Portfolio of Learning Excellence
Mechanical and Aerospace Engineering
College of Engineering
Utah State University

Submitted to
Office of the Provost
Selection Committee
Department Teaching Excellence Award

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Mechanical and Aerospace Engineering Department - Overview

Mechanical and Aerospace Engineering enthusiastically submits this Portfolio of Learning Excellence. Indeed, we believe we have a story of excellence to tell. We are one of the university's largest departments. Our faculty members are dedicated to teaching fundamentals and incorporating current research into the classroom. We have exciting senior design projects, a history of student success, and successful alumni. Once again, MAE will be well represented in the College of Engineering awards—for the second year in a row, MAE's Outstanding Advisor and Outstanding Teacher have been selected as the college's Outstanding Advisor and Outstanding Teacher.

MAE offers curricula for BS, MS, ME and PhD degrees in Mechanical Engineering and an MS degree in Aerospace Engineering. Our growing expertise in nuclear energy engineering has also produced student opportunity to learn at national labs and on campus with some of the top nuclear researchers in the nation. The department has grown beyond 600 undergraduate students, 77 MS, and 29 PhD students along with 18 FTE faculty and five staff members. With our growth and competitive nature has come recognition—MAE graduates consistently finish in the top 10% in intercollegiate national student design competitions, pursue PhD degrees at prestigious institutions, and are well received by industry. New opportunities to strengthen MAE's commitment to excellence and forward vision have come from growth in several areas:

- Student enrollment has increased by 32% over the past five years and 47% over the past seven years.
- Faculty research productivity as measured by research publications, winning research grants, patent applications, and students involved in research has more than doubled.
- Two thirds of MAE's tenured/tenure track professors have been hired since 2001.
- The new engineering building is an exceptional student centered teaching facility.

Research and education are not mutually exclusive but are different aspects of a single learning paradigm.

A major objective for this Portfolio of Learning Excellence is to show how a department with a high student to faculty ratio has successfully established and maintained a quality educational learning environment for both faculty and students while building its research enterprise.

Statement of the Departmental Philosophy of Teaching and Learning

The MAE Faculty's philosophy for teaching and learning is expressed in the guiding principles that govern curricula development, delivery, and expectations, i.e. the department's mission statement, program educational objectives, and program outcomes. Simply, our philosophy is outcome based.

Mission Statement: 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, or 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.

Program educational objectives (broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve.) Graduates will

1) succeed in entry-level engineering positions with mechanical, aerospace, computational, or manufacturing firms in regional, national, or international industries and with government agencies;
2) 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) 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) have proficiency in computer-based engineering, including modern numerical methods, software design and development, and the use of computational tools;
5) be prepared to communicate and work effectively on team-based engineering projects;
6) recognize the importance of, and have the skills for, continued independent learning.

Program outcomes (narrower statements that describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that students acquire in their matriculation through the program.) Graduates will 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 a multi-disciplinary team;
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;
l) an ability to work professionally in both thermal and mechanical system areas including the design and realization of such systems.

Maintaining an attitude of strong rigor in each class is an important feature of the MAE program. The MAE Faculty has determined that the long term interests of the graduates are best served via a curriculum that emphasizes engineering fundamentals as opposed to engineering technology applications.

Curriculum Governance

In semi-monthly faculty meetings, undergraduate curriculum issues are a standing agenda item. Moreover, MAE's spring retreat focuses on undergraduate curriculum issues and emphasizes closing the assessment loop on issues that have been discussed throughout the academic year. It is at this annual meeting that the assessment data for the constituents (students, alumni, and industry) are reviewed and evaluated, and adjustments are made in the program. Similarly, the fall retreat emphasizes graduate program issues.

