in the design of their airplanes. (b) Use AutoCad to make their drawings. (c) Acquire the skills of a configurator (in airplane design). (d) Perform several web-based and library searches in several assignments. (e) Use MS Word 2000 to write their reports and MS PowerPoint to prepare their oral presentations. (f) Use computer simulations to conduct parametric studies, process optimization, and 'what if' explorations in the design of their airplanes. (g) Become aware of state-of-the-art tools and practices used in industry through plant visits and presentations by practicing engineers.

Course Assessment (Fall 2002-Spring 2003): AE170 met the performance targets for outcome 3k.

Student Performance Summary: Students became experts in the Advanced Aircraft Analysis (AAA) program (used in many engineering schools as well as in industry). They used this program to perform computer simulations, parametric studies, and 'what if' explorations in the design of their airplanes. In the process, the students acquired the skills of a *"configurator"* in airplane design. They also enhanced their web-based research skills. A guest speaker from *Cessna Aircraft Company* discussed state-of-the-art tools and practices used in industry. The class also visited the Hiller Aviation Museum in San Carlos where we were given a guided tour. 70% of the students performed at the 70% level or higher in the assignments related to outcome 3k.

Student Survey Results: The confidence level of the students in this area is excellent in some of the skills listed (3k-1, 3k-2, 3k-3, 3k-4, 3k-6). On the other hand for some reason students do not perceive the AAA program as state of the art technology for design and analysis (3k-9).

Recommendation: Students would like to have more guest speakers from industry and visit aircraft design and manufacturing plants. Unfortunately this is not always possible because there are no such plans in our area. We will, however, increase the number of class visits to aviation museums [implemented in F03-S04].

<u>B.3.15.2 Conclusion (Fall 2003)</u>

The AE Program meets the performance targets for outcome 3k. AE students are required to use many modern tools in their curriculum, including the Microsoft Suite of Word, Excel, and PowerPoint, AUTOCAD (ME20), MATHCAD, MATLAB (E10), C-programming language (ME30), SIMULINK, Sub2D (AE162), Super2D (AE164) and AAA or SINDA and STK (AE170A&B). In addition, they use the Internet for literature searches and a variety of actual and virtual laboratory instruments as well as LABVIEW (ME120) for data acquisition and processing. Moreover, AE students learn in specific elective courses some powerful modern industry tools, such as FE software and SOLID WORKS (ME160), ProE (ME165), and COSMOS.

One improvement with regards to this outcome that is currently being implemented is inviting more guest speakers and organizing more field trips to make students more aware of modern tools used in industry.

B.4 Aerospace Engineering Professional Component

<u>B.4.1 Aerospace Engineering Curriculum Design and Content</u>

Senior Design Project (Aircraft or Spacecraft): AE 170 A & B		
Aerodynamics & Propulsion	**Dynamics & Control**	**Structures & Materials**
Capstone: ME114 Electives: AE110 AE169 ME149 Math 112 A,B Math 129 A,B Math 133 B Math 143 C	**Capstone:** AE168 Electives: AE110 ME187 ME106 EE112 EE132 ISE130 Math 129 A,B	**Capstone:** ME160 Electives: AE110 ME165 CE114 CE113 MatE187 MatE160

Experimental Methods: ME120
Applied Engineering Analysis: ME130

Thermal-Fluids	**Solid Mechanics**	**Dynamics & Controls**	**Electronics**
AE167 AE164 AE162 ME113 ME111	AE114 CE112 CE99 MatE25	ME147 AE140 AE165 ME101	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 (Ordinary Differential Equations)

Figure B.4.1 AE Curriculum Design

The AE curriculum is vertically integrated as shown in Figure B.4.1. Foundational engineering sciences (thermal-fluids, solid mechanics, dynamics & control, electronics) build upon mathematics, science, and basic engineering skills. These foundational sciences culminate in discipline specific courses, such as aerodynamics (AE162), compressible flow (AE164), propulsion (AE167), flight mechanics (AE165), rigid body dynamics (AE140), and aerospace structures (AE114), all of which emphasize AE applications. Two additional required courses give students advanced mathematics (ME130) and experimentation (ME120) skills. The curriculum concludes with both a synthesis of engineering skills (aircraft / spacecraft senior design project), as well as a concentration in one of three specialization areas: aerospace & propulsion, dynamics & control, or structures & materials. 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 AE 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 (see Appendix I-E): The AE 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 AE 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 AE 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, AE162, AE165, AE164, AE167 among others), computer modeling / simulations (AE162, AE164, ME113, ME114, AE110, AE168, AE169, ME160, ME165, AE170A&B among others), experimentation / product testing (AE114, AE162, AE164, ME120, ME114, CE113, AE170B among others), and design (AE162, AE164, AE165, AE167, AE170A&B among others).

