Program Self-Study Report
For the Degrees of
Bachelors of Science and Masters in

Aerospace Engineering

Submitted by:

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To

The Program Planning Review Committee
San Jose State University,
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A. EXECUTIVE SUMMARY

A1. Degree Titles

San Jose State University awards the following degrees:

- Bachelor of Science in Aerospace Engineering (BSAE)
- Masters of Science in Aerospace Engineering (MSAE)

Students pursuing these degrees may focus in one of the following areas:

- Aircraft Design
- Space Systems
- Space Transportation and Exploration

A2. Contact Information

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A3. Program Planning Review Summary

A3.1 BSAE Program

All constituents (AE Advisory Board, Employers, Alumni, faculty, and students agree that the Program Educational Objectives defined are appropriate. Moreover, input from faculty, graduating seniors, alumni, as well as the AE Advisory Board confirms that the AE Program is currently achieving these objectives. For the Fall 2005 ABET visit the BSAE Program adopted the eleven outcomes from EC 2000 Criterion 3. Based on the data presented in the AE Self-Study Report the AE Program satisfies all outcomes. As a result of our outcomes assessment, several improvements have been implemented in the BSAE curriculum, such as: (a) students design experiments, (b) students design airplanes and spacecraft subject to economic, environmental, social, political, ethical, safety, liability, and manufacturability constraints, (c) team skills are taught and assessed formally, (d) students tackle open-ended problems, (e) students research, present, and discuss in class safety, ethics, and liability issues in AE, (f) students research, present, and discuss in class contemporary engineering applications and their impact in a global and societal context. Although the AE Program was praised for its quality by the ABET evaluator, it did not receive a full six-year accreditation due to insufficient number of faculty. Advising of BSAE students is an issue of concern. AE faculty members are not currently included in the Department's advising team. As a result, some students receive improper advising and some are encouraged to switch majors to ME without ever having an opportunity to discuss their career plans with AE faculty.

A3.2 MSAE Program

The Program Educational Objectives were defined by the faculty and validated by the AE Advisory Board. They were assessed in Fall 2005 through examination of 24 MSAE project/thesis reports from AY 03-04 and 04-05. Although the majority of the reports satisfied all Program Educational Objectives, the results of this assessment revealed that: (a) a large number of reports (21%) were missing (unavailable for assessment), (b) ME faculty members supervise MSAE projects/theses without having the expertise called for in the project, (c) MSAE students are encouraged by the Chair to seek committee members outside the MAE Department despite the fact that AE faculty have the expertise and are willing to supervise their students, and (d) the MSAE Program at Lockheed-Martin is run with virtually no participation by the AE faculty. A fair number of MSAE students receive their degree without ever coming into contact with an AE faculty member through advising, coursework or project/thesis work. The results of these policies have been detrimental to the quality and visibility of the MSAE Program, especially at Lockheed-Martin where the enrollment has dropped from 35 students in 2002 to five in 2006.

A4. Program Planning and Strategies Summary

For the AE Program to reach its full potential requires (a) structural changes in the way the Program is managed and (b) a third faculty member to cover the area of Space Systems (focus area #2 in both BSAE and MSAE). AE faculty needs autonomy and authority in making programmatic decisions, such as planning and promoting their program, student advising, and curricular matters. The AE faculty will explore alternative models of instructional delivery, such as integrating AE courses through projects to engage undergraduate students in research (BSAE), and offering courses online. Moreover, AE faculty will explore the possibility of developing interdisciplinary programs with other majors as well as a concurrent BSAE / MSAE track for qualified students. AE10 will be re-established at the sophomore level as a hands-on course to connect AE sophomores with seniors through participation in national design competitions. At the graduate level, AE faculty will establish curriculum and research in Aircraft Design (including UAVs) and Planetary Entry, Descent, and Landing (EDL) technologies. Although the development of meaningful relationships with local industry (Lockheed-Martin, NASA Ames, Loral) has always been a high priority in the AE Program, currently the AE faculty members are excluded from planning and promoting these relationships. In fact, they are not allowed to teach their MSAE courses or supervise MSAE projects at off campus sites (ex. Lockheed-Martin). Unless these policies change, the AE faculty cannot effectively contribute to the COE goal "to be a preferred partner for applied research and development". The AE faculty will seek opportunities to collaborate with academic institutions and other professional organizations overseas in order to increase student exposure to international engineering practices through participation in exchange programs, design competitions, and conferences.

B. PROGRAM PLANNING REVIEW REPORT

B1. Last Program Planning Review

B1.1 BSAE Program – ABET Final Statement (2006)

B1.1.1 Introduction

The AE Program is administered by the Department of Mechanical and Aerospace Engineering. The mission of the Program is to provide an aerospace engineering education that prepares students with the knowledge, modem applications and lifelong learning skills required to serve the engineering profession and the industry. The Program has 139 undergraduate students with two full-time faculty members, three part-time faculty members, a full-time administrator, and a full-time technician. The services of the administrator and technician are shared with the ME Program. The AE Program has exclusive use of eight (8) instructional laboratories covering nearly 9,500 sq. ft.

B1.1.2 Program Strengths

- Faculty members are dedicated to teaching and improving the quality of classroom and laboratory instruction. A recent journal article written by several faculty members on the subject of teaching engineering problem solving skills indicates the faculty's motivation to continuously improve their educational processes.
- The Department Chair and faculty have been very resourceful in obtaining equipment donations from industry and in securing alternate sources of funding to maintain and upgrade the AE laboratories.
- Morale among faculty, staff and students is very high. There appears to be exceptionally good cooperation between the AE and the ME faculty members in the Department.

B1.1.3 Program Weakness

Criterion 5: Faculty and Criterion 7: Institutional Support and Financial Resources

Competent faculty members cover all curricular areas however teaching loads are very high with the small faculty. The number of faculty members is small relative to the number of students and the overall scope of the program. Little or no margin exists to accommodate faculty member departures, retirements, sabbaticals, or even extended leave situations. Recent attempts by the program to hire an additional full-time faculty member were unsuccessful due to budget cuts. Should this situation persist, the quality and continuity of the program may be compromised.

- Due-process response: The EAC acknowledges receipt of information stating that the College of Engineering will restore the program funding back to the level it was before the 2004 retirement of a the program faculty member, permitting the program to fill the vacant faculty position during the 2006-07 academic year.
- The weakness remains and will be a focus of the next review. In preparation for this review, the EAC anticipates documentation of the completed faculty hiring process, including documentation of the new faculty member's areas of expertise and how the new faculty member complements the existing faculty members to provide the range of expertise needed to cover all the major areas of aerospace engineering.

B1.2 MSAE Program External Review Summary (2003)

The following is an evaluation of the MSAE Programs at San Jose State University. The evaluation will focus upon the following nine elements as and was based upon the Department's self-study report and the evaluator's visit to campus (May 1 and 2, 2003):

A. Mission Statement and Goals
B. Academic Programs
C. Faculty
D. Department Leadership
E. Facilities / Technical and Staff Support
F. Students
G. Industry Connectivity
H. Strategic Planning
I. Continuous Assessment

Tile evaluation concludes with a summary of Program strengths and recommendations for continued improvement.

An obvious caveat is the fact that the evaluation was conducted when significant budgetary constraints were being applied to the CSU system. These constraints obviously have had, and will continue to have a negative impact on the MSAE Program in each of the areas enumerated above. In addition, it will become evident in what follows that I will be discussing issues of which the campus is already aware. In this case, my comments may serve to highlight these issues and possibly expedite their resolution.

B1.2.1 Mission Statement and Goals

An evaluation of any educational program should begin by referring to the program's mission statement and goals and the manner in which they reflect the mission of the College and University. The Mission Statement and Goals are concise and well stated. I note that only the MAE Department Goals mention the importance of preparing students for advanced academic degrees such as the Ph.D. or Doctor of Engineering. This does not derive from any goal in the College list. The omission at the College level should perhaps be addressed.

B1.2.2 Academic Program

Given the Mission and Goals of the Department, one moves next to the more detailed structure provided by the MSAE Program. Here "Program" refers to curriculum and degree requirements and how they support the Department's Mission and Goals. A review of the brief course descriptions given in the Self-Study report suggests well-rounded curricula in the traditional sub-disciplines of aerospace engineering. The nature of the courses is commensurate with the Department Goals. The units required for degree completion correspond to a total of eight (8) three-unit courses, excluding the thesis/project. This is a demanding load. One possible concern is whether courses can be offered with a frequency that can meet the needs of full-time students (realizing, of course, that part-time students constitute the majority in the department).

MSAE students are allowed to take courses outside the Department and have them count towards their degree. This kind of flexibility is beneficial to the students.

Finally, the possibility of a "5 year" BSAE/MSAE Program might be considered. Several departments in the College of Engineering at my institution have adopted such programs. The 5 year BS/MS would have three benefits: (I) the department could encourage the best undergraduates to stay on for the MS degree, (2) the students so enrolled would be full-time, and (3) the program would enhance the integration of undergraduate and graduate studies within the department.

B1.2.3 Faculty

In terms of numbers alone, the size of the full-time faculty would appear appropriate for enrollment, e.g., 281 FTES in the 2002-2003 AY. This number may not be appropriate, however, when one views the number of courses that must be covered and the desirability of offering these with a frequency that would suite full-time students. The teaching load of MAE faculty is considerable, especially when compared to that of Ph.D. granting institutions such as the UC system.

One of the MAE Missions is to contribute to the development and application of knowledge through faculty scholarship. One of the measures of this scholarship is archival publication, an activity that should receive increased importance within the Department. While not arguing for a "publish or perish" environment, increased activity by the MAE faculty in this area would be beneficial. It became obvious during my visit that increased emphasis is being placed upon generating research proposals and extramural funding in the college, a trend that would also argue for increased publication by Department faculty. Encouragement for increased faculty activity in research and scholarly activities must be accompanied by innovative approaches for managing teaching loads.

In interviewing faculty members, I was surprised to learn that there was no set formula or procedure for supporting full-time students with extramural funds. That is, when it was done, it was on an ad hoc basis. This is probably attributable to the fact that the majority of graduate students are employed full time by local industry, and thus support for fulltime students has not been a major concern. With the College's increased emphasis upon extramural funding, this issue should be addressed.

Overall, I found the quality of the MAE faculty to be high, not a surprising finding given the number of advanced degrees that earned at premier national institutions, e.g. MIT, Stanford, UC Berkeley, and Illinois. My interviews with Department members convince me that these were dedicated and energetic individuals. There appeared to be a seamless integration of the individuals devoted to the Mechanical and Aerospace Engineering programs, respectively. While commensurate with enrollment figures, the relatively small size of the faculty devoted to the AE Program was a concern. Adding to this "critical mass" problem is the recent departure of Dr. Pernicka to the University of Missouri-Rolla. A recent attempt to recruit two new faculty members, (one in AE) has been postponed due to the state's budget woes.

B1.2.4 Department Leadership

My interviews with Department faculty, students and staff indicated that Dr. Barez is an exemplary Department Chair. I was singularly impressed with his leadership skills and the obvious time and energy which he devotes to managing the Department. His abilities as an instructor are apparently on a par with his abilities as a manager as he received the "Professor of the Year Award" at the Pi Tau Sigma banquet on Thursday evening. It was my pleasure to attend the banquet as a guest of the Department.

In realizing the importance of faculty scholarship, Dr. Barez has been instrumental in mitigating the impact of the heavy Department teaching load. This has been accomplished through a variety of means, e.g., allowing classes with large enrollments to count as two assignments, and to assign courses in such a manner that only two preparations per semester are required. I also note that Dr. Barez has significantly decreased the Department's reliance on part-time instructors.

I spoke with the Department Graduate Coordinator, Prof. Agarwal about graduate student admissions policies and procedures. The concept of "Classified" and "Conditional" admittance statuses for incoming students is sound. The Graduate Student Survival Guide provided to all incoming students is both informative and concise. My only suggestion in the admissions area might be a requirement that all students take the Graduate Record Exam, rather than just those graduating from non-ABET accredited engineering programs. I suggest this not as a quality-control issue for the admissions process but as an important assessment tool for documenting the capabilities of the students entering the program. Some problems may arise here given the fact that many of the Department's graduate students are working full time in industry and several years may have passed since they completed their baccalaureate degrees.

B1.2.5 Facilities / Technical Support

Facilities are interpreted here as laboratory space and equipment. Dr. Barez gave me a brief tour of the labs on Thursday and the Department appears to have been provided adequate laboratory space. Laboratory equipment was also viewed as adequate, (particularly computers) but could use some updating. A significant amount of the equipment was obtained from industry donations. This is commendable, particularly as budget constraints are likely to force sharply decreased state expenditures for equipment, including computers.

A glaring deficiency is the lack of any technical support for the labs. A recent retirement of a lab technician has left the Department with no support in this area. Given the number of labs involved, it is remarkable that the Department has been able to maintain the facilities in working condition. I understand that the students, themselves, often troubleshoot and maintain some of the equipment. I realize that it is again budget shortfalls that have not allowed this position to be refilled. Nonetheless, I would say it should be a top priority in the College.

Departmental staff support is also a concern. A single staff member serves the entire department. This has obvious repercussions in terms of workload for the staff member involved, the Department faculty, and Department chair. My interview with Trinette Roberts indicated that she is a dedicated and industrious staff member, who has accommodated the increased workload (previously two staff members worked in the department) with patience.

B1.2.6 Students

On Thursday afternoon, I met with approximately ten graduate students in one of the labs. I deliberately did not record any names, as I wanted to ensure the students that their comments would be anonymous. The students expressed concern over the lack of laboratory technicians. Although laboratory equipment was felt to be acceptable, the general physical plant was viewed as being somewhat "run down". Concern was expressed by one full-time graduate student that he/she could not take more than 2 or 3 courses per semester, a fact that was extending his/her time to graduation. Along these lines the students cited the fact that course offerings were determined by minimum enrollment standards and budgetary constraints, and that this has led to difficulties in enrolling in required classes.

I was surprised to learn that quite a number of students left the AE program upon Dr. Pernicka's departure. The students made it clear that this was not due to any dissatisfaction with the remaining AE faculty but rather with the fact that Dr. Pernicka's departure left a definite void in the AE Program.

Students also said that there was little in the way of research associateships or teaching assistantships available in the Department. Finally, the students were very interested in the possibility of a joint Ph.D. program with one of the UC campuses. Many of the students are established in the area, and would very much like to pursue a doctorate without having to move away to another institution.

Lest my comments lead to a picture of negativism on the part of the students let me hasten to add that they had many good things to say about the College and the Department. The flexibility that the MSAE Program allows them in the completion of their degree was viewed as a real plus by the group. The relative simplicity of applying for graduate enrollment was also called out. The support, availability and openness of the faculty merited high praise. The fact that faculty members took the personal initiative to contact industry to obtain software for graduate student use was appreciated. Library facilities were regarded as first-rate by the students, particularly with the new Martin Luther King facility about to open on the edge of campus.

B1.2.7 Industry Connectivity

The Department and, indeed, the entire College of Engineering, have capitalized upon the location of the University and the diverse technology base in the surrounding valley. A prime example is the two Cohort Programs at the Lockheed-Martin Company in each of the Department's graduate programs. At the time of my visit, a new cohort program was in the planning stages. I would also encourage the Department's active participation in the NASA Ames Metropolitan Technology Center, particular as regards to the MSAE Program.

If industry connectivity has a "down-side" it may well be related to the pressure that some industries (particularly the semi-conductor industry) can bring to bear upon academic programs to produce students with rather narrow technical / manufacturing skills that can immediately be utilized by the companies in question. This is probably more of a concern at the undergraduate than at the graduate level. However, I believe it is important for the Department to prepare its MS students for pursuit of the Ph.D. or Doctor of Engineering degrees as well as for industry employment. My conversations with Dr. Barez indicated that he is well aware of this issue.

In my exit interview on Friday morning I mentioned that one challenge facing the Department was that of producing students that could serve the needs of local industry as well as preparing them to pursue doctoral degrees at any institution in the country. This latter attribute is indispensable for the continued national recognition of the College's programs.

The re-establishment of the Department Advisory Council (DAC) should be a high priority. My conversations with Dr. Barez indicated that this was occurring, with a goal of expanding the DAC beyond its original size. Feedback from the DAC is a vital element in assessing the quality of the graduate programs.

B1.2.8 Strategic Planning

The Department Self-Study Report on MSME and MSAE Programs addressed near-term planning for (i) Centrality to Mission, (ii) Quality of Instructional Programs, (iii) Societal Need, (iv) Financial Resource Effectiveness, Viability and Efficiency and (5) Future Outlooks for the Availability of Instructional Alternatives. These plans are focused and layout specific directions for the short term. What may be needed is an overall Strategic Plan that addresses long-term plans and goals. Strategic plans can be instrumental in garnering institutional support for sustenance of existing programs and future growth. Questions typically addressed in such plans are (a) Where do we want the graduate programs to be in five to ten years? (b) What programs can we identify that can serve as models? (c) What new research / educational areas should we pursue? (d) What will it take to move into the top ten programs in the country?

B1.2.9 Continuing Assessment

The Department Self-Study Report also addressed the issue of continuing assessment of the graduate programs. This was done in light of the ABET EC2000 philosophy for evaluating undergraduate programs. This near-term plan for assessing the Department's graduate programs is sound. To the list of five actions outlined on p. II of that report I would probably add (i) requiring Graduate Record Exams for students applying for admission and (ii) determining the number of MS graduates that go on to immediate Ph.D. programs at other institutions.

I would caution against making the graduate assessment procedure too formalized. Significant Department resources are undoubtedly already being directed toward assessment of the undergraduate programs. Attempting to bring these assessment tools into the graduate realm can easily overburden an already understaffed Department. One might consider a reduced set of assessment procedures such as (i) tracking

GRE scores over a period of time to detect any changes in the level of preparation of incoming students, (ii) seeking faculty input on the overall quality of the theses and projects the students are completing, and (3) tracking Ph.D. enrollment of MS students.

Program strengths:

- Well-rounded academic programs, with students highly valued by industry
- Excellent departmental leadership
- Highly qualified and energetic faculty, clearly devoted to the programs
- Good student / faculty relationship
- A unique and viable cohort program with Lockheed Martin Company
- Excellent industrial support

Recommendations for improving Program:

- Establish technical support for Department labs
- Increase staff support for Department office
- Increase journal publication activity on the part of the faculty
- Increase research proposal activity on the part of faculty
- Increase faculty complement in AE, e.g., a replacement for Dr. Pernicka
- Develop plan for support of full-time graduate students, e.g., research associateships
- Develop Strategic Plan

Obviously, a number of these recommendations address issues related to budgetary constraints beyond the direct control of the Department.

B1.3 Actions to Correct Previous Weaknesses

Faculty morale and cooperation among the AE and ME Faculty

The statement made by the ABET evaluator (section B1.1.2) regarding the high morale of the faculty and the "exceptionally good cooperation between the AE and the ME faculty members" is inaccurate. The cooperation between the AE and the ME faculty was indeed very good for several years following the merger of the AE Department with the ME Department in 1996. However, in the last four years tensions have risen between the two faculty due to inability to resolve important issues for the AE Program, such as BSAE and MSAE student advising, supervision of MSAE projects/theses, participation of AE faculty in the Lockheed-Martin MSAE Program, the quality of teaching in AE courses taught by part-time faculty, the distribution of resources between the AE and the ME Programs, and the Coordination of the AE Program in general. In addition, several ME faculty have made negative comments regarding the AE Program during Department meetings. Hence the morale of the AE faculty is currently very low.

Teaching loads / Reliance on part-time instructors

Both external evaluators (MSAE / 2003, ABET / 2005) pointed out that the teaching loads for the AE faculty were high (sections B1.1.3 and B1.2.3). This continues to be the case due to the 12 WTU (four-course) teaching load in the CSU system but also due to the need for two faculty members to cover all the core BSAE courses as well as several MSAE courses each. The statement made by the MSAE evaluator (section B1.2.4) that "Dr. Barez has been instrumental in mitigating the impact of the heavy Department teaching load…by allowing classes with large enrollments to count as two assignments, and to assign courses in such a manner that only two preparations per semester" is true only for the ME faculty. AE courses do not have enrollments high enough (50+ students) to count as 6 WTU. AE faculty could opt, of course, to teach ME courses with large enrollments (ex. ME111) and decrease their number of preparations to three per semester. However, this option would mean that several AE core courses would be taught by part-time instructors. AE faculty has chosen the higher number of course preparations per semester in an effort to cover as many AE courses as possible. Despite their effort, however, a very large percentage of

AE courses, especially at the graduate level, are taught by part-time instructors. The statement made by the MSAE evaluator (section B1.2.4) that "Dr. Barez has significantly decreased the Department's reliance on part-time instructors" is inaccurate.

Number of tenured / tenure-track AE faculty

Both external evaluators raised concerns (MSAE / 2003, ABET / 2005) about the small number of AE faculty members relative to the number of students and the overall scope of the Program (sections B1.1.3 and B1.2.3). Considering that AE student enrolment has risen significantly (~220 in AY 05-06) since these observations were made, the situation is much worse today. In fact, this is the third AY after the retirement of a senior AE faulty member and the MAE Department has not yet hired a replacement. Following a successful search in AY 04-05 the Department failed to hire an AE faculty member recommended by the Search Committee and approved by the Department faculty. Although budget cuts were cited as the main reason for not hiring, lack of commitment in supporting the AE Program was a major factor in the decision. This lack of commitment became obvious at our last Department meeting on Tuesday, May 16, 2006, when it was announced that the consensus among the ME faculty (about hiring an AE faculty member) had changed and we should, therefore, re-evaluate our needs as a Department. It was suggested to consider the possibility of hiring a faculty member in Mechatronics or Design instead of an AE faculty member, despite (a) the recommendation by the AE ABET evaluator, and (b) the fact that the Mechatronics and the Design options of the ME Program are currently supported by four and five faculty members respectively, while the AE Program with two degrees (BSAE and MSAE) is supported by only two faculty members.

The MSAE evaluator commented on the large number of students who left the Program upon Dr. Pernicka's Departure in 2001. Dr. Pernicka was replaced by Dr. Papadopoulos; however, Dr. Desautel retired in 2004, leaving the Program again with only two faculty members. Although student enrollment has been increasing, it is the belief of the AE faculty that the delay in hiring a replacement for Dr. Desautel has slowed down the growth of the AE Program. The Department has now agreed to hire a 3rd AE faculty member, although the position is now limited to the Assistant Professor level (it was Assistant or Associate Professor in the search during AY 04-05). A new Assistant Professor with proper expertise (Space Systems / Satellite Design) would, of course, satisfy the needs of the AE Program. However, based on the small number of applicants in the past two searches, the AE faculty are concerned that we limit our options and may not be able to find qualified candidates. Moreover, as of the time this report is being written, the faculty position has not yet been advertised.

Facilities / Technical Support

The deficiency pointed out by the MSAE evaluator remains to a large extent, despite the fact that the Department has since hired a capable lab technician. Considering the number of Department labs (both programs emphasize hands-on education) as well as their mix (physical experiments, computer hardware / software) he simply cannot effectively maintain all of them. Department office staff support also remains a concern, not only because a single staff member serves the entire Department but also because of inefficiencies in operations.

Technical Publications

Technical publications have increased significantly in the last five years, primarily due to the contributions of Dr. Papadopoulos and his successful mentoring of MSAE students. Following examples at other institutions, AE faculty now encourage all MSAE students to write their final reports in a conference / journal paper format and present their work in professional conferences (AIAA, SAE-Aerospace). To facilitate increased productivity in this area, students need to spend more time on their research projects. Hence, students are encouraged to start a research project in any graduate course and continue their work in AE295 or AE299 courses (MS project and thesis respectively).

B2. Program Planning Overview

B2.1 Assessment Life-Cycle Processes

B2.1.1 BSAE Program

The BSAE Program is accredited by the American Board for Engineering and Technology (ABET) based on eight Engineering Criteria [ref. 1]. Two new criteria introduced in 2000 are: Criterion 2, Program Educational Objectives (PEO) and Criterion 3, Program Outcomes (PO). Program Educational Objectives are defined with input from all program constituents and describe the expected accomplishments of graduates during the first several years following graduation [ref. 2]. Program Outcomes, on the other hand, describe what students are expected to know or be able to do by the time of graduation from the program. A systematic process must be in place to assess the achievement of both the PO – before students graduate – and the PEO – after graduates leave the program. This process needs to be ongoing to ensure the continuous improvement of each program [ref. 3].

BSAE Program Educational Objectives

The process of definition and assessment of the PEO is illustrated in Figure 1.

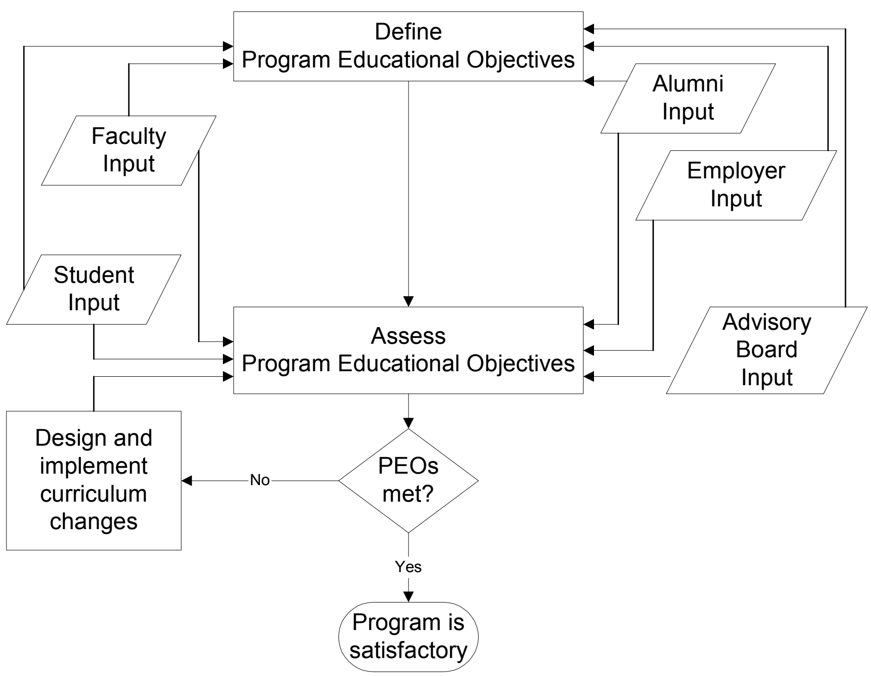

Figure 1 **BSAE and MSAE Program Educational Objectives definition and assessment process.**

Table 1 shows the various measures used to establish as well as to assess achievement of the PEO. Input from students, faculty, alumni, employers, as well as the AE Advisory Board led to the PEO shown in Table 2, which reflect the expectations of our constituents.

Table 1 Measures used for PEO assessment

	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	✓	✓	✓			✓	✓

Table 2 BSAE Program Educational Objectives

	BSAE graduates must 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.

BSAE Program Outcomes

ABET Criterion 3 [ref. 1] requires engineering programs seeking accreditation to demonstrate that their graduates have:
(a) An ability to apply knowledge of mathematics, science, and engineering.
(b) An ability to design and conduct experiments, as well as to analyze and interpret data.
(c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.
(d) An ability to function on multi-disciplinary teams.
(e) An ability to identify, formulate, and solve engineering problems.
(f) An understanding of professional and ethical responsibility.
(g) An ability to communicate effectively.
(h) The broad education necessary to understand the impact of engineering solutions in a global and societal context.
(i) A recognition of the need for, and an ability to engage in life-long learning.
(j) A knowledge of contemporary issues.
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

ABET encourages engineering schools to expand / reword each outcome, combine outcomes, and write additional outcomes as needed to reflect specific strengths of their programs. Thus, the AE Program faculty has adopted the following outcomes for the next assessment cycle (2005-2011):

(A) Ability to use mathematics, science, and engineering principles to identify, formulate, and solve aerospace engineering problems.

(B) Ability to design and conduct water tunnel, wind tunnel, and shock tunnel experiments, as well as to analyze and interpret data from such experiments.
(C) Ability to perform conceptual and preliminary design of aircraft or spacecraft to meet a set of mission requirements within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
(D) Ability to collaborate with people from different cultures, abilities, backgrounds, and disciplines to complete aerospace engineering projects.
(E) Ability to communicate effectively through technical reports, memos, and oral presentations as well as in small group settings.
(F) Understanding of professional and ethical responsibility.
(G) Broad education to understand current events, how they relate to aerospace engineering, as well as the impact of engineering solutions in a global and societal context.
(H) Recognition of the need for, and ability to engage in life-long learning.
(I) Ability to use the techniques, skills, and modern engineering tools (analytical, experimental, and computational) necessary for engineering practice.

Figure 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 BSAE 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 BSAE 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, outcome attributes have been defined, 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 courses. [Note: This numerical target will be replaced by more outcome-specific performance targets as AE faculty members develop rubrics to measure more accurately the skills described in each outcome.]
(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.

Each course contributes to at least one outcome. Hence, a particular outcome is addressed in several courses. Nevertheless, a subset of these courses is selected for assessment purposes, using the following requirements:

- Each outcome should be assessed in several courses to ensure that students acquire an appropriate level of breadth and depth in the skills of this outcome.
- The number of courses assessed for each outcome should be kept low to minimize faculty workload.
- ABET requires that all graduates have the skills described in all outcomes. As a result, elective courses alone cannot be used to make a case that a program meets a particular outcome.

- A large number of engineering students transfer to SJSU from community colleges in their junior year. Since we do not receive assessment data from these colleges freshman and sophomore courses are excluded for program assessment purposes.

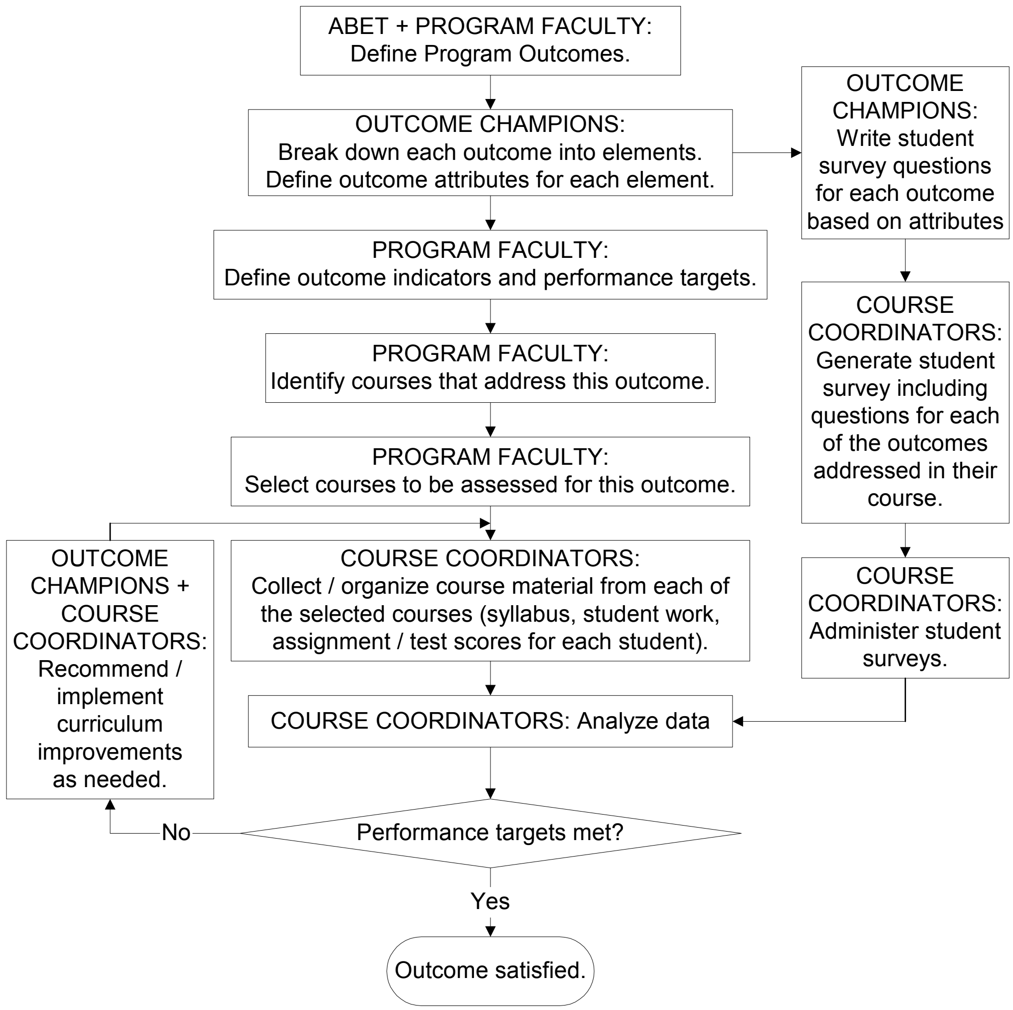

Figure 2 Program Outcome assessment process

Table 3 shows the courses selected for assessment and the outcomes addressed in each course. For each of these courses, the course coordinator must show evidence that the course includes the necessary elements to satisfy a particular outcome and collect / analyze data to show that performance targets are met. Moreover, for each outcome there is a designated outcome champion. Champions validate the evidence presented by course coordinators for individual courses and have the final word on whether the performance of a program is satisfactory with regards to their outcome. They meet with course coordinators and instructors, discuss their findings and make recommendations for course improvements. Outcome champions provide an additional level of accountability and ensure consistency in the process.

Table 3 BSAE Program – Outcome Matrix

	Outcomes								
	3A	3B	3C	3D	3E	3F	3G	3H	3I
AE162	+++	+++	++	+++	+++		++	+++	+++
AE164	++	+++		+++	+++		++	+++	+++
AE167	++			++			++	++	

AE171A AE172A	✓		+++	+++	+++	+++	+++	+++	+++
AE171B AE172B	✓		+++	+++	+++	+++	+++	+++	+++

+++ represents levels 5 and 6 in Bloom's Taxonomy.
++ represents levels 3 and 4 in Bloom's Taxonomy.
✓ Outcome is addressed but not assessed in this course.

B2.1.2 MSAE Program

MSAE Program Educational Objectives (MSAE – PEO)

The process of definition and assessment of the MSAE – PEO is illustrated in Figure 1. The PEO for the MSAE Program reflect our constituents' expectations that our graduates should have:

(1) A strong foundation beyond the undergraduate level in their chosen focus area as well as in mathematics, basic science and engineering fundamentals, to successfully compete for technical engineering positions in the local, national and global engineering market, advance in their current position or pursue doctoral studies.
(2) Contemporary professional and lifelong learning skills to be able to apply theory to solve practical aerospace engineering problems.
(3) Provide students with the expertise necessary to work in the analysis and design of aerospace engineering systems with possible specialization in areas such as:
- Aircraft Design
- Space Systems
- Space Transportation and Exploration

(4) Strong verbal and written communication skills, including the ability to write engineering reports.
(5) The ability to perform research and work independently to solve open-ended problems in aerospace engineering.

The criteria used to evaluate each report are shown in Table 4.

Table 4 Criteria used to evaluate MSAE project / thesis reports

Project / Thesis Title			
Student Name			
Faculty Advisor			
Focus Area			
PEO addressed			Max = 5
1	1	Application of mathematics appropriate for graduate level	
1	2	Application of science appropriate for graduate level	
1	3	Application of engineering fundamentals appropriate for graduate level	
2	4	Use of modern tools (computational or experimental)	
2	5	Appropriate literature search (# and appropriateness of references cited)	
2	6	Understanding of the cited literature (summary of previous work)	
2	7	Understanding of the work performed in the project	
3	8	In-depth analysis and / or design of an AE system	
4	9	Correct language and terminology	
4	10	Abstract, ability to summarize, draw conclusions	
4	11	Appropriate use of graphs and tables	
5	12	Clear objectives (problem definition)	
5	13	Appropriate assumptions / modeling of the problem	

Total Score (L=13-25, W=26-38, A=39-49, G=50-59, E=60-65) L = Lacking, W = Weak, A = Acceptable, G = Good, E = Excellent Max Possible Score = 65	

B2.2 Assessment Life-Cycle Matrix

B2.2.1 BSAE Program

ABET accreditation visits occur every six years. The BSAE – PEO are revisited every three years to ensure that they continue to reflect current industrial trends. AE Advisory Board members rate the PEO in terms of their importance to the AE industry and assess how well the current BSAE curriculum addresses these PEO. Outcomes are assessed on a three-year cycle, as shown in Table 5. Each semester two outcomes are assessed. Thus, it takes five years to complete the assessment of all nine outcomes (including the preparation of the self-study report).

Table 5 Timetable for outcomes assessment

	Outcomes								
	3A	3B	3C	3D	3E	3F	3G	3H	3I
Spring 06	X					X			
Fall 06		X					X		
Spring 07			X					X	
Fall 07				X					X
Spring 08					X				
Fall 08						X			
Spring 09	X						X		
Fall 09		X						X	
Spring 10			X						X
Fall 10				X	X				
Spring 11	Finalize Self-Study Reports								
Fall 11	ABET VISIT								

B2.2.2 MSAE Program

The MSAE – PEO are revisited every three years to ensure that they continue to reflect current industrial trends. As with the BSAE Program, the members of the AE Advisory Board rate the MSAE – PEO in terms of their importance to the AE industry and assess how well the current MSAE curriculum addresses them. The MSAE – PEO are assessed directly through student project / thesis reports every semester.

B3 Students

B3.1 Student Enrollment for the Last Five Years and Projection

Table 6 summarizes student enrollment in the BSAE and MSAE programs from 2001 – 2006. Considering the current demand for AE graduates the enrollment is expected to grow.

Table 6 BSAE and MSAE enrollment

Fall Enrollment	BSAE	MSAE	Total
2001	138	13	151
2002	147	17	164
2003	148	19	167
2004	139	16	155
2005	139	21	160
2006	179	24	203

B3.2 Student Sources

B3.2.1 Direct Entry

Table 7 shows a breakdown of new student enrollments in the last five years with first-time freshmen (column 2), transfer (column 3), and graduate students (column 5). First-time freshmen average 32 students in the last three years, transfer students average 23, and graduate entries average 9 in the same period, for a total of 64 new students per year.

Table 7 New student enrollments: FTF, transfer, graduate

AY	FTF	Transfer	*Total Undergraduate*	Graduate	**AE Total**
2001 – 2002	30	19	*49*	2	**51**
2002 – 2003	46	17	*63*	9	**72**
2003 – 2004	31	21	*52*	7	**59**
2004 – 2005	33	24	*57*	12	**69**
2005 – 2006	32	23	*55*	9	**64**

B3.2.2 Process for Acceptance of New Students

Admission into the BSAE Program

First-time freshmen applicants qualify for regular admission if they meet the following requirements:

- Have graduated from high school, earned a Certificate of General Education Development (GED) or passed the California High School Proficiency Examination; and
- Have a minimum eligibility index (the eligibility index is the combination of high school grade point average and score on either the ACT or the SAT (Eligibility Index Table is available in the SJSU catalog on page 438), and
- Have completed with grades of C or better each of the courses in the comprehensive pattern of college preparatory subject requirements.

Transfer students who have completed fewer than 60 transferable semester college units are considered lower division transfer students. Students who have completed 60 or more transferable semester college units are considered upper division transfer students.

Generally, applicants qualify for admission as lower division transfer students if they have a grade point average of at least 2.0 (C or better) in all transferable units attempted, are in good standing at the last college or university attended, and meet any of the following standards:

- Freshman admission requirements (grade point average and subject requirements) in effect for the term in which they are applying; or
- Were eligible as freshmen at the time of high school graduation except for the subject requirements, and have been in continuous attendance in an accredited college since high school graduation, and have made up the missing subjects.

Generally, applicants qualify for admission as upper division transfer students if they meet the following requirements:

- They have a grade point average of at least 2.0 (C or better) in all transferable units attempted; <u>and</u>
- They are in good standing at the last college or university attended; <u>and</u>
- They have completed at least 30 semester units of college coursework with a grade of C or better in each course to be selected from courses in English, arts, humanities, social science, science, and mathematics at a level at least equivalent to courses that meet general education requirements.

Admission into the MSAE Program

Students who desire to pursue an MSAE degree must satisfy each of the following requirements:

- Must hold a BSAE degree from an Accreditation Board of Engineering and Technology (ABET) accredited AE Program or equivalent. Special programs can be developed for those with degrees from other related disciplines. These programs must be approved by the Department Graduate Curriculum Committee.
- A minimum grade point average (GPA) of 3.0 on a 4.0 scale over the last 60 semester units completed in engineering and/or science. Conditional admittance may be granted for grade point averages between 2.5 and 3.0.
- Students from non-ABET accredited engineering programs and international universities must have obtained 1200 or more for the sum of verbal, quantitative, and analytic scores on the Graduate Record Examination (GRE). Scores for each section must also be 400 or greater. Special consideration may be given when the verbal score is below 400 but TOEFL score is above 600.
- The university admission requires that the students from non-English speaking countries must achieve a minimum TOEFL score of 550. This requirement is waived if the language of instruction at the home country is documented to be in English.

B3.2.3 Internal Transfer Students

Table 8 shows the number of students who transferred to the AE Program from other majors during the period from Fall 2001 to Spring 2005.

Table 8 Transfers to the AE Program (Fall 2001 – Spring 2005)

From	
Aviation	7
Computer Engineering	6
Computer Science	4
Electrical Engineering	7
General Engineering	4
Mechanical Engineering	4
Undeclared	9
Other majors	10
Total transfers to AE	**51**

B3.3 Program Orientation for New Students

B3.3.1 New BSAE Students

New undergraduate students entering the BSAE Program are given a brief orientation and initial advising by the Chair or available Department academic advisors. Information given to new students typically includes the AE Program layout and course prerequisite requirement. Transfer students make up a significant share of the Program's undergraduate students (approximately 38% in the last five years). Therefore, procedures for handling transfers are formalized and systematic. Upon entry transfer students meet with the Department Chair or an academic advisor for orientation and initial evaluation of academic progress. A selection of courses for the first term at SJSU is also developed.

B3.3.2 New MSAE Students

New graduate students entering the MSAE Program are given a brief orientation and initial advising by the Graduate Program Coordinator or the Department Chair.

B3.4 Advising

B3.4.1 Undergraduate Advising

ABET EC 2000 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.

Continuing BSAE 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. The Dean's office staff verifies the accuracy and completeness of the forms before forwarding them to the Records Office.