Narrative on Departmental Excellence in Teaching and Learning

1. Commitment to sustained excellence in teaching and learning

As evidenced by course development, committee service, mentoring, advising activities, national teaching awards, textbook writing, and pedagogical research, the MAE faculty has maintained student learning outcomes as a top priority. Pursuing and receiving several pedagogical grants, for example, has been an important strategy in garnering resources for curriculum development as well as for leveraging and supplementing the department's limited resources. These grants and proposal writing efforts are discussed in more detail in Appendix D:

Despite class sizes regularly at more than 100 students for most required courses, MAE student ratings for course quality and instructor effectiveness are comparable with other departments throughout the university as shown in Table 1. Some MAE professors consistently get high student ratings independent of class size, while most who get average student ratings for large classes receive much higher ratings for small classes.

Table 1. MAE student rating scores 2003-2009

		Overall Quality of Course			Instructor Effectiveness in Teaching		
Year	Semester	MAE	College	USU	MAE	College	USU
2009	Fall	4.5	4.9	5.0	4.4	4.8	5.1
2009	Summer	5.4	5.2	5.1	5.4	5.2	5.2
2009	Spring	4.5	4.8	5.0	4.5	4.7	5.1
2008	Fall	4.5	4.8	5.0	4.5	4.8	5.1
2008	Summer	5.4	5.2	5.1	5.5	5.3	5.2
2008	Spring	4.8	4.7	5.0	4.7	4.7	5.1
2007	Fall	4.7	4.8	5.0	4.7	4.8	5.1
2007	Summer	5.1	5.0	5.2	5.2	5.0	5.2
2007	Spring	4.6	4.7	5.0	4.7	4.7	5.1
2006	Fall	4.6	4.7	4.0	4.6	4.7	5.0
2006	Spring	4.8	4.8	5.0	4.8	4.9	5.1
2005	Fall	4.7	4.8	5.0	4.7	4.8	5.1
2005	Spring	4.6	4.7	5.0	4.7	4.7	5.1
Five Year Average		**4.8**	**4.9**	**5.0**	**4.8**	**4.9**	**5.1**

While some might worry about student ratings scores like ours that are just slightly below college and university averages, we hold another view. We are always concerned about ratings, and we respond accordingly as the balance of this portfolio will attest. We maintain, however, that even though large class sizes can take a small toll on those rating numbers, **our focus is on curriculum rigor, education quality, and the significance of a degree from Mechanical & Aerospace Engineering at USU**. Our pedagogy carries high expectations, and our students rise to those expectations. **We point to continually increasing numbers of undergraduate and graduate students entering our programs, and we cannot overlook the praise we receive from our graduates as well as the graduate programs they enter and employers who hire them**.

2. Ongoing assessment and improvement of teaching and learning quality

The department's curricula is developed, maintained, and updated by MAE faculty who use a never ending cycle of assessment, valuation, and improvement as documented in Appendix A. Data are collected and evaluated from a wide range of sources to determine how well our students meet the Program Outcomes and Program Educational Objectives. Annual internal data include instructor course evaluations, student ratings, graduating senior survey and interviews, internship reports,

advisory board feedback, and alumni survey. Annual external data include employer feedback, National Fundamentals of Engineering (FE) exam results, scores at national competitions, Graduate Record Exam scores, and placement of MAE graduates for employment and advanced degrees.

The mechanical engineering BS program is accredited on a six year cycle by ABET, Inc. The program must demonstrate and measure how well each of nine criteria is met. Moreover, a continuous improvement process must be demonstrated. MAE's latest program review was during 2008. ABET released its report for USU on August 12, 2009. The report gave the MAE program *a statement of compliance,* which means that MAE has satisfied the nine criteria with no concerns or weaknesses that need to be addressed. This is the evaluation each program strives to achieve.

Since the department's primary program constituents are students, alumni, and employers, they are the primary sources for data collected annually to provide a comprehensive overview of the MAE program.

Students trust the university to provide education experiences that culminate into degrees that facilitate graduates' abilities to achieve personal and professional goals. Their success in entry level positions opens or closes future opportunities. Since a significant fraction of MAE graduates continue on to post-graduate study, they expect the curriculum to provide an academic foundation for success at the best graduate programs in the country.