Experimentation: The AE curriculum includes 9 required laboratory courses (Phys.70, Phys.71, Phys.72, Chem.1A, MatE25, ME120, AE114, AE162 and AE164) and 2 elective laboratory courses (ME114, CE113). 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.

B.4.2 Preparation for Engineering Practice

Breadth and Depth: The AE Program provides graduates with an understanding of the basic principles and applications in both aeronautics and astronautics, so that they will be able to work in either field. In order to prepare for work in any of the specific disciplines of AE, all students are required to take courses in each of the main engineering science disciplines – fluid mechanics, thermodynamics, dynamics, controls, strength of materials and circuits. This foundation of engineering sciences is then applied in courses focusing on aerospace vehicle subsystems – aerodynamics, propulsion, structures, flight mechanics, stability and control, rigid body dynamics. These courses, as far as possible, address both aircraft and spacecraft system applications. Once students have completed these courses, they choose a stem or flight vehicle subsystem to specialize, by selecting electives from that particular area. Much 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. Finally, students choose to take either the aircraft or the spacecraft senior design course as a culminating experience. It is intentional that this choice of a design course in aircraft or spacecraft is the first and only time a student must choose between aeronautics and astronautics as a field.

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, AE162, AE164, AE65, AE167). Second, it requires the synthesis of principles from many different fields (AE170A&B). Third, it requires critical thinking to check the validity of assumptions and evaluate the various design solutions.

Design activities are integrated throughout the AE curriculum. 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. Several AE courses integrate design assignments using a variety of modern tools. For example, students perform parametric studies of structural weight vs. strength (AE114), wing parametric studies (AE162), orbit design (AE165), and turbojet component tradeoffs (AE167).

Senior Design Project (Aircraft or Spacecraft): The major culminating design experience comes in the two-semester senior project (AE170A&B). Students integrate aerodynamics, structures, flight mechanics, stability & control and propulsion (traditional AE disciplines), along with communications and power subsystems (traditional EE disciplines) while considering cost, ease of construction and implementation. The mission requirements are specified, followed by tradeoff studies, leading to the preliminary design. 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, multidisciplinary design projects, such as SPARTNIK (micro-satellite) and ICARUS (solar-powered, autonomous UAV) or participate in the SAE Aero Design West Competition[12]. These projects provide industry mentors and require involvement of mechanical, electrical, and computer engineers, and sometimes business majors, offering valuable experience in multidisciplinary teamwork.

Engineering standards and realistic constraints are incorporated throughout the senior design project. For example, economic constraints form part of the mission specification. Students perform a market analysis and discuss the technical and economic feasibility of designing, developing and building their product before embarking on a particular design. They face manufacturability requirements as they build, test and demonstrate their products. They evaluate any health, safety or environmental issues associated with their product, any technical solutions proposed to address such issues, as well as the cost involved. Finally, they research, present and debate in class a variety of safety, liability, and ethical issues related to aircraft / spacecraft and write a short report on each.

B.4.3 AE Program Review

The MAE and COE Curriculum Committees, the MAE Department faculty, and the AE Advisory Board all participate in reviewing the AE 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 AE Program meets both the AIAA and the ABET 2005 Engineering 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 Competence 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 directly supporting the AE Program. It should be noted that there are other faculty in the ME Program (and associated discipline / facilities) that provide additional, occasional contributions to the AE Program. The part-time faculty supporting the AE Program are very important, as they bring contemporary industry expertise and help provide adequate staffing in a time of minimal coverage. Appendix I-C gives the resumes of all full-time and part-time faculty within the Department. As a whole, the Department has eleven full-time tenure-track faculty members and one FERP-active (Faculty Early Retirement Program) faculty member. All eleven 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.

One AE faculty member retired last year (Dr. Desautel). However, in Spring 2005 the Department completed a successful faculty search and the AE Program will have one additional tenure-track faculty member in Fall 2005

[12] Our 2004-2005 team finished 5th in a field of 39 universities from the US and abroad.