All transfer courses must have course equivalencies completed before approval of a transfer student's Major Form. The vast majority of transfer courses are from California institutions and most are pre-approved by the Articulation Office of the University. A course without pre-approved articulation is evaluated on an individual basis by the SJSU course coordinator in the department that offers the course. Unique situations involving credit from universities outside the US have an additional requirement that they be evaluated for an appropriate level of units by the university.

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. The SJSU Records Office ensures that all students in the Program fulfill the University General Education requirements. Students are required to consult with General Education advisors at the Assessment Center in the Office of Admissions and Records.

The College of Engineering has two college-level student advising and supporting units: Engineering Student Advising Center and MESA Engineering Program. The Engineering Advising Center was established in Spring 2005 and provides the following services to all engineering students: General Education advising, monitoring and advising of students under probation, study skills workshops, and new student advising. The goal of the MESA Engineering Program is to increase the number of competent and qualified graduates entering the engineering profession from groups with low eligibility rates in college admissions. The program provides the following services: a Student Study Center, Academic Excellence Workshops, professional development workshops, freshmen orientation, career advising, and support to student organizations.

The university Academic Services provides academic advising and support to all SJSU students. The Learning Assistance Resource Center (LARC, www.sjsu.edu/larc) and Student Advising Center are the two main services units in the Academic Services.

LARC offers a variety of services to registered SJSU students, including:

- Individual or group tutoring
- Assistance in building writing skills
- Assistance in lower and upper division mathematics classes
- Skills improvement Seminars
- Group study/Adjunct classes in specific courses
- CBEST and WST test preparation
- Support in basic computer skills

The Student Advising Center offers a variety of services including:

- Drop-in advising on General Education requirements, undeclared advising, ELM/EPT placement, late add and drop processes, academic probation, and disqualification.
- Assistance with Academic Advising Reports and selecting General Education courses
- Group advising sessions
- Graduate school planning
- Seminars/workshops on specific topics, e.g., General Education, academic planning, study skills, choosing a major, probation/disqualification

B3.4.2 Graduate Advising

For the graduate program, the Admissions and Records Office of the University processes all applications for admission to the MSAE Program with the input from the MAE Graduate Coordinator. The Graduate Coordinator is responsible for advising all admitted students on MSAE Program requirements, the selection of courses, the preparation of theses/projects, etc. Each student is advised twice a year (once every semester) either in person or via email.

Each graduate student is provided with a MSAE program graduate course offering schedule and a Graduate Student Survival Guide. Students are advised to take Writing Skill Test (WST) during their first semester in the Program. They are also advised to complete the University Competency in Written English requirement during their first year at SJSU.

B3.5 Monitoring Student Performance

Undergraduate 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 an accumulative checklist in the student's advising folder and the Major Form filed, normally, 15 months prior to graduation.

Graduate student performance is monitored by the department graduate Program Advisor who receives a .2 release time for advising graduate students. The graduate advisor is responsible for making decision for admission, processing all the paperwork related to the program, along with monitoring students' performance until their completion of the program. Students are not allowed to register for classes without going through advising and evaluation of their performance every semester. A permanent record of students' current and past coursework and performance is kept by the advisor.

B3.6 Process to Ensure All Students Meet All Program Requirements

BSAE Students

To ensure that undergraduate students have a good grasp of fundamental concepts that serve as the basis for more advanced design and analysis courses, they are required to earn a minimum grade of "C" in key communication and mathematics courses (English 1A and 1B, Technical Writing E100W, Oral Communication, Math 30, 31, and 32), a minimum grade of "C-" in science courses (Chemistry 1A, Physics 50, 51, and 52 or 70 and 71) and in key engineering courses (CE112, ME101, ME111, ME113, ME130). 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.

MSAE Students

The graduate advisor is responsible for ensuring that all graduate students satisfy program requirements. Several forms and booklets are made available to students, which outline the requirements for successfully completing the MSAE program. An Advising Form, which students are require to complete before their hold is cleared, lists students' completed coursework with the grades obtained, along with the list of courses currently in progress and planned for next semester. Students present this form to their advisor, who monitors their performance and approves the courses.

B3.7 Problems with Current Advising Procedures

The AE faculty has identified the following problems in regards to AE student advising by the Department Advising Team, which includes the Department Chair.

- Although AE faculty members have served on the MAE Department Advising Team in the past, recent requests to include an AE faculty member on the Team have been ignored. Hence, BSAE and MSAE students are currently advised by ME faculty and a staff member, who do not have a good understanding of the AE field and the AE curriculum.
- BSAE students are often advised incorrectly. As a result, they are sometimes unable to take AE170A and B in their senior year. The Department has not taken responsibility for giving them incorrect information during advising nor provided options to correct the errors. This has resulted in AE student dissatisfaction with the Department and delayed graduations.

- MSAE students are often advised incorrectly. In several cases, students admitted into the MSAE Program with non-BSAE degrees were not advised to take the core BSAE courses.
- Many MSAE students are advised to seek project / thesis committee members outside the Department and their projects are supervised by the Department Chair who has no expertise in AE.
- AE students are advised out of AE and into ME before they have an opportunity to consult with an AE faculty member, who understands the AE field. This practice has decreased MSAE student enrollment at the Lockheed-Martin Program from 35 in 2002 to a mere five (5) students in 2006.

Advising involves more than checking the list of courses a student plans to take next semester. Quality advising involves student mentoring in areas such as career options, projects, as well as electives that support these options/projects. Hence, AE faculty are the most qualified to advise AE students. The AE faculty has requested that all AE students be advised by an AE faculty member, preferably the AE Coordinator. Moreover they have requested that a policy be established to require students from either major to see an advisor from their own field before changing majors. However, our request has not been granted.

B4 Program Educational Objectives (PEO)

B4.1 Constituencies

The AE Program has identified the following as its constituents:
- AE and ME students (the latter take AE courses as electives)
- AE Faculty
- Alumni of the BSAE and MSAE programs
- Employers of the AE program graduates
- The AE Advisory Board

B4.2 BSAE Program Educational Objectives Assessment

The AE Program has been developed to be consistent with the mission of SJSU, the College of Engineering (COE), and the Department of Mechanical and Aerospace Engineering (see Appendix A). The BSAE Program 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.

In Spring of 2003, the BSAE Program Educational Objectives were revised to conform to the new ABET definition, namely that Program Educational Objectives reflect the career and professional accomplishments of our graduates during the first several years after graduation (Table 2).

B4.2.1 Achievement of BSAE Program Educational Objectives

The BSAE Program Educational Objectives are achieved primarily through the BSAE Program curriculum, which is designed to emphasize problem solving, design skills and experiential learning. 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), ΣΓΤ (Aerospace Engineering Honorary Society), 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).

B4.2.2 Relationship between Program Educational Objectives and Program Outcomes

The BSAE Program Educational Objectives are linked to the 11 Program Outcomes specified by ABET EC 2000, Criterion 3 as shown in Table 9.

Table 9 BSAE Program Educational Objectives vs. 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 BSAE Program Educational Objectives is through the assessment of the BSAE Program Outcomes. This assessment is presented in section B.

B4.2.3 Faculty Assessment of the BSAE Program Educational Objectives

Two department meetings (April 5 and April 12, 2005) were dedicated to the assessment of the BSAE Program Educational Objectives by the faculty. Each PEO was presented and faculty were asked to share their opinion on how well our students meet this 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 10.

Table 10 Faculty assessment of BSAE Program Educational Objectives

	Average	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11
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.

B4.2.4 Exit Interviews

Twenty-four (24) graduating seniors were interviewed (Fall 2003 through Spring 2005). The three open-ended questions 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.

Question 2: Do you feel that our BSAE 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).

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

Positive comments:
- 25% (6) indicated that AE was a very exciting educational experience.
- 13% (3) said they enjoyed a close relationship with AE faculty members.

Negative comments:
- 17% (4) indicated that the equipment in some of the labs is old and does not function properly.

Finally, the more common suggestions were to:
- 17% (4) hire more AE faculty.
- 13% (3) add an undergraduate Computational Fluid Dynamics (CFD) course because employers require it in many cases.

B4.2.5 Employment Data

Twenty (20) alumni surveys were 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).

Table 11 BSAE 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

B4.2.6 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. One student has completed his Ph.D. degree in AE (Iowa SU, 2000) and is now an Aerospace Engineering professor at West Virginia University.

B4.2.7 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 12 shows a summary of their responses. 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% (10).

Table 12 Summary of alumni responses (N = 19)

		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*	15	1	3

	choices inherent in the engineering profession to provide for issues such as public safety, honest product marketing, and respect for intellectual property.			
4-2	An understanding of the ethical choices inherent in the engineering profession to provide for issues such as public safety, honest product marketing, and respect for intellectual property *is important* for the kind of work I do.	18	1	

B4.2.8 Employer Surveys

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

B4.2.9 Advisory Board Input

Advisory Board members have been carefully selected from industry to represent all levels of experience and practice (Appendix H). The Board convened for a full day 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 BSAE curriculum and if not, make recommendations for improvements. The results of their input are summarized in Tables 13 – 14.

Table 13 BSAE – 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 14 BSAE – PEO assessment 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.

B4.3 MSAE Program Educational Objectives Assessment

The MSAE Program Educational Objectives have been assessed through (a) Advisory Board input and (b) evaluation of MSAE project and thesis reports.

B4.3.1 Advisory Board Input

The Board convened for a full day 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 MSAE curriculum and if not, make recommendations for improvements. The input of the Board members is summarized in tables 15 – 16.

Table 15 MSAE – PEO importance rating by the AE Advisory Board

	Average	BM1	BM2	BM3	BM4	BM5
PEO 1	***4.0***	5	4	3	4	4
PEO 2	***3.6***	4	3	4	4	3
PEO 3	***4.2***	4	4	4	4	5
PEO 4	***4.6***	5	5	5	4	4
PEO 5	***4.9***	5	5	5	4.5	5

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 16 MSAE – PEO assessment by the AE Advisory Board

	Average	BM1	BM2	BM3	BM4	BM5
PEO 1	***4.0***	4	4	4	4	4
PEO 2	***3.2***	3	3	3	3	4
PEO 3	***4.8***	5	5	5	4	5
PEO 4	***5.0***	5	5	5	5	5
PEO 5	***5.0***	5	5	5	5	5

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

The response of the AE Advisory Board was almost unanimous that all five PEO are important (Table 15) addressed well through the MSAE curriculum (Table 16).

B4.3.2 Evaluation of Student Project and Thesis Reports

MSAE project / thesis reports are evaluated using the criteria shown in Table 4. Each PEO has been analyzed into several elements (skills) described by the numbered statements in the table. MSAE students are expected to demonstrate a minimum level of competence, represented by a score of three (3), in each of these skills. Twenty four (24) MSAE students graduated in AY 2003-2004 and 2004-2005. Of the 24 reports, nineteen (19) were evaluated using the form in table 17 and five (5) reports were missing. The assessment results are summarized in Table 17.

Table 17 MSAE Thesis / Project evaluation summary

PEO			Score
1	1	Application of mathematics appropriate for graduate level 3 (16%) did not meet this objective 16 (84%) met this objective	1=2 reports 2=1 3=2 4=5 5=9
1	2	Application of science appropriate for graduate level 1 (5%) did not meet this objective 18 (95%) met this objective	1=0 reports 2=1 3=3 4=3 5=12

1	3	Application of engineering fundamentals appropriate for graduate level 1 (5%) did not meet this objective 18 (95%) met this objective	1=1 reports 2=0 3=2 4=3 5=13
2	4	Use of modern tools (computational or experimental) 2 (11%) did not meet this objective 17 (89%) met this objective	1=2 reports 2=0 3=3 4=7 5=7
2	5	Appropriate literature search (# and appropriateness of references cited) 4 (21%) did not meet this objective 15 (79%) met this objective	1=3 reports 2=1 3=1 4=3 5=11
2	6	Understanding of the cited literature (summary of previous work) 2 (11%) did not meet this objective 17 (89%) met this objective	1=2 reports 2=0 3=2 4=4 5=11
2	7	Understanding of the work performed in the project 0 (0%) did not meet this objective 19 (100%) met this objective	1=0 reports 2=0 3=2 4=2 5=15
3	8	In-depth analysis and / or design of an AE system 3 (16%) did not meet this objective 16 (84%) met this objective	1=2 reports 2=1 3=6 4=6 5=4
4	9	Correct language and terminology 0 (0%) did not meet this objective 19 (100%) met this objective	1=0 reports 2=0 3=1 4=1 5=17
4	10	Abstract, ability to summarize, draw conclusions 0 (0%) did not meet this objective 19 (100%) met this objective	1=0 reports 2=0 3=1 4=1 5=17
4	11	Appropriate use of graphs and tables 2 (11%) did not meet this objective 17 (89%) met this objective	1=2 reports 2=0 3=1 4=5 5=11
5	12	Clear objectives (problem definition) 0 (0%) did not meet this objective 19 (100%) met this objective	1=0 reports 2=0 3=1 4=3 5=15
5	13	Appropriate assumptions / modeling of the problem 1 (5%) did not meet this objective 18 (95%) met this objective	1=0 reports 2=1 3=0 4=4 5=14

Total Score (L=13-25, W=26-38, A=39-49, G=50-59, E=60-65) L = Lacking, W = Weak, A = Acceptable, G = Good, E = Excellent Max Possible Score = 65	L=0 reports W=1 A=2 G=5 E=11

B5 Program Outcomes (PO) and Assessment

B5.1 Curriculum and Professional Component

B5.1.1 BSAE Curriculum Design and Content

Senior Design Project (Aircraft or Spacecraft): AE 171A, B or AE172A, B

Aircraft Design	Space Systems	Space Transportation & Exploration
Capstone: AE171A, B	**Capstone:** AE172A, B	**Capstone:** AE172A, B
3 Electives:	3 Electives:	3 Electives:
AE169	AE110 (Required)	AE110 (Required)
CE113	CE113	AE169 (Required)
CE114	CE114	CE113
ME114	ME114	CE114
ME160	ME160	ME114
ME165	ME165	ME160
ME187	ME187	ME165
Math 129 A,B	ME106	MatE187
Math 133 B	EE112	MatE160
	EE132	
	ISE130	
	Math 129 A,B	

Experimental Methods: ME120

Thermal-Fluids	Solid Mechanics	Dynamics & Control	Electronics
AE167	AE114	AE168	EE98
AE164	CE112	AE140	
AE162	CE99	AE165	
ME113	MatE25	ME101	
ME111			

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), ME130 (Applied Engineering Analysis)

Figure 3 BSAE Curriculum Design

The BSAE curriculum is vertically integrated as shown in Figure 3. Foundational engineering sciences (thermal-fluids, solid mechanics, dynamics, 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), aerospace structures (AE114), and aerospace vehicle dynamics & control (AE168), 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: aircraft design, space systems, space transportation & exploration. Students may focus in one area or mix and match electives, however, they must take at least one of the two capstone, senior design course sequences.

Appendix B shows the BSAE curriculum in detail along with the categories of the professional component each course satisfies. Table 24 (Appendix C) shows the Course and Section Size Summary for AY 2005-2006. Course syllabi for all technical courses are presented in Appendix E. Course Binders (available at the site visit) with sample assignments, exams and student work allow for an assessment of each course.

General Education: The BSAE 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 BSAE 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 BSAE 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, AE168 among others), computer modeling / simulations (AE162, AE164, ME113, ME114, AE110, AE168, AE169, ME160, ME165, AE171A&B, AE172A&B among others), experimentation / product testing (AE114, AE162, AE164, ME120, AE171B, AE172B among others), and design (AE162, AE164, AE165, AE167, AE171A&B, AE172A&B among others).

Experimentation: The BSAE 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.

Preparation for Engineering Practice

Breadth and Depth: The BSAE 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 [ref. 5, 6] (ME111, ME113, ME114, AE162, AE164, AE65, AE167, AE168, AE171A&B, AE172A&B). Second, it requires the synthesis of principles from many different fields (AE171A&B, AE172A&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 (AE171A&B or AE172A&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[1]. 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.

BSAE 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

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

B5.1.2 MSAE Curriculum Design and Content

MSAE Thesis: AE 299 (6 units) **MSAE Project: AE 295 A & B (6 units)**			
	Aircraft Design	**Spacecraft Systems**	**Space Transportation & Exploration**
Advanced Space Systems Engineering (AE296A)		AE 210	AE 210
Spacecraft Instrumentation & Payload Sensors		AE 222	AE 222
Orbital Mechanics & Mission Design		AE 242	AE 242
Advanced Astrodynamics		AE 243	AE 243
Spacecraft Dynamics & Control		AE 245	AE 245
Advanced Aircraft Stability & Control	AE 246		
Advanced Structures & Materials	AE 250	AE 250	AE 250
Advanced Aerodynamics	AE 262		AE 262
Advanced Compressible Flow (AE296C)	AE 264		AE 264
Space Propulsion Systems	AE 267	AE 267	AE 267
Computational Fluid Dynamics	AE 269		AE 269
Spacecraft Thermal Systems		AE 270	AE 270
Advanced Aircraft Design I and II (new)	AE271A, B		
Spacecraft Power Systems		AE 275	
Mathematics / Numerical Methods: ME230 (Advanced Engineering Analysis) & ME270 (Numerical Methods) OR ME273 (Finite Element Methods)			

Figure 4 MSAE Curriculum Design

The MSAE curriculum (Figure 4, see also Section B.II) provides students with an advanced education in AE theory and practice. It is designed to prepare students for professional careers in several fields of AE involving aeronautical and space systems research, design, development, testing, and systems integration.

The advanced engineering and high technology applications generic to modern aerospace industry are reflected in the curriculum. Laboratories equipped with modern electro-optical, electro-mechanical, and computer instrumentation provide experimental work in each area of specialization. Major facilities include a satellite ground station, a subsonic, supersonic, hypersonic wind tunnels, and workstation laboratories.

The student selects a faculty advisor who helps structure a program of study that meets individual needs and addresses areas of interest. While working closely with the faculty advisor, each student completes a thesis or project that results from an in-depth study of a particular research topic of interest. Opportunities to interact and collaborate with NASA and local industry can be easily pursued as well.

The MSAE Program offers courses designed to provide aerospace engineers with advanced level of knowledge and skills in three areas of specialization: (1) Aircraft Design, (2) Space Systems, and (3) Space Transportation and Exploration. The program consists of thirty (30) semester units of approved work, and at least twenty-four (24) must be 200-level courses in aerospace engineering and/or other engineering and science disciplines. The student has the choice of Plan A (with a Thesis) or Plan B (with a Project Report).

All students are recommended to concentrate their studies in one of the areas of specialization. Each area of specialization requires:

- 6 units of required courses for the degree.
- 12 units of 200-level AE courses suggested for the area of specialization.
- 6 units of elective courses subject to approval by the AE Program Advisor. The student may take up to 6 units of coursework from the BSAE program, or graduate courses from other departments or colleges
- 6 units of project (AE 295 A, B) or thesis (AE299)

Both the University GPA and the Department GPA must be at least 3.0.

B5.2 BSAE Program Outcomes

The USA Accreditation Board for Engineering and Technology (ABET) adopted recently a new set of criteria for evaluating engineering programs [ref. 1]. One of these, Criterion 3, refers to Program Outcomes. Program Outcomes describe what students are expected to know or be able to do by the time of graduation from the Program. A systematic process must be in place to assess the achievement of all the PO before students graduate. This process needs to be ongoing to ensure the continuous improvement of each program [ref. 3].

B5.3 General Education (GE) Contributions to Program Outcomes

B5.3.1 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

B5.3.2 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.

Table 18 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 C. 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 18 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

B5.3.3 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 19 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.

B5.4 BSAE Curriculum – Outcome Relationship

It was decided to adopt the original eleven (11) outcomes of ABET EC 2000 as Program Outcomes for the 2005 accreditation visit. Each outcome (a – k) was addressed in several courses of the BSAE curriculum. A subset of these courses was chosen for a thorough assessment of each outcome, as shown in Table 20. This subset consists of ten (9) required, upper division courses. Upper division courses prepare students at skill levels 3, 4, 5 or 6 of Bloom's Taxonomy in the particular outcomes they address.

Table 20 **BSAE Program – Outcome Matrix**

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

++ Skill level 3 or 4 in Bloom's Taxonomy
+++ Skill level 5 or 6 in Bloom's Taxonomy
✓ Skills relevant but not presently assessed

B5.5 Course Assessment

Figure 5 shows the process for assessing each of the selected courses. C***ourse coordinators*** assess their courses for the specific outcomes they address, as indicated in Table 20. 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.

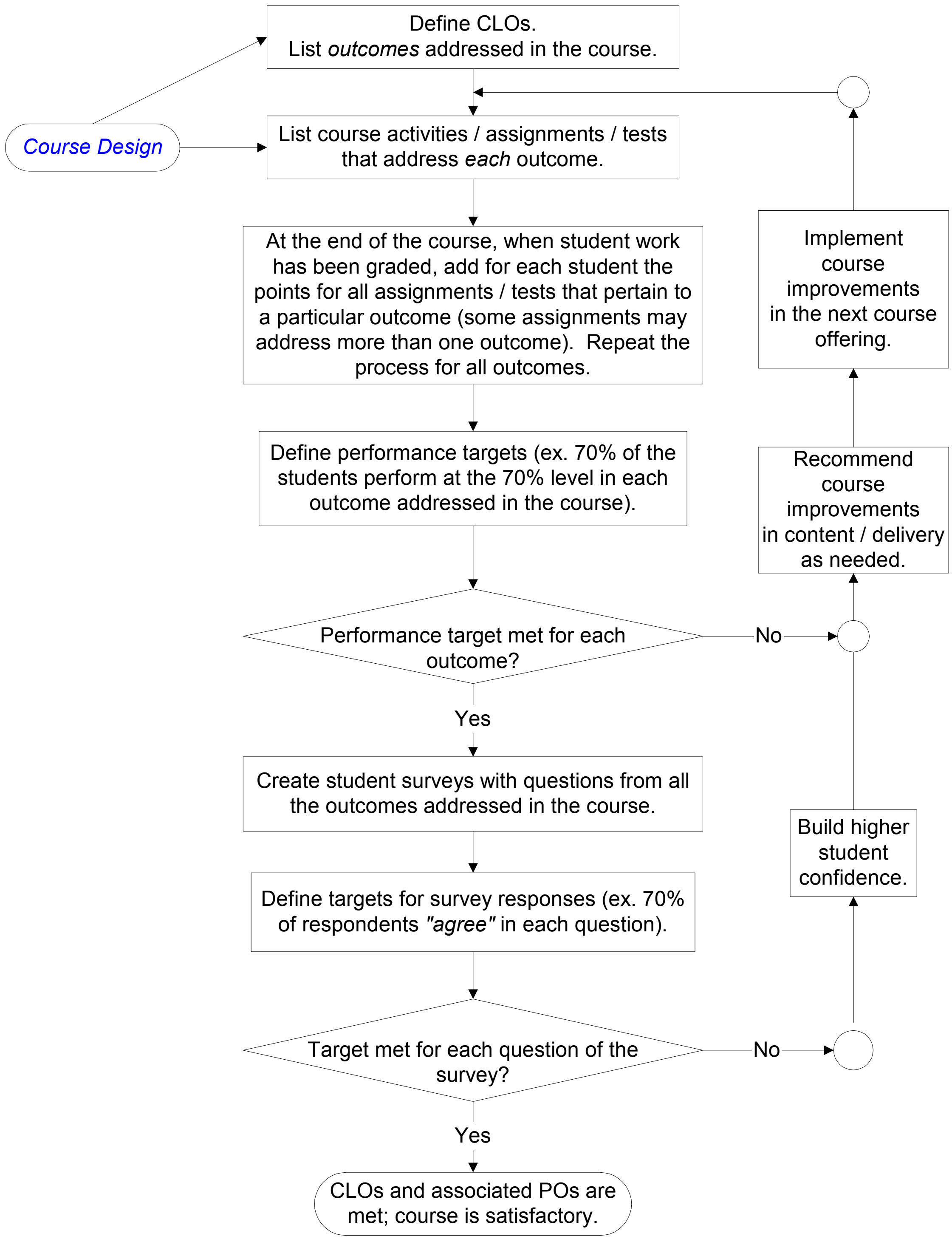

Figure 5 Course assessment flow chart

B5.6 Outcome Assessment

B5.6.1 Outcome 3a

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

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, etc.) to solve AE problems.

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 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%.

B5.6.2 Outcome 3b

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

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.

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 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	18 (95%)	1 (5%)	0

	calculations, perform error analysis, and tabulate / plot the results using appropriate choice of variables and software).			
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 discrepancies.	17 (89%)	2 (11%)	0

B5.6.3 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 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

Summary from Supporting Courses

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

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	

B5.6.4 Outcome 3d

AE graduates can work effectively on multidisciplinary teams.

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.

Summary from Supporting Courses

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.

B5.6.5 Outcome 3e

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

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.

Summary from Supporting Courses

M E111: Fluid Mechanics

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.

ME 113: Thermodynamics

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

AE162: Aerodynamics

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 (real world) problems.	16 (84%)	2 (11%)	1 (5%)
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.

B5.6.6 Outcome 3f

AE graduates understand their professional and ethical responsibilities.

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.

Summary from Supporting Courses

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.

B5.6.7 Outcome 3g

AE graduates can communicate effectively

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.

Summary from Supporting Courses

E100W: Technical Writing

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

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

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

ME113: Thermodynamics

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

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

Student Performance Summary: 86% of 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

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 (89%)	2 (11%)	0
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.

B5.6.8 Outcome 3h

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

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.

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. 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:

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

B5.6.9 Outcome 3i

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

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.

Summary from Supporting Courses

ME111: Fluid Mechanics

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

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

Student Performance Summary: Student performance on the Application Notes averaged 83% and on the Reflection Journals 91% (combined average of 86%).

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

ME113: Thermodynamics

Course activities related to outcome 3i: (a) One project includes a brief tutorial on library resources and information retrieval and assessment. (b) In-class quizzes require students to analyze unfamiliar problems from different points of view collaboratively in a team. (c) Applications of thermodynamic theory are heavily integrated into the course, and relevant articles and websites are available for students interested in further information. (d) A research project is assigned. Each 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,	38	4	2

textbooks or teachers).			
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

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-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 words in a book describe).	16	1	2
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	Analyze 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 (89%)	2 (11%)	0
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.

B5.6.10 Outcome 3j

AE students demonstrate knowledge of contemporary issues.

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.

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.

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.

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).

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.

B5.6.11 Outcome 3k

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

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.

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 (79%)	2 (11%)	2 (11%)
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].

B6 Data Analysis and Recommendations for Improvement

B6.1 BSAE Program

B6.1.1 Data Analysis Pertaining to the Program Educational Objectives

In regards to the appropriateness of the PEO, the constituents established that the PEO defined are appropriate for the BSAE Program. In regards to the achievement of the PEO, in general, the constituents agreed that the AE Program meets all four PEO, albeit with some weaknesses in (a) mathematics and science skills adequate for entry into a graduate program, and (b) writing skills.

Faculty Assessment

In general, the faculty was 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 has deep concern with a fraction of students that compromise academic integrity.

Student Assessment

The student responses during exit interviews validate PEO 1, 2, and 3 of the BSAE Program and indicate that the Program achieves these objectives. The comment made in regards to old and malfunctioning equipment referred to our old smoke tunnel in the aerodynamics lab (Room E107, Course AE162) and the shock tunnel in the gas dynamics lab (Room E164, Course AE164).

Alumni Assessment

Although the number of surveys received was small, the types of jobs our BSAE graduates hold indicate that the BSAE Program prepares them well for these positions. Moreover, 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.

AE Advisory Board Assessment

The response of the AE Advisory Board was almost unanimous that all four PEO are important (Table 13) and that all four PEO are addressed well through the AE curriculum (Table 14).

B6.1.2 Data Analysis Pertaining to the Program Outcomes

Based on the data presented in section B5 the BSAE Program satisfies all the outcomes. As a result of our outcomes assessment, several improvements have been implemented since our last ABET visit (1999), 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 (AE162, AE164) [ref. 4].
B. Students design airplanes and spacecraft with economic, environmental, social, political, ethical, safety, liability, and manufacturability constraints (AE171A&B, AE172A&B).
C. Team skills are taught and assessed formally (AE162, AE164, AE171A&B, AE172A&B).
D. Students tackle (i.e. identify, formulate, and solve) open-ended problems (ME111, ME113, ME114, AE162, AE165) [ref. 5]. Some of these problems involve integration of material from two or more courses [ref. 6].
E. Students research, present, and discuss in class safety, ethics, and liability issues in aerospace engineering (AE171A&B, AE172A&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) [ref. 7].

Outcome 3a Summary (Fall 2003)

Six (6) courses were targeted for assessment of outcome 3a in the BSAE Program. The analysis of the data shows that AE students are given adequate opportunities to apply mathematics, science, and engineering in their required coursework. Four 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 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 and AE167.

Outcome 3b Summary (Fall 2003)

Three (3) courses were targeted for assessment of outcome 3b in the BSAE 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. One of these courses has met and exceeded the student performance target level (60%) for outcome 3b. In summary, the AE Program satisfies all the elements of outcome 3b.

Outcome 3c Summary (Fall 2003)

Two (2) courses were targeted for assessment of outcome 3c in the BSAE 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.

Outcome 3d Summary (Fall 2003)

Eight (7) courses were targeted for assessment of outcome 3c in the BSAE 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.

Outcome 3e Summary (Fall 2003)

Outcome 3e targets students' ability to identify, formulate and solve engineering problems. The data from the 5 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, AE162, AE164, and AE167. In three of these courses the 60% performance target has been met. Hence, the AE Program satisfies outcome 3e.

Outcome 3f Summary (Fall 2003)

Two courses address engineering ethics in the BSAE technical curriculum. The thorough coverage of the subject in AE170A&B as well as the student performance on this outcome in this class, clearly demonstrate that the BSAE Program satisfies outcome 3f.

Outcome 3g Summary (Fall 2003)

Based on seven (7) courses assessed for communication skills (written and oral) the BSAE 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.

Outcome 3h Summary (Fall 2003)

All of the seven (7) courses assessed, met the performance targets for outcome 3h. Hence, the BSAE 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.

Outcome 3i Summary (Fall 2003)

Analysis of the available data for seven (7) courses shows that the BSAE 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.

Outcome 3j Summary (Fall 2003)

A number of contemporary issues are being discussed in the seven (7) courses that have been assessed for outcome 3j, all of which met the performance targets. Hence, the BSAE Program satisfies outcome 3j.

Outcome 3k Summary (Fall 2003)

The BSAE 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.

B6.1.3 Recommendations for Improvement

In response to faculty comments:

- There is more emphasis in analyzing and interpreting experimental data in AE162 and AE164.
- There is more emphasis in design of experiments. A rubric is being developed to help guide the students in all the elements of proper experimental design as well as to help guide the faculty in grading laboratory reports.

In response to student comments:

- The smoke tunnel was replaced in Spring 2004 with a new water tunnel.
- The AE164 lab (shock-tunnel) is currently being upgraded with a new data acquisition system and new photo equipment.
- A new undergraduate CFD course (AE169) was installed as an elective in Spring 2005.
- A new room for the Aircraft Design Laboratory is being sought to accommodate the number of students (currently 16 BSAE + 4 MSAE students) who work in aircraft design projects. Moreover, the number of computers in the Aircraft Design Laboratory needs to be increased from four to ten (10).

The AE Advisory 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 AE majors.
c. Introduce an AE Seminar where guest speakers from industry highlight the latest advances in the field as well as opportunities for employment.

By far, the most important recommendation by AE students, the AE faculty, the AE Advisory Board, and the ABET evaluator, was to hire a third AE faculty member. However, this is the third academic year after the retirement of a senior AE faulty member and the MAE Department has not yet hired a replacement. Following a successful search in AY 04-05 the Department failed to hire an AE faculty member recommended by the Search Committee and approved by the Department faculty. Although budget cuts were cited as the main reason for not hiring, lack of commitment in supporting the AE Program was a major factor in the decision of the Department administration. This lack of commitment became obvious at our last Department meeting on Tuesday, May 16, 2006, when it was announced that the consensus among the ME faculty (about hiring an AE faculty member) has now changed and we need to re-evaluate our needs as a Department. It was suggested that we may now wish to hire a faculty member in Mechatronics or Design, despite (a) the recommendation by the AE ABET evaluator, and (b) the fact that the Mechatronics and the Design options of the ME Program are currently supported by four and five faculty members respectively, while the AE Program with two degrees (BSAE and MSAE) is supported by only two faculty members.

The Department has now agreed to hire a 3rd AE faculty member. However, the position is now limited at the Assistant Professor level (it was Assistant or Associate Professor in the search during AY 04-05). A new Assistant Professor with proper expertise (Space Systems / Satellite Design) would, of course, satisfy the needs of the AE Program. However, based on the small number of applicants in the past two searches, the AE faculty are concerned that we limit our options and may not be able to find qualified candidates. Moreover, as of the time this report is being written, the faculty position has not yet been advertised.

B6.2 MSAE Program

B6.2.1 Data Analysis Pertaining to the Program Educational Objectives

The following findings emerged from the analysis of the data:

A. The MSAE Program at Lockheed-Martin is currently run with no input from the AE faculty.
B. Several MSAE project / theses were found to have been supervised by ME faculty with no expertise in the area of the project / thesis. As a result, the quality of some of them was poor.
C. A large number of reports were not available at the time of the analysis (21%). Additionally, in a few cases, committee members were replaced without their knowledge.
D. The percentage of reports that satisfied the various elements of PEO 1 ranged from 84% - 95%.
E. The percentage of reports that satisfied the various elements of PEO 2 ranged from 79% - 100%. In general, students seem to perform very well in their use of modern tools. They lack, however, in their citations of appropriate literature (21% of the reports were found weak or lacking) as well as in their understanding of this literature (11% of the reports were found weak or lacking). On the other hand, almost all of the evaluated reports demonstrated a good understanding of the work performed.
F. Students seem to perform well in the skills of PEO 3 (in-depth analysis / design of a system). One issue that was identified in relationship to this PEO is that there was a mismatch between the project / thesis topic, project / thesis advisor and the major.
G. Students seem to perform well in the skills of PEO 4 (communication skills). The percentage of reports that satisfied the various elements of PEO 4 ranged from 89% - 100%.
H. The percentage of reports that satisfied the various skills of PEO 5 ranged from 95% - 100%.

The following recommendations were made to the MAE Department to address these findings:

A. AE295A and AE299 (1st semester):
   a. Faculty who serve on a student's committee should not sign the grade form without first evaluating the student's end-of-semester written report.
   b. The AE295 and AE299 Coordinator (an ME faculty member) should not assign a grade for a student without the grade form signed by all three committee members.
B. The AE295B and AE299 (2nd semester): Students should not receive a passing grade without first submitting to their advisor a bound copy of their final report signed by all three committee members. A non-bound copy and a receipt (showing that a copy is in the process of being bound) would be acceptable accompanied by the cover page signed by all three committee members.
C. Committee Issues:
   a. Department policy should be clarified that students are not allowed to replace committee members at their discretion without approval of the committee members.
   b. Once established on the student's M.S. project / thesis proposal, the committee members cannot be changed, without consulting with the committee members themselves.
D. There should be checks and balances to ensure the integrity of our graduate programs. In particular, a student's M.S. project / thesis grade should be determined by the student's committee only.
E. Although the level of mathematics and science may vary from project to project, students are expected to use graduate level mathematics and science in their analysis or modeling.
F. By the end of the 1st month, in AE295A and AE299, students should be required to take the online tutorials offered by the SJSU Library, such as Info-Power.
G. By the end of the 1st month, in AE295A and AE299, students document and present a literature review related to their project / thesis.
H. The Project / Thesis cover page should read: for the degree of M.S. in Aerospace Engineering.
I. The Graduate Coordinator and Faculty Advisors will ensure that the topic area selected by their students is appropriate for the degree and is supported by the courses taken by the student.
J. On the Project Proposal Form, a line should be added to indicate the area of specialization.
K. Students should seek a committee chair and appropriate committee members in their field of study. Faculty should advise students only in their area of expertise.

L. Students admitted into a graduate program must enroll in at least one course per semester, selected from the list of approved MSAE courses for their area of specialization.
M. The coordination of the AE295A, B and AE299 courses should be given to the AE Coordinator.
N. All MSAE thesis / project topics and committees are approved by the AE Coordinator to ensure that (i) topics are appropriate for the MSAE degree and (ii) the committee chair and committee members have expertise in the area of each thesis / project.
O. The MSAE Program at Lockheed-Martin should be coordinated by the AE Coordinator and AE faculty should participate in this program through teaching as well as MSAE project / thesis supervision. Part-time instructors at Lockheed-Martin should meet with the AE Coordinator as well as the AE faculty member who coordinates the particular course, and curriculum changes should be approved by the AE faculty.

Recommendations K, M, N, and O are very important for the quality of the MSAE Program. However, the MAE Department administration has not addressed the issues which prompted these recommendations. ME faculty members continue to supervise MSAE projects/theses without having appropriate expertise. Moreover, MSAE students are encouraged by the Department Chair to seek committee members outside the MAE Department despite the fact that AE faculty have the expertise and are willing to supervise their students. The MSAE Program at Lockheed-Martin is run with virtually no participation by the AE faculty. A number of MSAE students receive their degree without ever coming into contact with full-time AE faculty through advising, coursework or project/thesis work. The results of these policies have been detrimental to the quality and visibility of the MSAE Program, especially at Lockheed-Martin where the enrollment has dropped from 35 students in 2002 to five (5) in 2006.

B7 Faculty

B7.1 Full-Time Faculty

The AE Program with two degrees (BSAE and MSAE) is currently supported by only two full-time, tenured / tenure-track faculty members. Appendix C, Tables 26 and 27 give the qualifications, activity levels, and workload of full-time AE faculty. Appendix F gives the VITA of the full-time AE faculty.

This is the third AY after the retirement of a senior AE faulty member (Dr. Desautel) and the MAE Department has not yet hired a replacement. Following a successful search in AY 04-05 the Department failed to hire an AE faculty member recommended by the Search Committee and approved by the Department faculty. Although budget cuts were cited as the main reason for not hiring, lack of commitment in supporting the AE Program was a major factor in the decision. The Department has now agreed to hire a 3rd AE faculty member, although the position is now limited to the Assistant Professor level (it was Assistant or Associate Professor in the search during AY 04-05). A new Assistant Professor with proper expertise (Space Systems / Satellite Design) would, of course, satisfy the needs of the AE Program. However, based on the small number of applicants in the past two searches, the AE faculty are concerned that we limit our options and may not be able to find qualified candidates. Moreover, as of the time this report is being written, the faculty position has not yet been advertised.

It should be noted that four of the six AE core courses (AE162, AE164, AE165, and AE167), the senior design project (AE171A&B, AE172A&B) and two of the three AE electives (AE110, AE169) are taught by full-time AE faculty. Of the basic AE disciplines – aerodynamics / gas dynamics, aerospace structures and materials, propulsion, flight mechanics, stability and control, all but two (stability and control, structures and materials) are represented on the current faculty. Of the three options – aircraft design, space systems, space transportation and exploration, two are covered by the current faculty.

B7.1.1 AE Faculty as Innovative Teachers

AE faculty has been awarded College, University, and National awards for the quality of their teaching. They have been using active and cooperative learning in the classroom and constantly experiment with alternative teaching methods, such as project-based learning integrating material from two or more courses taken concurrently by AE students [ref. 6], as a way to encourage undergraduates to participate in research and present their results in student or professional conferences.

B7.2 Part-Time Faculty

The part-time faculty supporting the AE Program is very important, as they bring contemporary industry expertise and help provide adequate staffing in a time of minimal coverage. Experienced practicing engineers from NASA Ames Research Center and Lockheed-Martin are used as lecturers and bring an additional element of professional practice and on-the-job realism to classroom instruction.

B7.3 Faculty Professional Development and Interactions with Industry

Professor Papadopoulos has contacts and exchange with NASA through his research. Moreover, he is very active with AIAA. Professor Mourtos has industry contacts with Cessna and Honeywell (Appendix H). Senior engineers from each of these companies serve on the AE Advisory Board and give lectures in AE171. Dr. Mourtos recently initiated contact with Boeing, which resulted in significant interaction between his students and Boeing engineers who visited his aircraft design class (AE171) twice in AY 04-05 to mentor students on a multi-disciplinary UAV project. Professor Mourtos is also very active in engineering education venues such as ASEE, ICEE, and UICEE (UNESCO International Center for Engineering Education). A complete list of publications, conference participation, and other professional activities for each faculty member can be found in Appendix F.

The Department has very limited resources for faculty professional development. Despite his excellent record of conference participation and publications, Dr. Papadopoulos has not received any travel support from the MAE Department since his appointment.

B8 Facilities

Table 21 provides a summary of the laboratory facilities used for instruction in the AE Program. It includes AE laboratories dedicated exclusively to AE courses. All labs are furnished with electronic locks to allow students to enter on an as-needed basis. The laboratory support of the AE curriculum is shown in Figure 6.

