Northwest Accreditation Department Self-Study
Department of Mechanical & Aerospace Engineering (MAE)
(Updated March 24, 2007)

A. Overview of Department

As part of a land-grant university, the Department of Mechanical and Aerospace Engineering (MAE) at Utah State University is focused on three basic objectives: (1) Teaching: a curriculum of instruction to produce well-educated citizens/graduates for the engineering workforce; (2) Research: student and faculty collaboration on research and development to discover new knowledge, technology, and applications; and (3) Service/Extension: the transfer of knowledge to the profession and society in both the public and private sectors.

MAE offers a major in Mechanical Engineering along with options in Aerospace, Computational, and Manufacturing Engineering. The undergraduate program is accredited by ABET, the recognized accreditor for college and university programs in applied science, computing, engineering, and technology. Graduate degrees include coursework and research structured by individual committees from faculty within the MAE Department and under the guidance of the School of Graduate Studies.

The Department of Mechanical and Aerospace Engineering provides each graduate with a foundation of knowledge and experience upon which to build successful careers in Mechanical, Aerospace, Computational, and Manufacturing Engineering or other fields where a strong engineering background is required or desirable. Undergraduate programs emphasize mechanical engineering fundamentals and computer-based problem solving while teaching students to learn, synthesize, and communicate engineering information. Graduate programs emphasize research by the faculty with a high level of student involvement providing enhanced preparation for engineering practice, research, and education. Students, faculty, and staff are committed to excellence in learning, discovery, and engagement in an environment that fosters diversity and mutual respect.

Expanding upon the mission statement, the Mechanical and Aerospace Engineering Department lists six specific undergraduate **Program Objectives** in the *Utah State University Bulletin*. These objectives, which are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve, are fully consistent with Utah State University's land-grant mission.

Program Educational Objectives

1) Graduates will succeed in entry-level engineering positions with mechanical, aerospace, computational or manufacturing firms in regional, national, or international industries, and with government agencies.

2) Graduates will succeed in the pursuit of advanced degrees in engineering or other fields where a solid foundation in mathematics, science, and engineering fundamentals is required.

3) Graduates will be able to synthesize mathematics, science, engineering fundamentals, and laboratory and work-based experiences to formulate and solve engineering problems in both thermal and mechanical systems areas.

4) Graduates will have proficiency in computer-based engineering, including modern numerical methods, software design and development, and the use of computational tools.

5) Graduates will be prepared to communicate and work effectively on team-based engineering projects.

6) Graduates will recognize the importance of, and have the skills for, continued independent learning.

Review of Program Objectives

MAE's mission statement and Program Objectives (listed above) are evaluated on a two-year cycle, corresponding to the printing of the *University General Catalog*. Objectives are tied closely to the University mission statement and the implicit mission of a land-grant institution. Consequently, we do not anticipate changes in these statements over the short term. The likelihood that Objectives 3-6 change in a two-year cycle is somewhat greater. Evaluation is based on the judgment of the MAE departmental faculty, with input from the Industrial Advisory Board. This review takes place during the daylong faculty retreat at the end of each academic year, which provides sufficient time for any changes to be included in the *University General Catalog*. Analysis of Program Outcomes is discusses in the Analysis and Assessment section.

Program Constituencies

The primary constituencies of the Mechanical Engineering Program are its students, alumni, employers, faculty, and the graduate schools of other colleges and universities.

B. Undergraduate and Graduate Academic Programs

1. Undergraduate Degree Offered

Bachelor of Science in Mechanical Engineering

Undergraduate Admissions

Freshman and transfer students must satisfy the admission policies and entrance requirements of both the University and the College of Engineering. Placement of incoming students depends on high school and/or prior college coursework, although the College of Engineering typically attracts students with excellent academic credentials at the high school level. Shown below are average high school gpa and ACT scores for freshmen entering the Mechanical Engineering Department. ACT

scores for MAE freshmen ranged 2 to 4 points higher than the average of all USU freshmen.

GPA and ACT scores for freshman entering the MAE Department

Year	HS gpa	ACT score
Fall 2002	3.56	24.8
Fall 2003	3.55	25.8
Fall 2004	3.62	26.0
Fall 2005	3.77	27.0
Fall 2006	No data	25.9

Those who complete a portion of the University Studies requirements by examination (CLEP) and/or by advanced placement (AP) credit may complete the Bachelor of Science degree in less than four years. Each student admitted is assigned an advisor, who helps plan and educational program fulfilling the student's professional goals.

Transfer Credit

University transfer guidelines can be found in the 2006-2007 General Catalog, page 67, or the on-line catalog on page 18 of the Undergraduate Admission section: http://www.usu.edu/ats/generalcatalog/PDF/2006-2007/10UndergradAdm-.pdf

Special Admission Requirements for Entry into the Upper-Division Professional Programs (PEP)

To be admitted to a professional program (junior and senior years of undergraduate study), students must successfully complete a required pre-professional program (a 2.3 gpa and no "D" grades). A full-time advisor in the dean's office advises pre-professional students and coordinates professional program admittance. Students cannot register for professional program courses (controlled by the computer registration process and the student's major code) until they are admitted to a professional program. Students may seek permission from the college academic advisor to take a limited number of professional program courses (15 credits) if they are within 10 credits of completing the requirements for admission and their pre-professional gpa is not marginal.

Academic Advising

The Advising Center within the Dean's Office assigns all MAE students an MAE faculty academic advisor for assistance with course selection, program planning, and meeting graduation requirements. It is however, the responsibility of the student to know the current regulations, and to follow the regulations.

The college Advising Center also maintains an extensive web site that addresses issues such as suggested program schedules, admission to professional programs, syllabi for engineering courses, university studies requirements, and articulation. Mechanical Engineering faculty members feel that the College Advising Center

represents an efficient use of resources, and have been pleased with its interaction with the MAE department and students.

Curriculum

The curriculum and other educational activities of Mechanical Engineering students are structured to ensure achievement of the Program Objectives described above. Program Outcomes will be discussed later in this section.