Alumni expect the university to continue to improve so that their degree(s) have increasing value over time. Alumni are the university's primary legacy to the society it serves. Alumni influence future generations of students. They also provide crucial resources via scholarships, internships, and gifts and endowments.

Employers rely on the university to provide an educational foundation and skill sets that are crucial for maintaining a competitive work force in a global business environment. Industry provides internships, scholarships, gifts and endowments, and research contracts.

The MAE ***Industrial Advisory Board*** is comprised of individuals who represent a spectrum of experience from senior management to recent graduates. The primary function of the board is to provide industry recommendations to:

- Improve the quality and effectiveness of the MAE BS, MS, and PhD degrees
- Evaluate and recommend continuous improvements in the MAE undergraduate curriculum as an essential element in maintaining ABET accreditation

Achievement of Program Outcomes

The Assessment and Evaluation Process for MAE program learning outcomes is shown as a continuous improvement cycle in Figure 1. Data discussed in the following paragraphs are collected on an annual basis to provide a comprehensive overview of our program.

Some of the instruments used to evaluate our program include the following:

- **Fundamentals of Engineering (FE) Exam:** The FE exam is a national exam required for professional licensure. Passing the exam is a graduation requirement for MAE students.
- **Senior Exit Survey and Interview**: MAE graduating seniors complete a Senior Exit Survey and attend an interview with the Department Head.
- **Alumni Surveys:** Former students from the MAE program are contacted two years after graduation and asked to provide feedback on their education.
- **Internship Reports:** Evaluations of student performance by both industrial supervisors and students are collected for students opting for credit in internship programs.

- **Course Notebooks:** For each course taught in MAE, a course notebook includes a syllabus, grade sheet, and High, Median, and Low examples of student performance. The qualitative evaluation of performance is conducted by the faculty annually. An evaluation of student performance from the course notebooks is summarized by a faculty review committee.
- **Industrial Advisory Board Feedback:** The Industrial Advisory Board reviews the MAE program and provides qualitative feedback to the Department Head.
- **National Design Competitions:** Many MAE students compete in national competitions. Their participation provides direct comparison with teams from other universities.