Table 21 AE instructional laboratories

Location / Name	Courses Served	Current Status	Adequacy of Instruction	No of students served annually	Area (ft^2)	Director
E107 Aerodynamics	AE162, AE262 AE 171A, B	Adequate	Adequate	60	1357	Mourtos
E133 Measurements & Instrumentation	ME 120	Good	Good	120	1600	Furman
E137 Computational Fluid Dynamics	AE167 AE110 AE169	Adequate	Adequate	50	400	Papadopoulos
E164 Gas Dynamics	AE164, AE264	Good	Good	40	1800	Mourtos
E164A Aerospace Structures	AE114, AE250	Adequate	Adequate	30	2622	Barez
E236 Space Engineering	AE110 AE172 A,B	Good	Good	15	1318	Papadopoulos
E240 Aircraft Design	AE171 A,B	Poor	Adequate	15	400	Mourtos
E272 Space Transportation & Exploration	AE172 A,B	Adequate	Adequate	15	1975	Papadopoulos

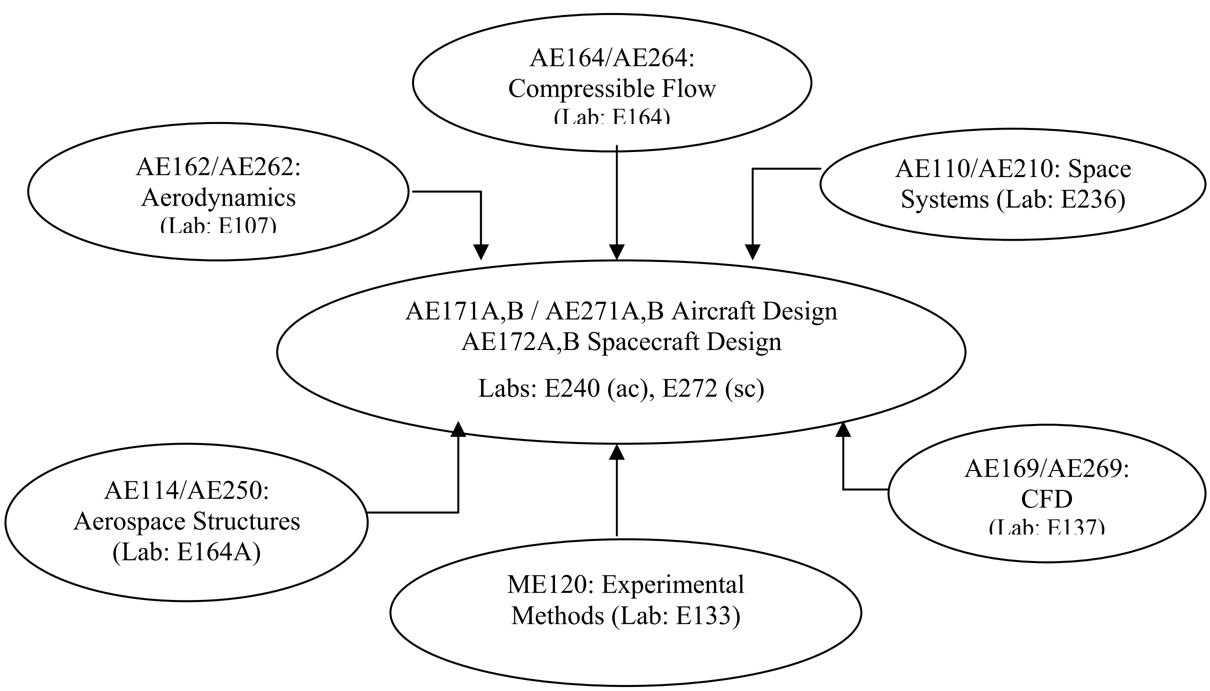

Figure 6 AE curriculum laboratory support

The MAE Department maintains an AE clubroom that serves as the headquarters for the student chapters of the AIAA and ΣΓΤ(AE Honorary Society). 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 22. Overflow lecture sections are scheduled in other facilities on campus through the Academic Scheduling Office.

Table 22 College of Engineering classrooms

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 23. 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, spreadsheets 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 23 College of Engineering 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)

B9 Institutional Support and Financial Resources

B9.1 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.

B9.1.1 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.

B9.1.2. 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.

B9.1.3. Contracts and Grants

The College also derives support from the return on indirect charges collected by the SJSU 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.

B9.1.4. 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.

B9.2 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.

B9.2.1 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.

B9.2.2 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.

B9.2.3. 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.

B9.2.4 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.

B9.2.5 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.

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 I, Non-Academic Support Units.

Co-Curricular Programs

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

Co-op Project Course (ENGR 197)

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

Global Technology Initiative (GTI)

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

Silicon Valley Leaders Symposium

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

Table 24 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

Table 25 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

B9.2.6 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 I, Non-Academic Support Units.

B10 Interdependence of Programs

B10.1 Service to SJSU

The department offers AE 198 (cross-listed with Tech 198) as the approved upper division general education V-area course for students at SJSU.

B10.1 Service to Off-Campus Programs

In the Summer of 2000, the MAE Department and the College of Engineering signed an agreement with the Lockheed-Martin Company in Sunnyvale, California to establish special-session cohort programs at Lockheed, one each in the MSAE and MSME programs. The agreement also provided Lockheed-Martin employees with an opportunity to apply for conversion to matriculating status in each program, and most have done so. The cohort programs started in Fall 2000. The MSAE cohort program at Lockheed-Martin started with 35 students compared to about 15 for the MSME cohort. Dr. Pernicka was involved in teaching courses in the area of space systems as well as supervising student projects. After Dr. Pernicka's departure (2001), Dr. Papadopoulos took his place. However, in the last few years the MSAE Program at Lockheed-Martin is run with virtually no participation by full-time AE faculty. MSAE students receive their degree without ever coming into contact with full-time AE faculty either through advising, coursework or project/thesis work. In fact, MSAE students are encouraged by the Department Chair to seek committee members outside the MAE Department despite the fact that AE faculty have the expertise and are willing to supervise their students. The results of these policies have been detrimental to the health and quality of the MSAE Program at Lockheed-Martin, where the enrollment has dropped to five (5) students in 2006. Although there may be other reasons why students have changed majors (ex. perceived job flexibility), it has been reported by several MSAE students that the Department Chair actively encourages them to switch majors from AE to ME.

C. PROGRAM PLANNING AND STRATEGIES

C1 Five-Year Plan and Strategies Overview

C1.1 Overview of AE Career Challenges and Opportunities

Based on input from the AE Advisory Board, AE Graduates will face increasing challenges in the work-place but at the same time new opportunities will become available.

C1.1.1 Challenges

- US aerospace industries face stiff competition from Europe for commercial aircraft, and this is likely to intensify from both the US and Europe attempting to increase their market share, as well as the eventual introduction of new competitors from Asia. The US industry will be even more pressed to reduce costs and shortening the design-to-manufacture cycle in order to introduce new products faster. Given the propensity of the US industry in seeking lower costs by outsourcing, this will inevitably affect the engineering design and testing cycle. Thus, graduates from US universities will face competition from well-educated, low-cost engineering manpower from India and China. The challenge for current and new AE graduates is to find ways to develop significantly enhanced, rather than merely improved products, within mostly mature fields.

- Aerospace technology is evolving at an increasing pace; concepts that seemed pure fantasy a few years ago are being implemented as we speak. The driving forces of commercial competition and armed conflict will remain. Even if conflict subsides, aerospace will play an increasing role in surveillance on a global scale. Advances in technology are mostly driven by the usual nano-, bio- and info-terminologies. Students will need to be equipped with the proper knowledge and methods to adapt to the changing technology, or be able to be easily re-trained.

- The reality of closely integrated cross-functional teams is here. Multi-Disciplinary Optimization (MDO) requires seamless communications between individuals and processes of previously estranged areas (such as Structures and Aerodynamics). In addition to cross functional teams within individual organizations, collaborative environments have been developed for engineers working in different companies and, increasingly, very different time zones. Communications and organizational skills will be essential for continued success in this environment.

- As projects come and go, the Aerospace Industry will find a need to reinvent itself. This is particularly true for defense contractors, which may see a variety of programs ranging from relatively simple training aircraft to sophisticated long range autonomous vehicles (UAVs) and missiles.

- Future AE graduates must be able to cope with change. Technological changes, collaborative changes, customer demand changes, etc, are all a reality. Engineers need to carefully balance the requirement that they be ever more skilled in their area of expertise, while being more aware of how their piece fits in the puzzle.

C1.1.2 Opportunities

- The current outlook for civilian aerospace programs is excellent, as new generation designs are brought to market. Environmental demands, coupled with high energy prices, have pushed aerospace engineers to develop drastically improved, all-new products. These new products will be the result of more focused expertise in specific areas such as materials, propulsion, aerodynamics, electronics, and systems architecture, as well as advances in automated manufacturing processes. As a result, aerospace companies have come to rely on experts in these and other specific fields, rather than individuals with more broad, but perhaps less detailed knowledge of several or all of the above subjects. On the other hand, technical teams will more than ever need to communicate and understand each others' areas of knowledge, given the highly integrated nature of modern aircraft.

- Civilian Transports: Airplanes currently in the design phase are destined to reach peak production within the next five to ten years. Recent market studies conducted by the major manufacturers pegged demand at 15,000 to 20,000 aircraft over the next 20 years. Aircraft such as the Boeing 787 and Airbus A350XWB (or equivalent) will likely be produced in large numbers in order to replace older generation designs (767, A300/310/330/340) and also to satisfy growing travel demands in both mature (U.S. domestic, Europe) and developing markets (with a focus on Asian markets). These airplanes will be manufactured using novel techniques and materials. They will be propelled by new generation engines designed to improve efficiency, as well as to mitigate the effects of aviation on the environment. In addition, advances in avionics and automated servo control systems will be incorporated to reduce pilot workload and increase safety. Perhaps more exciting news for new aerospace engineers will come from the need for follow on designs for Airbus' and Boeing's narrow body mainstays, the A318/319/320/321 and B737 aircraft. These are massive programs that will require pushing the boundaries of newer materials and manufacturing techniques in order to sustain the high volume production rates and performance benefits, which governments, customers, and even the non-flying public demand.

- The general aviation field is robust with 9,000-11,000 turbine aircraft deliveries forecasted by various manufacturers. For the past several years, airframe manufacturers have delivered a torrent of new and improved products, and demand for further models remains strong for the foreseeable future. Large cabin aircraft, such as those built by Dassault and Gulfstream, have increased in popularity, reporting brisk sales. New technologies, such as fly-by-wire flight control systems, are making their way into this market segment, providing exciting new opportunities for aerospace engineers. In the mid-size and small turbine arena, new and technologically advanced entrants from Cessna Aircraft and Raytheon, to name a couple, have benefited from what appears to be a very lucrative segment of the market. Finally, several designs in the emerging "Very Light Jet" market are currently in development or early production phases. These designs have been well received by the market, ensuring design and fleet sustainability work for years to come.

- New generation propeller aircraft with advanced electronics, propulsion, and structural technologies have prospered, reviving a market, as well as the prospects for work in smaller airframe manufacturers. A new type of airplane, the "Light Sport Aircraft" will make flight more accessible to recreational and entry level pilots. These new airplanes pose new challenges to aerospace engineers, who must develop more efficient and light weight structures and propulsion systems within extremely tight budgets and regulatory limits.

- No civilian development has been more visible than the recent boom in commercial suborbital transport ventures. The success of Scaled Composites' Space Ship One has brought much attention to this emerging field. New outfits have sprung up with innovative concepts. The industry as a whole, however, remains fragmented and devoid of any meaningful regulation. Early "pioneers" should find jobs that reward creativity and out-the-box thinking.

- Department of Defense aerospace applications are likely to remain strong, due to security reasons. This presents opportunities for US citizens graduating in the fields of interest (including AE), and the demand is likely to remain strong or increase as the current aging workforce is retiring. This affects both private and government sectors. To supply the demand, the AE Program at SJSU will need to attract more US citizens.

- There are opportunities for aerospace engineers interested in managerial tracks. Project Management continues to be an area where American companies excel over their overseas rivals. Aerospace engineers with their systems approach are uniquely positioned to make the most of these available opportunities, as only they understand the technology and unique language required to maintain a positive relationship within their organizations, and, increasingly, other parties within the collaborative environments.

C1.1.3 Recommendations by the AE Advisory Board:

- AE graduates must be strong in the fundamentals (e.g. fluid dynamics, thermodynamics, electromagnetism, chemistry, stability and control) relevant to AE applications. This basic knowledge will always be used as a foundation for any specialization during the initial employment period, as well as for re-training after a few years. Hence, the AE Program needs to have a strong collaboration with the Departments of Mathematics, Physics, and Chemistry to ensure that mathematics and science courses provide the background needed in aerospace engineering applications.

- The AE program should include overviews of the latest advances in various subjects, especially materials, computer science, and modeling software and methods. This could be accomplished through a joint University-Industry-Government program, where the appropriate expertise can be obtained if necessary for some short, specialized lectures, as well as for a demonstration of where and how these new technologies can be applied.

- The AE program should include increased opportunities for exposure and collaboration with foreign educational institutions. This could take the form of student exchange programs, or visiting lecturers. Students will benefit from learning the engineering practices and methods used elsewhere, as well as being exposed to other cultures and languages. This will be helpful in understanding the competition, or in working jointly with foreign partners of their respective employers (e.g. US-UK collaborations).

- The AE program should facilitate the re-training of the workforce by offering specialized sub-programs on specific subjects, with highly flexible schedules and full use of IT. Currently, the AIAA organization attempts to provide such overview courses during their conferences. Universities should be able to provide a much better service, going into more depth, and with a certification program.

C1.1.4 Curriculum Changes

To better prepare AE students for the challenges and opportunities discussed above, the following curriculum changes will be implemented in the next five years:

Lifelong Learning: The need to stay current is becoming more and more pressing as new technological advances continue to transform the workplace at a very rapid pace. In the mid-1980s the “half-life” of an engineer’s technical skills – that is, how long it takes for half of everything an engineer knew about his / her field to become obsolete – was estimated to vary from 7.5 years for mechanical to 2.5 years for software engineers [ref. 8], with aerospace engineers being somewhere between these two. Considering that these numbers are probably smaller today, there is an urgent need to revise / renew the AE curriculum often and prepare students to learn on their own.

Lifelong learners are characterized both by a value complex that reflects on their attitudes as well as a set of cognitive skills [ref. 9]. The first empowers them to work independently and diligently, practice cooperation when working in teams, and act ethically. The second allows them to access information effectively and efficiently from a variety of sources, read critically and assess the quality of information available, analyze new content by breaking it down, synthesize new concepts by making connections with prior knowledge, and reason by predicting, inferring, using inductions, questioning assumptions, using lateral thinking, and inquiring. To strengthen student preparation in lifelong learning the single, most important curriculum change will be to structure project-based learning in most, if not all AE courses and emphasize student research at both the undergraduate and graduate levels [ref. 6].

Good Citizenship / Living in a Complex, Multicultural Society: The AE curricula, both graduate and undergraduate will incorporate elements that integrate proper skills and values from these areas. These elements will include (a) emphasis on engineering ethics, (b) participation in professional societies (AIAA, SAE), and service-oriented honorary societies (ΣΓΤ), (c) multicultural / multidisciplinary teaming in engineering projects, and (d) opportunities for AE students to collaborate with peers from universities overseas on projects.

C1.1.5 Alternative Models of Instructional Delivery

In a five part series titled the Future of Engineering Education the authors discuss in great detail the problems of current instructional delivery methods in engineering and suggest alternative models. Rugarcia et al, point out [ref. 10] that traditional instructional methods will not be adequate to equip engineering graduates with the knowledge, skills, and attitudes they will need to meet the demands likely to be placed on them in the coming decades, while alternative methods that have been extensively tested offer good prospects of doing so. Felder et al [ref. 11] suggest that active and cooperative instructional methods offer a good prospect of equipping engineering students with the knowledge and skills they will need to practice their profession in the 21st century. Moreover, Rugarcia et al [ref. 12] state that focusing lectures, assignments, and tests entirely on technical content and expecting students to develop critical process skills automatically is an ineffective strategy. Instructors who wish to help students develop problem-solving, communication, teamwork, self-assessment, and other process skills should explicitly identify their target skills and adopt proven instructional strategies that promote those skills.

The current instructional delivery in AE does emphasize student-centered approaches. For example, AE faculty use small group problem-solving exercises in almost every class meeting, students work in teams to complete a variety of tasks, make in-class presentations, and complete several team projects. In addition, students are encouraged to present their work at conferences and several have won national awards. To further increase the effectiveness of our instructional delivery and serve students from diverse backgrounds and needs, the AE faculty will: (a) redesign several AE courses to emphasize formal project-based learning and integrative learning, (b) explore opportunities for AE students to engage in service-based learning, and (c) offer courses online.

C1.2 AE Program Goals

The AE faculty has set the following three goals for the next five years:

- Modernize the BSAE Program to reflect 21st century realities.
- Modernize the MSAE Program to reflect 21st century realities.
- Increase student and faculty exposure to international engineering practices

C2 Strategies and Actions Plan

GOAL 1: Modernize the BSAE Program to reflect 21st century realities.

Objective 1.1 Develop interdisciplinary programs

New jobs in the 21st century often require background from more than one discipline. By developing flexible, interdisciplinary programs in new areas related to AE, the Program will prepare graduates better equipped to fill these jobs.

Action 1.1.1 – Discuss with other programs / departments to explore possibilities
Action 1.1.2 – Establish the first such program / advertise / recruit students
Responsibility: AE Program Coordinator, Associate Deans for UG Studies, Associate Deans for Graduate Studies
Resources: None
Timeline: next 5 years
Success Metric: interest / student enrollment

Objective 1.2 Develop concurrent BSAE / MSAE track for qualified students

Many of our undergraduate students return to our Program for graduate work, often immediately upon completing their BSAE degree. A dual track program will allow qualified students (minimum GPA = 2.75 – 3.0) to plan ahead and streamline their schedule of classes, so they can earn both degrees in five years. This track was recommended by the MSAE Program evaluator in 2003 and is expected to increase graduate student enrollment.

Action 1.1.1 – Develop 5-year plan, brochures for students in BSAE / MSAE track
Action 1.1.2 – Establish BSAE / MSAE track, advertise, recruit qualified students
Responsibility: AE Program Coordinator, COE Associate Dean for UG Studies, COE Associate Dean for Graduate Studies and Research
Resources: None
Timeline: AY 2007-2008
Success Metric: # of years to complete degrees, student enrollment

Objective 1.3 Develop / offer MSAE courses online

Offering courses online will encourage more working professionals to pursue an MSAE degree. Dr. Mourtos has taught ME111 online (1999), one of the first two COE courses to be offered via the Internet.

Action 1.3.1 – Train AE faculty in WebCT
Action 1.3.2 – Develop webpages for each course to be offered online
Action 1.3.3 – Advertise
Responsibility: AE Coordinator, AE faculty
Resources: 0.2 release time per course developed
Timeline: next 5 years
Success Metric: # of AE course websites developed, student enrollment / success in online courses

Objective 1.4 Offer electives in aircraft systems

This was a recommendation made by the AE Advisory Board. These courses will give AE students more in-depth knowledge in aircraft systems, improving their design and systems integration skills. To minimize the resources needed, the AE Coordinator will explore the possibility of using one or two aviation courses as electives in focus area 1 (aircraft design).

Action 1.4.1 – Examine content of aircraft system courses in the Aviation Program / Discuss with Aviation Director
Responsibility: AE Program Coordinator
Resources: none
Timeline: AY 2007-2008

Success Metric: student enrollment in elective courses

Objective 1.5 Re-establish AE10 as a sophomore level course
Dr. Mourtos taught AE10 as a freshman, 3-unit course in the early days of the AE Program. Later, the course was reduced to a one-unit seminar team-taught by the AE faculty. AE10 will be taught as a 3-unit, hands-on course to keep AE sophomores engaged in their discipline by joining AE senior design teams and participating in national design competitions. The course will be offered at the sophomore level this time because AE students will be exposed to engineering in general and AE in particular in the new E10 course, which will incorporate laboratory experiments from all engineering disciplines.
Action 1.5.1 – Install AE10 in the Fall 2007 schedule of classes
Action 1.5.2 – Offer AE10 every Fall semester
Responsibility: AE Program Coordinator
Resources: 0.2 to teach the course
Timeline: AY 2007-2008
Success Metric: student enrollment / AE student retention

Objective 1.6 Convert core AE courses to integrated, project-based courses
Several AE core and elective courses have been integrated through projects during AY 05-06 [ref. 6]. Students worked in teams, defined an analytical or design problem of interest, and used theory or applications from each of the courses integrated. Several teams have produced high-quality projects, worthy of publication. The AE faculty will formalize this approach by requiring all students who take these courses to perform such projects.
Action 1.6.1 – Modify syllabi of core AE courses to reflect new course assignment
Responsibility: AE faculty
Resources: none
Timeline: Spring 2007 – Fall 2007
Success Metric: quality of student projects, student participation in conferences

GOAL 2: Modernize the MSAE Program to reflect 21st century realities.

Objective 2.1 Establish graduate curriculum / research in support of Focus Area # 1 (Aircraft Design)
Although an undergraduate aircraft design course sequence is well established, there are currently no graduate courses in the Program in this area. MSAE students accepted into the Program from other engineering fields often express interest in pursuing a project / thesis in this area, yet they lack the necessary background. In addition, there is a need to offer a graduate level course to teach class II methods in aircraft preliminary design as well as UAV applications. These courses will allow graduate students who are interested in pursuing projects in aircraft design an extra year to work on their project, thus increasing the quality of their work and the possibility of publication.
Action 2.1.1 – Relocate the Aircraft Design Laboratory to accommodate increased student enrollment and graduate students
Action 2.1.2 – Update computers in the Aircraft Design Laboratory (currently there are four and only two are working; need a minimum of ten); install laser color printer
Action 2.1.3 – Develop / teach AE271A and B
Action 2.1.4 – Publish student projects / theses in aircraft design.
Responsibility: Dr. Nikos J. Mourtos
Resources: 0.2 per semester (AE271A – fall, AE271B – spring)
Success Metric: quality of student projects, student participation in conferences
Timeline: S07 – S08

Objective 2.2 Establish graduate curriculum in Planetary Entry, Descent, and Landing (EDL) technologies.

Action 2.2.1 – Develop new courses in:

- Entry aerothermodynamics, reacting flow modeling / simulations, and Thermal Protection System (TPS) sizing
- Entry trajectory, ballutes, deployable surfaces, supersonic parachutes, and science station design

Action 2.2.2 – Identify instructors from local industry
Action 2.2.3 – Streamline new courses with the International Planetary Probe Workshop (IPPW) short courses.
Responsibility: Dr. Periklis Papadopoulos
Resources: Instrumentation (~ 10 x 5K = $50K)
Release time, travel and related expenses to participate in the IPPW.
Possible funding sources: NASA, NSF
Success Metric: student enrollment in new courses
Timeline: next 5 years

Objective 2.3 Develop research in Planetary Entry, Descent, and Landing (EDL) technologies.
Action 2.3.1 – Identify MSAE students to pursue a Ph.D. through the newly established Mississippi SU Gateway Ph.D. Program.
Action 2.3.2 – Develop with students a set of benchmark cases for code validations.
Responsibility: Dr. Periklis Papadopoulos
Resources: Increased computational resources for reacting flow modeling
Possible funding sources: local industry
Timeline: Over the next 5 years.
Success Metric: quality of student projects, student participation in conferences

Objective 2.4 Establish relationships with local industry (Lockheed-Martin, NASA Ames, Loral)
Action 2.4.1 – AE Coordinator coordinates MSAE Program at Lockheed-Martin (involved in planning, promoting, student advising, etc.).
Action 2.4.2 – AE faculty teach MSAE courses at Lockheed-Martin
Action 2.4.3 – AE faculty supervise AE295 projects at Lockheed-Martin
Responsibility: MAE Department Chair, AE Coordinator and AE faculty
Resources: none
Timeline: Over the next 5 years.
Success Metric: student enrollment in MSAE Off-Campus programs, collaborative research papers

GOAL 3: Increase student and faculty exposure to international engineering practices

Objective 3.1 Establish collaboration with international universities and other professional organizations
In today's globalized economy it is critical that both faculty and students are aware of engineering practices used elsewhere. Moreover, there is a need to educate new generations of students in other cultures and languages. This is necessary in order to understand US competitors but also to enhance collaboration in a global environment.
Action 3.1.1 – AE faculty establish relationships with universities overseas
Action 3.1.2 – AE students / faculty collaborate in projects with students / faculty from universities overseas
Action 3.1.3 – AE students visit universities overseas, present papers at international conferences, participate at international design competitions
Responsibility: AE faculty
Resources: travel money for AE faculty and students
Success Metric: student participation in joint projects with universities overseas, student participation in international conferences and design competitions
Timeline: Next five years

C3 Strategies and Actions Plan Summary Matrix

Table 26 Strategies and actions plan summary

GOAL 1: Modernize the BSAE Program to reflect 21st century realities					
	Objective 1.1: Develop interdisciplinary programs				
		Responsibility	*Resources*	*Timeline*	*Success Metric*
	Action 1.1.1	AE Coordinator	None	Next 5 years	Interest
	Action 1.1.2	AE Coordinator	None		Student enrolment
	Objective 1.2: Develop concurrent BSAE / MSAE track				
		Responsibility	*Resources*	*Timeline*	*Success Metric*
	Action 1.2.1	AE Coordinator	None	AY 07-08	# of years to complete BSAE / MSAE degrees, student enrolment
	Action 1.2.2	AE Coordinator	None		
	Objective 1.3: Develop / offer courses online				
		Responsibility	*Resources*	*Timeline*	*Success Metric*
	Action 1.3.1	AE faculty	0.2 release time per course developed	Next 5 years	
	Action 1.3.2	AE faculty			# of AE course websites developed
	Action 1.3.3	AE Coordinator			student enrollment / success in online courses
	Objective 1.4: Offer electives in aircraft systems				
		Responsibility	*Resources*	*Timeline*	*Success Metric*
	Action 1.4.1	AE Coordinator	None	AY 07-08	student enrollment in elective courses
	Objective 1.5: Re-establish AE10 as a sophomore level 3-unit course				
		Responsibility	*Resources*	*Timeline*	*Success Metric*
	Action 1.5.1	AE Coordinator	None	S07	student enrollment / AE student retention
	Action 1.5.2	AE faculty	0.2 to teach	F07	
	Objective 1.6: Convert core AE courses to integrated, project-based courses				
		Responsibility	*Resources*	*Timeline*	*Success Metric*
	Action 1.6.1	AE faculty	None	S07 – F07	quality of student projects, student participation in conferences

Table 26 Continued

GOAL 2: Modernize the MSAE Program to reflect 21st century realities					
	Objective 2.1: Establish graduate curriculum / research in aircraft design				
		Responsibility	*Resources*	*Timeline*	*Success Metric*
	Action 2.1.1	MAE Dept. Technician	Technician time	S07	A well functioning Aircraft Design Lab with modern computers and software
	Action 2.1.2	MAE Dept. Chair, Technician	$10K, technician time	S07 – F07	
	Action 2.1.3	Dr. N. J. Mourtos	0.2 per semester	F07 – S08	# of students enrolled
	Action 2.1.4	Dr. N. J. Mourtos / MSAE students	Travel / publication costs	Ongoing	quality of student projects, student participation in conferences
	Objective 2.2: Establish graduate curriculum in Planetary EDL technologies.				
		Responsibility	*Resources*	*Timeline*	*Success Metric*
	Action 2.2.1	Dr. P. Papadopoulos	$50K for instrumentation	Next 5 years	# of students enrolled
	Action 2.2.2	Dr. P. Papadopoulos	0.2 per course		
	Action 2.2.3	Dr. P. Papadopoulos	None		
		Responsibility	*Resources*	*Timeline*	*Success Metric*
	Objective 2.3: Develop research in Planetary EDL technologies.				
		Responsibility	*Resources*	*Timeline*	*Success Metric*
	Action 2.3.1	Dr. P. Papadopoulos	Increased computational resources and technical support	Next 5 years	quality of student projects, student participation in conferences
	Action 2.3.2	Dr. P. Papadopoulos			
	Objective 2.4: Establish relationships with local industry (Lockheed-Martin, NASA Ames, Loral)				
		Responsibility	*Resources*	*Timeline*	*Success Metric*
	Action 2.4.1	MAE Dept. Chair to allow AE Coordinator	None	LM: ASAP Other: Next 5 years	# of students enrolled in Off-Campus AE programs, collaborative research papers, student participation in conferences / industry projects
	Action 2.4.2	MAE Dept. Chair to allow AE faculty	None		
	Action 2.4.3	MAE Dept. Chair to allow AE faculty	None		
GOAL 3: Increase student and faculty exposure to international engineering practices					
	Objective 3.1: Establish collaboration with international universities and other professional organizations				
		Responsibility	*Resources*	*Timeline*	*Success Metric*
	Action 3.1.1	AE faculty	travel / publication money for AE faculty and students	Next 5 years	# of connections with universities overseas
	Action 3.1.2	AE faculty & students			# of collaborations with universities overseas, joined papers
	Action 3.1.3	AE faculty & students			AE student & faculty participation at international conferences / design competitions

C4 Five Year Student Recruiting, Faculty and Staff Hiring

C4.1 Student Recruiting and Retention

SJSU students come from very diverse ethnic and academic backgrounds and AE students are no exception. This is not expected to change in the next five years. AE student enrolment has been increasing for the last several years and reached 220 majors in AY 05-06. However, it is limited by lack of tenured / tenure-track AE faculty as well as current Department structures and policies.

The following outreach activities are planned on a semester / annual basis:

- Lectures / demonstrations on the AE profession and the AE Program in the E8 course
- AE laboratory demonstrations during COE Open House / high-school visitations
- High-school and middle-school presentations by AE seniors and faculty, especially in schools with high enrollment of minority students
- Presentations / demonstrations by AE seniors and faculty at the Tech Museum of Innovation (San Jose) and the Exploratorium (San Francisco)

In addition, for the AE Program to reach its full potential in terms of student enrollment (~300 students), several structural changes must take place:

- The AE Program must be administered with some degree of independence. The current Department structures and policies (ex. no support and authority for AE Coordinator, improper advising of AE students), limit rather, than promote growth.
- AE students must be advised by AE faculty members, who have knowledge of the AE field and vested interest in the well-being of their Program.

C4.2 Faculty Hiring Plan and Justification

What faculty recruitment and development opportunities are needed during the next five years to support the program? We take two distinct views to answer this question. The first view is from an aerospace systems perspective (Aeronautics / Astronautics or AE Program focus areas). The second view is from the disciplines perspective (courses). The following Tables 27 and 28 show the BSAE and MSAE focus areas and disciplines as well as the corresponding AE courses for each area / discipline.

Table 27 BSAE focus areas and courses

	BSAE		
	Aeronautical Engineering	Astronautical Engineering	
	Aircraft Design AE 171 A, B	Space Systems AE 172 A, B	Space Transportation & Exploration AE 172 A, B
Aerodynamics	AE162 AE164 AE169		AE162 AE164 AE169
Stability & Control	AE165 AE168		
Aircraft Propulsion	AE167		
Flight Mechanics	AE165		
Aerospace Structures & Materials	AE114		
Orbital Mechanics		AE165	AE165
Space Environment		AE110	AE110
Attitude Determination & Control		AE168	AE168
Telecommunications		AE110	AE110
Space Structures		AE114	AE114
Space Propulsion		AE167	AE167

Table 28 MSAE focus areas and courses

	MSAE		
	Aeronautical Engineering	Astronautical Engineering	
	Aircraft Design AE 271 A, B	Spacecraft Systems	Space Transportation & Exploration
Aerodynamics	AE262 AE264 AE269		AE262 AE264 AE269
Aircraft Stability & Control	AE246		AE246
Structures & Materials	AE250	AE250	AE250
Space Systems Engineering		AE210	AE210
Spacecraft Instrumentation & Payload Sensors		AE222	AE222
Orbital Mechanics & Mission Design		AE242	AE242
Astrodynamics		AE243	AE243
Spacecraft Dynamics & Control		AE245	AE245
Space Propulsion	AE267	AE267	AE267
Spacecraft Thermal Systems		AE270	AE270
Spacecraft Power Systems		AE275	

- The BSAE and MSAE Programs have three focus areas, as shown on the corresponding columns on the tables above. Currently, only two of these areas are covered by full-time, tenured / tenure-track AE faculty (Dr. Mourtos - Aircraft Design, Dr. Papadopoulos - Space Transportation and Exploration). Hence, there is an urgent need to hire a third AE faculty member to lead the area of Space Systems.
- Of the disciplines shown in these tables, AE faculty cover aerodynamics, propulsion, and space systems engineering. Hence, there is a need to hire AE faculty members with expertise in stability and control, orbital mechanics and astrodynamics, spacecraft instrumentation, spacecraft power systems, and aerospace structures and materials.

C4.3 Staff Hiring Plan and Justification

The AE Program needs a dedicated technician to maintain its eight laboratories. Three of these laboratories involve physical experiments and the rest are computer labs. The MAE Department currently has only one technician. It is not possible for one person to service 13 ME and eight (8) AE laboratories, especially when these laboratories involve a mix of various types of equipment and computers. Moreover, laboratories with physical (hands-on) experiments require a different set of skills to maintain than computer laboratories. One solution would be to hire a dedicated AE technician, who would have the time to service all the AE labs. Another solution would be to hire a Department technician with expertise in computer hardware and software. This would allow the current Department technician to concentrate on equipment supporting physical experiments for both programs (AE and ME), while the new technician would service the Department's office and laboratory computers.

In addition, there is a need for improved support from the MAE Department Office. A student assistant wholly dedicated to the needs of the AE Program would greatly ease faculty workload, especially in areas where administrative support should be expected but is currently not available (ex. preparation of statistical data, compilation/organization of data for self-study reports, etc.). This is very critical for the AE Program, which is currently supported by only two full-time faculty members.

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APPENDIX A BACKGROUND INFORMATION

I. College of Engineering Background Information

I.A General Information

College of Engineering
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Dean: Dr. Belle Wei
Associate Dean of Graduate and Extended Studies: Dr. Ahmed Hambaba
Associate Dean of Research: Dr. Kevin Corker
Associate Dean of Undergraduate Studies: Dr. Ping Hsu

I.B College of Engineering 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.

I.B.1 College of Engineering Goals

The College has identified three goals to achieve its vision and mission.

- 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

- To be a nationally recognized, professionally oriented graduate engineering program
  - 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

I.C Alignment with University Mission and Goals

University Mission

In collaboration with nearby industries and communities, SJSU faculty and staff are 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.

Goals

For both undergraduate and graduate students, the university emphasizes the following goals:

- 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.

Character and Commitment

San José State University is a major, comprehensive public university located in the center of San José and in the heart of Silicon Valley. SJSU is the oldest state university in California. 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 an uncompromising commitment to offer access to higher education to all persons who meet the criteria for admission, yielding a stimulating mix of age groups, cultures, and economic backgrounds for teaching, learning, and research. SJSU takes pride in and is firmly committed to teaching and learning, with a faculty that is active in scholarship, research, technological innovation, community service, and the arts.

I.D Faculty and Students

The following table provides a summary of the faculty and student counts for the College and each program under evaluation.

Table 29 COE Faculty and Student Head Count - Fall 2005

	HEAD COUNT		FTE	TOTAL STUDENT CREDIT HOURS
	FT	PT		
Tenure Track Faculty	66	5	60.53	
Other Teaching Faculty (excluding student assistants)	2	99	31.26	
Student Teaching Assistants	0	42	8.15	
Undergraduate Students	2367	647	2593.45	38901.75
Graduate Students	513	1022	645.86	9687.9
Professional Degree Students	0	0	0	0

FTE: Full-time Tenure Track Faculty = Tenured & Probationary. Part-time Tenure Track Faculty = Faculty Early Retirement Program (FERP). Full-time Other Teaching faculty = Lecturer at 1.00. Part-time Other Teaching Faculty = Lecturer < 1.00. Student Teaching Assistants = Grad. Assistants & Teaching Associates, which we only considered as part-time only.

A1.2.5 Engineering Personnel and Policies

Table 30 COE Personnel and Students – Fall 2005

	HEAD COUNT		FTE	RATIO TO FACULTY
	FT	PT		
Administrative	2	7	5.2	
Faculty (tenure-track)	82	5	70	
Other Faculty (excluding student Assistants)	5	120	42	
Student Teaching Assistants	0	42	9.15	
Student Research Assistants				
Technicians/Specialists	15			
Office/Clerical Employees	14	2		
Others				
Undergraduate Student Enrollment	2367	647	2214	19.7
Graduate Student Enrollment	513	1022		

A1.2.6 Non-Academic Support Units

The College of Engineering Computing Systems

The College of Engineering Computing Systems (ECS) is comprised of five full-time employees. Each individual is assigned an area of interest or specialization. The areas of interest and specialization are: faculty and staff desktop support, networking, World Wide Web (WWW), UNIX laboratories, and academic instructional laboratories. Several student assistants are shared by all ECS personnel.

Faculty and Staff Support

ECS develops and supports laboratory, faculty, and staff computer systems; implements, configures and maintains application software; network operating systems; provides Internet connectivity, and manages hardware and software licenses. ECS ensures the functionality, applicability, and maximum uptime of laboratory servers and workstations. As well, ECS ensures operational, reliable, secure, and optimal computer systems for academic computer laboratories and desktops.

The following list outlines specific work activities performed by ECS support personnel:

(1) Scott Pham, Information Systems Analyst, Career Level

Plan, design, specify, evaluate select, order, install, configure, maintain, and administer software and hardware for servers, clients, and peripherals in academic computer laboratories. (See Exhibit II-3a)

As needed, plan, specify, evaluate select, order, install, configure, and maintain software and hardware for faculty and staff desktop computers and peripherals.

Troubleshoot laboratory and user operating systems and application software. Diagnose and repair computers and peripheral equipment. Develop procedures for secure and efficient laboratory use. Development of quick-recovery procedures to restore corrupt laboratory computer systems.

Support faculty and staff as technical consultants for software, operating systems, and Internet connectivity issues.

Maintain currency of virus protection. Maintain FTP server with current virus software and updates. Maintain frequent email and personal contact with faculty and staff.

(2) William Black, Operating Systems Analyst, Career Level

Design, implement, and maintain UNIX laboratory hardware and software for the purpose of coursework and research. (See Exhibit II-3b)

Provide supplemental support to department technicians.
Assist in developing department and college-wide systems and policies.
Investigate and evaluate new products and solutions.
Assist the Network Administrator with developing and implementing network configuration changes.
Work directly with faculty and staff to resolve individual computer issues. (Help Desk)

(3) In the Process of Hiring, Information Systems Analyst, Career Level, Webmaster

Creates and manages the information content (words and pictures) and organization of the COE Web site (*http://www.engr.sjsu.edu*).
Manages the computer server and technical programming aspects of the Web site.
Educates and supports faculty and staff with Web related functions.
Works with ECS staff, department Chairs and Dean to establish the overall COE Web site design and policies.
The College of Engineering Webmaster typically "does it all." The Webmaster is someone with graphics design background who has also Web site creation skills and programming skills; mainly knowledge and experience with HTML, JAVA, and DHTML. The Webmaster administers multiple servers (i.e.: Web, FTP, Email, ListServer, Database, Applications, Files server) and writes or implement programs required by the faculty and staff.

(4) Ben Rashid, Information Systems Analyst, Career Level

The hardware technician provides hardware support and maintenance for the College of Engineering. The hardware technician is expected to: maintain, install, repair, and troubleshoot component level hardware in microcomputer systems, peripheral equipment, and local area networks; provide technical support for faculty and staff; act as liaison with hardware and software vendors; recommend upgrade requirements for software and hardware; maintain and monitor the College of Engineering computer inventory; and train and work closely with student assistants.

Specifically, Mr. Rashid troubleshoots email problems, desktop network issues, printing problems (including network printing), system performance issues, peripheral configuration, user account management, system security, part repair and service, hardware and software compatibility issues, and user data migration when new systems are installed.

(5) Kindness Israel, Information Systems Analyst, Expert Level, Director

The ECS Director is responsible for developing, implementing, managing, and maintaining cost-effective, reliable College-wide computing and network systems, which includes administrative systems, instructional computer labs, and Internet access. The Director makes specifications for procurement, installation, support, and maintenance of requisite hardware and software for the COE, makes recommendations for all Engineering departments, develops and implements operational policies, procedures, and practices necessary for reliable delivery of computing and network services in consultation with the Central Computing and Telecommunications, coordinates technology projects with the appropriate faculty, staff, and students, builds consensus and solicits input when making significant changes, and maintains good channels of communication in terms of decisions and policies associated with the delivery of technical services within the College. He provides support and direct supervision of personnel subordinate to this position (5 full time staff and 40 hours/week student assistants) including initiating and monitoring project planning and reviews, recommending personnel actions, preparing performance reviews, job descriptions, participates in recruitment of ECS personnel. He develops and implements requests and proposals for acquisition of equipment, software, supplies, and services, and assists in providing technical training for faculty and staff. The director also develops and maintains databases, records, documents, and files associated with computing and networking systems.

ECS Scope of Responsibility

(i) Network Infrastructure

Responsible Person(s): Kindness Israel, William Black, Scott Pham
Scope: COE Building, IS Building, Aviation Building, All Departments
Hardware/Software:

- COE IP Copper/Fiber Backbone (Currently 2000 ports)
    - 4 Alcatel 9 Slot OmniSwitches
    - 15 Alcatel 5 Slot OmniSwitches
    - 16 Alcatel 3 Slot OmniSwitches
    - 7 Alcatel 5024 OmniStacks
    - 4 Alcatel 1032 OmniStacks
    - Dozens of Netgear and Linksys Hubs
    - 6506 Cisco Router
    - 2511 Cisco Router
- COE Wireless Network
    - Linux Router/Gateway
    - 8 Wireless Linksys Access Points
    - RADIUS Server
- SUSU Wireless Network
    - Router
    - 4 Switches
    - 16 Cisco 1200 Access Points
- Design and Implementation of New Network (Upgrade to 4,000 ports)
    - New Cat6 Copper and Multimode Fiber Infrastructure by May 2005
    - New Cisco Electronics by August 2005

Student/Faculty Impact: Administration, Staff, Faculty, and Students
Policy/Guidelines: Internet usage policies are determined by the CSU Chancellor's office.

(ii) Core Servers

Responsible Person(s): Kindness Israel, William Black, Scott Pham
Scope: COE, All Departments
Hardware/Software:

- Firewall (Linux using iptables)
- Xvision Server (Alcatel SNMP Server)
- VPN Server (Firewall access for Faculty)
- 3 DNS Servers (Domain Name Server Address Resolution)
- DHCP Server (IP Address Leasing)
- MRTG Monitor (Security Monitoring)
- MIRROR Server (Linux Software Application Server)
- 3 ENGR MS Active Directory Servers (Primary Domain Controller)
- Oracle 8i INFO Database (Faculty/Staff Database)
- Oracle 8i CMPE Database (CMPE 138, 143)
- Application Development Server (Opentrak, Peoplesoft Access)

Student/Faculty Impact: Administration, Staff, Faculty, and Students
Policy/Guidelines: ECS is responsible for the procurement, installation, and maintenance of all hardware and software necessary to ensure the smooth operation of the COE computing infrastructure.

(iii) COE Academic Laboratories

Responsible Person: Scott Pham
Scope: E333, E390, E391, E407, E393, E394
Hardware/Software: 150 Pentium Computers, Domain Controller, and File Server / MS Win2000

Student/Faculty Impact: All Undergraduate Students, and Faculty
Policy/Guidelines: ECS is responsible for the procurement, installation, and maintenance of all hardware and software necessary to conduct computer laboratory instruction in the COE academic laboratories (Exhibit II-3a).