In particular, students gain an understanding of the fundamentals of mathematics and science through completion of the Mathematics and Basic Science sequence. This includes courses in basic chemistry, physics, mathematics through multi-variable calculus and ordinary differential equations, numerical methods, and basic materials science. With the exception of numerical methods, these courses are completed by the end of the sophomore year. In addition, our students are introduced to engineering design in the freshman year with MAE 1200 Engineering Graphics. Additional freshman/sophomore year work includes courses in statics, thermodynamics, electrical engineering, and strength of materials. The freshman/sophomore level curriculum provides students with the background necessary to enter the junior/senior (professional) program where they learn to apply engineering principles to develop, analyze, and improve both mechanical and thermal engineering systems.

The curriculum is rich with opportunities for students to engage in computer-based engineering. Beyond the required MAE 1200 Engineering Graphics course (which provides an introduction to solids modeling using Solid Edge), all students are required to complete a two-course sequence in basic numerical methods. The initial course, MAE 2200, covers the basics of software development using Fortran 90/95. The subsequent course, MAE 2210 covers the fundamentals of numerical methods, with an emphasis on methods used to solve ordinary and partial differential equations. This sequence is usually taken by students during the junior year, rather than the sophomore year (which is common at other universities). This decision was made to accommodate transfer students who usually have not taken equivalent courses. Beyond these required courses, electives such as finite element methods (MAE 5020) and computational fluid dynamics (MAE 5440) are offered at the senior level. The faculty also integrate numerical methods into many of the required and elective courses at the junior/senior level.

Team-based engineering is emphasized within the design portion of the curriculum. Design I (MAE 3800) is taught jointly with the Electrical and Computer Engineering Department. In this course mechanical and electrical engineering students work together to learn the fundamentals of project management, including project scheduling, engineering economics, proposal writing, technical writing, the use of engineering journals, technical presentations, and teamwork skills. Mechanical Engineering students also complete multidisciplinary, team-based projects with the Electrical and Computer Engineering students.

Design II (MAE 4800) represents the senior level capstone design project. Here, senior level students work in teams of 3-5 to define, schedule, document, and present to the faculty, students, and industry a variety of design projects. Projects include professional society- sponsored competitions such as the SAE Mini-Baja; the AIAA Design, Build Fly; and SAE Clean Snowmobile Challenge. Our students have fared very well in these society competitions. For instance, the students took 1st, 1st, and 5th places overall in the AIAA Design, Build and Fly competition during the years 1998, 1999, and 2000, respectively. The two separate student design teams working on the Mini-Baja project in 2001 took 5th and 24th places, respectively (out of more than 100 entrants). The students placed 6th out of more than 100 entries in 2002. They won all categories available for electric-powered snowmobiles in the 2006 Clean Snowmobile Challenge.

Students complete their senior design projects by submitting a thesis-quality report documenting the project. In addition to a project summary and recommendations, the documentation includes design constraints, a complete presentation of applicable theoretical, experimental and/or computational analysis, and drawings. The students also make a formal oral presentation to faculty, students, and where applicable, industry representatives.

Basic Course Requirements at Freshman, Sophomore, Junior and Senior Levels

At the beginning of each school year, each student should obtain a detailed, four-year requirement sheet. This sheet, which lists semester requirements for each of the four curricula (mechanical, aerospace, computational, and manufacturing), may be obtained from the College Student Services Center. All students in the department follow the pre-professional engineering curriculum for the freshman and sophomore years.

Prior to the junior year, the student must apply for admission to the professional program and, in consultation with the faculty mentor, select an area of emphasis. Students who are unable to take courses during the semester indicated on the curriculum requirement sheet may develop alternative schedules, consistent with prerequisites and the timing of course offerings.

A complete year-by-year list of required courses can be found on pages 402-404 of the 2006-2007 General Catalog or at http://www.usu.edu/ats/generalcatalog/-PDF/2006-2007/82MAE.pdf.

Verification of Student Progress

Students may obtain from the College Student Services Center a detailed four-year requirement sheet listing semester requirements for the mechanical, aerospace, and manufacturing engineering curricula. All students in the department follow the pre-professional engineering curriculum for the freshman and sophomore years. Prior to the junior year, students must apply for admission to the professional program and, in consultation with a faculty advisor, select an area of emphasis. Students who are

unable to complete courses during the semester indicated on the curriculum requirement sheet may develop alternative schedules, consistent with necessary prerequisites and the timing of course offerings.

Spring semester of the Junior year, students are required to fill out sheets along with a plan to complete remaining required and elective courses. This check sheet is submitted to the Mechanical Engineering Student Advisor who reviews this sheet for each individual student making sure that all requirements have been met. The check sheet is compared with the student's transcript for accuracy. If there is a problem, the student is notified and appropriate action is taken. The students are then referred to the University Graduation Office to obtain and Application for Candidacy for Graduation form. This form is filled out with information from the check sheet indicating which semester the remaining required and elective courses will be taken. The student signs the forms and the package is reviewed again by the Student Advisor and then forwarded to the Undergraduate Curriculum Committee Chairman for signature. Subsequently, the package advances to the Department Head and Associate Dean for signature. The signed Application for Candidacy for Graduation constitutes a contract and specifies the work required for the student to complete the degree.

The Mechanical and Aerospace Engineering Department Head has the responsibility to see that all departmental requirements are met. In addition, the Associate Dean had the responsibility to see that specific university requirements are met. All graduating seniors are monitored by both the MAE Department and the Dean's Office to verify the courses listed on the application are completed satisfactorily. For example, if a senior student fails a required course Spring Semester, he or she would have already been listed for graduation. However, diplomas are not issued until all grades are in and classes to be taken are checked against new transcripts. In this case, if a student fails a class he or she will be notified that his or her graduation is being held up, and no transcript will be issued until the deficiency had been removed.

GPA and Fundamentals of Engineering Requirements

MAE faculty members have a strong commitment to teaching and to preparing students to practice engineering. A cumulative 2.3 GPA for all technical courses is the minimum standard that pre-professional students must attain in order to be admitted to the professional program. A 2.0 cumulative GPA is required for graduation from any undergraduate program in the MAE department.