(Dr. Allen). It should be noted that four of the six AE core courses (AE162, AE164, AE165, AE167), the senior design project (AE170A & B) and two of the three AE electives (AE110, AE169) have always been taught by full-time AE faculty. Starting in Fall 2005, AE140 will also be taught by a full-time AE faculty member. All basic AE disciplines in the program – fluid mechanics / aerodynamics / gas dynamics, thermodynamics / heat transfer, propulsion, structures and materials, flight dynamics & controls are represented on the current faculty, although among the disciplines, flight vehicle structures & materials is represented solely by part-time faculty (as it always has been). In the Department as a whole, 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 methods, such as project-based learning integrating material from two or more courses taken concurrently by AE students (AE162 / AE165, AE164 / AE167), cooperative learning in the classroom, and encouraging undergraduates to participate in faculty research and present their results in conferences.

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. The faculty has become more involved with students through advising the student professional societies, design competitions, and providing career guidance. And through research and participation in local societies, the faculty helps students obtain internship employment, summer jobs, undergraduate research experience and full-time jobs upon graduation.

B.5.4 Faculty Professional Development and Interactions with Industry

Professor Papadopoulos has significant industry contact and exchange with Lockheed Martin and NASA through his research. Moreover, he is very active with AIAA. Professor Mourtos has industry contact with Cessna and Honeywell and recently initiated contact with Boeing, which resulted in significant interaction between his aircraft students and Boeing engineers who visited his aircraft design class (AE170A) twice last year to work with students on a multi-disciplinary UAV project. Professor Mourtos is also very active in engineering education venues such as ASEE and UICEE (UNESCO International Center for Engineering Education).

B.6 Facilities

Table B.6.1 provides a summary of the laboratory facilities used for instruction in the AE Program. It includes AE laboratories dedicated exclusively to AE courses as well as ME laboratories that serve AE students. The equipment and instrumentation in aerodynamics (E107) and space systems (E236) is excellent, in gas dynamics (E164) is good, and in structures (E164) is minimal.

Table B.6.1 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
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
E133 – Engineering Measurements	ME 120	Good	Good	120	1400	Furman
E137 – Computational Fluid Dynamics	AE169 AE110 AE170A,B	Adequate	Good	40	400	Papadopoulos
E164 - Gas Dynamics	AE164 AE170A,B	Adequate	Adequate	60	1800	Mourtos
E164A – Aerospace Structures	AE114 AE170A,B	Adequate	Adequate	30	800	Yee
E213 – Multimedia Computer Lab	Several AE courses	Excellent	Excellent	150	1600	Agarwal
E215 Computer Lab	All MAE students	Excellent	Excellent	800	1600	Agarwal
E236 Space Engineering	AE 110 AE 170 A,B	Good	Good	25	1318	Papadopoulos
E240 Aircraft Design	AE 170 A,B	Good	Good	15	400	Mourtos
E272 Spacecraft Design	AE 170 A,B	Good	Good	15	1975	Papadopoulos

All labs are furnished with electronic locks to allow students to enter the labs on an as-needed basis. The laboratory support of the AE curriculum is shown in Figure B.6.1.