(iv) Open Laboratories

Responsible Person: Scott Pham
Scope: E405 and E390
Hardware/Software: 50 Pentium Computers, Domain Controller / MS WinNT
Student/Faculty Impact: Undergraduate, Graduate Students, and Faculty
Policy/Guidelines: ECS is responsible for the procurement, installation, and maintenance of all hardware and software necessary to conduct computer laboratory instruction in the COE open laboratories (Exhibit II-3a).

(v) Department Laboratories

Responsible Person(s): Faculty members who conduct classes in the laboratories and department technicians.
Scope: Network access is provided by ECS.
Hardware/Software: MS Operating Systems, Sun Solaris, Linux
Student/Faculty Impact: Undergraduate, Graduate Students, and Faculty
Policy/Guidelines: ECS provides network access to all department laboratories. ECS provides secondary-level support to every department and research laboratory. Secondary-level support consists of answering any technical questions posed by the faculty or department technician thus ensuring the successful implementation of the project or class. Any ECS person may be called upon to assist.

(vi) Research Laboratories

Responsible Person(s): Faculty members who originally obtained the grant and department technicians.
Scope: Network access is provided by ECS.
Hardware/Software: Varies
Student/Faculty Impact: Graduate Students, Faculty
Policy/Guidelines: ECS provides network access to research laboratories such as the HAIL Lab, Cisco Laboratory, and faculty research laboratories. ECS provides secondary-level support to every department and research laboratory. Secondary-level support consists of answering any technical questions posed by the faculty or department technician thus ensuring the successful implementation of the project. Any ECS person may be called upon to assist.

(vii) UNIX (Solaris) Laboratories

Responsible Person(s): William Black, Kindness Israel
Scope: Primarily EE and CMPE Cadence Laboratories and Research Laboratories
Hardware/Software: 120 Sun Solaris, IBM AIX, and Linux on Intel Architecture
Student/Faculty Impact: Graduate Students enrolled in Cadence Classes, Department Graduate Research Projects
Policy/Guidelines: ECS provides UNIX support for all departments of the COE (Exhibit II-3b).

(viii) WWW.ENGR.SJSU.EDU Website

Responsible Person: In the Process of Hiring
Scope: COE, All Departments
Hardware/Software: Dell Linux Server / Apache, MySQL, PHP, WebAdmin, Photoshop
Student/Faculty Impact: All Administrative, Faculty, Staff, and Students

Policy/Guidelines: ECS maintains the COE home page and provides support for all departments and faculty. Many departments have their own webmasters. ECS has always sought to coordinate and streamline the efforts of the department webmasters with the COE main page.

(ix) Administrative Desktop Support

Responsible Person: Ben Rashid
Scope: Dean and Graduate Studies Offices, CEE, ChemE
Hardware/Software: Domain Controller and File Server / Microsoft Windows and Office Suite Software - All Versions, PeopleSoft, Oracle Discover Clients, Photoshop, and assorted workflow applications.
Student/Faculty Impact: Administration, Staff, and Faculty
Policy/Guidelines: ECS provides front-line support to the Dean and Graduate Studies, and CEE. The other departments in the COE have department-level technician support. ECS provides secondary-level support to every department. Secondary-level support consists of answering any technical questions posed by the faculty or department technician thus ensuring the successful implementation of the department's operation. Any ECS person may be called upon to assist.

(x) Email Support:

<u>Lotus Notes</u>
Responsible Person: Ben Rashid
Scope: COE, All Departments
Hardware/Software:
Lotus Notes Servers - Central Computing
Lotus Notes Clients - Ben Rashid
Student/Faculty Impact: Administration, Staff, and Faculty
Policy/Guidelines: It is the responsibility of ECS to install and configure the Lotus Notes client. Lotus Notes servers are administered by Central Computing. Lotus Notes is the preferred (and recommended) email service for administrative, staff, and faculty usage.

<u>Eudora</u>
Responsible Person: Scott Pham
Scope: COE, All Departments
Hardware/Software: Eudora Clients
Student/Faculty Impact: Administration, Staff, and Faculty
Policy/Guidelines: It is the responsibility of ECS to install and configure the Eudora client. Department technicians also assist with email client installations.

<u>MS Outlook, Mozilla, and Other Email Clients</u>
Responsible Person(s): ECS Staff
Scope: COE, All Departments
Hardware/Software: Eudora Clients, Mozilla, Netscape, and MS Outlook
Student/Faculty Impact: Administration, Staff, and Faculty
Policy/Guidelines: It is the responsibility of ECS to install and configure
Email clients in the absence of department technicians or in instances where special problems are encountered.

(xi) Faculty and Staff Desktop Support

Responsible Person(s): Department Technicians, Ben Rashid, ECS Staff
Scope: COE, All Departments
Hardware/Software: Microsoft Windows - All Versions
Student/Faculty Impact: Administration, Staff, and Faculty
Policy/Guidelines: ECS provides front-line support to the Dean and Graduate Studies, and CEE. The other departments in the COE have department-level technician support. ECS provides secondary-level support to every department. Secondary-level support consists of answering any technical questions posed by the

faculty or department technician thus ensuring the successful implementation of the department's operation. Any ECS person may be called upon to assist.

(xii) Backups

Responsible Person(s): ECS Staff
Scope: COE, All Departments
Hardware/Software: Intel Architecture, Sun Sparc, Network Devices, Core Servers, File Servers, and Domain Controllers / Linux, Solaris, Windows 2000, Databases, Student Accounts, and Research data
Student/Faculty Impact: Administrative, Faculty, Staff, and Students
Policy/Guidelines: Kindness Israel performs daily and weekly backups on the COE core servers, databases, and Linux student accounts. Solaris student accounts are the responsibility of William Black, Scott Pham is responsible for the academic laboratory domain controllers and related student accounts, and Ben Rashid is responsible for the administrative domain controllers and file servers. In the Process of Hiring is responsible for the COE WWW server and related accounts. Sigurd Meldal performs daily backups on the CMPE administrative accounts. The other COE departments perform no regular or scheduled backups.

(xiii) Anti-Virus and Security

Responsible Person(s): Scott Pham, Kindness Israel, William Black
Scope: COE, All Departments
Hardware/Software: Intel Architecture / Microsoft Windows - All Versions
Student/Faculty Impact: Administrative, Faculty, Staff, and Students
Policy/Guidelines: The COE purchases McAfee AntiVirus software for distribution to the faculty and staff. ECS oversees and ensures that antivirus software updates are distributed to the COE department technicians for installation.

Security is primarily a subdivision of networking. The primary network defense is the COE firewall. Unfortunately, an inordinate amount of time is required to track-down abusers of the system. The security and best practices of the CSU are posted on the ECS Networking Web Page.

(xiv) Software

Microsoft CD Library and Distribution Server (ecs_apps)
Responsible Person: Scott Pham
Scope: COE, All Departments
Hardware/Software: MS Operating Systems, MS Office Suite
Student/Faculty Impact: Faculty, Technical Staff
Policy/Guidelines: The COE purchases a minimal number of distribution disks and licenses. The original CDs are archived and the images are distributed via Juanita's share server which can be accessed using a password and shared link. All department technicians use the share server daily. Certain bootable CDs must be replicated from the original CDs. Juanita performs the CD creation task for the COE.

Software Licenses
Responsible Person: Scott Pham
Scope: Faculty
Hardware/Software: Matlab, McAfee, ASAP Contracts
Student/Faculty Impact: Faculty and Students
Policy/Guidelines: ECS obtains and maintains the software licenses. EE also has an extended version of Matlab applications. Matlab and AutoCad are distributed to the department technicians via the ECS application server along with non-licensed software.

(xv) COE and ECS Department Purchases

Responsible Person(s): Kindness Israel, Scott Pham, and Ben Rashid
Scope: COE, ECS, All Departments

Hardware/Software: All computer hardware/software necessary to maintain the COE and ECS departments.
Student/Faculty Impact: Administrative, Faculty, and Staff
Policy/Guidelines: In addition to the COE Dean and Graduate Studies office purchases, ECS also researches and advises faculty and technical staff about where and how to obtain the most cost efficient hardware and software.

(xvi) Staff Training

Responsible Person(s): ECS Staff
Scope: Department Technicians
Hardware/Software: Intel and Sun / Microsoft Windows - All Versions, Linux, Sun Solaris
Student/Faculty Impact: Department Technicians
Policy/Guidelines: ECS has conducted classes for department technicians and maintains a mailing list for the purpose of keeping the technical staff informed of upcoming relevant events and special classes. By and large, a constant dialog and exchange of information is conducted between ECS and the technical staff.

(xvii) Walk-In and Phone Support

Responsible Person(s): ECS Staff
Scope: COE, All Departments
Hardware/Software: All.
Student/Faculty Impact: Faculty, Technical, and Administrative Staff
Policy/Guidelines: ECS has an "open door" policy toward questions and eagerly looks forward to helping any COE faculty, staff, or student solve their computer or network problems.

(xviii) Special Projects

Responsible Person: Kindness Israel
Scope: Students
Hardware/Software: Linux / Linux
Student/Faculty Impact: Students
Policy/Guidelines: Kindness Israel is the sponsor of the San Jose State Linux Users Group (SJSULUG). The club meets in E239 and has built several Linux clusters for research projects.

(xix) Student Organization Rooms

Responsible Person(s): Department Technicians
Scope: Departments
Hardware/Software: Intel / Microsoft Operating Systems - All Versions.
Student/Faculty Impact: Faculty, Students
Policy/Guidelines: Club rooms are maintained by the departments. ECS provides network access.

(xx) Development of Disaster Recovery Documentation/FAQs

Responsible Person(s): ECS Staff
Scope: COE, ECS
Hardware/Software: All
Student/Faculty Impact: ECS Staff
Policy/Guidelines: Every ECS staff member is required to produce a disaster recovery booklet or spreadsheet of computers under their care. The documentation contains the name, type, location, and any pertinent information about how to login, shutdown, and restart the machine and its primary services. ECS also maintains several

(xxi) Software Development

Responsible Person(s): Kindness Israel, Student Assistant

Scope: Administration, Faculty, Staff
Hardware/Software: Linux on Intel Architecture / Advisor, Room Scheduler, Monitor Software, OpenTrak, Student Data, Login Accounts, COE Databases, Department Queries, UNIX Scripts.
Student/Faculty Impact: Administrative, Faculty, Students
Policy/Guidelines: ECS has traditionally employed a student programmer for the purpose of providing direct access to SIS and PeopleSoft data. These data have been used to create a number of products and solve complex IT problems.

(xxii) Inventory and Resources

Responsible Person: Kindness Israel
Scope: COE Building
Hardware/Software: Annual Inventory conducted with FD&O
Student/Faculty Impact: N/A
Policy/Guidelines: FD&O requires that all computer items and network equipment costing more than $5,000 be accountable. Overall, ECS is directly responsible for over a million dollars worth of computer and network equipment.

(xxiii) Computer and Printer Repair

Responsible Person(s): ECS Staff, Student Assistant
Scope: Academic Laboratories, Administrative Offices, Core Servers, ECS Desktops
Hardware/Software: Core Servers, Laboratory Computers, Administrative Computers, Sun Servers, Printers
Student/Faculty Impact: Undergraduate Students, Faculty, Administrative Staff
Policy/Guidelines: The academic laboratories are the sole responsibility of ECS. The Dean's office and Graduate Studies office are the sole responsibility of ECS. ECS also maintains the software and hardware contracts for the Cadence Solaris laboratories but does not purchase the licenses. Printers are generally cleaned and repaired locally by Ben Rashid or a student assistant.

Student Advising and Services

College of Engineering Units

The College of Engineering has two college-level student advising and supporting units: the Engineering Student Advising Center and the MESA Engineering Program.

The Engineering Advising Center was established in Spring 2005. The Center provides the following services to all engineering students:

- General Education requirement advising
- Monitoring and advising of students on probation
- Study skills workshops
- New Student Advising

The goal of the MESA Engineering Program is to increase the number of competent and qualified graduates entering the engineering profession from groups with low eligibility rates in college admissions. The program provides the following services: student study center, Academic Excellence Workshops, professional development workshops, freshmen orientation, career advising, and supports to student organizations.

Design and Fabrication Services

COE Central Shop is staffed by two full-time mechanics and several part-time student assistants. Central Shop provides a variety of services in the shops, laboratories, and related areas in support of the teaching and research needs of the instructional programs. The responsibilities of the central shop are maintenance and repair of mechanical equipment, design, fabrication and installation of teaching devices and apparatus for instructional, student projects, and faculty research needs, and providing guidance to faculty and students on machine operations.

II. Mechanical & Aerospace Engineering Department Background Information

II.A General Information

The Department of Mechanical and Aerospace Engineering at SJSU offers degree-based, and non-degree based programs in Mechanical Engineering and Aerospace Engineering.

II.B Mechanical and Aerospace Engineering 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.

II.C Department Support Expenditures

Table 31 Department support expenditures

Fiscal Year	1	2	3	4
	2002-03	2003-04	2004-05	2005-06
Expenditure Category				
Operations (not including staff)	69,	33,207	53,51	
Travel	1,	1,219	3,24	
Equipment				
Institutional Funds		0	22,16	
Grants and Gifts				
Graduate Assistants	0	0	0	
Part-time Assistance (other than teaching)	34,	24,059	11,89	

Note:

a. With the exception of the Grants and Gifts category, all expenditures are obtained from General Fund information only as that would be the money received as the institution's annual appropriation. The Operations, Travel, and Equipment – Institutional Funds information was obtained from PeopleSoft EUL01.Department Financial Report by Department (Oracle) for 2002-03 and N1171DF2-Financial Report by Department & Fund (InVision) for 2003-04.

b. With the change to the PeopleSoft financial reporting system, departments were not required to differentiate between types of operating expenses. If a department was ordering equipment or claiming travel, they could use the account number for supplies and services (operations) and that is where the expenditure would show so it is impossible to correctly identify travel and equipment costs at the college level. In 2004-05, this process changed as the financial system assigns an account based on item category, which overrides the account manually entered onto the requisition. Additionally, the rules regarding the use of miscellaneous course fee funds have recently been expanded to include the purchase of lab computers and some equipment is purchased with these funds.

c. Information obtained from the PeopleSoft Labor Cost Distribution Job Function by Period Earned report, the Graduate Assistant section for each department. Information had to be obtained from the Human Resources side of PeopleSoft as the financial side account for Graduate Assistants includes Teaching Associate costs.
d. Part-time Assistance category currently includes student assistant costs only. No Work Study costs are included. Temp Help costs fell into a gray area as that category was still being somewhat defined in 2003-04 so college-level information would not necessarily be accurate and the departments will need to provide detail. Information for this category was obtained from the same financial reports used for Operations, Travel, and Equipment – Institutional Funds.
e. Projections are based on the updated Base Budget allocations packet distributed to department chairs on November 9, 2004.

APPENDIX B AE CURRICULUM

B.I BSAE Curriculum

Table 32 BSAE Curriculum

Year; Semester No. of units	Course (Department, Number, Title)	Category (Credit Hours)			
		Math & Basic Sciences	Engineering Topics Check if Contains Design	General Education	Other
Freshman	Math 30 Calculus I	3.0	0.0	0.0	0.0
Fall	Chem 1A General Chemistry	5.0	0.0	0.0	0.0
18 units	E10 Intro to Engineering	0.0	3.0 (✓)	0.0	0.0
	English 1A Composition I	0.0	0.0	3.0	0.0
	Communications (GE Area A1)	0.0	0.0	3.0	0.0
	Human Performance (PE)	0.0	0.0	0.0	1.0
Freshman	Math 31 Calculus II	4.0	0.0	0.0	0.0
Spring	Physics 70 Mechanics	4.0	0.0	0.0	0.0
17 units	ME20 Design & Graphics	0.0	2.0	0.0	0.0
	English 1B Composition II	0.0	0.0	3.0	0.0
	Human Understanding & Development (GE Area E)	0.0	0.0	3.0	0.0
	Human Performance (PE)	0.0	0.0	0.0	1.0
Sophomore	Math 32 Calculus III	3.0	0.0	0.0	0.0
Fall	Physics 71 Electricity & Magnetism	4.0	0.0	0.0	0.0
18 units	MatE 25 Introduction to Materials	0.0	3.0	0.0	0.0
	ME30 Computer Applications	0.0	2.0	0.0	0.0
	American Studies 1A (GE)	0.0	0.0	6.0	0.0
Sophomore	Math 133A Differential Equations	3.0	0.0	0.0	0.0
Spring	Physics 72 Atomic physics	4.0	0.0	0.0	0.0
18 units	EE98 Intro to Circuit Analysis	0.0	3.0	0.0	0.0
	CE99 Statics	0.0	2.0	0.0	0.0
	American Studies 1B (GE)	0.0	0.0	6.0	0.0
Junior	CE112 Mechanics of Materials	0.0	3.0	0.0	0.0
Fall	ME101 Dynamics	0.0	3.0	0.0	0.0
16 units	ME111 Fluid Mechanics	0.0	3.0	0.0	0.0
	ME113 Thermodynamics	0.0	4.0	0.0	0.0
	E100W Engineering Reports	0.0	0.0	3.0	0.0
Junior	AE114 Aerospace Structures	0.0	3.0	0.0	0.0
Spring	AE162 Aerodynamics	0.0	3.0 (✓)	0.0	0.0
15 units	AE165 Aerospace Flight Mechanics	0.0	3.0 (✓)	0.0	0.0
	ME130 Applied Engr. Analysis	3.0	0.0	0.0	0.0
	Self and Society / Cultural Pluralism (GE area S)	0.0	0.0	3.0	0.0

Table 24 BSAE Curriculum (continued)

Year; Semester No. of units	Course (Department, Number, Title)	Category (Credit Hours)			
		Math & Basic Science	Engineering Topics Check if Contains Design	General Education	Other
Senior Fall 17 units	ME120 Experimental Methods	0.0	2.0	0.0	0.0
	AE140 Rigid Body Dynamics	0.0	3.0	0.0	0.0
	AE164 Compressible Flow	0.0	3.0 (✓)	0.0	0.0
	AE167 Aerospace Propulsion	0.0	3.0 (✓)	0.0	0.0
	AE171A Aircraft Design I	0.0	3.0 (✓)	0.0	0.0
	Or AE 172A Spacecraft Design I	0.0	3.0 (✓)	0.0	0.0
Senior Spring 15 units	AE171B Aircraft Design II	0.0	3.0 (✓)	0.0	0.0
	Or AE 172B Spacecraft Design II	0.0	3.0 (✓)	0.0	0.0
	AE168 Aero Vehicle Dynam. & Con.	0.0	3.0 (✓)	0.0	0.0
	Technical Elective	0.0	3.0	0.0	0.0
	Culture and Civilization (GE Area V)	0.0	0.0	3.0	0.0
Engineering Electives 9 units Advisor Approved	**Aircraft Design Option**				
	ME160 Finite Element Method	0.0	3.0	0.0	0.0
	ME165 Computer Aided Design	0.0	3.0 (✓)	0.0	0.0
	AE169 Computation. Fluid Dynamics	0.0	3.0 (✓)	0.0	0.0
	CE114 Intermediate Mechanics	0.0	3.0	0.0	0.0
	Space Systems Option				
	AE110 Space Systems Engineering	0.0	3.0 (✓)	0.0	0.0
	ME187 Auto Control System Design	0.0	3.0 (✓)	0.0	0.0
	EE112 Linear Systems	0.0	3.0	0.0	0.0
	Math 129A Linear Algebra	3.0	0.0	0.0	0.0
	Space Transportation & Exploration Option				
	AE110 Space Systems Engineering	0.0	3.0 (✓)	0.0	0.0
	AE169 Computation. Fluid Dynamics	0.0	3.0	0.0	0.0
	ME114 Thermal Engineering	0.0	4.0 (✓)	0.0	0.0
	Math 133B Partial Differential Eq.	3.0	0.0	0.0	0.0
TOTALS-ABET BASIC-LEVEL REQUIREMENTS		33	66	33	2
OVERALL TOTAL FOR DEGREE (Required units)		33			
PERCENT OF TOTAL					
Totals must	Minimum semester credit hours	32 hrs	48 hrs		
satisfy one set	Minimum percentage	25%	37.5 %		

Table reflects recent (Fall 2006) curriculum changes:

AE170A, B – Aerospace Vehicle Design have been replaced by AE171A,B – Aircraft Design and AE172A,B – Spacecraft Design

ME147 – Vibrations has been replaced by AE168 – Aerospace Vehicle Dynamics & Control

B.II MSAE Curriculum

CORE COURSES

ME 230 Advanced Mechanical Engineering Analysis. Designed to supplement and enrich students with advanced mathematical methods in treating problems selected from various areas of Mechanical Engineering. Topics discussed will include Fourier series, special functions, solutions to partial differential equations, and numerical methods. (Prereq: BSME or BSAE degree or consent of instructor) Fall/Spring

ME 270 Numerical Methods in Engineering. Introduction and application of numerical methods to the solution of physical and engineering problems. Generalized coordinate transformation, grid generation, and computational algorithms. Techniques for parabolic, elliptical and hyperbolic differential equations. Implicit and explicit methods of solution. Accuracy and stability considerations. (Prereq: BSME or consent of instructor) Spring

ME 273 Finite Element Methods in Engineering. Introduction into finite element methods. Defining elements and their properties. Discretization of the domain. Relation to Ritz method interpolation functions. Applications in solid mechanics, heat transfer, and fluid field problems. Computer programs for finite element application. Individual projects for students from different areas. (Prereq: BSME or instructor consent. Lecture 2 hours/lab 3 hours) Fall

GRADUATE COURSES IN AEROSPACE ENGINEERING

AE 210
(AE 296A) Advanced Space Systems Engineering. Overview of the engineering process used in aerospace mission and system design spanning the entire system life cycle for the near-Earth and outer space environment. Effects of gravity field, temperature and radiation on physical systems and the human organism. Mission program inception, proposal development, cost analysis, and risk management. (Prereq: BSAE or consent of instructor) Fall

AE 222 Spacecraft Instrumentation & Payload Sensors. Analysis/design of common spacecraft instrumentation and payload sensors. Mission-based characterization of payload sensors including electro-optical, visible, infrared, active/passive RF sensor types. Performance criteria and influence of orbit; computer simulations. (Prereq: BSAE or consent of instructor) Fall

AE 242 Orbital Mechanics & Mission Design. Two-body problem, conic sections, time of flight. Gibb's method of orbit determination, maneuver analysis for Earth orbiters and interplanetary flight. Euler-Hill equations . Mission design constraints on orbit geometry and launch window analysis. (Prereq: BSAE or consent of instructor. 3 units) Spring

AE 243 Advanced Astrodynamics. Analysis of spacecraft motion using different dynamic models and perturbations. Use of the state transition matrix and differential corrections technique for trajectory computation. Orbit determination and station keeping methods. Introduction to the three-body problem. Application of computational and analytic methods to solve astrodynamic problems. (Prereq: AE 242) Spring

AE 245 Spacecraft Dynamics & Control. Rigid body dynamics review. Attitude kinematical representations. Development and solution of general equations of motion. Single and dual-spin, zero and biased-momentum spacecraft. Control system design strategies. Common torquer elements. Computer simulations. (Prereq: BSAE or consent of instructor) Fall

AE 246 Advanced Aircraft Stability and Control. Natural longitudinal and lateral/directional motion of aircraft; mode shapes, eigenvalues, eigen vectors. Analysis and synthesis of various aircraft autopilots using classical and state space formulations. (Prereq: BSAE or consent of instructor) Fall

AE 250 Advanced Structures and Materials. Design and analysis of modern flight structures including static and dynamic structural response; materials design including metals, alloys, composites. Introduction to modern computational methods including finite elements. (Prereq: BSAE or instructor consent) Spring

AE 262 Advanced Aerodynamics. Thin airfoil theory. Prandtl's lifting-line theory. Subsonic and supersonic airfoil and wing theory. High-angle of attack aerodynamics. Boundary layer theory; Blasius and Falkner-Skan solutions, compressible boundary layers, turbulent flows, separation criteria. (Prereq: BSAE or instructor consent) Spring

AE 264
(AE296C) Advanced Compressible Flow. Advanced topics in compressible flow. Shock and expansion waves. Flow through nozzles and diffusers. Method of characteristics. Unsteady wave motion. Subsonic, transonic, supersonic, and hypersonic flows. (Prereq: BSAE or consent of instructor) Fall

AE 267 Space Propulsion Systems. Rocket propulsion fundamentals. Rocket dynamics, nozzle flow, thermochemical calculation of performance. Heat transfer in rockets. Solid-fueled ramjet, ducted rocket, hybrid rocket, dual fuel and mixed-mode rockets. Electric propulsion. Advanced space propulsion concepts. Combustion, ablative heat transfer. (Prereq: BSAE or instructor consent) Fall

AE 269
(AE296B) Advanced Computational Fluid Dynamics. The class will cover advanced topics in computational fluid dynamics and provide the students the opportunity to use numerical techniques to solve the Euler and Navier-Stokes equations. The students will use MatLAB, grid generation, CFD and visualization software for exercises and projects. (Prereq: BSAE or consent of instructor. Lecture 2hrs/lab 3 hrs) Fall

AE 270 Spacecraft Thermal Systems. Review of heat transfer fundamentals. Steady-state and transient problem modeling and computational solution techniques. Spacecraft thermal requirements; applicable standards. Applications to electronic packages, solar arrays, SDI designs, cryogenic and optical systems. (Prereq: BSAE or instructor consent) Fall

AE271A,B Advanced Aircraft Design I & II. (New course sequence, to be offered for the first time in Fall 2007 / Spring 2008)

AE 275 Spacecraft Power Systems. Design/implementation of space power systems including source, conversion, distribution protection, control and regulation elements. Integration into the spacecraft system. Generation elements include solar cells/arrays, fuel cells, batteries, nuclear. Test and verification. (Prereq: BSAE or instructor consent) Spring

AE 295A,B Aerospace Engineering Project I & II. Research and/or design projects involving aerospace systems/components. (Prereq: Admission to Candidacy for the Master's Degree; written proposal approved by AE Coordinator) Fall / Spring

AE 298 Special Projects in Aerospace Engineering. Advance individual work in Aerospace Engineering. (Prereq: Consent of project advisor. Credit/No Credit grading. 1-3 units) Fall / Spring / Summer

AE 299 Master's Thesis. Master's thesis work in Aerospace Engineering. (Prereq: Admission to candidacy for the Master's Degree; written proposal approved by Instructor and Graduate Advisor. 3 units taken twice, Credit / No Credit grading) Fall / Spring

APPENDIX C TABULAR DATA FOR THE AE PROGRAM

Table 33 Course and section size summary, AY 2005-2006

Course No.	Title	No. of sections offered	Enrollment	Type of Class (% Activity)[1]		
				Lecture	Lab	Other
AE 110	Space Systems Engineering	1	10	75	25	
AE 114	Aerospace Structures	1	27	75	25	
AE 140	Rigid Body Dynamics	1	29	100		
AE 162	Aerodynamics	1	26	75	25	
AE 164	Compressible Flow	1	25	75	25	
AE 165	Aerospace Flight Mechanics	1	23	100		
AE 167	Aerospace Propulsion	1	25	100		
AE 168	Aero. Vehicle Dynamics and Control	1	3	100		
AE 170A	Aerospace Vehicle Design I	2	17	25	75	
AE 170B	Aerospace Vehicle Design II	2	17	25	75	
AE 180	Individual Study	2	1			Sup. 100
AE 210 (AE296A)	Advanced Space Systems Engineering	1	10	100		
AE 242	Orbital Mech. & Mission Des.	1	4	100		
AE 246	Advanced AC Stability & Con.	1	5	100		
AE 250	Advanced Structures & Materials	1	5	100		
AE 262	Advanced Aerodynamics	1	11	100		
AE 267	Space Propulsion Systems	1	8	100		
AE269 (AE296B)	Advanced Comp. Fluid Dynamics	1	10	100		
AE 295A	Aerospace Engineering Projects I	2	3			Sup. 100
AE 295B	Aerospace Engineering Projects II	2	1			Sup. 100
AE 299	AE Master's Thesis	2	2			Sup. 100

1. Enter the appropriate percent for each type of class for each course (e.g., 75% lecture, 25% recitation).

Table 34 Faculty Workload Summary, AY 2005-2006

Faculty Member (Name)	FT or PT	Classes Taught (Course No. / Credit Hrs.) Term and Year	Total Activity Distribution[1]		
			Teaching	Research	Other
Mourtos, N.	FT	F05: AE164 3 hrs lecture + 3hrs lab AE170A 3 hrs lecture + 6 hrs lab AE262 3 hrs lecture	60%	20% (NSF)	20% Committee work
		S06: AE162 3 hrs lecture + 3hrs lab AE170B 3 hrs lecture + 6 hrs lab AE295A,B MSAE project supervision	60%	20% (NSF)	20% Committee work
Papadopoulos, P.	FT	F04: AE110 3 hrs lecture + 3hrs lab AE167 3 hrs lecture AE267 3 hrs lecture AE295A,B MSAE project supervision	80%		20% Committee work
		S05: AE 165 3 hrs lecture AE169 3 hrs lecture AE170B 6 hrs lab ME111 3 hrs lecture	80%		20% Committee work

1. Activity distribution should be in percent of effort. Members' activities should total 100%.

Table 35 Full-Time Faculty analysis, AY 2006-2007

Name	Rank	Highest Degree	Institution from which highest degree earned & year	Years of Experience			Profession. Registration (State)	Level of Activity (high, med, low, none) in:		
				Govern. / Industry Practice	Total Faculty	SJSU		Prof. Society (include society)	Research	Consulting Summer Work in Industry
Mourtos, Nikos	Professor	Ph.D. AA	Stanford 1987	0	22	22	Greece	High (ASEE, UICEE)	High	Low
Papadopoulos, Periklis	Associate Professor	Ph.D. AA	Stanford 1993	12	7	7	-	High (AIAA)	High	Low

APPENDIX D SJSU GENERAL EDUCATION REQUIREMENTS

I. Objectives

A university brings together many separate areas of learning, yet it is more than just a collection of specialized disciplines. General Education involves both the development of skills and the acquisition of knowledge through the study of facts, issues, and ideas. Regardless of major, all who earn undergraduate degrees should share a common universe of discourse.
The objectives of the San José State University General Education program are:

- 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; and
- To develop abilities to address complex issues and problems using disciplined analytic skills and creative techniques.

The advancement of academic discourse requires civility and a respectful attitude toward all members of the academic community in the expression and consideration of a variety of viewpoints. All courses shall reinforce the ethical responsibility of students and instructors to acknowledge respectfully the learning styles and forms of expression of individuals and members of all groups.

II. Minimum Units and Grades

- All students must complete 51 units of approved GE courses in letter grades.
- If a requirement is waived without unit credit (e.g., English 1B, 100W) or an area is satisfied with fewer units (e.g., quarter to semester unit conversions), additional approved GE courses may be required to complete a minimum of 48 GE units (CSU requirement).
- All three areas described in the guidelines must be completed by all students: Core GE (39 units), Advanced GE (9-12 units), and American Institutions.
- Written Communication and Mathematical Concepts courses require a minimum grade of C-.

III. Transfer and Second Baccalaureate Students

- Core GE may be satisfied by completing an Intersegmental GE Transfer Curriculum (IGETC) or a CSU 39-unit breadth certification prior to transfer. Second baccalaureate students satisfy Core GE with their first baccalaureate.
- All students must satisfy Advanced GE at SJSU regardless of GE completed at other institutions. EXCEPTION: Written Communication II may be satisfied prior to transfer.

IV. General Education Breadth

Students should be encouraged through academic advisement to experience a wide variety of perspectives in both their Core and Advanced GE courses. Individual Core areas may impose limits on the number of courses allowed in a particular discipline.

V. Prerequisites

The following GE courses require prerequisites to enroll:

- Written Communication 1A and 1B: English Placement Test (EPT)
- Mathematical Concepts: Entry Level Math Test (ELM)
- Advanced GE: Writing Skills Test (WST)
- If a student passes LLD 99 (Sophomore Writing), the student may register for ADVANCED GE courses. The student must fail the WST twice to enroll in LLD 99. This permission to enroll in ADVANCED GE does not apply to Written Communication II.

VI. Approved Courses

- All GE courses must be on the approved list of the California Community College (CCC), California State University (CSU), or University of California (UC) for CSU Breadth Requirement or the Intersegmental General Education Transfer Curriculum (IGETC) where and when the course is taken.

To find approved courses at SJSU, check the GE Course Listing in the *SJSU Schedule of Classes* or use the GE designator listed for the requirement. This designator is also listed for each GE class section in the *SJSU Schedule of Classes*.

Table 36 General Education Requirements

CORE GENERAL EDUCATION		ADVANCED GENERAL EDUCATION	
A. Skills		Prerequisites	
A1. Oral Communication	3	Writing Skills Test	
A2. Written Communication IA	3	Upper division standing	
A3. Critical Thinking	3	Completion of CORE GE	
B. Science (includes Mathematical Concepts)	9	Areas	
C. Humanities & Arts (includes Written Communication IB) (may include 6-unit American Institutions graduation requirement)	9	R. Earth & Environment	3
		S. Self, Society, & Equality in the U.S.	3
D. Social Sciences (may include 6-unit American Institutions graduation requirement)	9	V. Culture, Civilization, & Global Understanding	3
E. Human Understanding & Development	3	Z. Written Communication (may be waived with WST score and approval of major department)	3
Total units	39	Total units	9-12

Graduation requirement: American Institutions (may be satisfied in CORE GE with designated coursework)	6

VII. Assessment

All courses must have an approved Assessment Plan on file in the Office of Curriculum & Assessment (see Assessment section of GE Guidelines). In accordance with the approved plan, a summary of the assessment results must be presented for all sections of the course. Include a description of:

a. assignments (including length and style of required reading and writing)
b. examinations (number, format, and relation to competencies)
c. description of assessment strategies used and information reviewed dates and number of sections).

Instruction

Describe how the course is taught. Include:

a. methods of instruction (e.g., lectures, discussions, small groups, simulation), pointing out opportunities for active student learning
b. general qualifications of all those who might teach the course, with areas of expertise, experience, and training
c. description of how course will be coordinated to insure consistent implementation and assessment across all sections of the course

CORE GE: (A1) - ORAL COMMUNICATION

1. Goals

Courses shall cultivate an understanding of the social, psychological, political and practical significance of communication, with special emphasis on the roles of public communication in a free society. Students will give oral presentations and be encouraged to develop their sense of voice, which means speaking with confidence in public forums in ways that reflect their unique perspective and identity. Students will learn and appreciate a range of public speaking styles and forms of eloquence, while respecting the freedom of expression of all members of the community.

2. Student Learning

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.

3. Content

- *Diversity*. Issues of diversity shall be incorporated in an appropriate manner.
- *Major speech assignments*. Each class shall require students to present at least three major speech assignments that meet the following requirements. These presentations, delivered before a full classroom audience, shall be individually graded and, taken together, should account for at least 50 percent of the course grade. They shall require the student to address intellectually challenging topics of broad social relevance and to develop original presentations of sufficient length to demonstrate the major skills of the course. The assignments shall require the student to undertake substantial research from a variety of sources and to synthesize the evidence to support or explicate

the points of his or her presentation. These speeches shall be presented in the extemporaneous mode, allowing for adaptation to audience response. Whenever possible, the student should have the opportunity to develop further and clarify her or his ideas through a question and answer exchange with audience members. Each student shall receive extensive feedback on these assignments addressing a full range of rhetorical criteria such as content, organization, language, and delivery.

- *Additional speaking assignments*. Each course shall include additional oral assignments and exercises designed to enable students to master the skills required for the major assignments and/or to develop skills in additional forms of public speaking. Each student will have at least one opportunity to revise and improve a speech following formative feedback from the instructor and peers. Each student will have some collaborative experience in the social construction of oral messages. This may take the form of working with a peer support group, preparing a group presentation, engaging in debate, or participating in a structured individual conference with the instructor.
- *Written assignments*. Each of the three major speech assignments shall require full sentence outlines or argumentative briefs containing sufficient detail to show the relationships among the points and subpoints of the presentation and the evidence used to support these points. Additional written assignments should include appropriate papers, bibliographies, exercises, written speech analyses, and /or written peer critiques. The minimum writing requirement is 1500 words in a language and style appropriate to the discipline.

CORE GE: (A2) - WRITTEN COMMUNICATION IA

1. Goals

Courses should cultivate an understanding of the writing process and the goals, dynamics, and genres of written communication, with special attention to the nature of writing at the university. Students will develop college-level reading abilities, rhetorical sophistication, and writing styles that give form and coherence to complex ideas and feelings. A passing grade signifies that the student is a capable college-level writer and reader of English.

2. Student Learning

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.

3. Content

- *Diversity*. Issues of diversity shall be incorporated in an appropriate manner.
- *Writing*. Writing assignments shall give students repeated practice in pre-writing, organizing, writing, revising, and editing. The number of writing assignments and their careful sequencing are as important as the total number of words written. Eight to ten essays totaling a minimum of 8000 words are required. This minimum requirement excludes the final exam, journal writing, quizzes, and other informal or brief assignments. Although the majority of papers will be written outside of class, at least three essays shall be written in class. Students shall receive frequent evaluations from the instructor. Evaluative comments must be substantive, addressing the quality and form of writing.
- *Reading.* Reading for the course will be extensive and intensive. It shall include useful models of writing for academic, general, and special audiences.

CORE GE: (A3) - CRITICAL THINKING

1. Goals

Critical thinking courses should help students learn to recognize, analyze, evaluate, and produce reasoning.

2. Student Learning

Students will demonstrate, orally and in writing, proficiency in the course goals. Development of the following competencies will result in dispositions or habits of intellectual autonomy, appreciation of different world views, courage and perseverance in inquiry, and commitment to employ analytical reasoning. Students should be able to:

- distinguish between reasoning (e.g., explanation, argument) and other types of discourse (e.g., description, assertion);
- identify, analyze, and evaluate different types of reasoning;
- find and state crucial unstated assumptions in reasoning;
- evaluate factual claims or statements used in reasoning and evaluate the sources of evidence for such claims; and
- locate, retrieve, organize, analyze, synthesize, and communicate information of relevance to the subject matter of the course.

3. Content

- Students will analyze, evaluate, and construct their own arguments or position papers about issues of diversity such as gender, class, ethnicity, and sexual orientation; students will analyze, evaluate, and construct arguments about these issues and construct arguments or position papers of their own.
- Reasoning about other issues appropriate to the subject matter of the course shall also be presented, analyzed, evaluated, and constructed.
- All critical thinking classes should teach formal and informal methods for determining the validity of deductive reasoning and the strength of inductive reasoning, including a consideration of common fallacies in inductive and deductive reasoning.
- Courses shall require the use of qualitative reasoning skills orally and for written assignments. Substantial writing assignments are to be integrated with critical thinking instruction. Writing will lead to the production of argumentative essays, with a minimum of 3000 words required.

CORE GE: (B1, B2, & B3) – SCIENCE

1. Goals

Science is a continuous and adaptive process through which we discover and communicate how the natural world works, separate fact from inference, and establish testable frameworks. All students should master essential quantitative and qualitative skills that are necessary to understand scientific knowledge and methods and to incorporate these processes into the workplace and everyday life experiences.

2. Student Learning

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.

3. Content

- Students must complete at least one three-unit course in life science and one three-unit course in physical science. At lease one laboratory course must be completed.
- *Diversity.* Issues of diversity shall be incorporated in an appropriate manner.
- *Writing.* The minimum writing requirement is 1500 words in a language and style appropriate to the discipline.

All Science courses should demonstrate how scientists seek proof for causal relationships between microscopic phenomena and macroscopic observables.

<u>Life Science courses focus on</u>:

- structures and functions of living organisms;
- levels of organization of living systems, from atom to planet;
- strategies for survival and reproduction;
- patterns of evolution;
- principles of genetics, including the basis for variation; and
- interaction of organisms and their natural environment.

<u>Physical Science courses focus on</u>:

- laws of thermodynamics;
- structure of matter;
- interaction of matter and energy;
- behavior of physical systems through time;
- systems of classification; and
- physical processes of the natural environment.

CORE GE: (B4) - MATHEMATICAL CONCEPTS

1. Goals

The major goal is to enable the student to use numerical and graphical data in personal and professional judgments and in coping with public issues.

2. Student Learning

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.

3. Content

- *Diversity.* Issues of diversity shall be incorporated in an appropriate manner.
- *Writing.* The minimum writing requirement is 1500 words in a language and style appropriate to the discipline.

Survey of Basic Mathematical Concepts courses should focus on:

- basic mathematical techniques for solving quantitative problems appropriate to the course content;
- elementary numerical computation;
- the organization, classification, and representation of quantitative data in various forms, such as tables, graphs, rates, percentages, measures of central tendency and spread; and
- applications of mathematics to everyday life.

Application of Mathematical Concepts and Skills courses should:

- include the content listed above for Basic Mathematical Concepts courses; and
- focus on applications of mathematical concepts in one or more areas such as statistical inference, trigonometry, calculus, and analytic geometry.

CORE GE: (C1 & C2) - HUMANITIES & ARTS

Arts and Letters

1. Goals

Courses in Arts and Letters should give students knowledge and understanding of significant works of the human intellect and imagination. Students will examine the interaction of analytical and creative processes in the production and perception of such works, and the significance of the historical and cultural contexts in which the works are created and interpreted. Courses should enable students to participate in social and cultural communities associated with artistic and literary endeavors, enriching their personal and professional lives.

2. Student Learning

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); and
- write clearly and effectively.

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; and
- write clearly and effectively.

3. Content

- Students must complete at least one three-unit Arts course and one three unit Letters course.
- *Diversity.* Issues of diversity shall be incorporated in an appropriate manner.
- *Writing.* The minimum writing requirement is 1500 words in a language and style appropriate to the discipline.

Arts courses should give students the opportunity to:

- experience significant works of art in the classroom and in performances and exhibitions;
- understand the historical or cultural contexts in which specific works of art were created; and
- recognize the accomplishments of and issues related to women and diverse cultures reflected in such works of art.

Letters courses should give students the opportunity to:

- examine significant works of the human intellect and imagination;
- understand the historical and cultural contexts in which such specific texts were created; and
- recognize the accomplishments of and issues related to women and diverse cultures reflected in such texts.