Long-standing superior performance by USU students on the Fundamentals of Engineering Exam (FE Exam) reflects the quality of their education and their efforts in preparing for the engineering profession. Mechanical engineering majors are required to pass the FE Exam in order to graduate. Eighty-five to ninety-five percent of USU students pass the exam on the first attempt. A graph in the Analysis and Assessment section of this self-study compares performance at USU to that of students at ABET-accredited engineering programs nationwide. Note that USU MAE

students meet or exceed the national average in every category with the single exception of the PM Electrical Circuit portion.

2. Graduate Academic Programs

Degrees Offered

Master of Engineering in Mechanical Engineering
Master of Science in Mechanical Engineering
Doctor of Philosophy in Mechanical Engineering

Admission

All students intending to pursue graduate studies at Utah State University must complete and return an *Application for Admission* to the School of Graduate Studies. In addition to the general graduate admission requirements listed in the University General Catalog beginning on page 97,or on-line at http://www.usu.edu/ats/generalcatalog/PDF/2006-2007/34GradStudies.pdf, the department requires all graduate applicants to have a bachelor's degree from an accredited institution in Mechanical, Computational, Aerospace, or Manufacturing Engineering, or a closely related engineering discipline. A minimum GPA of 3.0 for MS applicants and 3.3 for PhD applicants is required for the last 60 semester or 90 quarter credits earned. All MAE graduate students are expected to be well acquainted with either the FORTRAN or C programming language.

Those students who do not have a BS degree in an appropriate engineering discipline may be admitted with nonmatriculated status and required to complete some remedial requirements. Applicants are also required to submit evidence of potential graduate-level success through GRE scores in the verbal and quantitative categories.

Specializations and Degree Programs

Details on specializations in Aerospace, Computational, Manufacturing Engineering, as well as specific requirements to complete Master's Degree Plans A, B, and C, the Master of Engineering Degree, and the PhD are available in the 2006-2007 General Catalog pages 404-406 or on-line at http://www.usu.edu/ats/generalcatalog/PDF/2006-2007/82MAE.pdf.

Curriculum

In addition to choices of 6000-plus level coursework listed in the 2006-2007 General Catalog, graduate students will complete reports, theses, and or dissertations, depending on the degree sought. Students and members of the faculty match their research interests to provide research experiences that will lead to publishing opportunities. Funded by government agencies and private industry, current MAE Department research topics include analytical and experimental structural dynamics, computational and experimental fluid dynamics, aerodynamics, plastics and composite materials, numerical modeling and design of composite structures, buried

structures, thermodynamics, heat transfer, cryogenics, intelligent control systems, manufacturing automation, spacecraft control, design and analysis of space systems, orbital mechanics, remote sensing, robotics, design theory and methodology, energy systems, biofuels, and production modeling and simulation.

C. Vital Statistics and Performance Data

DEPARTMENT OF MECHANICAL & AEROSPACE ENGINEERING

MAJORS (FALL SEMESTER)					
Undergraduate Headcount	**2002**	**2003**	**2004**	**2005**	**2006**
Mechanical Engineering	109	121	142	465	516
Pre-Aerospace Engineering	101	89	80	27	26
Pre-Mechanical Engineering	195	229	275	8	3
Total Undergraduate	**405**	**439**	**497**	**500**	**545**
Graduate Headcount					
Mechanical Engineering	42	41	45	36	59
Total Graduate	**42**	**41**	**45**	**36**	**59**
TOTAL MAJORS	**447**	**480**	**542**	**536**	**604**
Demographics					
Undergraduate					
% Full-time	92.8%	91.3%	92.0%	88.8%	89.5%
% Female	6.2%	6.2%	6.4%	8.0%	9.2%
% Minority	3.2%	2.7%	4.2%	3.2%	3.7%
% International	4.0%	2.5%	3.0%	5.0%	5.1%
Graduate					
% Full-time	71.4%	41.5%	88.9%	83.3%	64.4%
% Female	19.0%	9.8%	6.7%	5.6%	3.4%
% Minority	0.0%	4.9%	4.4%	5.6%	1.7%
% International	40.5%	22.0%	20.0%	30.6%	15.3%

STUDENT CREDIT HOURS (FALL SEMESTER)	**2002**	**2003**	**2004**	**2005**	**2006**
Remedial					
1000	148	180	188	186	212
2000	386	276	255	248	291
3000	807	882	1074	1026	1068
4000	205	227	201	272	201
5000	627	663	882	903	792
6000	252.5	234	235.5	216	345.5
7000	18	35	63.5	70.5	44
TOTAL STUDENT CREDIT HOURS	2443.5	2497	2899	2921.5	2953.5

DEGREES (ACADEMIC YEAR)	2001-02	2002-03	2003-04	2004-05	2005-06
Bachelor	47	63	39	71	73
Masters	18	29	27	25	17
Doctoral	2				3
TOTAL DEGREES	67	92	66	96	93

FIRST-YEAR RETENTION RATE (FALL COHORT)	2000	2001	2002	2003	2004
	80.0%	87.0%	69.2%	81.4%	69.4%

SIX-YEAR GRADUATION RATE (FALL COHORT)	1995	1996	1997	1998	1999
	66.7%	57.1%	33.3%	52.8%	50.0%

FULL-TIME FACULTY	2002	2003	2004	2005	2006
Headcount	13	16	15	15	16
Demographics					
% Female	0.0%	6.3%	0.0%	0.0%	6.3%
% Minority	0.0%	12.5%	13.3%	13.3%	12.5%

	2002	2003	2004	2005	2006
Rank					
Professor	3	3	3	3	5
Associate Professor	4	4	3	3	3
Assistant Professor	6	9	8	8	7
Lecturer			1	1	1

PERCENT OF FACULTY WITH TERMINAL DEGREES*	2002	2003	2004	2005	2006
	100.0%	87.5%	100.0%	100.0%	100%

* Analysis based on full-time instructional faculty.