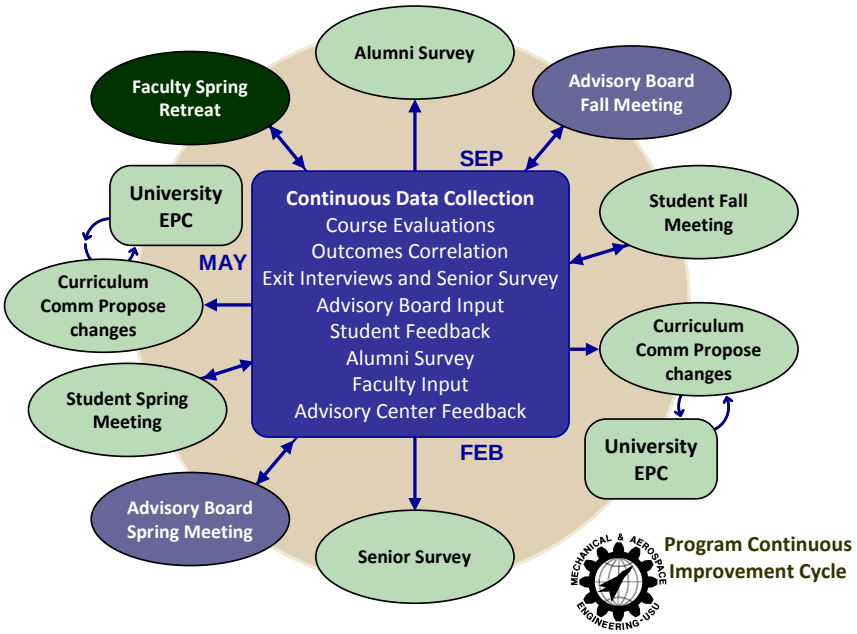


Figure 1. MAE Program Continuous Improvement Cycle

Evaluation of Program Outcomes: The evaluation of program outcomes is performed by the faculty. Achievement level is determined by the faculty based on all assessment data. Faculty members review the data and assign a score from 1 to 5 for each program outcome (five being the highest). A summary of the MAE program outcomes (a)-(l) evaluation results over several years is contained in Table 2. The data in the table represent aggregate scores based on the 1 to 5 scale. The basis for the data included in this table is described in detail in the remainder of this report section.

Based on departmental assessment and evaluation data, MAE faculty conclude that all program outcomes are, at a minimum, adequately met and many are, at best, strongly met.

Summary Comments and Observations

The MAE faculty has concluded that program outcomes are at least *adequately* met as shown in Table 2. Many program outcomes are being *satisfactorily* to *strongly* met. The *satisfactory* to *strong* outcomes tend to be more quantitatively based (a)–(e), (k)-(l) outcomes, while the more 'Professionalism' oriented outcomes are *adequately* met (f)-(j). In general, with the exception of program outcome (i), alumni, perhaps because they have had time to see the benefits of going through a rigorous program, feel stronger about their educational experiences than graduating seniors. This comprehensive database is used by faculty at the department's spring retreats to assess the effectiveness of the MAE curriculum. Subsequent changes to enhance student learning outcomes are a continuous process.

Table 2. Summary of the evaluation results of the program outcomes

Program Outcomes	Faculty Review	FE Exam	Sr. Exit Survey	Alumni Survey	Interns/ Employer	IAB	Meet Criterion?
(a) an ability to apply knowledge of mathematics, science, and engineering	4.1	5.0	4.2	4.4	4.5	4.3	Yes
(b) an ability to design and conduct experiments, as well as to analyze and interpret data	4.0	5.0	3.6	4.0	4.2	4.0	Yes
(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	3.5	NA[1]	3.8	3.8	4.0	3.7	Yes
(d) an ability to function on multidisciplinary teams	4.2	NA	4.0	4.0	4.3	4.0	Yes
(e) an ability to identify, formulate, and solve engineering problems	4.0	5.0	3.7	4.3	4.3	4.3	Yes
(f) an understanding of professional and ethical responsibility	3.0	3.0	3.7	3.8	4.3	4.0	Yes
(g) an ability to communicate effectively	3.3	NA	3.8	3.9	4.2	4.0	Yes
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	3.0	NA	3.4	3.7	4.2	3.7	Yes
(i) a recognition of the need for, and an ability to engage in life-long learning	3.0	NA	4.3	4.0	4.4	4.0	Yes
(j) a knowledge of contemporary issues	3.0	NA	3.4	3.5	4.1	3.7	Yes
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	4.5	NA	3.8	4.1	4.4	4.7	Yes
(l) an ability to work professionally in both thermal and mechanical system areas including the design and realization of such systems	4.0	NA	NA	4.1	NA	4.0	Yes
NA = not applicable							

Department Teaching Improvement Strategies: In an effort to capitalize on strengths as well as address areas for improvement revealed in the program outcome analysis (see Table 2), the following additional teaching improvement strategies have been implemented:

- Informal lunches: New and seasoned faculty members have regularly enjoyed informal lunches where they are able to exchange ideas about teaching. Discussions at these lunches have broadly involved teaching techniques and teaching aids; however, the primary topic has been the value of teaching well and why teaching is worth the effort.
- Numerical analysis: Realizing that our students need to be trained in the most current techniques, the MAE curriculum has added training in MATLAB, a powerful software that not only can be used for programming but also has excellent graphing capability.
- Capstone Design: Our capstone design courses are essential in properly training engineers. In review, the course's load has been extremely demanding, and the objectives were determined to be a bit too broad. This past year we restructured the two courses and created a new Capstone Design (see point 5 in this section and Appendix A), and we are developing a separate professionalism and ethics course.
- Math: Changes in the Math Department required MAE to alter some requirements. We are currently reviewing students' needs in math and restructuring MAE's math courses. Our evaluations help insure that math is appropriately integrated throughout the curriculum.