CORE GE: (C3) - HUMANITIES & ARTS

Written Communication 1B

1. Goals

Written communication 1B will reinforce and advance the abilities developed in Written Communication 1A, broadening and deepening students' understanding of the genres, audiences, and purposes of college writing. Students will develop a mature writing style appropriate to university discourse, sophistication in writing argumentative essays, mastery of the mechanics of writing, and proficiency in basic library research skills and in writing papers informed by research.

2. Student Learning

Students shall write complete essays that demonstrate the ability to:

- refine the competencies established in Written Communication 1A (see CORE GE: (A1) -- Oral Communication);
- use (locate, analyze, and evaluate) supporting materials, including independent library research;
- synthesize ideas encountered in multiple readings; and
- construct effective arguments.

3. Content

- *Diversity.* Issues of diversity shall be incorporated in an appropriate manner.
- *Writing.* This course should emphasize those skills and activities in writing and thinking that produce 1) the persuasive argument, and 2) the critical essay, each of which demands analysis, interpretation, and evaluation. Writing assignments shall give students repeated practice in pre-writing, organizing, writing, revising, and editing. The number of writing assignments and their careful sequencing are as important as the total number of words written. Six to eight essays totaling a minimum of 8000 words are required. This minimum requirement excludes the final examination, journal writing, quizzes, or other informal or brief assignments. Although the majority of papers will be written outside of class, at least three essays shall be written in class. Students shall receive frequent evaluations from the instructor. Evaluative comments must be substantive, addressing the quality and form of writing.
- *Reading.* Reading for the course shall include useful models of writing for academic and general audiences; readings shall be used consistently with the course goal of enhancing ability in written communication and reading. A substantial portion of the reading should be devoted to analytical, critical, and argumentative essays. Instructors should help students develop and refine strategies for reading challenging material.
- *Research.* The course shall include an introduction to the library and to basic research strategies, including locating materials, evaluating them, using them effectively (e.g., quoting, paraphrasing, summarizing), and citing them properly. Instructors shall assign a traditional research paper or a series of short essays in which library research informs the student's position or thesis.

CORE GE: (D) - SOCIAL SCIENCES

1. Goals

Social Science courses should increase the student's understanding of human behavior and social interaction in the context of value systems, economic structures, political institutions, social groups, and natural environments.

2. Student Learning

Students shall be able to identify and analyze the social dimension of society as a context for human life, the processes of social change and social continuity, the role of human agency in those social processes, and the forces that engender social cohesion and fragmentation. Students will be able to:

- place contemporary developments in cultural, historical, environmental, and spatial contexts;
- identify the dynamics of ethnic, cultural, gender/sexual, age-based, class, regional, national, transnational, and global identities and the similarities, differences, linkages, and interactions between them; and
- evaluate social science information, draw on different points of view, and formulate applications appropriate to contemporary social issues.

Human Behavior students will be able to recognize the interaction of social institutions, culture, and environment with the behavior of individuals.

Comparative Systems, Cultures and Environments students will be able to compare and contrast two or more ethnic groups, cultures, regions, nations, or social systems.

Social Issues students will be able to apply multidisciplinary material to a topic relevant to policy and social action at the local, national, and/or international levels.

3. Content

- Students must complete at least one course each in Human Behavior, Comparative Systems, and Social Issues.
- *Diversity.* Issues of diversity shall be incorporated in an appropriate manner.
- *Writing.* The minimum writing requirement is 1500 words in a language and style appropriate to the discipline.
- All courses in Social Science should include content to promote all of the above competencies.

CORE GE: (E) HUMAN UNDERSTANDING AND DEVELOPMENT

1. Goals

Students will understand themselves as integrated physiological, social, and psychological entities who are able to formulate strategies for lifelong personal development. Courses shall address challenges confronting students who are entering the complex social system of the university, so that students can employ available university resources to support academic and personal development.

2. Student Learning

Students shall:

- recognize the physiological, social/cultural, and psychological influences on their well-being;
- 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
- recognize themselves as individuals undergoing a particular stage of human development and recognize how their well-being is affected by the university's academic and social systems, and how they can facilitate their development within the university environment.

3. Content

- *Diversity.* Courses shall incorporate issues of diversity in an appropriate manner.
- *Writing.* The minimum writing requirement is 1500 words in a language and style appropriate to the discipline.

Courses shall enable students to achieve the competencies described above by including:

- a focus on the interdependence of the physiological, social/cultural, and psychological factors that contribute to the process of human development and determine the limitations, potential, and options of the individual across the lifespan;

- an understanding of the university as a learning center for the integrated person, an introduction to its resources, and an appreciation for the intellectual and social vitality of the campus community; and
- an inventory and evaluation of university-level learning skills (e.g. methods of inquiry, critical thinking, study skills, research skills, and information literacy), and an exploration of the application of these skills to the student's academic and personal development.

GRADUATION REQUIREMENTS

American Institutions

1. Goals

Courses in American Institutions should meet one or more of the following requirements: *U.S. History, U.S. Constitution,* and *California Government*. Students enrolled in these courses should be exposed to alternative interpretations of the historical events and political processes that have shaped the social, economic, and political systems in which they live.

These courses will provide a multicultural framework, including both conflict and consensus perspectives, of the choices and options available to individuals and groups in their social, economic, and political relations. The focus of the courses is the growth of a multicultural society and the interactions, including cooperation and conflict, as these many and varied peoples have dealt with social, economic, and political issues.

2. Student Learning

To fulfill the requirements for *U.S. History*, students should consider the principal events, developments, ideas, politics, and international relations in all the territories now in the United States from the beginnings of this society until the present. While considering these trends, students should be asked to analyze certain themes including:

- earliest inhabitants, colonization, the American Revolution and the early Republic, territorial expansion, economic development, Civil War and Reconstruction, foreign relations, Populism, Progressivism, the New Deal, wars and conflicts of the 20th century, the Fair Deal, the Great Society, McCarthyism, the civil rights movement, mobilization of minorities, new feminism, and modern times. Included within the study of these themes should be a consideration of women and gender relations from the colonial period to the present; the history and experience of racial and ethnic minorities; emigration to the United States and the experiences of these immigrants to this country; and patterns of race and class relations from the period of European colonization to the present.

To fulfill the requirements for *U.S. Constitution* and *California Government,* students should study how political decisions are made, their consequences for individuals and society, and how individuals and groups may affect the decision-making process. As students study the meaning and content of the democratic process as it has evolved in the United States and California, at a minimum, they should recognize:

- the foundations of the political system, including the evolution of the philosophies of the U.S. and California constitutions, political culture, separation of powers, bureaucracy, federalism, and relations among various levels of government. Students should also analyze the evolving institutions of government, including a study of the powers of the President, Congress, and the Judiciary;
- the links between the people and government, including participation and voting, political parties, interest groups, and public opinion and socialization. Students should also analyze the rights and obligations of citizens, the tension between various freedoms of expression and due process and the maintenance of order, and the efforts to end racial and gender discrimination in both the public and private sectors of society; and

- the operations of California government, including the similarities and differences between the California and U.S. Constitutions, the relationship between state and local government in California, the basic issues of California politics, and a careful assessment of the impact of demographic changes on the history and politics of the state and the nation.

3. Content

- *Diversity*. Issues of diversity shall be incorporated in an appropriate manner.
- *Writing*. The minimum writing requirement is 1500 words in a language and style appropriate to the discipline.
- All courses in American Institutions should include content to promote all of the above competencies.

ADVANCED GENERAL EDUCATION: (R)

Earth & Environment

1. Goals

Students will cultivate knowledge of the scientific study of the physical universe and its life forms. Students will understand and appreciate the interrelationship of science and human beings to each other.

2. Student Learning

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.

3. Content

- *Diversity.* Issues of diversity shall be incorporated in an appropriate manner.
- *Writing.* Written assignments should include both in-class and out-of-class writing, giving students practice and feedback throughout the semester. A single final term paper would not satisfy the requirement. A minimum of 3000 words of writing is required in a language and style appropriate for the discipline.
- Courses will focus on the scientific study of life forms or the physical universe, based on knowledge and skills established in Core GE Science.

ADVANCED GENERAL EDUCATION: (S)

Self, Society, & Equality in the U.S.

1. Goals

Students will study the interrelationship of individuals, and racial groups, and cultural groups to understand and appreciate issues of diversity, equality, and structured inequality in the U.S., its institutions, and its cultures.

2. Student Learning

After successfully completing the course, students shall be able to:

- describe how religious, gender, ethnic, racial, class, sexual orientation, disability, and/or age identity are shaped by cultural and societal influences in contexts of equality and inequality;
- describe historical, social, political, and economic processes producing diversity, equality, and structured inequalities in the U.S.;
- describe social actions by religious, gender, ethnic, racial, class, sexual orientation, disability, and/or age groups leading to greater equality and social justice in the U.S.; and
- recognize and appreciate constructive interactions between people from different cultural, racial, and ethnic groups in the U.S.

3. Content

- *Diversity.* Issues of diversity shall be incorporated in an appropriate manner.
- *Writing*. Written assignments should include both in-class and out-of-class writing, giving students practice and feedback throughout the semester. A single final term paper would not satisfy the requirement. A minimum of 3000 words of writing is required in a language and style appropriate for the discipline.
- All courses in Self, Society, and Equality in the U.S. should include content to promote all of the above competencies.

ADVANCED GENERAL EDUCATION: (V)

Culture, Civilization, & Global Understanding

1. Goals

Courses in Culture, Civilization, and Global Understanding should give students an appreciation for human expression in different cultures and an understanding of how that expression has developed over time in different cultures. These courses should also increase students' understanding of how other cultural traditions have influenced American culture and society, as well as how cultures in general both develop distinctive features and interact with other cultures.

2. Student Learning

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.

3. Content

- *Diversity.* Issues of diversity shall be incorporated in an appropriate manner.
- *Writing*. Written assignments should include both in-class and out-of-class writing, giving students practice and feedback throughout the semester. A single final term paper would not satisfy the requirement. A minimum of 3000 words of writing is required in a language and style appropriate for the discipline.
- Courses will address significant achievements of the human intellect and imagination in a comparative context to understand and appreciate different ideas, cultures, values, religions, institutions, languages, and peoples of the world.

ADVANCED GENERAL EDUCATION: (V)

Written Communication II

1. Goals

Students will develop advanced proficiency in college-level writing and appropriate contemporary research strategies and methodologies to communicate effectively to both specialized and general audiences. Written Communication II should reinforce and advance the abilities developed in Written Communication IA and IB, and broaden and deepen these to include mastery of the discourse peculiar to the discipline in which the course is taught.

2. Student Learning

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.

3. Content

- *Diversity.* Issues of diversity shall be incorporated in an appropriate manner.
- *Writing.* Written assignments should include both in-class and out-of-class writing, giving students practice and feedback throughout the semester. A single final term paper would not satisfy the requirement. Assignments will total a minimum of 8000 words assigned throughout the semester, providing frequent practice and feedback for improving application skills.
- *Reading.* Readings used in the course should be models of excellence.
- *Discipline*. Written Communication II courses are discipline specific. All courses will use language and forms of writing appropriate to the discipline.

APPENDIX E COURSE SYLLABI

Course: **Math 30 – Calculus I**

Course Description: Introduction to calculus including limits, continuity, differentiation, applications, and introduction to integration. Graphical, algebraic and numerical methods of solving problems.

Prerequisites: Satisfactory score on the mathematics placement exam; satisfaction of the ELM requirement.

Textbook: Calculus - Early Transcendentals, 5th Edition, Stewart, James. Thomson Learning/Brooks/Cole: Belmont, CA

Course Objectives:
Upon completion of the course, students will be able to do the following:

1. Demonstrate understanding of the basic ideas of calculus: limits, continuity, differentiation and integration.
2. Analyze and solve a variety of applications including problems involving rates of change in the natural, social and physical sciences, equations of motion, optimization and related rates.
3. Differentiate functions composed of elementary functions using differentiation formulas.
4. Evaluate limits.
5. Find the equation of the tangent line of a function and approximate a function using its linearization.
6. Give practical interpretations of the derivative of the function.
7. Explain the relationship between a function and its graph, a function and its derivative.
8. Graph functions using information obtained from its derivative.
9. Understand the concept of antidifferentiation.

Topics Covered:

- Limit of a function, limit laws, the definition of a limit, continuity, limits at infinity, infinite limits, horizontal and vertical asymptotes, tangent lines, velocity, and other rates of change.
- Derivatives of polynomials, exponential functions, trigonometric functions, logarithmic functions, and hyperbolic functions. The product rule, quotient rule, and chain rule. Implicit differentiation, higher order derivatives, related rates, differentials, and linear approximations.
- Maximum and minimum values, the Mean Value Theorem, curve sketching, indeterminate forms, and L'Hopital's Rule.
- Newton's method, an introduction to antidifferention.
- Optimization problems.

Class Schedule: 2 x 1.5 hour OR 3 x 50 min lectures per week.

Contribution of Course to Meeting the Professional Component: Three semester units of college level mathematics.

Relationship of Course to Program Outcomes:
This lower-division college level mathematics course contributes to the Program Outcomes as follows:
Outcome 3a: Proficiency in the ability to apply knowledge of mathematics, science and engineering through problem solving and oral presentations.

Prepared by: M. Blockus **Date: Spring 2005**

Course: **Math 31 – Calculus II**

Course Description: Definite and indefinite integration with applications. Sequences and series. Graphical, algebraic, and numerical methods of solving problems.

Prerequisites: Math 30 or 30P (with a grade of C- or better).

Textbook: Calculus – Early Transcendentals, 5th Edition, Stewart, James.
Thomson Learning/Brooks/Cole: Belmont, CA

Course Objectives:
Upon completion of the course, students will be able to do the following:
1. Demonstrate understanding of the definition of the definite integral and it's properties.
2. Apply the Fundamental Theorem of Calculus.
3. Evaluate integrals by using one of the following techniques: integration by substitution, integration by parts, integration by partial fractions. Use a table of integrals.
4. Derive integral formulas for volumes, areas, arc length, work, hydrostatic force, etc. by way of Riemann sums.
5. Determine the convergence or divergence of numerical sequences and series. Use various tests of convergence.
6. Find series representations for functions.

Topics Covered:
- Areas and distances. The definite integral. The Fundamental Theorem of Calculus. Indefinite integrals. The substitution rule.
- Areas between curves. Volumes by cross-sectional area, washers and cylindrical shells. Work problems.
- Integration by parts. Trigonometric integrals. Integration of rational functions. Approximation of definite integrals. Improper integrals.
- Arc length. Area of a surface of revolution. Applications to physics and engineering.
- Sequences. Series. The integral test. The comparison test. Absolute and conditional convergence. The ratio and root tests.
- Power series. Representation of functions as power series. Taylor and Maclaurin series.
- Complex numbers.

Class Schedule: 4 x 50 min lectures per week.

Contribution of Course to Meeting the Professional Component: Four semester units of college level mathematics.

Relationship of Course to Program Outcomes:
This lower-division college level mathematics course contributes to the Program Outcomes as follows:
Outcome 3a: Proficiency in the ability to apply knowledge of mathematics, science and engineering through problem solving and oral presentations.

Prepared by: M. Blockus **Date: Spring 2005**

Course: **Math 32 – Calculus III**

Course Description: Functions of more than one variable, partial derivatives, multiple integrals and vector calculus. This course will provide the students with basic knowledge and techniques of multivariable and elementary vector calculus that will be needed in solving applied problems. It also provides the students with the mathematical foundation necessary in learning their upper division courses. Graphical, algebraic and numerical methods of solving problems.

Prerequisites: Math 31 (with a grade of C- or better).

Textbook: Calculus – Early Transcendentals, 5th Edition, Stewart, James.
Thomson Learning/Brooks/Cole: Belmont, CA

Course Objectives:
Upon completion of the course, students will be able to do the following:

1. Demonstrate understanding of the basic ideas of calculus of multivariable functions: limits, continuity, differentiation and integration.
2. Graph standard surfaces and space curves in 3-dimensions.
3. Evaluate limits of functions of two variables.
4. Demonstrate expertise in elementary 3-dimensional geometry and elementary vector analysis, calculate partial derivatives, directions derivatives, and gradients of functions.
5. Use calculus to solve optimization problems for functions of several variables.
6. Differentiate and integrate vector functions, and solve problems involving the equations of motion in space.
7. Set up and evaluate multiple integrals in rectangular, cylindrical and spherical coordinates.
8. Express volumes and surface area as multiple integrals, and to solve applied problems using the basic ideas of multivariable calculus.
9. Find the equation of the tangent plane to a surface and approximate a function using its linearization.

Topics Covered:

- Introduction to 3-dimensional geometry: coordinate axes and planes, polar, cylindrical and spherical coordinates, equations of lines, planes and quadric surfaces.
- Vectors and vector functions: 2-, 3-, and n- dimensional vectors, dot product, cross product, geometric interpretation of vectors and their properties, vector functions, space curves, differentiation and integration of vector functions, applications such as arc length, curvature, motion in space.
- Calculus of functions of several variables: limits, continuity, partial differentiation, tangent planes, linear approximations, chain rule, directional derivatives, gradient vector, optimization problems, Lagrange multipliers, double and triple integration, applications of integration such as surface areas and volume, triple integrals in spherical and cylindrical coordinates.

Class Schedule: 2 x 1.5 hour OR 3 x 50 min lectures per week.

Contribution of Course to Meeting the Professional Component: Three semester units of college level mathematics.

Relationship of Course to Program Outcomes:
This lower-division college level mathematics course contributes to the Program Outcomes as follows:
Outcome 3a: Proficiency in the ability to apply knowledge of mathematics, science and engineering through problem solving and oral presentations.

Prepared by: M. Blockus **Date: Spring 2005**

Course: **Math 129A – Linear Algebra I (Elective)**

Course Description: Matrices, systems of linear equations, vector geometry, matrix transformations, determinants, eigenvectors and eigenvalues, orthogonality, diagonalization, applications, computer exercises. Theory in R^n emphasized; general real vector spaces and linear transformations introduced.

Prerequisites: Math 31 (with a grade of C- or better) or instructor consent.

Textbook: Linear Algebra and its Applications, 3rd edition. Lay.
Elementary Linear Algebra. Spence, Insel, and Friedberg.

Course Objectives:
Upon completion of the course, students will be able to do the following:
1. Real vectors and matrices, and their sums and products.
2. System of linear equations and matrix-vector equation representation.
3. Gaussian elimination to calculate Reduced Row Echelon Form, and to solve a linear system.
4. General solution of a linear system in vector form.
5. Rank of a matrix.
6. Span and linear independence for sets of vectors.
7. Matrix transformations, range and null space, one-to-one and onto properties.
8. Determinates.
9. Subspaces of R^n, especially row space, column space, and null space of a matrix.
10. Basis and dimension of a subspace.
11. Dimension theorem for a matrix transformation.
12. Eigenvalues, eigenvectors and characteristic polynomial for a matrix.
13. Diagonalizable matrices.
14. Dot product of vectors and orthogonality of vectors and subspaces.
15. Least squares method.

Topics Covered:
- Systems of linear equations.
- Vector geometry and vector space.
- Matrix transformations.
- Matrix algebra and determinants.
- Eigenvectors and eigenvalues.
- Diagonalization.
- Orthogonality.

Class Schedule: 2 x 1.5 hour OR 3 x 50 min lectures per week

Contribution of Course to Meeting the Professional Component: Three semester units of college level mathematics.

Relationship of Course to Program Outcomes:
This upper-division college level mathematics course contributes to the Program Outcomes as follows:
Outcome 3a: Proficiency in the ability to apply knowledge of mathematics, science and engineering through problem solving and oral presentations.

Prepared by: Wasin So **Date: Spring 2005**

Course: **Math 133A – Ordinary Differential Equations**

Course Description: First order differential equations, Separable equations, Linear equations, Exact equations, Linear second order equations, Homogenous linear equations, Nonhomogenous equations, Variation of parameters, Laplace transforms and inverse Laplace transforms, and Series solutions.

Prerequisites: Math 32 (with a grade of C- or better) or instructors consent.

Textbook: Fundamentals of Differential Equations, 6th edition. Nagle, Saff and Snider.

Course Objectives:
Upon completion of the course, students will be able to do the following:
1. Solve first order differential equations.
2. Find and apply Annihilators, using variation of parameters.
3. Solve nonhomogenous and homogenous equations.
4. Apply Laplace transforms and inverse Laplace transforms.
5. Apply Taylor series method, Power series and analytic functions.

Topics Covered:
- Direction fields; meaning of a solution for first order equations.
- Separable equations, linear equations, exact equations, special integrating factors, substitutions and transformations: restrict to homogenous equations and Bernoulli's equation.
- Linear second order equations, homogenous linear equations, auxiliary equations with complex roots, nonhomogenous equations: the method of undetermined coefficients, the superposition principle and undetermined coefficients, variation of parameters.
- Laplace Transforms, inverse Laplace transform, initial value problems, transforms of discontinuous functions, convolution, impulses and the Dirac delta function.
- Series solutions of differential equations, Taylor series method, Power series, and analytic functions.

Class Schedule: 2 x 1.5 hr lectures per week.

Contribution of Course to Meeting the Professional Component: Three semester units of college level mathematics.

Relationship of Course to Program Outcomes:
This upper-division college level mathematics course contributes to the Program Outcomes as follows:
Outcome 3a: Proficiency in the ability to apply knowledge of mathematics, science and engineering through problem solving and oral presentations.

Prepared by: R.P. Kubelka **Date: Spring 2005**

Course: **Chem 1A – General Chemistry**

Course Description: First semester of college level General Chemistry. Course is required of all Science and Engineering majors except Computer Science. Topics including stoichiometry, reactions, atomic structure, periodicity, bonding, states of matter, energy changes, solutions using organic and inorganic examples. Lab program complements lecture.

Prerequisites: Proficiency in high school chemistry or Chemistry 10 (with a grade of "C" or better; "C-" not accepted) or instructor consent; proficiency in high school algebra and eligibility for Math 19; eligibility for English 1A.

Textbook: Chemistry: The Central Science, 9^{th} Edition, Brown, LeMay and Bursten.

Course Objectives:

1. Report the correct number of significant figures and units in calculations.
2. Make use of selected conversion factors in dimensional analysis problems.
3. Convert between moles, mass and number of particles, making use of stoichiometric factors.
4. Calculate a % composition given a molecular formula and vice versa (empirical formula and molecular formula problems).
5. Name salts, acids, bases and covalent compounds. Provide the formula of these compounds given their chemical name.
6. Provide the net ionic representation of any salt, base or acid by using the solubility and dissociation rules. Explain the difference between solubility and dissociation.
7. Identify weak and strong acids and bases.
8. Construct molecular, total and net ionic equations for double displacement reactions. Identify the physical state of species.
9. Recognize an oxidation, a reduction, an oxidation agent, a reducing agent and a redox reaction.
10. Calculate an oxidation number.
11. Balance a reduction oxidation reaction under acidic reactions.
12. Know some basic example of real life applications of reduction oxidation and double displacement reactions (fuel cells, lead storage battery, acid rain, etc.)
13. Perform stoichiometric calculations for chemical and non-chemical systems whether they have a known or unknown limiting reactant.
14. Calculate the molarity of a solution given the necessary data whether you are starting with a mass of solute or with a concentrated solution. Be able to calculate any one variable given the other necessary data in the equation for molarity.
15. Name elements, provide their symbols and be able to determine number of electrons, protons and neutrons for any chemical species.
16. Provide very brief descriptions of the accomplishments of Planck, Thompson, Rutherford, Millikan, Rydberg, Bohr, de Broglie and Schrodinger.
17. Explain everything that goes on in a cathode ray tube.
18. Use de Broglie's equation and have a simple understanding of what it means.
19. Calculate and convert between wavelength, frequency and energy understanding the relationships between these. What is ionizing radiation. Have some general understanding of what color is and why things exhibit color.
20. Calculate the energy associated with a given electronic transition in a hydrogen atom.
21. Know what each quantum number represents and how to obtain the quantum numbers for any electron in an atom.
22. Using an elements position in the periodic table, be able to do the full and abbreviated electronic configuration of an element including the nl^x notation, the quantum numbers for any electron in an atom and a representative diagram of orbitals with correct electron filling. Be able to predict whether the atom is paramagnetic or diamagnetic. Provide the number of unpaired electrons and predict the expected oxidation states. Identify an element given the four quantum numbers of the last electron or the nl^x notation of the element.

23. Know what is meant by electronegativity, electron affinity and ionization potential.
24. Organize a set of elements in order of increasing atomic radius, ionic radius, first ionization energy and electronegativity.
25. Using the elements position in the periodic table determine its: metal/nonmetal properties; acid/base properties; insulator/conductor/semiconductor properties. Understand the role electronic configuration plays in band gap theory and how manipulating elemental composition alters the energy gap
26. Determine whether a bond is metallic, ionic, covalent or polar covalent.
27. Represent ionic bonding using Lewis dots.
28. Provide Lewis dot diagram, the molecular geometry, hybridization and polarity of a covalent molecule.
29. Determine the bonding types in a molecule as well as the types of orbital used to make the particular bond.
30. Explain and understand the concept of pressure. How to convert from height readings in one liquid to mercury heights and vice versa. Convert temperatures in C to K.
31. Use PV = nRT to derive relationships between variables in that equation such as $P_1V_1 = P_2V_2$ as well as relationships with density and molecular weight. Understand and be able to use Dalton's Law of Partial Pressures.
32. Understand the fundamentals of the Kinetic Molecular Theory of Gases including root mean square velocity and Graham's Law of Effusion and Diffusion. Use this knowledge to explain the gas laws at molecular level including the role of temperature, collision rate, force of collisions, number of particles plays on determining the pressure of a gas.
33. Understand the nature of each of the intermolecular forces and be able to describe what is going on. Be able to recognize which force is present in a given substance. Be able to organize a set of molecules/atoms in order of increasing force.
34. Define basic properties of viscosity, surface tension, capillary action, boiling and vapor pressure. Be able to organize a set of pure substances in order of increasing strength in these properties making use of knowledge of intermolecular forces.
35. Give examples of materials that manipulate intermolecular forces in the real world. (adhesives, coatings, nanotechnology, DNA, etc.).
36. Understand specific heat. Be able to do calculations using the heat equation for temperature changes. Understand the signage for heat.
37. Perform calculations of heat transfer with and without phase changes and with both combined.
38. Use Hess' Law to obtain the heat of reaction. Be able to use heats of formation to obtain heats of reaction. Understand what are exothermic and endothermic reactions and how chemicals can store energy. Know examples of materials and reactions that are relevant for energy sources such as coal, gasoline, fuel cells, LNG.
39. Learn basic nomenclature for alkanes, alkenes and alkynes. Learn a few of the organic functional groups and why these molecules are important (gasoline, ethanol, amino acids).

Topics Covered:
Moles/empirical/molecular, naming/solubility/net ionic equation, stoichiometry, reduction oxidation reactions, molarity, atomic structure, electronic configuration, periodic properties, bonding, forces, gases, heat transfer, heats of reaction, organic. Examples of applications of chemistry to biology, medicine and engineering fields.

Class Schedule:
Lecture: (3) sessions each week. Each lecture session is 50 minutes. Lab: (1) session each week. Each lab session is 3 hours. Seminar: (1) session each week. Each seminar is 50 minutes

Contribution of Course to Meeting the Professional Component: Five semester units of basic science.

Relationship of Course to Program Outcomes: This course contributes to outcomes 3a and 3b.

Prepared by: Karen. A. Singmaster **Date: Spring 2005**

Course: **Physics 70 – Mechanics and Thermodynamics**

Course Description: This course is the first semester course in a sequence of three semester courses in general physics developed for those students planning careers in science and engineering. The course begins with a study of particle kinematics and dynamics followed by the work-energy theorem and the laws of conservation of energy and momentum. Basic concepts of rotational motion and oscillations are also covered. The last part of the semester is devoted to the study of heat, thermodynamics and kinetic theory.

Prerequisites: Math 30 or 30P.

Textbook: Sears & Zemansky, University Physics, 11th Edition, Volume 1, Hugh D. Young and Roger A. Freedman (Addison-Wesley, San Francisco, 2004)

Course Objectives:

1. Understand and apply the concepts of displacement, velocity, and acceleration
2. Understand and apply the concepts of kinetic and potential energy, work, inertia, momentum, and impulse
3. Understand and apply Newton's laws; projectile motion
4. Draw a free-body diagram and determine whether an object is in equilibrium
5. Determine rotational characteristics of an object under the influence of a torque
6. Calculate the wave amplitude and frequency of an object obeying Hooke's law
7. Calculate the pressure and density of fluids at rest and in motion.
8. Understand kinetic theory and apply the laws of thermodynamics

Topics Covered:

- Kinematics
- Dynamics
- Forces
- Work and Energy and Conservation
- Momentum
- Systems of Particles
- Pendulum
- Collisions
- Rotational Kinematics and Rotational Dynamics
- Rotational Energetics, Angular Momentum
- Rigid Body Mechanics
- Oscillations, Wave Motion, Mechanical Waves
- Temperature
- Gas Laws, Ideal Gas
- First First and Second Law
- Entropy

Class Schedule: 2 x 1.5 hour lectures + 1 x 3 hour lab session per week.

Contribution of Course to Meeting the Professional Component: Four semester units of basic science.

Relationship of Course to Program Outcomes: This course contributes to outcomes 3a and 3b.

Prepared by: Joseph Becker **Date: Spring 2005**

Course: **Physics 71 – Electricity and Magnetism**

Course Description: Physics 71 is the second course in a three semester course series. This course covers the fundamental principles of electric and magnetic fields, basic dc and ac circuits, and electro-magnetic waves. This is a calculus-based course, which provides students with an excellent background for future courses in science and engineering.

Prerequisites: Phys 70 & Math 31.

Textbook: Sears & Zemansky, University Physics, 11th Edition, Volume 2, Hugh D. Young and Roger A. Freedman (Addison-Wesley, San Francisco, 2004)

Course Objectives:
1. Calculate electric and magnetic fields caused by discrete and continuous distributions of electric charges and current elements, respectively.
2. Use Gauss' law to calculate the magnitude of the electric field caused by symmetric distributions of electric charges.
3. Apply Ampere's law to calculate the magnitude of the magnetic field caused by current elements.
4. Apply Faraday's law to calculate the induced EMF caused by changes in magnetic flux.
5. Calculate the force on charges moving and currents flowing in a magnetic field.
6. Simplify complex electric circuits into simpler circuits for analysis for using Ohm's law and Kirchhoff's rules.
7. Understand how to simplify and combine series and parallel circuit elements.
8. Analyze DC and AC circuits by calculating the current through circuit elements, the power dissipated in resistors, the phase angle between current and voltage.
9. Calculate energy stored in capacitors and inductors in electric circuits and understand their role in AC circuit oscillation.
10. List the various types of magnetism found in materials.
11. List Maxwell's equations in integral and differential form and their uses.

Topics Covered:
- Electric Charge and Coulomb's Law.
- The Electric Field Equipotential Lines and Gauss' Law for electricity.
- Capacitance Measurement Electric Potential Current, Voltage, and Resistance Measurements.
- The temperature Dependence of Resistance Current and Resistance Measurement.
- DC Circuits Multiloop Circuits and Kirchhoff's Rules.
- The Magnetic Field.
- Ampere's Law.
- The RC Circuit Faraday's Law of Induction.
- Diode Circuits.
- Inductance.
- Motion of Charged Particles in Magnetic Field, Magnetic Properties of Matter Magnetic Field Measurement, Biot-Savart Law.
- Alternating Current Circuits.
- Faraday's Law.
- Maxwell's Equations in integral and differential form.
- The RLC Circuit Electromagnetic Waves.

Class Schedule: 2 x 1.5 hour lectures + 1 x 3 hour lab session per week.

Contribution of Course to Meeting the Professional Component: Four semester units of basic science.

Relationship of Course to Program Outcomes: This course contributes to outcomes 3a and 3b.
Prepared by: Joseph Becker **Date: Spring 2005**

Course: **Physics 72 – Atomic Physics**

Description: Physics 72 is the third course in a three semester course series. This course is a study of geometric and physical optics and the basic quantum structure of atoms, molecules, nuclei, and solids. Optical spectra, lasers, semiconductor devices.

Prerequisites: Physics 71, Chemistry 1A.

Textbook: Sears & Zemansky, University Physics, 11th Edition, Volume 1 & 2, Hugh D. Young and Roger A. Freedman (Addison-Wesley, San Francisco, 2004)

Course Objectives:
1. Describe the wave nature of light.
2. Calculate the reflection and refraction of light rays caused by mirrors and thin lenses, respectively.
3. Calculate interference and diffraction effects caused by thin films and apertures, respectively.
4. Describe the concept of light polarization and the principles involved in optical gratings.
5. Describe the wave nature of matter.
6. Calculate energy levels of potentials and the hydrogen atom using Schroedinger's equation.
7. Calculate the effect of potential barriers on particle transmission.
8. Describe the principles involved in the operation of a laser.
9. Describe the principles of molecular binding.
10. Explain the different types of radioactive decay and calculate half-lives.
11. Describe energy bands and gaps in insulators, conductors, and semiconductors.

Topics Covered:
- Nature and Propagation of Light
- Reflection and Refraction at Plane Surfaces
- Spherical Mirrors and Lenses
- Interference
- Diffraction
- Gratings and Spectra
- Polarization
- Light and Quantum Physics
- The Wave Nature of Matter
- The Structure of Atomic Hydrogen
- Atomic Physics
- Electrical Conduction in Solids
- Nuclear Physics

Class Schedule: 2 x 1.5 hour lectures + 1 x 3 hour lab session per week.

Contribution of Course to Meeting the Professional Component: Four semester units of basic science.

Relationship of Course to Program Outcomes: This course contributes to outcomes 3a and 3b.

Prepared by: Joseph Becker Date: Spring 2005

Course: **Engr 10 – Introduction to Engineering**

Course Description: E10 gives students a taste of engineering through hands-on design projects, case studies, and problem-solving using computers. Students learn about the various aspects of the engineering profession and acquire both technical skills and non-technical skills, such as communication skills, team skills, and how to deal with ethical dilemmas. In addition, the course supports students in their efforts to succeed in engineering through personal and professional development.

Prerequisites: High School Geometry, Trigonometry, Algebra.

Textbook: *Mc Graw-Hill BEST Series*. Required Modules:

- *Design Concepts for Engineer,* Horestein, M. N.
- *Engineering Ethics,* Fleddermann, C. B.
- *Engineering Success,* Schiavone, P.
- *Spreadsheet Tools for Engineers with Excel 2002*, Byron Gottfried.
- I*ntroduction to MATLAB for Engineers*, William Palm.

Course Goals & Student Learning Objectives:

Goal 1: Educate students about the engineering profession and expose them to several engineering disciplines through problem solving for the purpose of providing information to assist them in their choice of major.

By the end of the course students will be able to:
1. Identify the various types of engineers and their job functions along with the kind of problems they solve in the real world.
2. Solve simple engineering problems from each discipline using mathematical modeling.
3. Identify and be able to resolve a variety of ethical problems that arise in the process of solving engineering problems

Goal 2: Give students a basic understanding of engineering methods, including experimentation, data analysis, and computer skills.

By the end of the course students will be able to:
1. Use a rational approach to estimation.
2. Check consistency of dimensions in engineering equations.
3. Design and perform simple experiments.
4. Evaluate and analyze the data from an experiment.
5. Create an engineering graph using graphing software.
6. Calculate and plot a linear regression of data.
7. Calculate and plot a curve through a set of data.
8. Write an engineering report using a word processor.
9. Prepare and give an engineering presentation using appropriate software.

Goal 3: Introduce students to engineering design through a variety of projects

By the end of the course students will be able to:

1. Develop a flow chart of the design process.
2. Define "real world" problems in practical (engineering) terms.
3. Search for, and study existing solutions.
4. Develop constraints and criteria for evaluation.
5. Look for and analyze alternative solutions.
6. Make decisions considering the trade offs between the various solutions.

7. Develop final specifications.
8. Communicate the results (selling the design).

Goal 4: Provide opportunities for students to practice communication and team skills
By the end of the course students will be able to:

1. Work harmoniously in a team and collaborate with teammates for the solution of engineering problems.

Goal 5: The course will provide support in academic success strategies, personal and professional development.
By the end of the course students will be able to:

1. Become aware of the types and availability of services to students at SJSU.
2. Assess your strengths and weaknesses based on the Attributes, Employment, and Astin Student Involvement models. You will also set goals, and develop a plan/timeline to achieve these goals.
3. Develop an appreciation of your own personality type and thinking preference (MBTI, HBTI) as well as those of others.
4. Become aware of the student chapters of the various engineering professional societies and encouraged to participate in their activities.

Course Topics:

<u>Week</u> <u>Lecture Topics</u>

1. Introduction to engineering and engineering disciplines, timeline to engineering education, attributes(ABET).
2. Engineering job titles, professional societies, learning styles, the role of the university.
3. Project and time management, guidelines for technical reports and oral presentations.
4. Engineering design, engineering design tools, flow charts.
5. Design process, brainstorming.
6. Critical Thinking Problems. Solar cell seminar.
7. The role of failure in engineering design.
8. The engineering method: modeling, estimation, approximations.
9. Innovation, product evolution.
10. Teamwork, cooperative learning, intellectual property, patents.
11. Why study ethics; case studies.
12. Risk, safety and accidents; case Studies.
13. The rights and responsibilities of engineers.
14. Engineering problem solving, Bloom's Taxonomy, corporate structure.
15. Looking into the future, course review.
16. Final Exam.

Week	Laboratory Topics
1	Team Formation, Introduction to Spreadsheets
2	Solution of eng. Problems using Spreadsheets,
3-5	Regression and Curve Fitting Methods, Trapezoidal Approximation, Log. Plots.
6-7	Solution of CE, ME and EE Problems
8-9	Group Presentations, Technical Reports
10-14	MATLAB familiarization and Problem Solving (Plotting Functions, Type of Problems, Rational Operators / Conditional Statements,)
15	Final Project Presentations, Technical Reports
16	Final Exam

Class / Laboratory Schedule: 2 x 50 min lectures + 1 x 3hour laboratory per week (EXCEL, MATLAB)

Contribution of Course to Meeting the Professional Component:
3 semester units of engineering topics, approximately 2/3 engineering science and 1/3 engineering design.

Relationship of Course to Program Outcomes:

	3a	3b	3c	3d	3e	3f	3g	3h	3i	3j	3k
Learning Objectives											
1									B	B	
2	B				B						
3						B					
4	B				B				B		
5	B										
6, 7, 8, 9, 10		B									B
11, 12							B				B
13, 14, 15, 16, 17, 18, 19			B				B				
20			B				B				
21				B							
22									A		
23									B		
24				B					B		
25									B		

Prepared by: John Athanasiou Date: Spring 2005

Course: **EE 98 – Introduction to Circuit Analysis**

Description: The objective of this course is to introduce the basics of AC/DC and transient analysis. This course builds on the foundations of physics and mathematics and is essential for all upper division EE courses. Topics cover basic circuit components and sources. Series and parallel connections follow, enabling the presentation of linearity and superposition. Ohm's Law, Kirchhoff's laws and Thevenin and Norton equivalency are presented. Circuit analysis is performed on first- and second-order circuits, including transient analysis, and steady state analysis. Power calculations investigate real and reactive components. Operational amplifiers are discussed along with an introduction to negative feedback.

Prerequisites: Phys 71 or Phys 51, Math 133A (co requisite)

Textbook: Fundamentals of Electric Circuits, by Alexander and Sadiku, McGraw Hill.

Course Objectives:

1. Analyze resistive networks containing series and parallel connections.
2. Use Ohm's Law to calculate voltage, current, and resistance in simple DC circuits.
3. Calculate a Thevenin or Norton equivalent source as well as interchange between the two.
4. Apply the theories of linearity and superposition as an aid in solving circuits.
5. Understand, analyze, and design with inductors and capacitors.
6. Calculate the natural and step responses of first- and second-order networks.
7. Calculate and sketch the frequency response of first- and second-order networks.
8. Utilize phasor analysis in first- and second-order systems.
9. Calculate the power dissipated in/supplied by a component, source, or network.
10. Analyze simple operational amplifier circuits with negative feedback.
11. Work in a group. Students work in groups on homework sets.
12. Appreciate the need for attention to detail and consistency. Students learn the importance of units, significant figures, and consistency in symbols.
13. Present information orally in a clear and concise manner. A portion of each student's grade reflects class participation. They may choose to participate in demonstrations, to volunteer to explain concepts on the board, or participate in class discussions about real-world applications of the current circuit topologies.

Topics Covered:
- Ohm's Law
- Kirchhoff's Laws
- Nodal Analysis
- Mesh Analysis
- Super position
- Source transformation
- Thevenin Theorem
- Norton Theorem
- Capacitors
- Inductors
- Phasor
- Impedance and admittance
- Instantaneous and Average Power
- Effective or RMS Value
- Apparent power and power factor
- Complex Power

Class Schedule: 2 x 75 min OR 3 x 50 min lectures per week
Contribution of Course to Meeting the Professional Component: Three (3) semester units of engineering science

Relationship of Course to Program Outcomes: The course contributes to outcomes 3a, 3b, 3c, 3e, 3f, 3g, 3i, and 3k. Moreover, the course contributes towards one or more technical specialties that meet the needs of Silicon Valley companies.

Prepared by Ray Chen Spring 2005

Course: **CE 99 – Statics**

Description: Study of bodies in equilibrium. Applications to particles, two-dimensional and three-dimensional structural systems. Topics include free body diagrams, centroids, shear and moment diagrams, distributed loads, moments of inertia and friction.

Prerequisites: Math 31 (Calculus II), Phys 70 or Phys 50 (Mechanics)

Textbook: Vector Mechanics for Engineers, Statics, 6th Edition, Beer and Johnston

Course Objective: By the end of this course, students can construct free-body diagrams and apply equations of static equilibrium to solve for unknown forces for two and three-dimensional statically determinate structures. The students will also be proficient in finding the centroid of lines, areas and volumes, and calculating moments of inertia of areas. The student should also be proficient in solving problems involving distributed forces and forces due to friction.