Annual Budget for 2006 $4.5 million 43% E&G 57% Sponsored Research

E&G Allocations 2006-07	Percent
Faculty Salaries	**69**
Professional & Classified Salaries	**11**
Adjunct Teacher Salaries	**3**
Graduate Teaching Assistantships	**4**
Undergraduate Wages	**2**
Operating Expenses	**6**
Startup & Hiring Expenses	**4**

MAE Faculty Research Productivity	2006	Change from 2003
• Graduate Student Enrollment		
MS Students, Fall 2006 (Includes 24 BS/MS)	49	48%
PhD Students, Fall 2006	16	100%
• Support Staff		
3 Professonal , 2 Post Doctoral Researchers, 4 Classified,	10	80%
• Refereed Journal Publications	36	12%
• Refereed Conference Papers	45	96%
• Research Expenditures	$2.5 million	223%
• Research Awards	$5.8 million	344%
• Research Proposals	$20 million	188%

D. Analysis and Assessment

Evaluating the Achievement of Program Objectives

Program Objectives describe expected capabilities and accomplishments of our graduates within their first few years following graduation. These are related to the **Program Outcomes** that, in contrast, describe what units of knowledge or skill students are expected to acquire from the program to prepare them to achieve the program educational objectives. These are typically demonstrated by the student and measured by the program at the time of graduation.

Should the faculty identify deficiencies in meeting any of the Program Objectives, corrective actions are formulated primarily at the Program Outcome level, the level at which the Department acts most effectively. Actions involve evaluation of course offerings and other aspects of the program that influence Outcomes, such as student involvement in society activities.

Program Educational Objectives

Listed below are seven program educational objectives designed to assess the quality and completeness of the teaching process and to fulfill the Program Objectives listed in the opening segment of this report. This section goes on to outline the assessment and evaluation cycle and the various tools used to gather information about Program Outcomes. These tools include the student course evaluations, senior exit interview, competitiveness in national/international contests, performance on the Fundamentals of Engineering Exam, and alumni surveys.

1) **Fundamentals:** Students will identify, formulate, and solve basic engineering problems utilizing:

1. linear algebra
2. calculus-based statistics
3. multivariable calculus
4. differential equations
5. calculus-based physics
6. chemistry
7. material science
8. solid mechanics
9. fluid mechanics
10. thermal science
11. manufacturing science

2) Communication: Students will develop and demonstrate the ability to communicate engineering information, including geometry, technical concepts, and results, by

1. participating in oral presentations
2. developing engineering drawings and specifications
3. writing proposals and reports
4. participating in team-based engineering projects

3) Laboratory experiences: Students will participate in and evaluate laboratory experiences, which

1. include experimental design, data collection, and data analyses a
2. incorporate the use of modern laboratory and data acquisition equipment multivariable calculus
3. utilize statistical analysis and interpretation of data solid mechanics
4. develop basic manufacturing skills thermal science
5. may include work-based learning experiences, such as internships

4) Computer-based engineering: Students will demonstrate proficiency in the application of computer technology to engineering problem solving through the

1. application of modern numerical methods and computational techniques
2. design and development of engineering software
3. integration of numerical solutions into the engineering process of design and analysis
4. use of current commercial engineering software

5) Humanities and social sciences: Students will acquire significant exposure to the humanities and social sciences so as to

1. provide an appreciation for the broad impact of engineering solutions on society
2. demonstrate an understanding of the fundamentals of the history, principles, form of government, and economic system of the United States
3. demonstrate a knowledge of contemporary global issues solid mechanics
4. contribute to the development of the individual as a responsible well-rounded citizen

6) Design and synthesis: Students will participate in the design and realization process in which they will

1. develop a set of multidisciplinary engineering requirements
2. synthesize material from mathematics, science, and engineering fundamentals to solve engineering problems
3. design, develop, and verify software to solve engineering problems
4. bring a system from requirements definition to concept development, then specification
5. prototype and testing, and production or fabrication using significant engineering analysis
6. demonstrate the links between design, prototyping, testing, manufacturing, and other disciplines fluid mechanics
7. manage a project including budgeting and detailed planning

7) Independent learning: Students will recognize the importance of, and demonstrate the skills required for, independent learning through

1. independent study required in the engineering curriculum
2. exposure to case studies in ethics and professional responsibility
3. exposure to advanced topics in engineering science
4. exposure to advanced topics in engineering research
5. studying for and passing the Fundamentals of Engineering Examination

ABET Program Outcomes

ABET 2006-2007 Criteria for Accrediting Engineering Programs states that each student graduating with a BS degree within the MAE program is expected to 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, economic, environmental, 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.

Assessment Process for Program Outcomes

The following is a diagram of the assessment and evaluation cycle in the Department of Mechanical and Aerospace Engineering. The MAE web site (www.mae.usu.edu) contains a comprehensive data base and discussion of MAE's ongoing commitment to continuous improvement.