3. Faculty development for teaching

Hiring new faculty is a long, laborious, and expensive proposition; therefore, it is in the department's best interest to make faculty success a priority. This means providing strong and consistent guidance and mentoring. Each assistant professor undergoes a comprehensive evaluation relative to his/her role statement (defined in the box below) and department expectations each year. The MAE Promotion and Tenure Committees do an excellent job helping assistant professors understand the tenure process and providing honest and constructive feedback. These efforts are reinforced by the Department Head and the Dean as outlined below.

Role Statement Expectations

Because USU takes very seriously its commitment to teaching, a record of effective instruction is one of the hallmarks of success for faculty at Utah State. As you establish your credentials as an instructor, advisor and mentor, reviewers of your credentials will look for a pattern of continuous improvement as well as evidence of your dedication to high-quality teaching. USU and the College of Engineering expect you to be an active participant in the ABET continuous assessment and improvement processes of your Department's accredited curricula.

Dean H. Scott Hinton developed an Engineering Educator model as illustrated in Figure 2, which illustrates the most important elements that must be considered to develop a successful academic career at a research intensive university. Each summer, Dean Hinton holds a one-on-one meeting with each tenure track faculty member in the college to evaluate progress towards qualifying for tenure. In this interview he often uses these models to review and assess faculty members' professional development. The models have proven to be quite effective in communicating expectations and providing guidance to achieve those expectations.

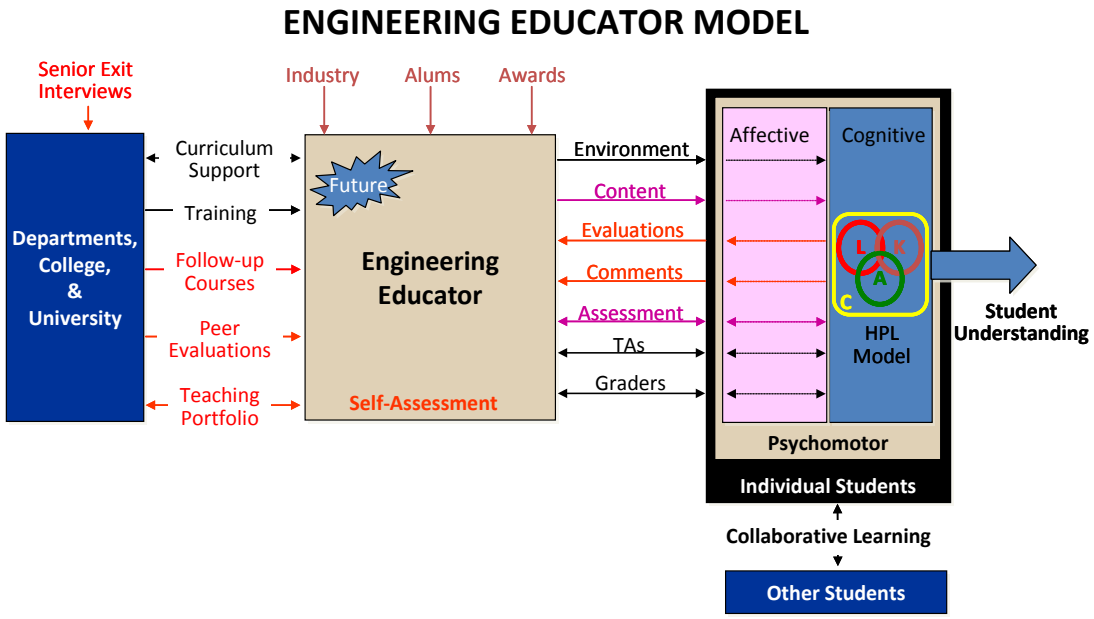


Figure 2. Engineering Educator model prepared by H. Scott Hinton, Dean of Engineering