Topics:

1. Forces, vectors, components of a vector
2. Two-dimensional equilibrium of a particle
3. Three-dimensional force systems
4. Three-dimensional equilibrium of a particle
5. Vector product, moment of a force about a point
6. Moment of a couple
7. Equivalent force systems
8. General two-dimensional equilibrium, free body diagrams
9. Equilibrium of two and three force bodies
10. Truss analysis
11. Analysis of frames and machines
12. Centroids of lines and areas
13. Distributed loads
14. Moments of inertia of areas
15. Friction
16. Internal forces, shear and moment diagrams for beams
17. Fluid statics

Class / Laboratory Schedule: 2 x 50 min lectures per week

Course Contribution to Professional Component: Two (2) semester units of engineering science

Relation of Course to Program Outcomes: This course contributes to outcomes 3a, 3e, and 3g.

Prepared by: Steven M. Vukazich Date: March 15, 2005

Course:	**Engr 100W – Engineering Reports on the Earth and Environment**
Course Description:	Regular technical writing assignments and company-focused oral presentations while integrating effects of environmental factors as they relate to products, systems and engineering processes.
Prerequisites:	English 1B (with a grade of C or better); Completion of core GE, satisfaction of Writing Skills Test and upper division standing.
Textbooks:	1. Cunningham W., Cunningham M.A., Principles of Environmental Science: Inquiry and Applications, McGraw-Hill, 2004. 2. Markel M., Technical Communication, 7th ed., Bedford / St. Martins Press, 2004.

Course Objectives:
Upon completion of the course, students will be able to do the following:

1. Demonstrate an understanding of the methods and limits of scientific investigation.
2. Distinguish science from pseudo-science.
3. Apply a scientific approach to answer questions about the earth and environment.
4. Express (explain, analyze, develop, and criticize) ideas effectively, including ideas encountered in multiple readings and expressed in different forms of discourse.
5. Organize and develop essays and documents for both professional and general audiences, including appropriate editorial standards for citing primary and secondary sources.
6. Communicate using a variety of technical, professional writing formats.
7. Refine the competencies established in Written Communication IA and IB as summarized below.
   a. Perform effectively the essential steps in the writing process (prewriting, organizing, composing, revising, and editing)
   b. Express (explain, analyze, develop, and criticize) ideas effectively
   c. Use correct grammar (syntax, mechanics, and citation of sources) at a college level sophistication.
   d. Write for different audiences (both specialized and general)
   e. Use (locate, analyze, and evaluate) supporting materials, including independent library search.
   f. Synthesize ideas encountered in multiple readings.
   g. Construct effective arguments.

Topics Covered:

<u>Writing Topics:</u>
Technical Description, Compare and Contrast, Memos, Good/Bad News Letters, Lab Report, Technical Proposal, Executive Summary, Progress Reports, Incident Reports, Feasibility Report, Trip/Conference Report, Activity Report, Task Report, Process Explanation, Technical instructions, Interviewing, Oral Presentations, Developing Visual Aids, Promotional Pieces, PowerPoint Skills.

<u>Environmental Topics:</u>
Science vs. Pseudoscience, Water, Energy, Soil Conservation and Agricultural Issues, Marine Protection, Hazardous Materials, Landfill Dumping Sites, Pollution, Storm Water Control, Environmental Law, Underground Storage Tanks, Ecology, Pesticides, Public Policy, Waste Minimization, Manufacturing Processes, Occupational Health and Safety, Recycling, Social Responsibilities/Ethics, Environmental Impact Reports.

<u>Research Methodology:</u>
Methods and limits of scientific research, science and critical thinking, library resources, Internet resources, professional journals, documentation.

Class Schedule: 2 x 50 min lectures + 1 x 3 hour lab per week.
Relationship of Course to Program Outcomes: Contributes to Program Outcomes 3d, 3g, 3h, and 3j.

Prepared by: Jeanne Linsdell Date: Spring 2005

Course: **ME 101 – Dynamics**

Description: Vector mechanics. 2-D and 3-D motion of particles and rigid bodies.
Force, energy, and momentum principles.

Prerequisites: CE 99, Math 32. Grade of "C" or better required for AE and ME majors.
Textbook: *Vector Mechanics for Engineers: Dynamics*, 7th Edition, by F. P. Beer, E. R. Johnston, and W. E. Clausen, McGraw-Hill, Boston, 2004.

Student Learning Objectives: By the end of the course, students should be able to:

1. Distinguish between kinematics and kinetics in dynamics of solids.
2. Develop analytical models for given dynamic situations using particle and rigid body dynamics theories.
3. Characterize a motion to be rectilinear, curvilinear, planar rigid-body and 3-dimensional rigid-body dynamics.
4. Properly describe the motion of a particle in terms of kinematics for general curvilinear motion as well as in moving reference frames.
5. Apply Newton's second law in solving dynamics problems involving particles and rigid-bodies.
6. Apply the principles of energy and momentum in solving problems involving particles and rigid-bodies in motions and subject to impacts.
7. Apply vector mechanics, differential equations and integral calculus as needed in modeling and solving dynamics of engineering systems.

Course Topics

Week 1 Introductory Concepts
Week 2 Point Kinematics
Week 3 Point Dynamics: Force, Mass, Acceleration
Week 4 Point Dynamics: Force, Mass, Acceleration
Week 5 Point Dynamics: Energy Methods
Week 6 Point Dynamics: Energy Methods
Week 7 Point Dynamics: Momentum Methods
Week 8 Point Dynamics: Momentum Methods
Week 9 Planar Rigid Body Kinematics
Week 10 Planar Rigid Body Kinematics
Week 11 Planar Rigid Body Dynamics
Week 12 Planar Rigid Body Dynamics
Week 13 Planar Rigid Body Energy & Momentum
Week 14 Planar Rigid Body Energy & Momentum
Week 15 Review

Class Schedule: 3 x 50-min OR 2 x 75 min lectures per week
Course Contribution to Professional Component: 3 semester units of engineering topics, approximately 2/3 engineering science and 1/3 engineering design.

Course Relationship to Program Outcomes:

Outcome 3a: Apply knowledge of mathematics, science, and engineering to solve engineering problems. There are weekly homework assignments spanning kinematics and dynamics using force, energy, and momentum principles in vector notation. Classes include working sessions with unsolved problems provided by the instructor, then tackled by small teams, and finally reviewed as a whole class. Quizzes and a comprehensive final exam test understanding given information, evaluating assumptions, answering concept questions, and performing calculations. Outcome 3e: Identify, formulate, and solve engineering problems. Some exam questions are more open-ended than textbook problems and require that students defend their assumptions instead of simply providing a solution.

Prepared by: John Lee Date: Spring 2005

Course: **ME 111 - Fluid Mechanics**

Description: Fluid Mechanics is the science that deals with the behavior of fluids, at rest or in motion. In particular, it is concerned with the forces generated on various surfaces by the presence and / or motion of fluids. This course provides an introduction to fluid mechanics through the use of theory, problem solving, laboratory demonstrations, and films. The theory includes a study of fluid properties, fluid statics, the basic principles of fluid flow (continuity, momentum, energy), pipe flow and boundary layers. The laboratory demonstrations include flow visualization in a water tunnel and pressure distributions on an airfoil in a wind tunnel.

Prerequisites: Math 32, CE 99

Textbook: Crowe, C.T., Elger, F.E. & Roberson, J.A., *Engineering Fluid Mechanics*, Wiley, 8^{th} ed. 2005.
Course website: <www.engr.sjsu.edu/nikos/courses/me111/>

Learning Objectives: By the end of the course, students should be able to:

1. Define a fluid and describe how it differs from a solid.
2. Describe the differences between liquids and gases and explain the origin of these differences.
3. Define the fluid properties of, such as density, specific weight, specific gravity, pressure, temperature, specific heat, specific internal energy, specific enthalpy, viscosity, surface tension, and vapor pressure.
4. Distinguish between Newtonian and Non-Newtonian fluids.
5. Solve problems involving viscosity, surface tension, and vapor pressure.
6. Define and distinguish between absolute pressure, gage pressure, and vacuum.
7. Explain Blaise Pascal's law of pressure transmission.
8. Derive the basic differential equation of Hydrostatics starting with the equilibrium of a fluid element.
9. Derive the equation for the pressure variation of a uniform-density fluid.
10. Solve problems involving manometers.
11. Classify a flow as uniform / nonuniform, steady / unsteady, laminar / turbulent, attached / separated, one-dimensional / two-dimensional / three-dimensional.
12. Calculate mass flow rate, volume flow rate, and mean velocity for a flow.
13. Derive the integral form of the continuity equation for a control volume.
14. Identify, formulate, and solve problems involving the continuity equation for a variety of cases involving one-dimensional, uniform and nonuniform, compressible and incompressible, steady and unsteady flows.
15. Derive Euler's equation for a moving fluid.
16. Derive Bernoulli's equation and list the assumptions made in the derivation.
17. Apply Bernoulli's equation to flow velocity measurements and pressure calculations.
18. Predict cavitation in enclosed pipes or hydraulic machines.
19. Describe qualitatively the differences between ideal (fully attached) and real (separated) flow over a circular cylinder.
20. Derive the momentum equation for a fluid, starting with Newton's 2nd law of motion.
21. Identify, formulate, and solve problems involving the momentum equation in a variety of applications including stationary and moving vanes, nozzles, and pipes with bends.
22. Derive Reynolds transport theorem (control volume equation).
23. Derive the integral form of the energy equation starting with the Reynold's transport theorem and the 1^{st} law of thermodynamics.
24. Identify, formulate, and solve problems involving the energy equation in a variety of applications including reservoirs, pipes with minor losses, pumps, turbines, and nozzles.
25. Identify, formulate, and solve problems involving the simultaneous application of continuity, momentum, and energy equations.

26. Plot the hydraulic and energy grade lines for a variety of flow systems involving reservoirs, pipes of varying diameters, pumps, turbines, and nozzles.
27. Describe qualitatively and quantitatively both laminar and turbulent flow in a pipe and predict transition from laminar to turbulent flow inside a pipe.
28. Derive the equation for the shear stress distribution across a pipe section.
29. Derive the equation for the velocity distribution across a pipe section in laminar flow.
30. Use the Moody diagram in a variety of problems involving head losses in pipes, including the design of pipes for certain discharge with a given head loss per unit length.
31. Calculate minor losses (i.e., head losses in pipe inlets, outlets, valves, and other fittings.
32. Select the right size pump for a given pipeline / system.
33. Work effectively in a team to solve fluid mechanics problems.
34. Communicate effectively ideas and problem solutions relating to fluid mechanics.
35. List several examples of regional, national, and / or global contemporary problems related to fluid mechanics (ex. environmental issues, natural resources and energy conservation, etc.) articulate a problem / position statement for each, and explain what makes these issues particularly relevant to the present time.
36. Identify possible solutions to these problems, as well as any limitations of these solutions.

Topics

Week	Films / Demonstrations
1. Introduction. Team building. Learning styles inventory.	
2. Fluid Properties.	
3. Fluid Statics. Manometers.	
4. Fluids in motion, flow classification.	Water-tunnel & wind-tunnel demos
5. Fluids in motion, Continuity.	
6. Pressure variation in fluids. Bernoulli's equation.	Film: Cavitation
7. Momentum equation.	
8. Momentum equation.	
9. Momentum equation.	
10. Energy principle.	
11. Energy principle.	
12. Pipe flow.	Film: Turbulence
13. Pipe flow	
14. Surface Resistance.	Film: Fundamentals of boundary layers.
15. Surface Resistance	

Class Schedule: 2 x 75 min lectures per week
Course Contribution to Professional Component: Three (3) semester units of engineering science

Course Relationship to Program Outcomes

	3a	3b	3c	3d	3e	3f	3g	3h	3i	3j	3k
Learning Objectives	B			B	C		B		C	B	
1,2,3,4											
5	B			B	B						
6,7									B		
8, 9	B										
10	B			B	B						
11									B		
12	B				B						
13	B										
14	B			B	C		B		B		
15,16	B										
17,18	B			B	B						
19	B								B		
20	B										
21	B			B	B						
22,23	B				B						
24,25	B			B	C						
26	B				B						
27	B								B		
28,29	B										
30,31,32	B			B	B						
33				B							
34							B				
35,36				B			B	B	C	B	

Prepared by: Nikos J. Mourtos **Date: Spring 2005**

Course: **CE 112 – Mechanics of Materials**

Description: Stress distributions, strain, stresses and deformations in machines and structures subject to axial, bending and torsional loads, including combined loads. Stability of columns.

Prerequisite: CE 99 Statics (C- or better)
Corequisites: MatE 25, Math 133A (Differential Equations)

Textbook: R.C. Hibbeler, "Mechanics of Materials, 6^{th} Edition, Prentice Hall, 2005.

Course Objectives:

1. To learn to analyze a structure for internal forces
   Student learning outcomes: The student will demonstrate the ability to:
   a) Determine internal axial forces in both statically determinate and statically indeterminate axially loaded prismatic and non-prismatic members subjected to applied forces, temperature variations and prestrain effects
   b) Determine internal torques in both statically determinate and statically indeterminate torsionally loaded prismatic and non-prismatic solid circular shaft and hollow tubes subjected to applied torques..
   c) Determine internal shears, moments and axial forces in beams and accurately draw shear and bending moment diagrams.

2. To learn the fundamentals of analysis of stress
   Student learning outcomes: The student will demonstrate the ability to:
   a) Determine internal stresses in both statically determinate and statically indeterminate axially loaded prismatic and non-prismatic members subjected to applied forces, temperature variations and prestrain effects.
   b) Determine internal stresses in both statically determinate and statically indeterminate torsionally loaded prismatic and non-prismatic solid circular shaft and hollow tubes subjected to applied torques.
   c) Determine normal and shear stresses in rectangular beams, beams with flanges and built-up beams of various shapes.
   d) Use Mohr's Circle to analyze stress at a point and determine principal stresses.

3. To learn the fundamentals of analysis of deflections
   Student learning outcomes: The student will demonstrate the ability to:
   a) Calculate deflections of beams using integration, superposition method
   b) Analyze statically indeterminate beams using superposition

4. To learn the fundamentals of stability analysis
   Student learning outcomes: The student will demonstrate the ability to:

a) Use Euler's formula to evaluate the stability of long columns.

Topics covered:

1. Internal forces in members subjected to axial, torsional and bending loads
2. Concept of stress and strain, Mohr's circle for plane stress
3. Stress-strain relationship, generalized Hooke's Law
4. Stresses and strains in axially loaded members
5. Stresses, strains, and rotations in torsionally loaded shafts.
6. Stresses in beams
7. Deflections of beams
8. Combined stresses
9. Analysis of columns
10. Statically indeterminate problems
11. Design of members subjected to axial, torsional, and flexural loads

Class / Laboratory Schedule: 2 x 75 min lectures per week

Course Contribution to Professional Component: Three (3) semester units of engineering science topics

Relation of Course to Program Outcomes: This course contributes to outcomes 3a, 3c, and 3e.

Prepared by: Akthem Al-Manaseer Date: March 16, 2005

Course: **CE 113 – Mechanics of Materials Laboratory** **(Elective)**

Course Description: This course provides students with an in-depth understanding of mechanics of materials concepts through experimentation and application to problems in which the theoretical assumptions do not apply. Students practice leadership skills in laboratory teams and improve communication skills through presenting experimental results and writing laboratory reports. Topics include experimental stress analysis, verification of theoretical models through testing, deflection of beams, inelastic bending and column instability.

Prerequisite: CE 112 Mechanics of Materials

Textbook: Civil Engineering Faculty, "CE 113 Laboratory Manual" – required
R.C. Hibbeler, "Mechanics of Materials, 6th Ed., Prentice Hall, 2005

Course Objectives:

1. To verify mechanics of materials theory on real specimens
   Student learning outcomes: The student will demonstrate the ability to:
   a) Identify when theory applies and when theory is limited by simplifying assumptions
   b) Identify reasons why actual measurements will differ from theoretical calculations
2. To learn to run an experiment
   Student learning outcomes: The student will demonstrate the ability to:
   a) Perform pre-laboratory calculations to estimate experimental parameters, outcomes and limits
   b) Develop an organized and meaningful data sheet
   c) Use software tools to reduce and analyze data
   d) Organize a team to share responsibilities for operating equipment and collecting data
3. To learn to use testing equipment and measurement instrumentation
   Student learning outcomes: The student will demonstrate the ability to:
   a) Use the laboratory equipment correctly and safely to perform all experiments
4. To learn to write a laboratory report
   Student learning outcomes: The student will demonstrate the ability to:
   a) Write experimental objectives and procedures
   b) Present results in a organized and clear manner
   c) Draw graphs and figures to summarize key findings
   d) Put together a complete report including tables of contents, references and appendices

Topics Covered:

1. Plane stress and strain
2. Mohr's circle of stress
3. Use of a testing machine and strain gages
4. Bending and shear stress distribution in a flanged beam
5. Beam deflection theory for a beam of variable cross section
6. Inelastic bending and plastic moment
7. Use of the Berry strain gage
8. Column stability and Euler's equation
9. Properties of wood and strength of wood

Class / Laboratory Schedule: 2-hour lecture every other week, 3-hour laboratory on alternate weeks
Course Contribution to Professional Component: One semester unit of engineering science
Relation of Course to Program Outcomes: This course contributes to outcomes 3a, 3b, 3d, 3g, and 3k. Moreover, it contributes towards proficiency in one of four recognized civil engineering areas.

Prepared by: Kurt McMullin **Date:** March 17, 2005

Course: **ME 113 – Thermodynamics**

Course Description: This course provides an introduction to engineering thermodynamics. Relevant topics include: properties of simple compressible substances, ideal gas and other equations of state, first and second laws of thermodynamics, energy and irreversibility, power cycles and refrigeration cycles, gas mixtures, gas-vapor mixtures and chemically reacting mixtures.

Prerequisites: Physics 70 or 52, Math 32. (ME and AE majors must earn grade of "C-" or better)

Textbook: *Thermodynamics: An Engineering Approach*, by Cengel and Boles, 3rd ed., McGraw-Hill, 1998.

References: *Engineering Thermodynamics: Fundamentals and Applications*, by F. Huang, 2nd ed., Macmillan Publishing Co., 1988.
Fundamentals of Engineering Thermodynamics, by Moran and Shapiro, 2nd ed., John Wiley and Sons, Inc., 1992.
Engineering Thermodynamics, by J. B. Jones and R. E. Dugan, Prentice-Hall, 1996.
Schaum's Outline of Theory and Problems of Thermodynamics for Engineers, by M. C. Potter and C. W. Somerton, McGraw-Hill, 1993.

Student Learning Objectives: By the end of the course, students should be able to:

1. Demonstrate teamwork and communication skills through projects and written reports.
2. Demonstrate open-ended problem solving skills through collaborative in-class exercises and presentation.
3. Use units correctly as an additional check of engineering analysis.
4. Estimate order of magnitudes in engineering design and analysis.
5. Use tabulated data, basic equations of state, and computer programs to determine the phase (vapor, liquid or solid) and properties (temperature, pressure, specific volume, internal energy, enthalpy and entropy) of a pure substance.
6. Identify a system and properly apply the basic laws of thermodynamics (first and second laws) and conservation of mass.
7. Analyze the thermodynamic performance of common steady-flow engineering devices, including turbines, compressors, heat exchangers, and valves
8. Analyze the performance of a simple Brayton cycle.
9. Analyze the performance of a simple Rankine cycle.
10. Analyze the performance of a simple vapor compression cycle. Understand and analyze different air-conditioning and cooling processes involving air-water vapor mixtures.
11. Analyze the performance of engineering systems involving non-reacting gas mixtures.
12. Work in teams to write a report on a contemporary issue facing thermodynamics based on the use of library resources.
13. Work in teams to write a report on global and societal impacts of thermodynamic applications based on the use of library resources.

Topics

<u>Week</u> <u>Lecture Topic</u>

1. Basic concepts in thermodynamics (Chapter 1)
2. Properties of pure substances (Chapter 2)
3. Equations of state (Chapter 2)
4. First law of thermodynamics (Chapters 3 and 4)
5. Steady flow devices (Chapter 4)
6. Second law of thermodynamics (Chapter 5), Entropy
7. Entropy, cont. (Chapter 6) Exam 1
8. Exergy (Chapter 7)
9. Carnot cycle, Rankine cycle (Chapter 9)
10. Power plant components, second law efficiency, cogeneration (Chapters 8 and 9)
11. Gas power cycles (Chapter 8)
12. Refrigeration cycles (Chapter 10)
13. Gas mixtures and gas-vapor mixtures (Chapters 12 and 13)
14. Gas-vapor mixtures and psychrometrics (Chapter 13)
15. Air conditioning processes (Chapter 14)
16. Global/societal impacts, contemporary issues, Review

Class Schedule: 2 x 100 min lectures per week

Course Contribution to Professional Component: Four (4) semester units of engineering science topics

Course Relationship to Program Outcomes

	3a	3b	3c	3d	3e	3f	3g	3h	3i	3j	3k
Learning Objectives	**C**		B	B	**A**		B		A	**B**	
1				**B**			**B**		**A**		
2	B				A						
3	A										
4	A		B								
5,6,7	C										
8,9,10	C										
11	B										
12				B			B		A	B	
13				B			B	B	A		

Prepared by: Jinny Rhee Date: Spring 2005

Course: **CE 114 – Intermediate Mechanics** **(Elective)**

Course Description: Design and analysis of structural and machine elements, combined stresses, failure theories, curved beams, shear flow, shear center and unsymmetrical bending.

Prerequisite: CE 112 Mechanics of Materials

Textbook: R.C. Hibbeler, "Mechanics of Materials", 3rd Ed., Prentice Hall, 1997.

Course Objectives: Reinforce the concepts of basic mechanics of materials and extend the students' analysis capability to complex components, shapes, and loadings.

Topics Covered:
1. Conventional and true stress and strain
2. Analysis of statically-indeterminate axial systems
3. Inelastic behavior of axial systems; residual stress
4. Impact loads on axial systems
5. Analysis of statically-indeterminate torsional components
6. Non-circular solid shafts in torsion
7. Non-circular thin tubes in torsion
8. Open thin-walled sections in torsion
9. Unsymmetrical bending
10. Shear flow and shear center
11. Curved beams
12. Inelastic bending
13. Three-dimensional stress distributions
14. Failure theories

Class Schedule: 2 x 75 min lectures per week

Course Contribution to Professional Component: Three (3) semester units of engineering topics = 2/3 engineering science + 1/3 engineering design.

Relation of Course to Program Outcomes: This course contributes to outcomes 3a, 3c, 3e, and 3k. Moreover, it contributes towards proficiency in one of four recognized civil engineering areas.

Prepared by: William Blythe Date: April 14, 1999

Course: **AE 114 – Aerospace Structures**

Description: The course builds on fundamental understanding of the mechanics of materials to enable design and analysis of aircraft, missile, spacecraft and other aerospace structures. Course covers static, elastic, and stress analysis of structures. Structural materials. Defection analysis of structural systems. Conventional, stiffened, sandwich, and composite structures. Structural dynamics. Thermal effects.

Prerequisites: Grade of 'C-' or better in CE 112; Engr 100W (may be taken concurrently)
Textbooks: *Mechanics of Aircraft Structures*, by C.T. Sun, John Wiley & Sons, Inc., 1998.

References:
1. Allen, D. H. and Haisler, W. E., *Introduction to Aerospace Structural Analysis*, Wiley, 1985
2. Timoshenko, S. P. and Goodier, N., *Theory of Elasticity*, 3rd. ed., McGraw-Hill, 1970
3. Timoshenko, S. P. and Gere, J. M., *Theory of Elastic Stability*, 2nd. ed., McGraw-Hill, 1961
4. Timoshenko, S. P. and Woinowski-Krieger, S., *Theory of Plates and Shells*, 2nd. ed., 1959
5. Wang, C. T., *Applied Elasticity*, McGraw-Hill, 1953

Student Learning Objectives: By the end of the course, students should be able to:
1. Apply the theories of bending and torsional deformation of advanced beams and classical plates to analyze aerospace structures.
2. Estimate the shear flows, shear stresses, and shear center in thin-walled structural sections.
3. Apply the principle of fracture mechanics in failure analysis.
4. Perform basic analysis of laminated plates.
5. Apply the energy theorem and Castigliano's first and second theorems to solve linear elastic structural problems.
6. Apply the formulations of two dimensional finite element stiffness matrixes to solve linear elastic structural problems.

Course Topics:

Week#	Lecture Topic(s)
1	Introduction, course objectives, aerospace structures
2	Basic types of aerospace structures; Free body diagrams
3	Advanced beam theory; Shear and moment diagrams
4	Torsion, Laboratory (1)
5	Statically determinate and statically indeterminate structures
6	Thin walled closed sections; Shear flows
7	Shear flows in thin walled open sections
8,9	Shear center; Review
10	Applied elasticity, Laboratory (2)
11	Theory of plates
12	Principle of energy methods
13	Principle of superposition; Failure analysis
14	Advanced energy method, Laboratory (3)
15, 16	Finite element method

Class Schedule: 3 x 50 min lectures + 1 x 3 hour lab per week
Course Contribution to Professional Component: Three (3) semester units of engineering science topics
Prepared by: Raymond K. Yee Date: Spring 2005

Course: **ME 114 – Heat Transfer (Elective)**

Course Description: The purpose of this course is to provide an overview of basic principles of heat transfer and their application to engineering problems through use of theory, collaborative problem solving, and laboratory experiments. This overview includes an introduction to steady and unsteady conduction, numerical methods, free and forced convection, heat exchanger design, and radiation. The laboratory includes experiments relating to measurement procedures, air conditioning, cooling of a computer chassis, external convection and transient conduction, and heat exchangers.

Prerequisites: Math 133A, ME 113 with a "C-" or better

Textbook: Heat Transfer: A Practical Approach, 2nd edition, Yunus Çengel

Learning Objectives: By the end of the course, each student should demonstrate an ability to:

<u>Steady-State Conduction</u>
1. Apply the heat diffusion equation to calculate temperature distributions and heat transfer rates in simple geometries.
2. Determine the variation of thermal conductivity between classes of materials (metals, ceramics, and polymers), phases of matter, and with temperature (and pressure for gases).
3. Calculate thermal resistances, including contact resistances, and develop thermal circuits.
4. Analyze heat transfer from finned surfaces.
5. Explain the importance of effective cooling of electronics.
6. Calculate energy conserved and money saved through the addition of insulation.

<u>Numerical Methods</u>
7. Apply finite difference techniques to compute heat conduction in 1- and 2-dimensional configurations, under steady and transient conditions.
8. State sources of uncertainty in computational fluid dynamics programs and determine ways to improve their accuracy

<u>Transient Conduction</u>
9. Analyze transient conduction using lumped capacitance and determine when its use is appropriate.
10. Calculate temperatures for transient heat conduction in multi-dimensional geometries where lumped capacitance does not apply.

<u>Convection</u>
11. Explain the importance of boundary layers to heat transfer.
12. Explain the importance and source of the convection transfer equations.
13. Explain the significance of non-dimensional parameters such as Re, Pr, Nu, and Sc.
14. Explain the analogy between heat and mass transfer.
15. Use correlations to determine heat transfer coefficients and/or temperatures for external flow over plates, cylinders, spheres, and tube banks.
16. Use correlations to determine heat transfer coefficients and/or temperatures for internal flow in tubes.
17. Determine conditions under which convection is natural, forced, or mixed.

<u>Heat Exchangers</u>
18. State the main categories of heat exchangers.
19. Determine overall heat exchanger coefficients for heat exchangers using the log-mean-temperature-difference (LMTD) and number of transfer units (NTU) methods.
20. Calculate heat transfer and pressure drop for a heat exchanger given a graph of j and f vs. Re.

<u>Radiation</u>

21. Explain the differences among intensity, emissive power, radiosity, and irradiation and between spectral and hemispherical.
22. Explain the difference between diffuse and grey.
23. Apply Wien's Displacement Law, the Stefan-Boltzmann Law, band emission, and blackbody functions.
24. Compute the radiative properties emissivity, absorptivity, reflectivity, and transmissivity.
25. Apply Kirchoff's Law.
26. Account for environmental radiation.
27. Explain theoretical causes of the Greenhouse Effect.
28. Compute view factors.
29. Calculate radiation exchange between blackbodies.
30. Analyze radiation exchange between two diffuse, gray surfaces in an enclosure.

<u>Experimental Methods</u>

31. Calculate the effect of measurement uncertainty on experimental results using simple methods.
32. Determine how to experimentally analyze the effect of fan and heat sink performance on computer chip junction temperature.
33. Determine how well theoretical moist air mixture and energy balance equations match a real air conditioning system.
34. Measure the performance of a real heat exchanger.
35. Design an experiment that can be used to calculate the thermal conductivity of an unknown solid substance.

<u>Teamwork, Communication, and Learning Skills</u>

36. Effectively work in teams on experiments and lab reports.
37. Write laboratory reports using professional technical language and format.
38. Cite the work of others in laboratory reports correctly.
39. Use material learned from the textbook independently to perform analyses
40. Analyze a heat transfer problem and choose the appropriate analysis methods without being prompted.

Class Schedule:

Week	Lecture Topic	Experiment
1	Heat transfer overview, intro to conduction	
2	General heat conduction equation	Air Conditioning
3	Heat generation, resistance method	Air Conditioning
4	Conduction in cylinders and spheres, fins	
5	Lumped capacitance, 1-D transient heat transfer	Thermal Resistances in a Computer
6	Semi-infinite solids, multi-dimensional systems	Thermal Resistances in a Computer
7	Steady-state and transient numerical methods	
8	Introduction to convection	Finite Difference Project
9	Convection governing equations, flat plate flow	
10	Flow over cylinders and spheres, internal flow	Flow over a Cylinder/Transient Conduction
11	Turbulent internal flow, natural convection	Flow over a Cylinder/Transient Conduction
12	Heat exchangers	
13	Intro to radiation, radiative properties	Heat Exchangers
14	Atmospheric and solar radiation, view factors	Heat Exchangers
15	Black and grey surface radiation heat transfer	

Class Schedule: 3 x 50 min lectures + 1 x 3 hour lab per week

Course Contribution to Professional Component: Four (4) semester units of engineering topics

Course Relationship to Program Outcomes

	3a	3b	3c	3d	3e	3f	3g	3h	3i	3j	3k
Learning Objectives	C	C	B	A	B	A	C	A	B	A	B
1	C										
2,3,4	B										
5										A	
6	B									A	
7,8					A						B
9,10	C										
11-17	B										
19, 20	C										
21,22	B										
23-26	C										
27								A			
28	B										
29,30	C										
31-34	B	C									
35	B	B	B		B						
36				A							
37							C				
38						A	A				
39									B		
40					B						

Prepared by: Nicole (DeJong) Okamoto Date: Fall 2003

Course: **ME 130 – Applied Engineering Analysis**

Description: Analytic models for engineering processes and systems in fluid mechanics, heat transfer, solid mechanics, and machine design. Practical interpretations of analytic and approximate solutions for steady and non-steady state problems. Introduction to linear algebra and statistics.

Prerequisites: Math 133A, Grade C- or better in ME 101 and ME 113

Textbook: "Applied Engineering Analysis," notes by Tai-Ran Hsu, SJSU, January 2005.

Student Learning Objectives: By the end of the course, students should be able to:

1. To fully understand the physical (engineering) interpretations of fundamentals of mathematical terms such as variables, functions, differentiation and derivatives, integration, differential equations, etc.
2. To acquire experience and skill in basic methodologies in differentiation, integration and solving ordinary and partial linear differential equations.
3. To be able to relate special tools such as Laplace transform and Fourier series for modeling engineering phenomena and facilitate the mathematical solutions
4. To be able to establish mathematical models, such as differential equations and appropriate boundary and initial conditions for fundamental mechanical engineering problems in fluid mechanics, vibration and heat conduction of solids and find ways to solve these equations.
5. To be proficient in finding solutions of integrals and related information from tool books such as mathematical handbooks, spreadsheets and computer software such as Mathcad and Matlab.
6. To learn the basic principles of linear algebra and its application in engineering analysis.
7. To understand the basic principles of statistics and its application in quality controls in manufacturing processes.

Course Topics:
Week 1: Chapter 1: The basic principles of engineering analysis and its applications.
Week 2: Chapter 2: The principles of calculus, derivatives, orders of derivatives and mathematical modeling.
Week 3: Chapter 3: Introduction to ordinary and partial differential equations. Derivation and solutions of first order ordinary differential equations.
Week 4: Chapter 3: Application of first order ordinary differential equations in fluid mechanics, heat conduction in solids and kinematics of rigid body.
Week 5: Chapter 4: Solution of homogeneous, second-order linear differential equations with constant coefficients.
Week 6, 7: Chapter 4: Application of ordinary differential equations in mechanical vibration.
Week 7, 8: Chapter 5: Laplace transform and its physical meaning. Application of Laplace transform in solving differential equations relevant to engineering applications.
Week 9: Chapter 6: Fourier series and its engineering applications.
Week 10: Chapter 7: Introduction to partial differential equations.
Week 11,12: Chapter 8: Linear algebra and its application in engineering analysis.
Week 13-15: Chapter 10: Introduction to statistics and applications to manufacturing process and quality control.

Class Schedule: Three (3) x 50 minute lectures per week

Course Contribution to Professional Component: Three semester units of engineering science topics

Course Relationship to Program Outcomes

	3a	3b	3c	3d	3e	3f	3g	3h	3i	3j	3k
ME 130	C		c		B				a		
Learning Objectives											
1	A		B								
2	A				A						
3	A				B				b		
4	A		A		A						
5					C				a		
6	C				C						
7	C		c		B						

Prepared by: Tai-Ran Hsu Date: Spring 2005

Course: **AE 140 – Rigid Body Dynamics**

Description: Coordinate frames and descriptions of absolute and relative motion. General equations of rotational motion for single and multibody systems in Euler and Lagrangian formulations. Elasticity and dissipation effects. Spinning body motions. Impulsive motions. Applications to aerospace vehicles.

Prerequisites: Grade of "C" or better in ME101.

Textbook: *Principles of Dynamics*, 2nd Edition, by D. T. Greenwood, Prentice-Hall, 1988.

Student Learning Objectives: By the end of the course, students should be able to:

1. Derive point-mass equations of motion using Newton's or Lagrange's method.
2. Identify and use conservation principles (energy, momentum) to extract useful information from equations of motion.
3. Use Newtonian, Lagrangian, and Eulerian methods to determine equations of motion for rigid bodies.
4. Apply fundamental concepts of nutation and precession in describing the motion of aerospace vehicles.
5. Numerically integrate equations of motion to determine point-mass and rigid body motion.

Course Topics

Week 1	Introductory Concepts (textbook Chapter 1)
Week 2	Kinematics of a particle (Chapter 2)
Week 3	Kinematics of a particle (Chapter 2)
Week 4	Dynamics of a particle (Chapter 3)
Week 5	Dynamics of a particle (Chapter 3)
Week 6	Dynamics of a system of particles (Chapter 4)
Week 7	Dynamics of a system of particles (Chapter 4)
Week 8	Lagrange's equations (Chapter 6)
Week 9	Lagrange's equations (Chapter 6)
Week 10	Kinematics of rigid body motion (Chapter 7)
Week 11	Kinematics of rigid body motion (Chapter 7)
Week 12	Dynamics of a rigid body (Chapter 8)
Week 13	Dynamics of a rigid body (Chapter 8)
Week 14	Vibration theory (Chapter 9)
Week 15	Review

Class Schedule: 2 x 75 min lectures per week
Course Contribution to Professional Component: 3 semester units of engineering topics, approximately 2/3 engineering science and 1/3 engineering design.

Course Relationship to Program Outcomes
This course focuses primarily on Outcome 3a: Apply knowledge of mathematics, science, and engineering to solve engineering problems. Mathematical skills reinforced are from vector calculus and differential equations. Aerospace vehicle applications provide a primary context for engineering problem scenarios.

Prepared by: John Lee   Date: Fall 2004

Course: **ME 160 – Introduction to Finite Element Method (Elective)**

Description: This course is structured to introduce students with the basic theory of Finite Element Analysis and to provide a hands-on experience of its application. The course is taught in a lecture lab mode. There are two meetings per week, the first meeting is utilized to focus on the theory and the second meeting focuses on the application of FEA.

Prerequisites: Grade of "C-" or better in CE 112 and ME 130.

Textbooks:
1. Pro/ENGINEER Tutorial – Wildfire 2.0, by R. Toogood SDC Publication, 2004.
2. Pro/ENGINEER – WILDFIRE 2.0 Pro/Mechanica Structure Tutorial – Integrated Mode, by Roger Toogood, SDC Pub.
3. A 1st Course in Finite Element Method, D. Logan, PWS Kent Pub. 3rd Ed.

Laboratory: The laboratory consists of (a) Interactive instruction on computer model creation and problem solution, (b) assigned homework solution, and (c) work on the semester project.

Student Learning Objectives: By the end of the course, students should be able to:

1. Describe the Finite Element Analysis (FEA) procedure
2. Develop stiffness equation for Spring, Beam, and 2-D Solid elements
3. Assemble element stiffness equations in to a global equation
4. Identify and apply boundary conditions to a global structural matrix and reduce it to a solvable form
5. Identify the application and characteristics of Spring, Beam, 2-D solid, and 3-D solid elements
6. Use Pro/ENGINEER to create 3-D models of engineering parts
7. Set up and solve 1-D, 2-D, and 3-D structural problems using Pro/MECHANICA
8. Optimize engineering parts using Pro/MECHANICA
9. Interpret results obtained in Pro/MECHANICA solutions
10. Write a comprehensive project report

Course Topics

	Lecture Hours
FEA Overview: History; users; concept of FEA	1
FEA Process and Procedure: Analysis steps, element types, stiffness concept, solution procedure	3
Introduction to the Direct Method	5
Formation of stiffness matrix	
Assembly of global matrix	
Stiffness matrix for a spring Element	
Examples of Spring Structures	
Truss Element	7
FEA Process	
Transformation Matrix	
Stiffness Matrix	
Examples	
Symmetry Concept	
Beam Element	6
FEA Process	
Stiffness Matrix	
Examples	
2-D Plane and 3-D Solid Elements	5
FEA Process	

Stiffness Matrix
Element Equation
Examples
Modeling Techniques
Axisymmetric Element 4
FEA Process
Stiffness Equation
Element Equation
Applications – Pro/E and Pro/Mechanica 15

Class / Laboratory Schedule: 75 min lectures + 75 min laboratory per week

Course Contribution to Professional Component: Three (3) semester units of engineering topics = 2/3 engineering science + 1/3 engineering design.

Course Relationship to Program Outcomes

Learning Objectives	3a	3b	3c	3d	3e	3f	3g	3h	3i	3j	3k
1, 2, 3, 4	B										
2, 3, 4, 7, 8					B						
5, 6, 7, 8, 9											C
10							B				

Prepared by: Raghu B. Agarwal Date: Spring 2005

Course: **AE 162 - Aerodynamics**

Description: Aerodynamics is the science concerned with the flow field surrounding an aerospace vehicle. Of special interest are the forces generated on aerospace vehicles as they move through the atmosphere. This course provides an introduction to aerodynamics through the use of theory, problem solving, laboratory experiments, computer simulations, films, and project-based learning in combination with AE165.

Prerequisites: Grade of "C-" or better in ME 111; Prerequisite or Co-requisite: E100W.

Textbook: Anderson, J. D. Jr., *Fundamentals of Aerodynamics*, McGraw-Hill, 3rd ed., 2001.

Course website: <www.engr.sjsu.edu/nikos/courses/ae162/>

Laboratory: The laboratory consists of (a) Computer assignments for solving potential flow and subsonic airfoil problems, (b) water tunnel experiments to study the flow patterns around an airfoil, a forebody, and a delta wing, and (c) wind tunnel experiments to study boundary layer flows as well as the effects of Reynolds number and angle of attack on the performance of an airfoil.

Student Learning Objectives: By the end of the course, students should be able to:

1. Explain the nature of aerodynamic forces.
2. Define the aerodynamic center and the center of pressure for an airfoil.
3. Define the dimensionless aerodynamic coefficients for an airfoil (2-D) and a wing (3-D).
4. Calculate aerodynamic forces and moments on bodies by integrating surface pressure and shear stress distributions.
5. Use flow similarity to design wind tunnel tests.
6. Classify a flow as 1-D, 2-D or 3-D, uniform or non-uniform, viscous or inviscid, compressible or incompressible, steady or unsteady, subsonic, transonic, supersonic or hypersonic.
7. Derive Euler's and Bernoulli's equations for incompressible, inviscid, steady, 1-D flow.
8. Use the momentum equation to calculate the drag from wake traverses behind a body.
9. Explain physically the meaning of the divergence of the velocity vector.
10. Distinguish between pathlines, streamlines and streaklines of a flow.
11. Define streamlines and calculate equations for streamlines passing through various points of a flow field.
12. Define the vorticity of a flow field and distinguish between rotational and irrotational flows.
13. Define circulation and calculate it around various paths.
14. Define the stream function and the potential function for a flow and calculate each, if they exist.
15. Define potential flow.
16. Analyze the elementary flows (uniform, source / sink, doublet, vortex, corner) as well as combinations of them.
17. Use the SUB-2D program to explore D' Alembert's paradox for lifting and non-lifting bodies.
18. Explain and apply the Kutta-condition for any sharp edge of a wing.
19. Explain Kelvin's theorem and its implications for the vortex system of an airfoil.
20. Use and interpret airfoil nomenclature.
21. Describe the aerodynamic characteristics of an airfoil and their importance in airplane design.
22. Explain the design and the performance improvements of modern airfoils (LS, MS, and supercritical).
23. Explain the 3 different types of stall along with the desirable and non-desirable features of each type.
24. Use experimental data, thin airfoil theory results, and computer programs to predict aerodynamic characteristics of airfoils (ex. lift and drag at various angles of attack, pitching moment about various points, ac location, etc.)
25. Use the SUB-2D program to explore the effects of thickness and camber on the aerodynamic characteristics of airfoils.
26. Use the SUB-2D program to explore interference between wings (biplanes, wing-empennage).