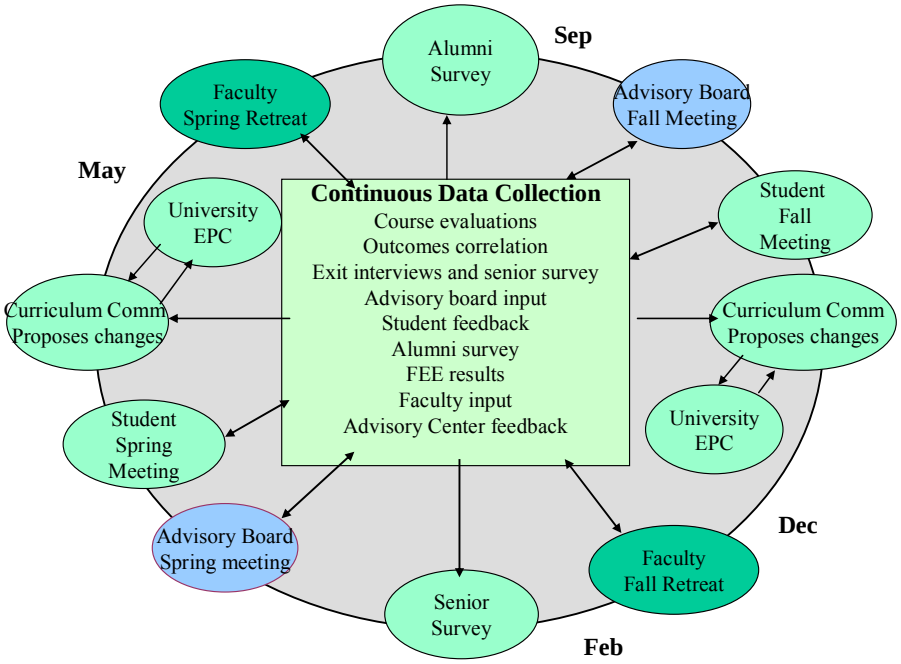

Diagram of assessment and evaluation cycle in the Department of Mechanical and Aerospace Engineering at Utah State University

Industrial Advisory Board Review

The Industrial Advisory Board, comprised of up to 15 individuals who represent a spectrum of experiences from senior management to recent graduates, reviews Program Outcomes and offers qualitative feedback on how well we are meeting them. The Board, at its spring meeting on campus, is charged with advising the faculty regarding desired competencies for graduates, noting competency gaps and strengths of intern-level students and graduates, and noting areas where the Department should increase emphasis, considering faculty expertise, student strengths, and market demands.

Finally, we also look to success in meeting the ABET Educational Objectives described as a measure of meeting the Program Outcomes. Meeting ABET Objectives is a strong indicator that overall Outcomes are also being met. Conversely, if certain

Objectives are not being met, then Outcomes related to that Objective are most likely not being met and become part of the corrective actions agenda.

Gathering Data for Assessment

Individual Course Assessments

A notebook is maintained for each MAE course. This notebook is updated each semester with examples of student work and the instructor's assessment as to how well the students were able to achieve the applicable ABET program outcomes.

Student Course Evaluations

Student evaluations of individual courses are also used to assess Outcomes. Student evaluation forms consist of a series of 20 questions, however we limit our assessment to the "general evaluation" questions regarding a) the overall quality of the course, and b) the instructor's effectiveness in teaching the course. These data are used to help assess an instructor's teaching effectiveness as part of faculty annual evaluations by the Department Head. The average values for the Department change very little from year to year. For 2006 these values for the MAE Department, College and the University are:

	Spring 2006		Fall 2006	
	Course Quality	Instructor Effectiveness	Course Quality	Instructor Effectiveness
MAE	4.8	4.8	4.6	4.6
Engineering College	4.8	4.9	4.7	4.7
University	5.0	5.1	5.0	5.0

Senior Exit Interviews

All graduating seniors are invited to complete a Senior Exit Survey in which they are asked to rate their confidence in their preparation in engineering fundamentals, communication, laboratory experience, computer-based engineering, humanities and social sciences, design and synthesis, and independent learning.

They are asked to list co-op or summer internship in which they participated and the salary they were paid.

Lastly, they are asked to rate their satisfaction with quality of teaching and advising in the college, and the equity of treatment they received from faculty, administrators, other students, etc. Open-ended questions give graduates an opportunity to suggest changes in Department procedures.

These responses are used not only to address problems that are exposed, but also they are compared to results of an employment survey and an alumni survey that are administered two years after students graduate. Comparisons are useful in identifying curriculum strengths and weaknesses relative to the ABET program outcomes.

A copy of the Senior Exit Survey instrument appears in the Appendix.

Alumni Survey

MAE asks alumni to provide feedback regarding the Department and their education. The Department believes that after its graduates practice engineering for two years, they are able to provide valuable insight into how well their education prepared them for their chosen careers. Alumni are contacted by mail and telephone; respondents are rewarded with a Department t-shirt. A copy of the Alumni Survey instrument appears in the Appendix.

Employment Survey

Employment/Education Surveys of recent graduates are conducted each spring under the auspices of the Office of Analysis, Assessment, and Accreditation (AAA). This office sends each department the same survey instrument and the names of 50 graduates who received bachelor's degrees in the past two years.

AAA uses the campus-wide data to respond to questions and concerns posed by legislators, regents, accreditation bodies, and other University constituents. The data are used by MAE to address issues with faculty, Advisory Board members, and graduate and undergraduate curriculum committees.

The survey instrument appears in the appendix.

Here are some of the results from 2004 and 2006 interviews.

		2004	**2006**
1.	Percent of Graduates completing survey	91%	75%
2.	Number of respondents	63	71
3.	Number attending graduate school full time	22	5
4.	Percent in engineering	59%	60%
5.	Percent in Biomedical	27%	0%
6.	Percent in other fields	13%	40%
7.	Percent pursuing MS degree	54%	60%
8.	Percent pursuing PhD degree	45%	20%
9.	Percent who did not name degree	0%	10%
10.	Employment		
11.	Within Utah	35%	48%
12.	Outside of Utah	62%	41%
13.	No response – location	3%	11%
14.	Private Sector	74%	70%
15.	Public Sector	24%	20%
16.	Education	3%	2%
17.	No response – Sector	0	3
18.	Salary – high	$60,000	$106,000
19.	Salary – median	$48,490	$51,672
20.	Salary – low	$36,000	$27,040

Fundamentals of Engineering Exam Performance

The following Table summarizes FE Exam results for USU students compared to national averages.