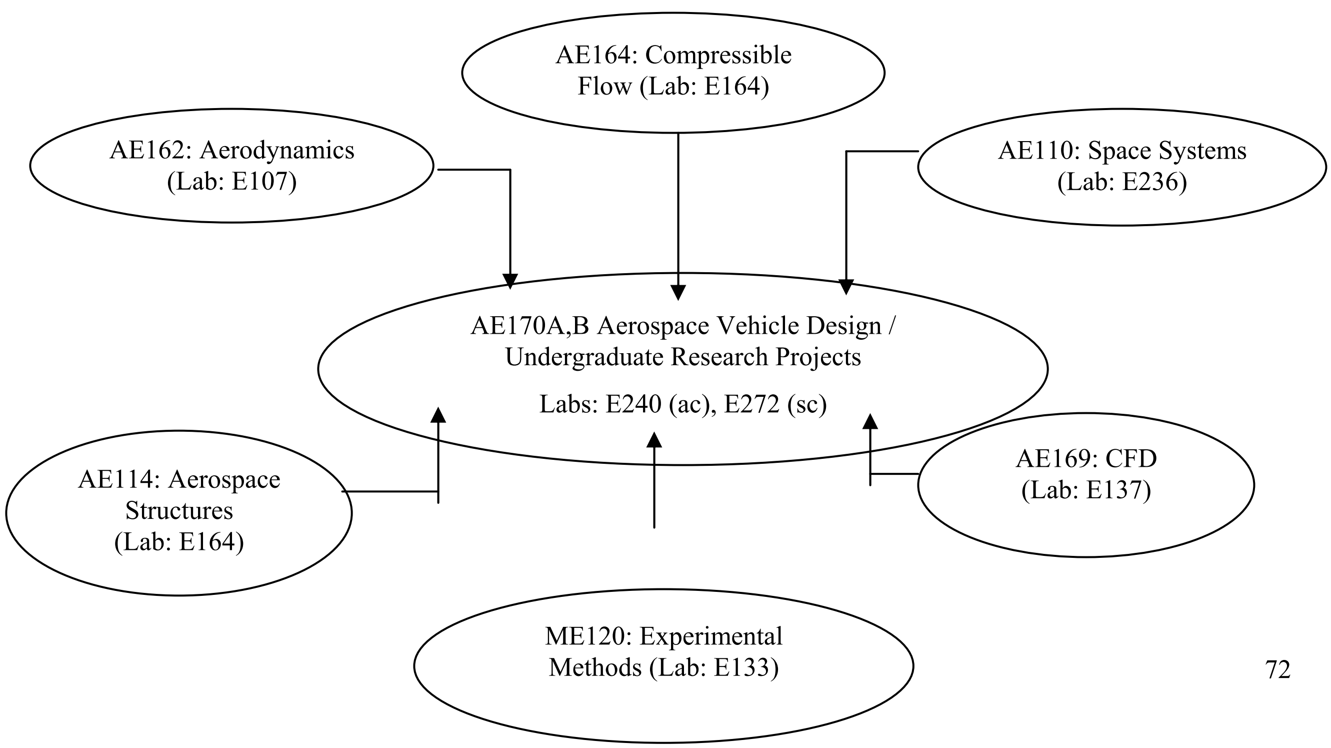

Figure B.6.1 Aerospace Engineering Curriculum Laboratory Support

The MAE Department maintains an AE clubroom that serves as the headquarters for the student chapters of the AIAA and other related student chapters of professional societies. The clubs are invited to maintain their own web pages linked to the Department web page. The AIAA 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.

Sabbatical leave

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.

Reduced teaching load for new faculty members

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.

<u>Co-op Project Course (ENGR 197)</u>

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.

<u>Global Technology Initiative (GTI)</u>

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 Aerospace Engineering Program Criteria

<u>B.8.1 Curriculum Program Criteria</u>

The program specific criteria related to curriculum content are as follows (the courses that cover each topic are shown in parenthesis):

- *Aeronautical Engineering: graduates must demonstrate knowledge of aerodynamics* (required courses: ME111, AE162, AE164, AE170ac), *aerospace materials* (required courses: MatE25, AE114, AE170ac; elective: MatE187), *structures* (required courses: CE99, CE112, AE114, AE170ac; electives: MatE160, CE114), *propulsion* (required courses: AE167, AE170ac), *flight mechanics* (required courses: AE165, AE170ac), *and stability and control* (required courses: AE165, AE170ac; capstone course: AE168).

- *Astronautical Engineering: graduates must demonstrate knowledge of orbital mechanics* (required courses: AE165, AE170sc), *space environment* (required course: AE170sc; elective: AE110), *attitude determination and control* (required courses: AE170sc; electives: AE110, AE168), *telecommunications* (required course: AE170sc; elective: AE110), *space structures* (required courses: AE114, AE170sc; elective: AE110) *and rocket propulsion* (required courses: AE167, AE170sc; elective: AE110).

The program at SJSU is Aerospace Engineering, so our graduates must demonstrate knowledge in one of the two areas (aeronautical or astronautical) and in addition, knowledge of some topics from the area not emphasized.

B.8.2 Senior Design Project

AE programs must demonstrate that their graduates have design competence, which includes integration of aeronautical and astronautical topics. The AE170A&B course sequence satisfies this requirement. AE seniors choose either the aircraft or the spacecraft section of the course. Both sections involve preliminary and detailed design of an aircraft or spacecraft, building and testing of their product, and participation in national professional society design competitions.

B.8.3 Faculty Program Criteria

Program faculty must have responsibility and sufficient authority to define, revise, implement and achieve program objectives.

The AE faculty has formed an AE Advisory Board (see Appendix III-B) that meets twice a year. In the most recent meeting[13], the Board examined the PEO for currency and the BSAE curriculum to ensure it adequately addresses these objectives. The AE faculty is also charged with the responsibility and authority to develop courses and laboratories in support of the PEO.

Program must demonstrate that faculty teaching upper division courses have an understanding of current professional practice in the aerospace industry.

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 undergraduate and graduate student projects, participation in professional societies (AIAA, SAE, ASEE), and publishing.

[13] May 20, 2005.