27. Design and perform an experiment to study the performance of an airfoil, analyze and interpret the results from this experiment, compare with analytical / computational predictions and other published experimental data, and explain any discrepancies.
28. Explain induced drag in 3 different ways.
29. Use the Biot-Savart law to calculate induced velocities in the vicinity of line vortices.
30. Explain geometric and aerodynamic twist and how it is used in wing design.
31. Explain how rectangular, swept, and delta wings differ in terms of maximum lift, lift slope, stall angle of attack, induced drag, skin friction drag, L/D at low speeds, and L/D at high speeds.
32. State Helmholtz' vortex laws and explain how we use them to model the flow around a wing.
33. Describe the horseshoe vortex model for a wing and its limitations.
34. Describe Prandtl's lifting-line theory, its limitations and the results for an elliptical and a general lift distribution.
35. Apply Prandtl's lifting-line theory to calculate the aerodynamic characteristics of airplane wings.
36. Use the method of images to discuss and calculate aerodynamic interference for (a) wings flying in the vicinity of each other (i.e., wing/tail/canard combination, biplanes, etc.), (b) wind-tunnel boundaries, and (c) ground effects.
37. Use the SUB-2D program to analyze ground effects for an airfoil.
38. Describe qualitatively and quantitatively laminar and turbulent boundary layers in terms of their thickness, velocity profiles and shear stress variation along a surface.
39. Predict transition from laminar to turbulent flow.
40. Calculate the skin friction drag and estimate the pressure drag of bodies.
41. Predict location on an airfoil surface and inside a nozzle, where BL separation is likely to occur.
42. Design and perform an experiment to study the boundary layer on a flat plate, analyze and interpret the results from this experiment, compare with analytical predictions, and explain any discrepancies.
43. Work effectively in a team to (a) define and solve open-ended problems that combine aerodynamics and flight performance, (b) design and perform wind tunnel experiments, and (c) analyze and interpret experimental data.
44. List several examples of regional, national, and / or global contemporary problems related to aerodynamics (ex. environmental issues, natural resources and energy conservation, etc.) articulate a problem / position statement for each, and explain what makes these issues particularly relevant to the present time.
45. Identify possible solutions to these problems, as well as any limitations of these solutions.

Course Topics

Week	Topic(s)	Lab
1, 2	Introduction; aerodynamic forces & moments, flow similarity	
3,4	Lift and drag calculations using the momentum equation	Flow visualization
5,6,7	Potential flow theory	Airfoil lift and drag
8,9	Airfoils: characteristics, design and performance	Airfoil pressure distributions
10,11	Wings: Horseshoe vortex and Prandtl's lifting-line theory	
12	Aerodynamic interference and ground effects (method of images)	
13	Boundary layers and skin friction drag calculations	Boundary layer measurements
15,16	Student project presentations	

Class / Laboratory Schedule
2 x 75 min lectures per week, 3 x 2hr laboratory periods a semester (subsonic tunnel, water tunnel)

Course Contribution to Professional Component
Three (3) semester units of engineering topics = 2/3 engineering science + 1/3 engineering design.

Course Relationship to Program Outcomes

	3a	3b	3c	3d	3e	3f	3g	3h	3i	3j	3k
Learning Objectives	C	C	B	C	C		C	B	C	B	C
1,2,3,4	B				B						
5	B	B			B						
6					B				B		
7, 8, 9	B				B						
10		B							A		
11,12,13,14,15	B				B						
16	B				B						
17	B			B	B		B		C		C
18,19,20	B										
21,22,23			B					B	C		
24, 25,26	B	B	B	B	B		B				C
27		C		C			C		C		C
28, 29	B				B						
30,31,32,33,34	B		B						B		
35	B				B						
36,37	B			B	C		B	B	C		C
38, 39, 40, 41	B				B			B	B		
42		C		C			C		C		C
43	C		B	C	C		C	A	C	B	C
44, 45				B			B	A	C	B	

Prepared by: Nikos J. Mourtos **Date: Spring 2005**

Course: **AE 164 – Compressible Flow**

Course Description: Compressible flow is high-speed flow. As the flow speed surpasses roughly 30% of the speed of sound (Mach = 0.3) air density variations become significant. This course provides an introduction to compressible flow through the use of theory, problem solving, shock tunnel experiments, and project-based learning in combination with AE167.

Prerequisites: Grade "C-" or better in ME 111, ME 113; E100W

Textbook: Anderson, John Jr., *Modern Compressible Flow*, 3rd ed., McGraw-Hill, 2003. Course website: <www.engr.sjsu.edu/nikos/courses/ae164/>

Laboratory: The laboratory consists of a 6-hr shock tunnel experiment.

Student Learning Objectives: By the end of the course, students should be able to:

1. Define and explain physically the following: (a) Conservation law, (b) Energy and internal energy (c) Entropy, (d) Equilibrium state, (e) Time-reversible and time-irreversible process, (f) Enthalpy, (g) Real gas, (h) Perfect gas, (i) Thermally perfect gas, (j) Calorically perfect gas, (k) Adiabatic process, (l) Isentropic process, (m) Compressibility and compressible flow.
2. Use the 1st and 2nd law of thermodynamics to calculate heat transfer, work done and entropy changes in a thermodynamic system.
3. Use the equation of state and the definition of enthalpy to calculate thermodynamic properties.
4. Calculate the isothermal and isentropic compressibility of a gas for given conditions.
5. Define and explain physically the following: (a) Speed of sound and Mach number, (b) Stagnation and sonic (critical) conditions for isentropic flow, (c) Stagnation and sonic (critical) conditions for flow with heat addition.
6. Derive the conservation equations for 1-D compressible flow (isentropic, adiabatic, with heat addition, with friction).
7. Use thermodynamics and conservation equations to calculate flow parameters at various points of a flow field.
8. Derive the alternative forms of the energy equations.
9. Calculate stagnation and critical conditions at various points of a flow field for isentropic flow, adiabatic flow, flow with heat addition and flow with friction.
10. Explain physically what happens to flow parameters when the flow (a) crosses a normal shock wave, (b) is heated or cooled and (c) is subjected to friction.
11. List the differences between a Mach wave and a shock wave.
12. Explain the conditions under which you get a bow shock in front of a body or a compression corner.
13. Explain the conditions under which you get an oblique shock at the nose of a body or at a compression corner.
14. Explain the differences between the flow over a cone and the flow over a wedge.
15. Calculate the flow properties downstream of a Mach wave.
16. Calculate the flow properties downstream of an oblique shock wave.
17. Calculate the flow properties downstream of a Prandtl-Meyer expansion wave.
18. Calculate the lift and drag coefficients on supersonic airfoils using shock - expansion theory.
19. Calculate the flow properties downstream of a reflected / refracted shock wave.
20. Explain the differences between a stationary and a moving shock, steady and unsteady wave motion.
21. Calculate the flow conditions in a shock tube behind the incident and the reflected shock waves.
22. Calculate the speed of the incident and the reflected shock waves in a shock tube.
23. Design a shock tunnel to achieve supersonic flow of a given Mach number in the test section (i.e., select appropriate driver and driven gases, diaphragm pressure ratio, etc).
24. Define quasi 1-D flow.
25. Explain mathematically & physically the relationship between flow cross-sectional area and local Mach (or flow speed).
26. Explain what we mean by "choked flow".

27. Describe what happens to the flow inside a Laval nozzle as we change the exit pressure and / or the reservoir pressure.
28. Explain what we mean by (a) ideally expanded, (b) overexpanded and (c) underexpanded nozzle.
29. Calculate the flow properties at various locations of an (a) ideally expanded, (b) overexpanded and (c) underexpanded nozzle.
30. Calculate the location of a shock in a Laval nozzle (assuming there is one).
31. Design a supersonic / hypersonic wind tunnel (i.e. select the appropriate reservoir, throat and nozzle exit conditions to get the desirable test section conditions).
32. Explain what we mean by an "unstarted" supersonic wind tunnel.
33. Define potential flow.
34. Define linearized flow and explain its limitations.
35. Use compressibility corrections to calculate pressure, lift, and pitching moment for an airfoil in compressible flow from known incompressible data of this airfoil.
36. Define the critical and the divergence Mach numbers for an airfoil.
37. Estimate the critical Mach number of an airfoil.
38. Calculate the lift and wave drag of supersonic airfoils using linearized theory.
39. Calculate the lift and wave drag of supersonic airfoils using Busemann's (2nd order) theory.
40. Sketch a supercritical airfoil and describe how it works.
41. Explain what our ancients meant by "sound barrier".
42. Describe the advantages and disadvantages of swept wings.
43. Work effectively in a team to (a) define and solve open-ended problems that combine compressible flow and jet / rocket engine performance, (b) design and perform shock tunnel experiments, and (c) analyze and interpret experimental data.
44. List several examples of regional, national, and / or global contemporary problems related to compressible flow (ex. sonic boom, access to space, etc.) articulate a problem / position statement for each, and explain what makes these issues particularly relevant to the present time.
45. Identify possible solutions to these problems, as well as any limitations of these solutions.

Course Topics

Week	Topic(s)	Lab
1, 2	Introduction; review of thermodynamics	
3,4	1-D compressible flow, normal shocks, flow with heat addition and friction	
5,6,7	Mach waves, oblique shock and expansion (Prandtl-Meyer) waves	
8,9	Moving shocks, shock tunnels	Shock Tunnel
10-12	Quasi 1-D flow; nozzles, diffusers, supersonic wind tunnels	
13,14	Linearized subsonic and supersonic flow	
15,16	Student project presentations	

Class / Laboratory Schedule

2 x 75 min lecture periods per week + 2 x 3 hr laboratory periods per semester (shock tunnel).

Course Contribution to Professional Component:

Three (3) semester units of engineering topics = 2/3 engineering science + 1/3 engineering design.

Course Relationship to Program Outcomes

	3a	3b	3c	3d	3e	3f	3g	3h	3i	3j	3k
Learning Objectives	B	C		B	B		C	B	C	B	C
1 - 19	B			**B**	B						
20 - 23	B	C		C	B		C		C		**C**
24 - 42	B			B	B						
43		C		C			C		C		C
44,45							B	B	B	B	B

Prepared by: Nikos J. Mourtos **Date: Fall 2004**

Course: **ME 165 Computer Aided Design in Mechanical Engineering (Elective)**

Course Description: This course is structured to provide students an introduction of the Computer Aided Design (CAD), geometric modeling and computer graphics, more specifically, to introduce theory and application of lines, curves, surfaces and solid models. Topics covered include analytical, interpolation, and approximation methods of generating wireframe, surface and solid models. Along with the theoretical presentations, commercial CAD software are introduced and applied to create engineering components and assemblies and do a finite element analysis.

Prerequisites: Grade of "C-"or better in CE 112 and ME 130.

Textbook: Pro/Engineer Wildfire 2.0 by Roger Toogood, SDC publications.

Laboratory: The laboratory consists of (a) interactive instruction on computer model creation and problem solutions (b) completing homework assignments, and (c) work on the term project.

Student Learning Objectives: By the end of the semester, students will be able to
1. Describe the history of CAD.
2. Transform Geometric model entities in 2D.
3. Transform geometric model entities in 3D.
4. Identify characteristics of analytical, interpolation and synthetic curves.
5. Understand how various surfaces in CAD are created.
6. Understand how 3D solids in CAD models are created.
7. Use and apply Pro/Engineer for 3D modeling.
8. Use and apply Pro/Mechanica for simple engineering problems.
9. Be able to write a comprehensive project report.

Course Topics

Week	Topic(s)
1	CAD Overview: CAD concepts, Historical perspective, Terminology, Role of CAD in industry, Hardware and software requirements.
2	Review of general techniques in geometric modeling, a comparison of commercial CAD software.
3	File transfer Background, Review of Geometric Dimensioning and Tolerancing (GD & T)
4	Transformation - Basics
5	Transformations - Combined
6,7	Curves
8	Surfaces - Types and Creation
9	Solids - Types and Creation
10	FEA - Fundamentals
11	FEA - Procedure
12	FEA - Analysis
13	FEA - Analysis
14	Review
NOTE:	Introduction and application of Pro/E and Pro/M during lab sessions.

Course Contribution to Professional Component: Three (3) semester units of engineering topics = 2/3 engineering science + 1/3 engineering design.

Course Relationship to Program Outcomes

	3a	3b	3c	3d	3e	3f	3g	3h	3i	3j	3k
Learning Objectives											
1									A		
2, 3, 4, 5, 6	B										
7, 8											C
9							B				

Prepared by: Raghu Agarwal Date: Spring 2005

Course: **AE 168 – Aerospace Vehicle Dynamics and Control**

Course Description: Students are provided with the fundamentals of aerospace vehicle attitude dynamics, stability and control. Design and performance analysis of common aerospace vehicle control including autopilots and attitude control systems are presented. Both aircraft and spacecraft control systems are examined. Course homework involves both numerical and analytical treatments of basic control system design.

Prerequisites: AE 140, AE 165

Textbook: Wie: *Space Vehicle Dynamics and Control*
J. Roskam: *Airplane Flight Dynamics and Automatic Controls* (Part I)

Student Learning Objectives: By the end of the course, students should be able to:

1. Derive equations of motion for spacecraft, aircraft and missiles.
2. Determine aircraft longitudinal and lateral stability.
3. Describe the fundamental concepts involved in autopilot modeling and control.
4. Apply stability criteria to control of spacecraft dynamics.
5. Model spacecraft spin stabilization.
6. Model spacecraft three-axis control.
7. Use Matlab to model and design feedback control systems

Course Topics

Week

1. Class overview, general thoughts on control. Kinematics and dynamics review.
2. Fundamentals of control systems analysis review. Spin stabilization.
3. Dual-spin stabilization. Three-axis active control.
4. Momentum exchange systems. Environmental effects and passive gravity gradient stabilization.
5. Effects of structural flexibility. Summary of spacecraft control and design considerations.
6. Aircraft and missile equations of motion.Small perturbations development.
7. Stability derivatives.
8. Static stability.
9. Dynamic stability.
10. Longitudinal attitude control.
11. Longitudinal path control.
12. Lateral / directional attitude control.
13. Pilot modeling and an overview of handling qualities.
14. Missile control considerations.
15. Systems considerations in aircraft control system design.
16. Summary and review for the final exam.

Class Schedule: 2 x 75 min lecture periods per week

Course Contribution to Professional Component: Three (3) semester units of engineering topics = 2/3 engineering science + 1/3 engineering design

Course Relationship to Program Outcomes

	3a	3b	3c	3d	3e	3f	3g	3h	3i	3j	3k
Learning Objectives											
1,2,3,4	B				B						
5,6	B				B						
7			B								**B**

Prepared by: Nikos J. Mourtos **Date: Spring 2006**

Course: **AE 169 – Computational Fluid Dynamics (Elective)**

Description: Physical and mathematical foundations of computational fluid dynamics with emphasis on applications. Solution methods for model equations, Euler, and Navier-Stokes equations; finite volume formulation; classification of partial differential equations and solution techniques; truncation errors, stability.

Prerequisites: AE 164 Co-requisite ME 114
Textbook: Lomax, Pulliam, and Zing, Fundamentals of Computational Fluid Dynamics

Student Learning Objectives: By the end of the course, students should be able to:

1. Use numerical tools to model the flow filed around aerodynamic bodies
2. Generate computational grids
3. Determine the accuracy of numerical methods
4. Design methods based on linear theory
5. Apply algorithms and methods to solve the Euler and the Navier-Stokes equations for simple geometries

Course Topics

- Explicit and implicit time differencing methods
- Central, upwind, and characteristic spatial differencing techniques
- Classical relaxation methods
- Multi-grid methods
- Grid generation
- Practical examples and real life lessons
- Contemporary methods and codes

Class Schedule: 2 x 50 min lecture periods + 1 x 90 min laboratory period per week

Course Contribution to Professional Component: Three (3) semester units of engineering topics / engineering science

Course Relationship to Program Outcomes

	3a	3b	3c	3d	3e	3f	3g	3h	3i	3j	3k
Learning Objectives											
1,2,3,4, 5	B				B						C

Prepared by: Periklis Papadopoulos **Date: Spring 2006**

Course: **AE 171 A, B – Aircraft Design**

Description: This is a capstone, senior design, 2-semester course sequence. Students work in teams to develop mission specifications and design an airplane to meet those specifications. In the 1st semester, students use the Advanced Aircraft Analysis program to perform the conceptual and preliminary design of this airplane. Written reports are due approximately every two weeks on each step of the design process. In the 2nd semester, students participate in the SAE AERO DESIGN WEST competition or work on industry-sponsored projects, which involve the design, manufacture, and flight-testing of RC or UAV airplanes. The course also includes field trips as well as guest speakers, discussions and assignments on safety, reliability, professionalism and ethics, global, societal and contemporary issues.

Prerequisites: ME20, AE 162, AE 165; AE 114; AE 167 (corequisite); AE 168 (corequisite)

Textbook: J. Roskam: Airplane Design, Parts I-VIII, Roskam Aviation and Engineering Corp., Rt. 4, Box 274, Ottawa, Kansas, 66067
Course website: www.engr.sjsu.edu/nikos/courses/ae170

Learning Objectives: By the end of the course, students should be able to:

1. Define an appropriate set of mission requirements and sketch the mission profile of an airplane.
2. Define, calculate, and evaluate measures of merit (MOM) for an airplane.
3. Perform a literature search and collect data to show the need for a particular airplane.
4. Discuss the economic and technical feasibility of a particular airplane.
5. Identify the critical mission requirements of an airplane.
6. Evaluate the configuration of airplanes and describe the connection between configuration choices (ex. high wing, tandem landing gear) and mission requirements.
7. Describe the pros and cons of the various conventional aircraft configurations.
8. Describe the pros and cons of unconventional aircraft configurations such as canards, 3-surface, swept-forward wings, flying wings, tailless, V/STOL, stealth, etc.
9. Select an appropriate configuration for an airplane with a specified mission.
10. Estimate the takeoff weight of an airplane based on the mission requirements using the weight fraction method.
11. Calculate the takeoff weight sensitivities of an airplane to changes of critical parameters such as L/D, sfc, etc.
12. Perform tradeoff studies between range and payload (with AAA).
13. Construct a matching graph based on specific performance constraints (stall speed, cruise speed, takeoff and landing distance, maneuverability requirements) and use it to predict the required thrust/power and wing area of an airplane.
14. Prepare CAD drawings of the cockpit and the fuselage of an airplane based on specific payload requirements.
15. Design the wing, high-lift system, and lateral controls of an airplane (by hand and with AAA).
16. Design the empennage and the directional controls of an airplane (by hand and with AAA).
17. Design the landing gear of an airplane using tip-over and ground clearance criteria and (for retractable landing gear) show the retraction feasibility with appropriate drawings.
18. Perform a weight and balance analysis for an airplane and draw the c.g. excursion diagram (by hand and with AAA).
19. Perform static longitudinal and directional stability analysis for an airplane and draw the corresponding x – plots.
20. Perform a critical evaluation of the landing gear design, the empennage, the weight and balance, and the stability and control analysis to ensure that an airplane is not prone to tip-over problems, too much c.g. travel, too much or too little stability and / or a minimum control speed problem.
21. Estimate the drag polars of an airplane for the takeoff, cruise (low and high speed), and landing configurations.
22. Procure, fabricate, and assemble the various parts for an airplane (RC or UAV).

23. Evaluate the design through flight-testing and identify any modifications / improvements needed to meet the mission requirements.
24. Work harmoniously and effectively in a team to solve engineering problems related to the design, fabrication and testing of an airplane and to communicate the results in technical reports and oral briefings.
25. Communicate effectively in a team environment, negotiate and resolve conflicts, motivate and coach others in your team, organize and delegate work as needed, develop a team vision and set team goals, and manage resources.
26. Evaluate your own performance as well as that of your teammates using specific criteria, such as the quality of their work, their commitment to the team / project, leadership skills, responsibility, abilities, communication skills, and personality.
27. Develop a milestone schedule (timeline) for an engineering project and follow it.
28. Demonstrates knowledge of the ME code of ethics.
29. Identify possible courses of action, discuss the pros and cons of each one, and decide on the best one, given a job-related scenario that requires a decision with ethical implications.
30. Write high quality design reports (i.e., using correct language and terminology, correct technical information,
and professionally prepared graphs and tables).
31. Give clear, informative, technically correct oral presentations using professionally prepared visual aids.
32. Evaluate and describe accurately the environmental impact of their airplane.
33. Evaluate and describe accurately any health / safety issues related to their airplane.
34. List several examples of regional, national, and / or global contemporary problems related to aircraft design (ex. transportation, environmental and safety issues, energy conservation, etc.) articulate a problem / position statement for each, and explain what makes these issues particularly relevant to the present time.
35. Identify possible solutions to these problems, as well as any limitations of these solutions.

Course Topics

<u>Week (AE 171A)</u>

1,2	Introduction to Aircraft Design. Team building. Mission requirements.
3,4,5	Weight sizing. Performance sizing.
6	1st oral presentation and oral examination.
7 & 12	Case studies on aircraft safety, ethics and liability issues
8,9	Configuration design (conventional & unconventional).
10,11	Design of the fuselage, wing, high-lift system and lateral controls.
13	Field trip to Hiller Aviation Museum.
14,15	Design of the empennage, longitudinal / directional controls, landing gear. Weight and balance analysis.
16	2nd oral presentation and oral examination.

<u>Week (AE 171B)</u>

1,2	SAE PROJECT: Configuration design, estimation of lift capability.
3,4	SAE PROJECT: Weight & balance, stability & control.
5 & 10	Case studies on aircraft safety, ethics and liability issues.
6-9	SAE PROJECT: Flight-testing, re-design, oral presentation.
11-13	SAE AERO DESIGN WEST COMPETITION
14-16	Field trips, guest speakers, outreach, student conference day.

Class Schedule: 3 hr lecture + 6 hr laboratory per week
Course Contribution to Professional Component: Six (6) semester units of engineering design

Course Relationship to Program Outcomes

Aircraft Design	3a	3b	3c	3d	3e	3f	3g	3h	3i	3j	3k
Learning Objectives		C	C	C		C	C	B	C	B	C
1,2			*A*								
3,4			B						C		
5			A								
6,7,8,9			C						C		
10,11,12,13			C								C
14,15,16			C								C
17,18,19,20,21			C								C
22,23		C									
24, 25, 26, 27				C			C		*C*		
28,29						C					
30,31							C				
32,33								B			
34,35										B	

Prepared by: Nikos J. Mourtos **Date: Fall 2006**

Course: **AE 172 A, B - Spacecraft Design**

Description: This two-semester course is the culminating experience for the AE degree. Students employ the fundamentals of spacecraft design to complete an open-ended design project. Derived requirements, subsystem design and interface considerations, and preliminary sizing are all factored into the final design. Spacecraft construction, integration, test, launch, and operations are also considered as part of the design process. The last four design classes have participated on the "Spartnik" microsatellite project. This is an effort to design and construct a satellite to be placed into low earth orbit that will be controlled from a ground station in a department laboratory.

Prerequisites: ME20, AE 162, AE 165; AE 114; AE 167 (corequisite); AE 168 (corequisite)

Textbook: Wertz, J.R. & Larson, W.J., *Space Mission Analysis and Design,* Kluwer Academic Publishers.

Laboratory: This course is essentially a continuous lab to complete the design and construction of a spacecraft.

Student Learning Objectives: By the end of the course, students should be able to:

1. Design and test spacecraft hardware.
2. Apply the complete product development cycle: Basic idea / societal need / market study / economic and budget analysis;
3. Create the baseline design; Establish the final design; Test the manufactured hardware; Evaluate / analyze operation and data returned.
4. Work harmoniously and effectively in a team to solve engineering problems related to the design, fabrication and testing of a spacecraft and communicate the results in technical reports and oral briefings.
5. Communicate effectively in a team environment, negotiate and resolve conflicts, motivate and coach others in your team, organize and delegate work as needed, develop a team vision and set team goals, and manage resources.
6. Evaluate your own performance as well as that of your teammates using specific criteria, such as the quality of their work, their commitment to the team / project, leadership skills, responsibility, abilities, communication skills, and personality.
7. Develop a milestone schedule (timeline) for an engineering project and follow it.
8. Demonstrates knowledge of the ME code of ethics.
9. Identify possible courses of action, discuss the pros and cons of each one, and decide on the best one, given a job-related scenario that requires a decision with ethical implications.
10. Write high quality design reports (i.e., using correct language and terminology, correct technical information, and professionally prepared graphs and tables).
11. Give clear, informative, technically correct oral presentations using professionally prepared visual aids.
12. Evaluate and describe accurately the environmental impact of their spacecraft.
13. Evaluate and describe accurately any health / safety issues related to their spacecraft.
14. List several examples of regional, national, and / or global contemporary problems related to spacecraft design (ex. environmental issues, natural resources and energy conservation, etc.) articulate a problem / position statement for each, and explain what makes these issues particularly relevant to the present time.
15. Identify possible solutions to these problems, as well as any limitations of these solutions.

Course Topics

Week (AE 172A)

1-5 Introduction to spacecraft design. Team building.
6 First oral presentation and oral examination.
7 Case study on safety, ethics and liability issues.
8-11 Spacecraft design topics.
12 Case study on safety, ethics and liability issues.
13 Field trip to Hiller Aviation Museum.
14,15 Spacecraft design topics
16 Second oral presentation and oral examination.

Week (AE 172B)

1-5 Introduction to spacecraft design. Team building.
6 Third oral presentation and oral examination.
7 Case study on safety, ethics and liability issues.
8-11 Spacecraft design topics.
12 Case study on safety, ethics and liability issues.
13-16 Field trips, guest speakers, outreach, student conference day.

Class Schedule: 3 hr lecture + 6 hr laboratory per week
Course Contribution to Professional Component: Six (6) semester units of engineering design.

Course Relationship to Program Outcomes

Spacecraft Design	3a	3b	3c	3d	3e	3f	3g	3h	3i	3j	3k
Learning Objectives		C	C	C		C	C	B	C	B	C
1		C	C								C
2,3			C								C
4,5,6				C			B				
7			B								
8,9						C					
10,11							C				
12,13								B			
14,15										B	

Prepared by: Periklis Papadopoulos **Date: Spring 2005**

Course: **ME 187 - Automatic Control Systems Design (Elective)**

Description: Formulation of dynamic systems. Analysis of the behavior of analogous electrical, mechanical, thermal, hydraulic, and pneumatic systems in Laplace, Fourier, and time domain. Establishment of design criteria. Design of feedback control systems.

Prerequisites: Grade of "C-" or better in ME 111 and 130; ME147.

Textbook: *Modern Control Engineering* (4th Edition) by Katsuhiko Ogata, Prentice Hall, Inc., 2002, ISBN 0-13-060907-2

Course website: <http://www.engr.sjsu.edu/wdu/ME187>

Student Learning Objectives: By the end of the course, students should be able to:

1. Model various dynamic systems (mechanical, electrical/electronic, fluid, and thermal systems)
2. Understand Laplace Transform theorems and use Laplace Transform to solve linear, time-invariant, differential equations.
3. Derive Transfer Function and Impulse-response function of various dynamic systems (1st order-, 2nd order-, thermo-, fluid-, mechanical-, and electrical- systems) using Laplace Transform.
4. Analyze the transient and steady-state response of the first-order and the second-order systems.
5. Apply Routh's Stability Criterion to test a system' absolute and relative stability.
6. Construct the Root-Locus plots of a transfer function system and understand physical meaning of poles of system.
7. Design a control system using Root-locus method.
8. Conduct control systems design through Lead-, Lag-, and Lag-lead Compensation methods.
9. Analyze linear dynamic system behavior in frequency domain and stability conditions.
10. Understand PID controls and effects of Proportional, Integral, and Derivative control actions on systems.
11. Establish design specification and design feedback control systems.
12. Draw Bode Diagrams and Nyquist Plots with MATLAB.
13. Apply Nyquist Stability Criterion to conduct stability and relative stability analysis.
14. Use MATLAB control toolbox and simulation toolbox to do system analysis and design.
15. Solve a comprehensive problem involving modeling, stability analysis, controller design, and MATLAB simulation.

Course Topics

Week	Topic(s)
1	Introduction to classical control methods
2	The Laplace Transform
3,4	Modeling of dynamic systems: mechanical, electrical/electronic, fluid, and thermal systems
5,6	Transient response analyses
7	Routh's stability criterion and steady-state response analyses
8	Root-locus analysis
9,10	Control systems design by the root-locus method
11,12	Frequency-response analysis
13	Nyquist plots and Nyquist stability criterion and analysis
14	Control systems design by frequency response
15	PID controls
16,17	Project (a comprehensive problem involving modeling, stability analysis, controller design, and MATLAB simulation)

Class Schedule: **3 x 50 min lectures per week**
Course Contribution to Professional Component: **Three (3) semester units of engineering topics**

Course Relationship to Program Outcomes

	3a	3b	3c	3d	3e	3f	3g	3h	3i	3j	3k
Learning Objectives											
1	C				C						C
2	B										
3	B				B						**C**
4	**C**	B			B						B
5	**B**				B						
6	**C**										B
7	**C**		C		B						B
8	**C**		C		**B**						B
9	B	B									B
10	A										**C**
11	A		B		B						B
12	B										**C**
13	B										
14	C	**B**									**C**
15		**B**	C	**B**	B		**B**		A		**C**

Prepared by: Winncy Y. Du   Date: Spring 2004

APPENDIX F FACULTY VITA

F.I NIKOS J. MOURTOS

PERSONAL

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Email:	njmourtos@sjsu.edu	njmourtos@comcast.net

EDUCATION

1983-1987: Ph.D., Aeronautical & Astronautical Engineering, Stanford University.
1982-1983: ENGINEER, Aeronautical & Astronautical Engineering, Stanford University.
1980-1982: M.S., Aeronautical & Astronautical Engineering, Stanford University.
1975-1980: B.S., Mechanical Engineering, University of Patras, Greece.

Short Courses & Workshops Attended

2006, Oct. 26: Seeing Faculty as Learners: Three Theoretical Frameworks for Faculty Development w. J. Froyd & J. Layne, Professsional and Organizational Development Network in Higher Education Conference, Portalnd, Oregon.
2006, Oct. 25: Leading your own workshop on Course Design w. Dee Fink, Professsional and Organizational Development Network in Higher Education Conference, Portalnd, Oregon.
2005, Jan.19-20: Working with Others: Communicating more effectively to get the results we want, Cadence University, San Jose, California.
2003, Oct. 17: SNAME ABET Program Evaluator Training, San Francisco, California.
2003, May 1: Assessment, workshop w. Joni E. Spurlin, COE, SJSU.
2003, Mar. 14: Helping new faculty members get off to a good start: A workshop for administrators and mentors, w. R. Felder & R. Brent, COE, SJSU.
2001, Mar. 31-Apr. 1: ABET Workshop on Engineering Criteria 2000, Los Angeles, California.
1998, Oct. 22-23: Teaching Effectiveness Wokshop, w. R. Felder & R. Brent, FAMU.
1998, Oct. 1-3: Pacific Crest Teaching Institute, w. D. Apple, SJSU.
1998, Sep. 15: Portfolios: What are they good for? w. G. Rogers, NSF/ASEE visiting scholar, COE, SJSU.
1998, Apr. 16: NSF Shaping the Future of Undergraduate Engineering Education in SMET, COE, SJSU.
1998, Mar. 12: Outcomes Assessment in Engineering Education, w. G. Rogers, NSF/ASEE visiting scholar, COE, SJSU.
1997, Oct. 16: The Internet in Higher Education: Silicon and Fiber replacing Bricks and Mortar, w. B. Oakley, COE, SJSU.
1997, Apr. 11: Teaching with Style, workshop w. T. Grasha, SJSU.
1996, Aug. 12-16: Cooperative Learning, workshop w. K. Smith, Michigan State U.
1995, Jan. 24-25: Cooperative Learning, workshop w. K. Smith, COE, SJSU.
1993, Jun. 15-18: Instrumentation for Engineering Measurements, w. A. J. Schiff, Stanford University.
1991, Jul. 22-Aug. 2: Aircraft Design Education Seminar, w. J. Roskam, University of Kansas.
1990, Apr. 23-27: Aircraft Conceptual Design, w. D. P. Raymer, UCLA.
1988, Oct. 6-7: Aerodynamic Analysis and Design, AIAA Professional Study Series, Palo Alto, California.
1988, Jul. 11-15: Aircraft Design Short Course, w. L. Nicolai, J. Pinson, et al., Bergamo Center, Dayton, Ohio.

PROFESSIONAL CAREER

2006-present:	Assistant Director, Center for Faculty Development & Support, SJSU.
1999-present:	Professor, Department of Mechanical & Aerospace Engineering, SJSU.
1996-2002:	Faculty Instructional Development Coordinator, College of Engineering, SJSU.
1998-2002:	Faculty-in-Residence for Innovative Pedagogy, Institute for Teaching & Learning, SJSU.
1991-1999:	Associate Professor, Department of Mechanical & Aerospace Engineering, SJSU.
1988-1991:	Assistant Professor, Department of Aerospace Engineering, SJSU.
1985-1988:	Lecturer, Departments of Mechanical and Aerospace Engineering, SJSU.
1980-1987:	Research Assistant, Joint Institute for Aeronautics and Acoustics, Department of Aeronautics and Astronautics, Stanford University, California.
1987:	Teaching Assistant, Department of Mechanical Engineering, Stanford University, California.

A. Workshops

A1. Workshops for Faculty

- Program Educational Objectives and Outcomes: How to Design a Sustainable, Systematic Process for Continuous Improvement
- Course Design to Meet the Specs: Lectures, Activities, and Assignments to Address Specific Instructional Objectives
- Teaching Engineering in the New Millenium; A Teaching Effectiveness Workshop for New Engineering Faculty
- Exploring Teaching & Learning Styles pat 1: The Felder-Silverman Model
- Exploring Teaching & Learning Styles part 2: The Kolb Learning Cycle
- Involving Students in the Act of Learning (Active, Cooperative, and Problem-Based Learning)
- The Nuts and Bolts of Cooperative Learning
- Cooperative Learning: Structured Controversies
- So, what exactly does it take for your students to learn something new? (Conditions of Learning)
- Bloom's Taxonomy and Instructional Objectives
- Other Workshops for Faculty:
    - Introduction to Engineering: Teaching Design to Freshmen
    - Introduction to Engineering: a Time for Change
    - Session Facilitator during NSF Workshop "Shaping the Future of Undergraduate Engineering Education in SMET", COE, SJSU.

A2. Workshops for Science Teachers

Energy Transformation (parts 1 and 2, NSF-sponsored)

B. Courses Taught

Aerospace:	AE 10 Introduction to Aerospace Engineering (developed as a new course)
	AE 162 Aerodynamics (developed as a new course)
	AE 164 Compressible Flow
	AE 167 Aerospace Propulsion (developed as a new course)
	AE 171 A,B Aircraft Design I and II (developed as new courses)
	AE 271 A,B Advanced Aircraft Design I and II (to be offered AY 07-08)
	AE 262 Advanced Aerodynamics (developed as a new course)
	AE 264 Advanced Compressible Flow (developed as a new course)
Mechanical:	ME 101 Dynamics
	ME 102 Engineering Mechanics
	ME 111 Fluid Mechanics
	ME 112 Fluid Mechanics Laboratory

General Engineering:	ENGR. 10 Introduction to Engineering ENGR/PHYS/MATH 96 A Problem-Based, Integrated Calculus, Physics and Engineering (Team leader in developing / teaching this 10 unit course)
General Education	AE 11 B From Insects to Jumbo Jets: The Science of Flight (developed as a new course for the SJSU MUSE program)

C. Research Areas

C1. Technical
- Low Speed & High Angle of Attack Aerodynamics.
- Modeling and Control of Vortical Flows.
- Boundary Layers and Flow Separation.
- Hot Gas Ingestion in Jet-Powered, V/STOL Aircraft.
- Airplane Design.

C2. Engineering Education
- Active, Cooperative, and Problem-Based Learning.
- Learning Styles, Taxonomy of Educational Objectives, Conditions of Learning.
- Instructional Design.
- Course & Program Assessment.

HONORS & AWARDS

2006 UICEE Bronze (5th Place) Award for a distinguished contribution in delivering an outstanding paper to the 9th UICEE Annual Conf. on Engineering Education in Muscat, Oman, Feb. 11 – 15.
2005 UICEE Diamond (Best Paper) Award for a distinguished contribution in delivering an outstanding paper to the 8th UICEE Annual Conf. on Engineering Education in Kingston, Jamaica, Feb. 7 - 11.
2004 Honorable Mention Award for Research on College Teaching and Learning from the SJSU, Center for Faculty Development.
2004 UICEE Silver (4th Place) Award for a distinguished contribution in delivering an outstanding paper to the 7th UICEE Annual Conf. on Engineering Education in Mumbai, India, Feb. 9 - 13.
2003 UNESCO International Centre for Engineering Education Silver Badge of Honor for distinguished contributions to engineering education, outstanding achievements in the globalization of engineering education through the activities of the Centre, and, in particular, for remarkable service to the UICEE.
2002 College of Engineering McCoy Family Award for Excellence in Faculty Service
2001 Faculty-in-Residence for Collaborative Learning, Center for Faculty Development & Support, SJSU.
2000 Outstanding Zone Campus Representative Award, from the American Society for Engineering Education, for outstanding initiative in representing ASEE on the campus and for stimulating interest among faculty.
2000 Campus Representative Award, from the American Society for Engineering Education, for outstanding achievement in promoting membership in the PSW section.
1999 Campus Representative Award, from the American Society for Engineering Education, for outstanding achievement in promoting membership in the PSW section.
1998 Faculty-in-Residence for Innovative Pedagogy, from the Institute for Teaching & Learning.
1998 Outstanding Zone Campus Representative Award, from the American Society for Engineering Education, for outstanding initiative in representing ASEE on the campus and for stimulating interest among faculty.
1998 SJSU Award on Research in Teaching & Learning, from the Institute for Teaching & Learning.
1998 Who's Who Among America's Teachers: The best teachers in America selected 1997 by the best students.
1997 Ralf R. Teetor Educational Award from the Society for Automotive Engineering for outstanding contributions in engineering education.
1996 Presidential Special Recognition Award, for exceptional achievements in advancing the University's mission.

1996 College of Engineering Excellence in Teaching Award, SJSU.
1995 Teacher Scholar, nominated by the School of Engineering and selected by the Institute for Teaching & Learning, SJSU.
1993 Tenure, Department of Aerospace Engineering, SJSU.
1991 Summer Faculty Fellowship from ASEE to continue research on Hot Gas Ingestion of Jet V/STOL Aircraft, NASA Ames Research Center.
1990 Summer Faculty Fellowship from ASEE to research Hot Gas Ingestion of Jet V/STOL Aircraft, NASA Ames Research Center.
1990 Meritorious Performance & Professional Promise Award for outstanding contributions to the academic community at SJSU.
1980 Research Assistanship from the Joint Institute for Aeronautics & Acoustics, (Dept. of Aeronautics & Astronautics, Stanford University / NASA Ames Research Center) to perform research on High Angle of Attack Aerodynamics.
1980 Scholarship from the Institute of Governmental Scholarships for ranking 2nd in the senior Mechanical Engineering class, U. of Patras, Greece.
1979 Scholarship from the Institute of Governmental Scholarships for ranking 4th in the junior Mechanical Engineering class, U. of Patras, Greece.
1978 Summer Internship from the International Association for the Exchange of Students for Technical Experience at Brneska Strojirna (Steam Boiler and Gas Turbine Design and Manufacturing Co.) in Brno, Czechoslovakia.
1978 Scholarship from the Institute of Governmental Scholarships for ranking 1st in the sophomore Mechanical Engineering class, U. of Patras, Greece.

PUBLICATIONS

Journal Articles

Mourtos, N.J., A Sustainable, Systematic Process for Continuous Program Improvement, Invited Paper, *Global J. of Engineering Education*, to be published, 2006.
Mourtos, N.J., The Scholarship of Teaching Engineering at San Jose State University; a Faculty Member's Perspective, Invited Paper, *Global J. of Engineering Education*, Vol.10, No.1, Mar. 2006.
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. 2, 2005, pp.77-87.
Mourtos, N.J., DeJong-Okamoto, N., Rhee, J., Open-Ended Problem Solving Skills in Thermal Fluids Engineering, Invited Paper, *Global J. of Engineering Education*, vol.8, no. 2, 2004, pp.189-199.
Mourtos, N.J., From Learning to Talk to Learning Engineering: Drawing Connections across the Disciplines, *UICEE World Transactions on Engineering and Technology Education*, vol.2, no.2, pp. 195-200, June 2003.
Mourtos, N.J., Allen, E.L., Introducing Cooperative Learning through a Faculty Instructional Development Program, *ASEE J. of Engineering Education*, Oct. 2001, pp.669-675.
Mourtos, N.J., Portfolio Assessment in Aerodynamics, *ASEE J. of Engineering Education*, Apr. 1999, pp.223-229.
Mourtos, N.J., The Nuts & Bolts of Cooperative Learning in Engineering, *ASEE J. of Engineering Education*, Jan. 1997, pp.35-37 (Received the 1998 SJSU Award on Research in Teaching & Learning from the Institute for Teaching & Learning.
Mourtos, N.J., Flow past a Flat Plate with a Vortex / Sink Combination, *ASME J. of Applied Mechanics*, Jun. 1996.
Mourtos, N.J., Control of Vortical Separation on a Circular Cone, *The Aeronautical J.*, Jul. 1990. Also, *AIAA paper No. 88-0482*.

Papers in Conference Proceedings

Mourtos, N.J., Workshop: Program Educational Objectives and Outcomes: How to Design a Sustainable, Systematic Process for Continuous Improvement, Proc., 36th ASEE / IEEE Frontiers in Education Conf., Oct. 2006.