Subject Apr 2000-Apr 2005	USU ME % Correct	National % Correct
AM Subject		
Chemistry	65	63
Computers	78	67
Dynamics	71	64
Electrical Circuits	57	57
Engineering Economics	63	62
Ethics	70	69
Fluid Mechanics	70	62
Mat Sci/Str Mat	71	63
Mathematics	73	65
Mech of Materials	69	60
Statics	70	58
Thermodynamics	67	59
PM Subject		
Electrical Circuits	41	45
Chemistry	52	49
Computers	75	63
Dynamics	54	46
Engineering Economics	49	45
Ethics	79	75
Fluid Mechanics	59	50
Mathematics	65	59
Mat Sci/Str Mat	68	59
Mech of Materials	53	44
Statics	69	57
Thermodynamics	54	47
No. Examinees Passing	245	17,671
No. Examinees Taking	257	20,810
% Examinees Passing	95%	85%

Subject Oct 2005-Oct 2006	USU ME % Correct	National % Correct
AM Subject		
Mathematics	78	72
Engineering Probability and Stat	70	63
Chemistry	63	65
Computers	78	70
Ethics and Business Practices	79	78
Engineering Economics	69	65
Engineering Mechanics (Statics)	73	65
Strength of Materials	82	72
Material Properties	72	61
Fluid Mechanics	72	63
Electricity and Magnetism	59	57
Thermodynamics	63	57
PM Subject		
Advanced Engineering Mathematics	76	70
Engineering Probability and Stat	58	51
Biology	51	51
Engineering Economics	60	60
Application of Engineering Mechanics	54	46
Engineering of Materials	56	51
Fluids	61	57
Electricity and Magnetism	48	47
Thermodynamics and Heat Trans	61	54
No. Examinees Passing	80	4,065
No. Examinees Taking	86	5,232
% Examinees Passing	93%	78%

National Design Competitions

National competitions such as Mini-Baja, and the AIAA Design, Build and Fly are externally reviewed. MAE students continue to prove that they can compete with the very best from across the nation as they consistently finish in the top 10 percent in intercollegiate student design competitions. Our success in these national competitions provides another measure of our success in meeting Program Outcomes. For example:

In 2005 Competitions
Students won the NASA Great Moonbuggy Race against 28 university teams in May.

Students took first place out of 20 teams in the RASC-AL Forum, a NASA/Universities Space Research Association-sponsored space mission design competition in Cocoa Beach, Florida, in May.

Students took 6th place out of 44 teams in the AIAA-sponsored Design, Build and Fly competition, in Baltimore, Maryland, in May.

Students took 13th place out of 139 teams in the SAE-sponsored Mini Baja competition in Tucson, Arizona, in June.

In 2006 Competitions:
Students took First Place in the University Rocket Launch Competition sponsored by the Experimental Sounding Rocket Association with their Chimaera Rocket, Green River, Utah, in January.

Students won the SAE Clean Snowmobile Challenge Rookie Award and First Place in the Zero Emissions Category, in Houghton, Michigan, in March.

Summary of Analysis and Assessment

Based on the assessment data, the MAE faculty has implemented changes that it feels will better prepare the MAE graduates for employment and graduate school opportunities. Changes are made on a continuing basis in courses, labs, advising, progress and graduation policies, and innovative additions to the curriculum. For example:

In AY 2002-03:

1) MAE 5300, Mechanical Vibrations, became an required course;
2) Advanced engineering math, including calculus-based statistics and emphasizing applications and facility with math engineers because a required course;
3) Statistics was given greater emphasis in a variety of courses; and
4) The number of credits for the capstone course and machine design was reduced so students could elect several enriching courses.

In AY 2003-04:

1) Design II was offered Fall and Spring semesters to better accommodate graduation schedules;
2) Senior Design Projects were redesigned to emphasize teamwork, engineering analysis, critical design presentation, final report writing, and design and shop drawings, in an effort to get away from designing in a machine shop or with a CAD program.
3) The order in which courses are taken and prerequisites were changed to improve the logical presentation of information.
4) Five 3-hour courses for each emphasis were organized and required to give students a better balance of interests.

In AY 2004-05:

1) MAE's mission statement was affirmed, along with the use of the above-listed assessment tools.
2) Computational engineering was approved by the Board of Regents as an emphasis area for the bachelor's degree in Mechanical Engineering.

In AY 2005-06:

1) Faculty members voted to allow students in the MAE professional program only one opportunity to repeat a course, addressing the concern that there were a number of students repeating too many classes. The policy is more stringent that USU's general policy.
2) Based on FE exam results and student performance in electrical network analysis, a new pilot course developed by the ETE Department for MAE majors was offered during Summer 2005 and will be repeated each fall.

AY 2006-07:

1) To strengthen student exposure to professional/ethical issues in the curriculum, faculty members incorporated two lectures on ethics and professionalism into MAE 1200, Engineering Graphics. All MAE freshman will take the course and complete case study homework assignments for use in assessing learning outcomes. A more comprehensive treatment of ethics/professionalism was added to MAE 3800 Design I, and, beginning Spring 2007, the final design report for MAE 4800 Design II will include a section in which students discuss how ethics and contemporary issues are related to their design.
2) Students must take and pass a Computer and Information Literacy (CIL) exam. Regardless of skill level or background, everyone must pass the CIL as part of the University Studies requirement. The six topics are ethics, electronic presentations, operating systems, document processing, information, and spreadsheets.
3) To eliminate some overlapping course materials, master's students no longer may take the following electives: Math 5610, 5620, 5640, or 5710. Some topics discussed in these courses were being covered in undergraduate

requisite courses. The Graduate Committee and other faculty members felt students would be better served by taking Math 5410, 5420, 5460, 5760, 6270, 6410, 6420, 6440, 6450, 6470, 6610, 6620, 6640, or ECE 6030 that has a strong math component.

4) After evaluating programs across the country, the MAE department determined that Master of Science students are better served by tailoring their coursework to their research area (a decision made along with the major professor), students in Plan A (Thesis) and Plan B (Report) no longer are required to take mechanical engineering fundamentals courses MAE 6040 Continuum Mechanics and Elasticity or MAE 6410 Fluid Dynamics. Plan C (Coursework Only) students will continue to take these courses as part of their required 33 credits of coursework. MAE 5300 Vibrations has also been removed from Plan A, B, and C requirements.
5) Potential graduate students now are asked to fill out a pre-application. After evaluations, the Department may choose to pay the candidate's application fees in an effort to attract more and better graduate students.

E. Challenges and Recommendations

The general feeling of the faculty is that the number of faculty members is inadequate to provide a quality educational experience and expand its research and graduate student enrollment. One of our primary long-term goals is to improve the Department's national reputation through heightened visibility in scholarly activities, including an increased level of publication in peer-reviewed journals by the faculty. Toward that end, we need to increase the size of the faculty so that the "standard" teaching load for all faculty involved in scholarly research activities is reduced to three courses per year. With anticipated enrollment and research growth, we expect that at least five new faculty positions will justified over the next few years.

It is through top-notch research that departments gain recognition for programs that attract the best students. It is not difficult to make the case that MAE is understaffed relative to other mechanical engineering departments nationwide.

In recent years, the Department has pushed the research model and had excellent success. Increased research means more time spent in the laboratory and mentoring students. As faculty members try to meet the three responsibilities of their positions—teaching, research, and service—they are stretched thinner and thinner in each area. It becomes more difficult to maintain a healthy balance among responsibilities.

The Department's greatest challenge is to manage its positive growth in virtually every category. The Department must find innovation solutions for reducing class size, leverage faculty time and talent with graduate teaching assistants, and improve its infrastructure.

MAE Priority Goals

1) Reducing class size of required courses by offering them each semster;
2) Increase graduate student enrollment by 100%;
3) Increase graduate TA positions by 300%;
4) Expand teaching and research support infrastructure to leverage faculty time and expertise for improved efficacy in meeting the Department's Mission Statement;
5) Increase diversity within the Faculty and Students with an emphasis on recruiting women;
6) Reduce faculty teaching load to three courses per year for faculty with sustainable research programs;
7) Establish Endowment funds for the Department.

Appendix – Surveys

Student Course Evaluation
Department of Mechanical and Aerospace Engineering
Utah State University

INSTRUCTOR: **COURSE:** **SECTION:**

Student evaluations are an important part of the assessment of teaching effectiveness. Please respond as honestly and candidly as possible. Disregard questions which do not seem to be applicable. The completed forms and the computer data will not be available to the instructor until after class grades are awarded.

Please use black or blue pen or # 2 pencil only.

Excellent Very Good Good Fair Poor Very Poor No Applicable

I. General Evaluation

1. The overall quality of this course was:
2. The instructor's effectiveness in teaching the subject matter was:

II. Information About the Course

1. The extent to which course objectives were clear was:
2. Relevance of assignments to course content was:
3. Relevance of material presented in class to course goal(s) was:
4. Appropriateness of workload to course goal(s) was:
5. Relevance of exams to course goal(s) was:
6. Fairness of course grading procedures was:
7. The extent to which course responsibilities of students were clarified was:
8. Helpfulness of assigned text/readings to achieving course goal(s) was:

III. Information About the Instruction

1. The extent to which course organization helped learning was:
2. The helpfulness of explanations by the instructor, if/when needed was:
3. Instructor's use of examples, if/when appropriate, was:
4. Instructor's use of class time to help students learn the subject matter was:
5. Instructor's enthusiasm for subject of course was:
6. Instructor's helpfulness in resolving student's questions was:
7. The extent to which the instructor was prepared for class was:
8. Opportunity to ask questions was:
9. Opportunity for students to make comments and express opinions was:
10. Availability of extra help, if/when needed, was:

IV. Information About Students

1. At the beginning of the semester, my interest in the subject matter was:
   High Medium Low
2. My current GPA at USU is in the range of: 4.0-3.5 3.4-3.0 2.9-2.5 2.4-2.0 1.9-1.0
3. This course is being used for: my major my minor a liberal Arts and Sciences major, minor or certificate general education an elective other
4. I am a: freshman sophomore junior senior graduate other
5. Grade I expect to receive is: A B C D F Other

1. What aspects of the teaching or content of this course do you feel were especially good?
2. What changes could be made to improve the teaching or the content of this course.

Graduating Seniors (Exit) Survey
Department of Mechanical and Aerospace Engineering
Utah State University

We invite all MAE graduating seniors to complete this survey and appreciate your willingness to do so. Your response will be of great value in our continuous efforts to improve the educational experience of MAE students.

Name_____ Semester of Graduation_____
DEGREE: _____

What do you consider your primary area(s) of interest or emphasis?

Aerospace	□	Automation/Controls	□
Manufacturing	□	Mechanics/Dynamics	□
Thermal/Fluids	□	Broad-Base	
Design	□	Mechanical Engineering	□

We expect all of our graduates to be well qualified in the following areas. Please rate how confident you are of YOUR abilities in each of the following areas.

AREA	**HOW CONFIDENT** 1 = very **Un**confident 5 = very confident				
Fundamentals	**1**	**2**	**3**	**4**	**5**
Linear Algebra	□	□	□	□	□
Calculus-based Statistics	□	□	□	□	□
Multivariable Calculus	□	□	□	□	□
Differential Equations	□	□	□	□	□
Physics	□	□	□	□	□
Chemistry	□	□	□	□	□
Material Science	□	□	□	□	□
Solid Mechanics	□	□	□	□	□
Fluid Mechanics	□	□	□	□	□
Thermal Science	□	□	□	□	□
Manufacturing Science	□	□	□	□	□
Communication	**1**	**2**	**3**	**4**	**5**
Oral presentations	□	□	□	□	□
Written proposals and reports	□	□	□	□	□
Engineering drawings and specifications	□	□	□	□	□
Participation on team-based engineering projects	□	□	□	□	□
Laboratory Experiences	**1**	**2**	**3**	**4**	**5**
Experimental design, data collection and analyses	□	□	□	□	□
Use of modern laboratory and data acquisition sytems	□	□	□	□	□
Statistical analysis and interpretation of data	□	□	□	□	□
Basic manufacturing skills	□	□	□	□	□