Mourtos, N.J., Papadopoulos, P., Agrawal, P., A Flexible, Problem-Based, Integrated Aerospace Engineering Curriculum, Proc., 36th ASEE / IEEE Frontiers in Education Conf., Oct. 2006.
Mourtos, N.J., Program Educational Objectives and Assessment: A Systematic Process for Continuous Improvement, Proc., 5th ASEE Global Colloquium on Engineering Education, Oct. 2006.
Komives, C., Mourtos, N.J., Anagnos T., McMullin, K.: Enhancing Inquiry Skills in Engineering through a University-School District Partnership, Proc., 9th International Conference on Engineering Education, July 2006.
Mourtos, N.J., A Systematic Approach for Defining and Assessing Program Educational Objectives and Outcomes, Proc., World Congress on Computer Science, Engineering, and Technology Education, Mar. 2006.
Mourtos, N.J., Program Outcomes and Assessment: A Sustainable, Systematic Process for Continuous Improvement, Lead Paper, Proc., 9th Annual UICEE Conf. on Engineering Education, Feb. 2006 (Bronze Award).
Du, W.Y., Furman, B.J., Mourtos, N.J., On the Ability to Design Engineering Experiments, Proc., 8th Annual UICEE Conf. on Engineering Education, Feb. 2005.
DeJong-Okamoto, N., Rhee, J., Mourtos, N.J., Educating Students to Understand the Impact of Engineering Solutions in a Global / Societal Context, Invited Keynote Address, Proc., 8th Annual UICEE Conf. on Engineering Education, Feb. 2005 (Best Paper Award)
Mourtos, N.J., DeJong-Okamoto, N., Rhee, J., Defining, Teaching and Assessing Problem Solving Skills, Proc., 7th Annual UICEE Conf. on Engineering Education, Feb. 2004 (Silver Award)
Mourtos, N.J., Defining, Teaching and Assessing Lifelong Learning Skills, Proc., 33rd ASEE / IEEE Frontiers in Education Conference, Nov. 2003.
Mourtos, N.J., Allen, E.L., Assessing the Effectiveness of a Faculty Instructional Development Program, part 2: Teaching and Learning Styles, Lead Paper, Proc., 6th Annual UICEE Conf. on Engineering Education, Feb. 2003.
Mourtos, N.J., Furman, B.J., Assessing the Effectiveness of an Introductory Engineering Course for Freshmen, Proc., 32nd ASEE / IEEE Frontiers in Education Conf., Nov. 2002.
Nelson, C., Kirk, D., McMullin, K., Meyers, S., Mourtos, N.J., Viajar, P., Technological Literacy for K-6 Teachers: How Things Are Designed and Work Invited Paper, Proc., ASEE Annual Conf., Jun. 2002.
Mourtos, N.J., McMullin, K., A Comparison of Student Learning and Satisfaction in Online and Onground Engineering Courses, Proc., 4th Annual UICEE Conf. on Engineering Education, Feb. 2001.
Mourtos, N.J., Allen, E.L., Assessing the Effectiveness of a Faculty Development Program, part 1: Cooperative Learning, Lead Paper, Proc., Global Congress on Engineering Education Conf., Jul. 2000.
Mourtos, N.J., A Model of Learning as it applies to Engineering, Proc., ASEE / IEEE Frontiers in Education Conf., Nov. 1996.
Mourtos, N.J., The Nuts & Bolts of Cooperative Learning in Engineering, Honorable Mention, Ben Dasher Award Committee, Proc., ASEE / IEEE Frontiers in Education Conf., Nov. 1994.
Mourtos, N.J., Using Cooperative Learning in Engineering Courses, Proc., ASEE Pacific South-West Conf., Sep. 1994.
Desautel, D., Hunter, J., Mourtos, N.J., Pernicka, H., Development and Integration of Modern Laboratories in Aerospace Education, Proc., AIAA Aerospace Ground Testing Conf., Jul. 1992.
Mourtos, N.J., An Integrated Lecture / Laboratory Sequence in Aerodynamics, Proc., ASEE Annual Conf., Jun. 1990.
Mourtos, N.J., San Jose State University Development of Aircraft Design Laboratory, Proc., ASEE Annual Conf., Jun. 1990.

Technical Reports

Mourtos, N.J., Couillaud, S., Carter, D., Hange, C., Wardwell, D., Margason, R.J., Flow Visualization Studies of VTOL models during Hover in Ground Effect, NASA TM 108860, Jan. 1995.
Mourtos, N.J., Margason, R.J., Evaluation of a Prediction Method for V/STOL Aircraft Hot-Gas Ingestion, NASA TM 103828, Jan. 1991.

Mourtos, N.J., Roberts, L., Control of Vortical Separation on Conical Bodies, Ph.D. Thesis, Aeronautics & Astronautics, Stanford University. Also Joint Institute for Aeronautics & Acoustics TR 78, Jun. 1987.

Mourtos, N.J., Tavella, D.A., The Aerodynamics of Delta Wings of Elliptical Cross-Section with Separated Flow, Joint Institute for Aeronautics & Acoustics TR 69, Dec. 1985.

Mourtos, N.J., Flow past a Flat Plate with a Vortex / Sink Combination, Joint Institute for Aeronautics & Acoustics TR 58, Sep. 1984.

Mourtos, N.J., The Aerodynamic Design of a Remotely Piloted Vehicle, B.S. Thesis, Mechanical Engineering, University of Patras, Greece, Jun. 1980.

CONFERENCE PRESENTATIONS

Oct. '06 Workshop: Program Educational Objectives and Outcomes: How to Design a Sustainable, Systematic Process for Continuous Improvement, 36th ASEE / IEEE Frontiers in Education Conf., San Diego, California, USA.

Oct. '06 A Flexible, Problem-Based, Integrated Aerospace Engineering Curriculum, 36th ASEE / IEEE Frontiers in Education Conf., San Diego, California, USA.

Oct. '06 Program Educational Objectives and Assessment: A Systematic Process for Continuous Improvement, 5th ASEE Global Colloquium on Engineering Education, Rio de Janeiro, Brazil.

Feb. '06 Program Outcomes and Assessment: A Sustainable, Systematic Process for Continuous Improvement, Lead Paper, 9th Annual UICEE Conf. on Engineering Education, Muscat, Oman. Received the Bronze Award.

Feb. '05 On the Ability to Design Engineering Experiments, Lead Paper, 8th Annual UICEE Conf. on Engineering Education, Kingston, Jamaica.

Feb. '04 Defining, Teaching, and Assessing Problem Solving Skills, Lead Paper, 7th Annual UICEE Conf. on Engineering Education, Mumbai, India. Received the Silver Award.

Nov. '03 Defining, Teaching, and Assessing Lifelong Learning Skills, 33rd ASEE / IEEE Frontiers in Education Conf., Boulder, Colorado.

Feb. '03 Assessing the Effectiveness of a Faculty Instructional Development Program, part 2: Teaching and Learning Styles, Lead Paper, 6th Annual UICEE Conf. on Engineering Education, Cairns, Queensland, Australia.

Nov. '02 Assessing the Effectiveness of an Introductory Engineering Course for Freshmen, 32nd ASEE / IEEE Frontiers in Education Conf., Boston, Massachusetts.

Mar. '02 Workshop: A Faculty Reward System Promoting the Scholarship of Teaching and Learning, Lilly Conf. on College & University Teaching, Lake Arrowhead, CA., co-presented w. Harper, V., Sprague, J., Nelson, C. Hegstrom, T., Saylor, C.

Apr. '01 A Comparison of Student Learning and Satisfaction in Online and Onground Engineering Courses, 2nd Annual SJSU Conf. on the Scholarship of Teaching & Learning.

Feb. '01 A Comparison of Student Learning and Satisfaction in Online and Onground Engineering Courses, 4th Annual UICEE Conf. on Engineering Education, Bangkok, Thailand.

Oct. '00 Using Learning Styles Preferences Data to Inform Classroom Teaching and Assessment Activities, 30th ASEE / IEEE Frontiers in Education Conf., Kansas City, Missouri.

Jul. '00 Assessing the Effectiveness of a Faculty Development Program, part 1: Cooperative Learning, Lead Paper, 2nd Global Congress on Engineering Education, Wismar, Germany.

Nov. '99 Assessing the Effectiveness of a Faculty Development Program, 29th ASEE / IEEE Frontiers in Education Conf., San Juan, Puerto Rico.

Nov. '97 Portfolio Assessment in Aerodynamics, 27th IEEE / ASEE Frontiers in Education Conf., Pittsburgh, PA.

Jun. '97 Problem-Based, Integrated Calculus, Physics, and Engineering, ASEE Annual Conf., Milwaukee, WI.

Mar. '97 Workshop: From Learning to Talk to Learning Engineering: Drawing Connections across the Disciplines, Lilly Conf., on College & University Teaching, Lake Arrowhead, CA.

Nov. '96 A Model of Learning as it Applies to Engineering, 26th IEEE / ASEE Frontiers in Education Conf., Salt Lake City, UT.

Mar. '96 Promoting Self-Reflection through Portfolio-Type Activities in a Cross-Disciplinary Setting, Lilly Conf. on College & University Teaching, Lake Arrowhead, CA (co-presented).

Nov. ’94 The Nuts and Bolts of Cooperative Learning in Engineering, Honorable Mention, Ben Dasher Award Committee, 24th IEEE / ASEE Frontiers in Education Conf., San Jose, CA.
Oct. ’94 Using Cooperative Learning in Engineering Courses, ASEE Pacific South-West Conf., Sacramento, CA.
Jun. ’90 An Integrated Lecture / Laboratory Sequence in Aerodynamics, ASEE Annual Conf., Toronto, Canada.
Jun. ’90 SJSU Development of Aircraft Design Laboratory, ASEE Annual Conf., Toronto, Canada.
Jan. ’88 Control of Vortical Separation on a Circular Cone, 26th AIAA Aerospace Sciences Meeting, Reno, NV.

GRANTS

1998 ITL Knight-Ridder Champions Fellowships, “Explore / Create Multimedia in Engineering Education” (PI).
‘97-’98 ITL Learning Productivity Grant, “Problem-Based, Integrated Interdisciplinary Course-Sequence in Math, Physics, and Engineering” (PI).
’94-‘95 NASA Ames Research Center, “An Experimental Investigation of the Effects of Turbulence on Microphone Forebodies” (cont’d).
1993 Graduate Student Stipend Program, “Automobile Aerodynamics”.
1993 ESL, “Ice Detection on Airplane Wings During Takeoff”.
1992 NASA Ames Research Center, “An Experimental Study of Spanwise Blowing on Delta Wings”.
1992 Lockheed Missiles & Space Co., “Modeling of an Attitude Control System”.
1991 NASA Ames Research Center, “An Improved Prediction Method for Jet-Powered V/STOL Aircraft Hot Gas Ingestion”.
1990 College of Engineering, SJSU, for summer research.

REVIEWER FOR

- International Journal of Engineering Education (2005)
- UICEE Annual Conference on Engineering Education (2000 – 2005)
- UICEE Global Journal on Engineering Education (2004)
- UICEE World Transcations on Engineering & Technology (2002 – 2005)
- ASEE Journal of Engineering Education (1996 – 1999)
- ASME Journal of Applied Mechanics (1997)
- International Journal of Mechanical Engineering Education (1991)
- McGraw-Hill Publishing Co. (2 books: 1997, 2004)
- Thomson Engineering (2 books: 2004)
- John Wiley & Sons (1 book: 2004)
- Monash University, Melbourne, Australia (M.S. thesis: 2003)
- School of Mechanical and Production Engineering,
- Nanyang Technological University, Singapore (Ph.D. thesis: 1998)
- University of Kuwait (new course proposal: 2004).

M.S. THESES / PROJECTS DIRECTED

2006 Verification of Airworthiness of Modified KR-2 Aircraft, Michael Nordin
2006 Formation Flying of Jet Transports, Woon-Ho Cho.
2006 Mechanical Integration, Testing and Delivery of the Large Area Telescope (LAT) for the GLAST program, Eliazar Ortiz.
2005 The Design of a Hybrid Airplane, Jim Colosimo.
2005 The Design of a Small, Unmanned Aerial Vehicle, Jeremy Scheerer.
2004 A User-Friendly, Interactive Program for Subsonic Jet Engine Compressor Analysis and Design, Sajesh Giri.
2003 Three-Dimensional Image Registration, Miki Sode.
2003 Numerical Techniques Used in Modeling Species Concentrations & Evaporation Rates in a Multi-Component, Evaporating Droplet, Robert Shearer.
2003 Thermochemical Analysis of Hydrogen Peroxide with Applications to Rocket Design, Robert A. Robles.
1997 An Experimental Study of the Response of a Microphone Mounted in a Flat Plate, Hedayat U. Hamid.
1997 Computational Investigation of the Aerodynamic Characteristics of Delta Wings with various Leading-Edge Shapes, Akbar Sultan.
1997 An Automatic Data Acquisition System for the SJSU Subsonic Wind Tunnel, Spiros Agellopoulos.
1997 An Experimental & Computational Investigation of the Separated Flow over a Flat Plate with a Vortex/Sink Combination, Marcus Brooks.
1996 Computational Investigation of the Low-Speed S1223 Airfoil with and without a Gurney Flap, Edward Tejnil.
1996 Pressure Distribution on the Underside of a Flat-Bottom Race Car, Alan Dezzani.
1994 Experimental Investigation of Spanwise Blowing on a 40-degree Swept Trapezoidal Wing, Stephane Couillaud.

OTHER ACADEMIC AND PROFESSIONAL RESPONSIBILITIES

2006- Assistant Director, Center for Faculty Development & Support, SJSU.
• Assess teaching / learning needs of SJSU faculty. Develop workshops to help orient faculty towards 21st century learning centered teaching. Provide consultation support for faculty and departments on teaching, learning, and assessment.

2006- BSAE / MSAE Assessment Coordinator, SJSU.
• Design an assessment process for program educational objectives, program outcomes, and program criteria, collect and analyze data, prepare the AE self study report.

'02-'06 Program Assessment Coordinator, Dept. of Mechanical & Aerospace Engineering, SJSU.
• Designed an assessment process for program educational objectives, program outcomes, and program criteria, led department faculty in the implementation of this process, collected and analyzed data, prepared the self study reports, and presented the results to ABET evaluators during a successful accreditation visit (Fall 2005).

'96-'03 Faculty Instructional Development Coordinator, College of Engineering.
• Organized "Conversations on Teaching" (workshops, seminars, informal discussions) on teaching, learning and assessment in engineering; mentored engineering faculty.

'02-'03 Mentor in "Peer-Partners in Teaching" program of the Center for Faculty Development & Support, SJSU.

'98-'02 Faculty-in-Residence for Innovative Pedagogy for the Center for Faculty Development & Support, SJSU.
• Offered workshops on Cooperative Learning and Learning Styles ; mentored SJSU faculty on teaching-related issues.

'97-'03: Coordinator, Introduction to Engineering Course for Freshmen, College of Engineering.
• Responsible for content delivery and course assessment, training new instructors, semi-annual freshman design competition.

'96-'02: Campus Representative, American Society for Engineering Education.

• '95: Co-organizer, ASEE / PSW Conference in San Jose.
'95-'96, '87-'88: Volunteer Faculty Mentor.
1995- Faculty Advisor, SJSU ΣΓΤ (Aerospace Honor Society) Student Chapter.
'90-'98: Faculty Advisor for the SJSU AIAA Student Chapter.
• 1994: Organized Student Conference at SJSU for the PSW Region.
• 1991: Organized Short Course in V/STOL Aircraft Design at SJSU with experts from NASA Ames Research Center.

CONSULTING

'03-'08: Consultant: "Partnership for Student Success in Science", an NSF-sponsored project to improve K-12 Science Education (collaboration among nine schools districts, San Jose State University, Synopsys, and Agilent Technologies), California.
'03-'06: External evaluator for "A Model Curriculum for Civil Engineering Technology", an NSF-sponsored project at Evergreen College, California.
1996: Expert witness, Collins Schlothauer Attorneys at Law, case involving a gas leak.
1992: Wind tunnel testing of golf ball barrier netting for Roxford Fordell.
1991: Wind tunnel testing of arrows for Liston & Associates.

INDUSTRIAL EXPERIENCE

1991, 6:3-8:16	ASEE Summer Faculty Fellow, STOVL / Powered-Lift Technology Branch, NASA Ames RC.
1990, 6:8-8:17	ASEE Summer Faculty Fellow, Fixed Wing Aerodynamics Branch, NASA Ames RC.
1978, 7:1-8:31	Design Engineer, Steam Boiler and Gas Turbine Design, Brneska Strojirna Co., Brno, Czechoslovakia.
1977, 7:1-8:31	Assembly Engineer, Kritikos Cloth-Spinning Co., Patras, Greece.
1976, 6:15-9:15	Powerline Engineer, Scounakis Shipyard, Salamis, Greece.

SOCIETY AFFILIATION

- Professional & Organizational Development Network in Higher Education ('06-present)
- UNESCO International Center for Engineering Education ('00-present
- American Society for Engineering Education (ASEE) ('88-present)
  - SJSU ASEE Campus Representative ('96-'02)
- American Institute for Aeronautics and Astronautics (AIAA)
- Demokritos Society of America; Board Member ('97-present)
- Democritos Professional Society; President ('93 – '96)
- Greek Technical Chamber

F.II PERIKLIS PAPADOPOULOS

PERSONAL

Phone:	Office	(408) 924-7168	Home	(408) 615-8033
	Fax	(408) 924-3995		
Email:	ppapado1@email.sjsu.edu			

EDUCATION

1992	Ph.D., Aeronautical & Astronautical Engineering, Stanford University Dissertation: *Computation of Heat Shield Erosion in a Dusty Martian Atmosphere* Honorary mention for best thesis of the year
1987	M.S., Aeronautical & Astronautical Engineering, Stanford University
1985	B.S., Mechanical Engineering, Illinois Institute of Technology, Chicago, Illinois High Honors/Dean's List
1981	Lycee Leonin, Athens, Greece, High School Diploma and DiplÔme de Langue Français

Short Courses & Workshops Attended

2001, Feb.	Economics of Space Transportation, AIAA
1999, Sep.	C as a Second Programming Language, DeAnza College
1999, Jan.	Object Oriented Analysis and Design, UC Berkeley Extension
1998, Aug.	Launch-Space Education Services / United States Space Foundation, McLean, VA Advanced Launch Systems – Reusables

PROFESSIONAL CAREER

2003-present	Associate Professor, Mechanical and Aerospace Engineering, SJSU, California
1999-2002	Adjunct Professor, Mechanical and Aerospace Engineering, SJSU, California
1991-2003	Senior Research Scientist, NASA-ARC / ELORET – Thermosciences Institute, Moffett Field, California
1989-1991	Teaching Assistant, Aeronautics and Astronautics, Stanford University, California
1988-1989	Laser Production Engineer, Hewlett Packard, Santa Clara, California
1983-1985	Project Assistant, Illinois Institute of Technology, Chicago, Illinois
1983-1984	Research Assistant, Soil Dynamics Laboratory, Illinois Institute of Technology, Chicago

Courses Taught

AE110	Space Systems Engineering
AE162	Aerodynamics
AE164	Compressible Flow
AE165	Flight Mechanics
AE167	Aerospace Propulsion
AE169	Computational Fluid Dynamics (developed as new course)
AE170A	Aerospace Vehicle Design I – Section II Spacecraft Design
AE170B	Aerospace Vehicle Design II – Section II Spacecraft Design
AE262	Advanced Aerodynamics
AE267	Space Propulsion Systems
AE269	Advanced Computational Fluid Dynamics (developed as new course)
ME111	Fluid Mechanics
ME270	Numerical Methods in Engineering

HONORS & AWARDS

2002 Group Achievement Award in recognition of outstanding dedication to the improvement of Space Shuttle safety through the expansion of Space Shuttle abort capability, presented by NASA-HQ administrator, Sean O'Keefe, Sep. 2002.
2002 Invited speaker at the JANNAF Interagency Propulsion Committee, 2nd Modeling and Simulation Subcommittee Joint Meeting, "A Geometry-Centered Approach for Two-Stage-To-Orbit Vehicle Synthesis", Destin, Florida, April 2002.
2001 NASA Award for 'Turning Goals into Reality", July 2001.
2001 NASA Group Achievement Award, July 2001.
2001 Invited speaker at the 35th Thermophysics conference, "Simulations in Support of Shuttle Orbiter Contingence Abort Aerodynamic Database Enhancements", AIAA, Anaheim, CA.
2000 Certificate of appreciation in recognition of excellence in successfully completing the X-33 Task ARC-01 that contributed to the X-33 vehicle aerothermodynamics and verifications, NASA X-33 Program Office.
2000 Certificate of appreciation in recognition of excellence in successfully completing the X-33 Tasks ARC-19 and ARC-23 that contributed to the reusable launch vehicle environments analysis synthesis and design, NASA X-33 Program Office.
2000 Spotlight award, Thermosciences Institute.
1998 Invited speaker at the 6th International Conference on Numerical Grid Generation in Computational Field Simulations, University of Greenwich, London.
1997 Group achievement award for outstanding contributions to the NASA/Industry Reusable Launch Vehicle and X-33 Programs in the area of thermal protection system Technology development, NASA-ARC
1997 Public service group achievement award for outstanding achievement in defining the aeroheating environment for the Lockheed-Martin Skunk Works X-33 Reusable Launch Vehicle, NASA ARC.
1996 Certificate of appreciation, in recognition of outstanding contributions to NASA's Reusable Launch Vehicle X-33 Program, NASA-ARC.
1996 Outstanding performance award for contributions in grid generation and CFD simulations of complex configurations related to numerous projects including X-33, X-34, Neptune, and Mars 2001, Thermo sciences Institute.
1995 Certificate of recognition for superior employee performance, Thermosciences Institute.
1992 Honorary mention for best Ph.D. thesis of the year at Stanford University.
"Dean's List" during all undergraduate academic years.
Member, Tau-Beta-Pi National Engineering Honorary Society.
Member, Pi-Tau-Sigma National Mechanical Engineering Honorary Fraternity.

PUBLICATIONS

J. Hauser, P. Papadopoulos, W. Dai, J-M., Muylaert, Physical and Numerical Modeling for Advanced Propulsion Systems, Accepted in the special issue of the *CFD J. of International Society for CFD*, Vol. TBD, 2006.

P. Papadopoulos, and P. Subrahmanyam, Web Based Computational Investigation of Aerothermodynamics of Atmospheric Entry Vehicles, *J. of Spacecraft and Rockets*, Vol. TBD, 2006.

W. Dai, P. Papadopoulos, J. Hauser, Box Technique For The Generation Of Highly Complex 3D Multi-block Structured Grid Using GridPro, Accepted for publication in the special issue on Advances in Grid Generation and Applications of the *International J. of CFD*, Vol. TBD, 2006.

P. Papadopoulos, D. K. Prabhu, C. B. Davies, M. J. Wright, E. Venkatapathy, P. Wercinski, Grid Generation Strategies For Shuttle Contingency Abort Aerodynamics, Accepted for publication in the special issue on Advances in Grid Generation and Applications of the *International J. of CFD*, Vol. TBD, 2006.

P. Papadopoulos, and P. Subrahmanyam, Trajectory Based Automatic Grid Generation Tool For Atmospheric Entry CFD Modeling, Accepted for publication in the special issue on *Advances in Grid Generation and Applications* of the *International J. of CFD*, Vol. TBD, 2006.

P. Papadopoulos, and V. Zafiris, Geometric Quality Metrics for Volume Grids, Accepted for publication in the special issue on *Advances in Grid Generation and Applications* of the *International J. of CFD*, Vol. TBD, 2006.

P. Papadopoulos, and P. Subrahmanyam, A Structured Multiblock Compressible Flow Solver SPARTA For Planetary Entry Probes, *Advances in Fluid Mechanics VI, WIT Transactions on Engineering Sciences*, Vol. 52, pp.235-243, 2006.

N. J. Mourtos, P. E. Papadopoulos, and P. Agrawal, A Flexible, Problem-Based, Integrated Aerospace Engineeing Curriculum, Proc., 36th ASEE/IEEE Frontiers in Education Conf., San Diego, Ca., Oct. 28-31, 2006.

P. Papadopoulos, P. Subrahmanyam, Integrated OLAP Cubes Database Driven Aerothermodynamic Trajectory Analysis For Planetary Probes, 4th International Planetary Probe Workshop, Pasadena, CA, 27-30 June, 2006.

P. Papadopoulos and P. Subrahmanyam, SPARTA: A Structured Multiblock Compressible Flow Solver for Planetary Entry Probes, Advances in Fluid Mechanics, 8-10 May 2006, Skiathos, Greece.

P. Papadopoulos, P. Subrahmanyam, Trajectory Coupled Aerodynamics Modeling For Atmospheric Entry Probes at Hypersonic Velocities, 44th AIAA Aerospace Sciences Meeting and Exhibit, Reno, Nevada, 9-12 Jan, 2006.

P. Papadopoulos, P. Subrahmanyam, Web Based Computational Investigation of Aerothermodynamics of Ballistic Entry Atmospheric Vehicles, AIAA Atmospheric Flight Mechanics Conf., San Francisco, CA, 15-18 August, 2005.

P. Papadopoulos, P. Subrahmanyam, Database Driven Planetary Probe Automatic Geometry And Grid Generation Tool For Atmospheric Entry Simulations, 3rd International Planetary Probe Conf., Anavyssos, Attiki, Greece, 27 June – 1 July, 2005.

P. Papadopoulos, P. Subrahmanyam, "Trajectory Based Computational Aerothermodynamic Investigation Tool SPARTA For Planetary Entry Probes," 3rd International Planetary Probe Conf., Anavyssos, Attiki, Greece, 27 June – 1 July, 2005.

P. Papadopoulos, P. Subrahmanyam, "Trajectory Based Automatic Grid Generation Tool For Atmospheric Entry CFD Modeling," 9th International Grid Generation in Numerical Field Simulations Conf., San Jose, Ca., June 11-18, 2005.

P. Papadopoulos, P. Subrahmanyam, Computational Investigation and Simulation of the Aerothermodynamics of Reentry Vehicles, AIAA/CIRA 13th International Space Planes and Hypersonics Systems and Technologies Conf., Centro Italiano Ricerche Aerospaziali (CIRA), 16-20 May 2005.

P. Papadopoulos, P. Subrahmanyam, Airbreathing Engine Analysis and Simulation Tool For Space Vehicle Design, AIAA/CIRA 13th International Space Planes and Hypersonics Systems and Technologies Conf., Centro Italiano Ricerche Aerospaziali (CIRA), 16-20 May 2005.

Yendler, B., Poffenbarger, N., Patel, A., Bhave, N., Papadopoulos, P., New Approach for Thermal Protection System of a Probe During entry, 2nd International Planetary Probe Workshop, 23-27 August 2004, NASA Ames Research Center, Moffett Field, CA.

Leong, J.N., Papadopoulos, P., A Search for Viable Venus and Jupiter Sample Return Mission Trajectories for the Next Decade, 2nd International Planetary Probe Workshop, 23-27 August 2004, NASA Ames Research Center, Moffett Field, CA.

Dougherty, R.J., Papadopoulos, P., Software Risk Identification for Interplanetary Probes, 2nd International Planetary Probe Workshop, 23-27 August 2004, NASA Ames Research Center, Moffett Field, CA.

Prabhakar S., Papadopoulos, P., ARPA: Airbreathing and Rocket Propulsion Analysis Tool for Space Vehicle Design, JANNAF Conf., Colorado Springs, Colorado, December 1-5, 2003.

Prabhu, D.K., Marvin, J.G., Davies, C., Wright, M.J., Venkatapathy, E., Papadopoulos, P.E., and Brown, J., X-33 Computational Aeroheating Predictions and Comparisons with Experimental Data, Technical Comments, *J. of Spacecraft and Rockets*, Vol. 40, no. 4, July-August 2003.

Papadopoulos, P., Crews, Development of a Design Integration Tool for System-Level Performance Analysis of Liquid-Propellant Rockets, AIAA 2003-5056, AIAA/ASME/SAE/ASEE Joint Propulsion Conf. Proc., 20-23 July 2003, Huntsville, AL.

Crews, T., Papadopoulos, P., "Design Tool for Engineering-Level Evaluation of Liquid Rocket Engine Sub-Systems," AIAA 2003-5057, AIAA/ASME/SAE/ASEE Joint Propulsion Conf. Proc., 20-23 July 2003, Huntsville, AL.

Wright, M.J., Loomis, M., Papadopoulos, E.P., Aerothermal Analysis of the Fire II Afterbody Flow, *J. of Thermophysics and Heat Transfer*, Vol. 17, no. 2, April-June 2003.

Prabhu, D.K., Papadopoulos, P.E., Davies, C.B., Wright, M.J., McDaniel, R.D., Venkatapathy, E., Wercinski, P.F., Shuttle Orbiter Contingency Abort Aerodynamics, II: Real-Gas Effects and High

Angles of Attack, AIAA 2003-1248, invited paper at the 41st AIAA Aerospace Sciences Meeting and Exhibit, Reno, Nevada, Jan. 2003.

Wercinski, P.F., Chen, Y-K, Loomis, M., Tauber, M., McDaniel, R., Wright, M., Papadopoulos, P.E., Gary, A., Yang, L., Neptune Aerocapture Entry Vehicle Preliminary Design, AIAA 2002-4812, AIAA Atmosphere Flight Mechanics Conf., Monterey, CA. Aug. 2002.

Papadopoulos, P.E., Reuther, J., Haimes, B., Harris, S., A Geometry-Centered Approach for Two-Stage-to-Orbit Vehicle Synthesis, *Invited Paper*, JANNAF Interagency Propulsion Committee, 2nd Modeling and Simulation Subcommittee Joint Meeting, Destin, Florida, April 2002.

Papadopoulos, P.E., Wright, M., Melton, J., Loomis, M., Brown, J., Davies, C., Wercinski, P., Gomez, R., Venkatapathy, E, Simulations in Support of Shuttle Orbiter Contingency Abort Aerodynamic Database Enhancements, *Invited Paper* at the 35th AIAA Thermophysics Conf., Anaheim, Ca., June 2001.

Wright, M.J., Loomis, M., Papadopoulos, E.P., Aerothermal Analysis of the Fire II Afterbody Flow, AIAA *Best Paper Award*, AIAA Paper No. 2001-3065, June 2001.

P. J. Gage, M. J. Wright, D. K. Prabhu, P. E. Papadopoulos, J. Olejniczak, D. Olynick, Preliminary Design Interfaces For High-Fidelity Engineering Software: Web-based Analyses For Vehicle Engineering, *Advances in Engineering Software*, Vol. 31, pp. 697-705, 2000.

G. Palmer, Y-K., Chen, P. Papadopoulos, M. Tauber, Reassesment of Effect of Dust Erosion on Heatshield of Mars Entry Vehicle, *J. of Spacecraft and Rockets*, Vol. 37, no. 6, 2000.

Gage, P.J., Wright, M.J., Prabhu, D.K., Papadopoulos, P.E., Olejniczak, J., Olynic, D., Perliminary Design Interfaces for High-Fidelity Engineering Software: Web-based Analyses for Vehicle Engineering, 5th National Symposium on Large-Scale Analysis, Design and ISE, Williamsburg, VA., Oct. 15, 1999.

Wercinski, P., Papadopoulos, P., Venkatapathy, E., Chen, Y-K., Yang, L., Modeling High-Energy Aerocapture Trajectories for Outer Planet Orbiter Missions, *J. of Spacecraft and Rockets*, Vol. 4, 1999.

Palmer, G., Chen, Y.-K., Papadopoulos, P., and Tauber, M., "An Aerothermal Analysis and TPS Sizing of the Mars 2001 Lander Vehicle," submitted to the special edition on planetary issues of the *J. of Spacecraft and Rockets*, Vol. 4, 1999.

Papadopoulos, Olynic, D., Prabhu, D., Chen, Y-K., and Cheatwood, F. M., CFD Code Comparisons for Mars Entry simulation, special edition on planetary issues of the *J. of Spacecraft and Rockets*, Vol. 4, 1999.

Palmer, G., Chen, Y.-K., Papadopoulos, P., and Tauber, M., An Aerothermal Analysis and TPS Sizing of the Mars 2001 Lander Vehicle, AIAA 37th Aerospace Sciences Meeting, Reno, NV, Jan. 12-15, 1999.

Popp, J., Naughton, J., Papadopoulos, P., Venkatapathy, E., Ragent, B., Simulation of Galileo Probe Descent Through Jovian Clouds, AIAA 37th Aerospace Sciences Meeting, Reno, NV, Jan. 12-15, 1999.

Papadopoulos, P., Venkatapathy, E., Prabhu, D., Loomis, M., and Olynick, D., Current Grid Generation Strategies and Future Requirements in hypersonic Vehicle Design, Analysis and Testing, *Applied Mathematical Modeling*, vol. 23, pp.705-735, 1999.

Prabhu, K.P., Venkatapathy, E., Kontinos, D.A., Papadopoulos, P.E., "X-33 Catalytic Heating," AIAA 98-2844, AIAA 7th AIAA/ASME Joint Thermophysics and Heat Transfer Conf., Albuquerque, NM, June 15-18.

Prabhu, D., Loomis, M., P., Venkatapathy, E., Polsky, S., Papadopoulos, P., Davies, C., and Henline, W., D., X-33 Aerothermal Environment Simulations, AIAA 98-0868, AIAA 36th Aerospace Sciences Meeting and Exhibit, Reno, NV, Jan. 12-15 , 1998.

Papadopoulos, Olynic, D., Prabhu, D., Chen, Y-K., and Cheatwood, F. M., "CFD Code Comparisons for Mars Entry simulation," AIAA 98-0272, AIAA 36th Aerospace Sciences Meeting and Exhibit, Reno, NV, January 12-15 , 1998.

Loomis, M., Papadopoulos, P., Venkatapathy, E., Davies, C., Campbell, C., "Aerothermal CFD Validation and Prediction for the X-38 Program," AIAA 97-2484, AIAA 32nd Thermophysics Conf., Atlanta, GA, June 23-25, 1997.

Wercinski, P. F., Henline, W. D., Tran, H., Milos, F., Papadopoulos, P. E., Chen, Y. -K., Venkatapathy, E., and Tauber, M., "Trajectory, Aerothermal Conditions, and Thermal Protection System Mass for the Mars 2001 Aerocapture Mission," AIAA Paper 97-0472, 35th Aerospace Sciences Meeting and Exhibit, Reno, NV, January 6-10, 1997.

Papadopoulos, P., Venkatapathy, E., Henline, W. D., and Wercinski, P. F., Aerothermal Heating Simulations with Surface Catalysis for the Mars 2001 Aerocature Mission, AIAA Paper 97-0473, 35th Aerospace Sciences Meeting and Exhibit, Reno, NV, Jan. 6-10, 1997.

Polsky, S., Papadopoulos, P., Sussman, M. A., Venkatapathy, E., Wilson, G, J., Lawrence, S. L., and Henline, W. D., Evaluation of CFD Requirements and Accuracy for Prediction of Re-Entry Heating Environments, Thermosciences Institute Internal Report, TSI-STA02-96-01, Thermosciences Institute, MS 230-2, NASA-ARC, Moffett Field, CA 94035-1000, Dec., 1995.
Tokarcik, S., Papadopoulos, P., Venkatapathy, E., Deiwert, G.S., The NASA Ames 16-Inch Shock Tunnel Nozzle Simulations and Experimental Comparison, AIAA 95-6038, AIAA 6th International Aerospace Planes and Hypersonics Technologies Conf., Chattanooga, TN., 3-7 April, 1995.
Papadopoulos, P., Venkatapathy, E., and Deiwert, G. S., CFD Simulations of the DLR HEG Contoured Nozzle with Air Test Gas, 4th European High-Velocity Database Workshop, ASTEC, Noordwijk, The Netherlands, Nov. 21-25, 1994.
Papadopoulos, P., Tauber, M., Chang, I., Heatshield Erosion in a Dusty Martian Atmosphere, *J. of Spacecraft and Rockets*, Vol. 30, No. 2, 1993, pp. 140-151.
Tauber, M., Henline, W., Chargin, M., Papadopoulos, P., Chen, Y., Yang, L., Hamm, K., Mars Environmental survey Probe Aerobrake Preliminary Design Study, *J. of Spacecraft and Rockets*, Vol. 30, No. 4, 1993, pp. 4311-437.
Papadopoulos, P., Tauber, M. E.,and Chang, I. D., Aerobraking in a Dusty Martian Atmosphere, AIAA Paper 90-1700, AIAA/ASME 5th Joint Thermophysics and Heat Transfer Conf., Seattle, WA, June 18-20, 1990.

OTHER ACADEMIC AND PROFESSIONAL RESPONSIBILITIES

- Established a laboratory in virtual collaborative advanced engineering.
- Initiated a research project to design and built a Sunphotometer.
- Established a laboratory for space transportation and exploration research and studies.
- Served as a member of the International Steering committees of the International Planetary Probe Workshop (IPPW) and the International Society of Grid Generation (ISGG) in numerical field simulations.
- Organized the 9th International conference on Numerical Grid Generation in Computational Field Simulations at San Jose State University, and the 2nd, 3rd, and 4th conferences on planetary probes.
- Published the proceedings of the ISGG conference.
- Selected to be the Guest Editor for the special issue on Advances in Grid Generation and Applications of the prestigious International Journal of CFD.
- Technical exchange with Edwards-Air Force Base to built computational tools for Modeling of Rocket Engines.
- Coordinated with the USAF academy to implement tools and develop instructional material for space mission analysis and design.
- Lead students of the local American Institute of Aeronautics and Astronautics (AIAA) chapter at SJSU to design and analyze a Two-Stage-To-Orbit (TSTO) concept for the national student competition on space transportation vehicle design.
- Established a memorandum of understanding between the SJSU/MAE department and the Lockheed Martin Co. (LMCO and LMTO) for development of business opportunities in the areas of space transportation, propulsion, and engineering and technology services and to jointly submit proposals to government agencies.
- Supervised student publications that obtained: Best Paper Award at the AIAA Atmospheric Flight Mechanics Conference in San Francisco, Ca. August 2005; Best paper Award and 3rd place at the International Planetary Probe Workshop III in Athens, Greece and 3rd place at the AIAA western regional student conference in the graduate division.

APPENDIX G AE LABORATORIES

G.I AERODYNAMICS LABORATORY

Director: Dr. Nikos J. Mourtos

Purpose: To provide BSAE students with experiments in basic flow measurements, such as pressure distributions on airfoils, lift and drag measurements on wings and other aerodynamics bodies, and flow visualization.
To provide MSAE students with high-angle-of-attack flow visualization around airfoils, conical bodies and delta wing aircraft, and boundary layer measurements on a flat plate.

Courses and Enrollment:

AE 162	Aerodynamics	30 students / year
AE 171A, B	Aircraft Design I, II	15 students / year (on demand)
AE 262	Advanced Aerodynamics	10 students / year

Location: E-107 1357 Square Feet

Existing Stations & Major Equipment:

- Subsonic Tunnel, 1 ft x 1 ft, 0 - 150 ft/s with NACA 4412 airfoils (pressure distribution and sting mounted models), lift and drag dynamometer, pitot and boundary layer probes, multi-bank manometer, pressure sensors, a variety of drag models, monitoring cabinet and calibration systems.
- Subsonic Portable Smoke Tunnel, 6 in x 6 in, with NACA 4412 airfoils (pressure distribution model), multi-bank manometer, and control unit.
- Water tunnel with dye injection system, control panel, 2D airfoil, conical body, and delta-wing aircraft models.
- Micro-computer Data Acquisition Systems (DAS) w. Labview

New Stations & Equipment Needed:

Second subsonic tunnel, 12"x 20", 0-200 ft/s, open circuit, with force, pressure instrumentation, models & probes	$30,000
One-component laser doppler velocimetry (LDV) system	$30,000
Hot-wire anemometry with flow analyzer and real-time processor	$20,000
High-speed, multi-channel pressure scanner system with host	$30,000
Update micro-computer Data Acquisition System (DAS) w. software	$15,000
Total for new equipment:	$125,000

G.II AIRCRAFT DESIGN LABORATORY

Director: Dr. Nikos J. Mourtos

Purpose: To provide BSAE and MSAE students with hardware and software to support senior design and MS projects / theses in aircraft design.

Courses and Enrollment:

AE 171 A, B: Aircraft Design I, II		15 students / year
AE 271 A, B: Advanced Aircraft Design I, II	(new course; AY 07-08)	10 students / year

Location: E-240 400 Square Feet

Existing Stations & Major Equipment:

- Hardware: 2 working PCs, Internet connected, Printer.
- Software: Advanced Aircraft Analysis (AAA), Sub2D, Super2D, SolidWorks, CAD, ProE, C++, Microsoft Office (desktop publishing).

New Stations & Equipment Needed:

- The space in E240 is inadequate for 20 students; the lab needs to move to a larger room
- 10 x PCs, Internet connected, w. AAA site license $50,000
- Laser color printer $30,000

Total for new equipment: **$80,000**

G.III AEROSPACE STRUCTURES LABORATORY

Director: Dr. Fred Barez

Purpose: To provide students with experience in structural vibrations related to aerospace structures; natural frequency and damping measurements; model extraction; data collection and interpretation

Courses and Enrollment:

AE 114: Aerospace Structures	30 students / year
AE 250: Advanced Aerospace Structures	10 students / year

Location: E-164A — 800 Square Feet

Existing Stations & Major Equipment:

- B & K 4808 Shaker unit
- B & K 2712 Power amplifier
- B & K 1050 Vibration exciter
- PCB Accelerators and charge amplifiers
- Tektronix and Philips Oscilloscopes
- Vibration stations

New Stations & Equipment Needed:

Model analysis software and hardware	$15,000
Shaker system for large structure setting	$15,000
Total for new equipment:	**$30,000**

G.IV COMPUTATIONAL FLUID DYNAMICS LABORATORY

Director: Dr. Periklis Papadopoulos

G.V COLABORATIVE ADVANCED ENGINEERING ENVIRONMENT (CAEE)

Director: Dr. Periklis Papadopoulos

G.VI GAS DYNAMICS LABORATORY

Director: Dr. Nikos J. Mourtos

Purpose: To provide BSAE and MSAE students with experiments in gas dynamics and compressible flow measurements and optical visualization; moving and stationary shock waves, nozzle flow, gas kinetics, supersonic flows.

Courses and Enrollment:

AE 164	Compressible Flow	30 students / year
AE 172 A&B	Spacecraft Design I, II	15 students / year
AE 264	Advanced Compressible Flow	10 students / year

LOCATION: E-164 1800 Square Feet

Existing Stations and Major Equipment:

- Shock Tube, 4” x 4”
- Spark-source
- 6” Mach-Zender interferometer visualization system
- Data acquisition system
- Associated pressure sensors with amplifiers, triggers, electronic shutters, and auxiliary instrumentation.
- Fully equipped black and white negatives /prints processing darkroom, a transmission densitometer, and half-meter spectrometer.

New Stations & Equipment Needed:

➢ Compressible Nozzle Flow Station – simple, subsonic capable, extended run or continuous, with multiple pressure measurements and capability for schlieren / shadowraph nozzle exit flow visualization: SJSU design and fabrication.	$ 6,000
➢ Pressure measurement system and schlieren flow field visualization instrumentation	$ 2,000
➢ Microcomputer-workstations with supporting applications software	$10,000
Total for new equipment	$18,000

G.VII SPACE TRANSPORTATION AND EXPLORATION LABORATORY

Director: Dr. Periklis Papadopoulos

APPENDIX H AE ADVISORY BOARD

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