AREA	HOW CONFIDENT 1 = very **Un**confident 5 = very confident				
Computer-based Engineering	**1**	**2**	**3**	**4**	**5**
Application of numerical methods and computational techniques	□	□	□	□	□
Design and development of software	□	□	□	□	□
Integration of numerical solutions into the process of design and analysis	□	□	□	□	□
Problem solving using current commercial engineering software	□	□	□	□	□
Humanities and Social Sciences	**1**	**2**	**3**	**4**	**5**
Appreciation for broad impact of engineering solutions on society	□	□	□	□	□
Fundamentals of history, principles, form of government and economic system of the United States	□	□	□	□	□
Contribute to the development of the individual as a responsible well-rounded citizen	□	□	□	□	□
Knowledge of contemporary global issues	□	□	□	□	□
Awareness of professional and ethical expectations for the practicing engineer	□	□	□	□	□
Design and Synthesis	**1**	**2**	**3**	**4**	**5**
Develop a set of multidisciplinary engineering requirements	□	□	□	□	□
Synthesize material from mathematics, science and engineering fundamentals to solve engineering problems	□	□	□	□	□
Bring a system from requirements definition to concept development, then specification, prototype and testing, and production or fabrication using engineering analysis	□	□	□	□	□
Demonstrate the links between design, prototyping, testing, manufacturing and other disciplines	□	□	□	□	□
Manage a project including budgeting and detailed planning	□	□	□	□	□
Independent Learning	**1**	**2**	**3**	**4**	**5**
To learn independently	□	□	□	□	□

Please list all co-op or summer internships programs in which you participated.
Company:
Hourly pay: $

Please list any professional society activities (AIAA, ASME, SAE, SME) in which you participated.

Please rate your level of satisfaction with the following topics.

Topic	**HOW WELL SATISFIED** 1 = very **DIS**satisfied 5 = very satisfied				
Quality of instruction by faculty in:	**1**	**2**	**3**	**4**	**5**
Mathematics	□	□	□	□	□
Sciences	□	□	□	□	□
Freshmen Engineering/Graphics	□	□	□	□	□
Humanities and Social Sciences	□	□	□	□	□
Engineering, outside of MAE	□	□	□	□	□
Broad subject areas within MAE (Not a specific MAE course)	□	□	□	□	□
• Material Science	□	□	□	□	□
• Solid Mechanics	□	□	□	□	□
• Fluid Mechanics	□	□	□	□	□
• Thermal Science	□	□	□	□	□
• Manufacturing Science	□	□	□	□	□
• Design	□	□	□	□	□
Quality of advising with respect to:	**1**	**2**	**3**	**4**	**5**
Course planning	□	□	□	□	□
Career planning	□	□	□	□	□
Graduate education	□	□	□	□	□
Equity of treatment by:	**1**	**2**	**3**	**4**	**5**
Academic administrators	□	□	□	□	□
Faculty	□	□	□	□	□
Staff	□	□	□	□	□
Student teaching assistants	□	□	□	□	□
Fellow students	□	□	□	□	□

What do you consider to be the strengths of your undergraduate engineering education at Utah State University?

What do you consider to be areas for improvement within the undergraduate engineering program at Utah State University?

Please make any other comments that will help improve the educational experience for MAE students.

Alumni Survey
Department of Mechanical and Aerospace Engineering
Utah State University

USU Education	**Disagree or Agree**				
	1 = strongly **Dis**agree, 5 = strongly **A**gree				
My MAE education at USU has given me:	**1**	**2**	**3**	**4**	**5**
…an ability to apply knowledge of Mathematics, science, and Engineering	□	□	□	□	□
…an ability to design and conduct experiments, as well as to analyze and interpret data	□	□	□	□	□
…an ability to design a system, component, or process to meet desired needs.	□	□	□	□	□
…an ability to function on multi-disciplinary teams.	□	□	□	□	□
…an ability to identify, formulate, and solve engineering problems.	□	□	□	□	□
…an understanding of professional and ethical responsibility.	□	□	□	□	□
…an ability to communicate effectively.	□	□	□	□	□
…the broad education necessary to understand the impact of engineering solutions in a global and societal context.	□	□	□	□	□
…a recognition of the need for, and an ability to engage in life-long learning.	□	□	□	□	□
…a knowledge of contemporary issues.	□	□	□	□	□
…an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	□	□	□	□	□

Note: The following segment of the survey was added Spring 2007, and will be collected annually.

Alumni,
The MAE department at USU would like to feature you on our website. Current and prospective students and faculty are interested in where your education at USU has taken you. Let us know what you are doing and how MAE helped you prepare for your current career.

Please email your picture to Bonnie Ogden at bogden@engineering.usu.edu with the following information:
Your Name:
When did you graduate?
What degree? (BS, MS, or PhD)
Where are you currently working? (Company name and location)
Brief statement or comments about positive experiences at USU's Mechanical and Aerospace Engineering. (we may be required to edit for length)

Employment/Education Survey
Office of Analysis, Assessment and Accreditation
Utah State University

Number Name
Department Major
Telephone Email

Sources of Information: Student Spouse Parent Other
(Mark all that apply)

Hello, my name is and I am with the Department of [Mechanical and Aerospace Engineering] at Utah State University. This is not a solicitation; we are only seeking information about our recent graduates. Is this _____?

If Yes--Could I ask you a few questions about your experience since leaving USU? They will require only two or three minutes of your time. Thank you.

If No---How are you related to _____ ? Could I ask you a few questions about her/his experience since leaving USU? They will require only two or three minutes of your time. Thank you. **If No --**Call ends

If Yes--Are you a full or part-time student? Full-time Part-time

If Yes--At what college or university? In what subject?

What degree are you seeking? 2nd Bachelor Master Doctor None Other

If No—Are you currently employed? Yes No

If Yes: Is your job full or part-time? Full-time Part-time

Is the job related to your USU degree? Yes Somewhat No

Who is your employer? **(Add or correct employer here)**

In which state or country is the job located?

In your current job, what was your starting salary? The information you give us will be kept confidential and will only be used to compute a department average.

Per year
Per month
Per hour

If No--Are you currently looking for a full- or part-time job? Yes No

What is your current address: (Add or correct address here)
Street/city/state/zip

That is the last question. Thank you for your help. Goodbye.