The educator model identifies the major elements in the teacher student relationship: the psychological and physical elements that affect student learning outcomes, self assessment, feedback from the major constituents, and infrastructure that supports the learning process. It is important to note that the model suggests that each faculty member allocate at least 10% of his/her professional effort to contemplate and prepare for the long range future. The development of this model was strongly influenced by the following two publications.

How People Learn: Brain, Mind, Experience, and School, Commission on Behavioral and Social Sciences and Education, National Research Council, National Academy Press, ISBN 0-309-07036-8 (Ninth Printing July 2004)

Knowing what Students Know: The Science and Design of Educational Assessment, Commission on Behavioral and Social Sciences and Education, National Research Council, National Academy Press, ISBN 0-309-07272-7 (Third Printing M 2004)

Several MAE faculty members regularly take advantage of the variety of university and college resources to improve their teaching effectiveness and have reported positive results from using these resources, which include the following:

Provost Office

- Teaching Academy for New Faculty
- FACT Center
- ADVANCE at Utah State
- Provost Faculty Development and Diversity Lectures/Workshops
- Office of Sponsored Program

College Training

- Dr. Dan Householder, Utah State University, NSF CAREER Award mentoring and consulting, ongoing
- Dr. David Plant, McGill University, "Building Research Teams," Presented at USU, College of Engineering Faculty Retreat, August 15, 2007
- Dr. Karl Smith, Purdue University, "How Students Learn," Presented at USU, College of Engineering Faculty Retreat, August 16, 2006
- Scott Johnson and Ty Newell, UIUC, "Student Rating Workshop," Presented at USU College of Engineering, Fall 2005
- Michael Davis, IIT, "Engineering Ethics Workshop," Presented at USU College of Engineering, June 2004

The Dean's office has organized the following group meetings to facilitate communication among the junior faculty and provide professional development mentoring:

- Spring 2008 – Scott Hinton, Chris Hailey, Jagath Kaluarachchi, Ray DeVito and 1st & 2nd-year faculty
- Spring 2008 – Scott Hinton, Chris Hailey, Jagath Kaluarachchi and 1st & 2nd-year faculty
- Spring 2008 – Scott Hinton, Chris Hailey and 1st & 2nd-year faculty
- Fall 2007 – Scott Hinton, Associate Deans, and 1st-year faculty
- Fall 2006 – Scott Hinton and 1st-year faculty

Department Training/Mentoring

Tenure track faculty members undergo an annual comprehensive evaluation administered by their Promotion and Tenure Committees and the Department Head independently. The Role Statement comprises part of that evaluation, which does the following:

- Encourages faculty to be active in the appropriate professional societies
- Emphasizes faculty development
- Emphasizes using ABET assessment measures in teaching assignments

All tenured faculty members participate in a post tenure review every five years. The standard for appraisal is whether the faculty member under review discharges conscientiously and with professional competence the duties appropriately associated with his or her position as specified in the role statement. Peer evaluation of classroom performance is also part of the post-tenure review within the college.

4. Provision of resources for students

As our students graduate and pursue careers and further education, we recognize that they represent themselves as well as Utah State University. MAE as an entire department, therefore, acknowledges its need to *invest multiple resources*, be they time, funding, counsel, or opportunities *to effect desired learning outcomes*. That type of **consistent investment of resources has resulted in a community of learners that fosters involvement across critical pedagogical areas**. Following is a list of the resources available for students that significantly add to the learning outcomes.

Student experience and involvement:
MAE recognizes students' need to gain real-world engineering and professional experience concurrently with academic preparation.

- About half of our annual BS graduates participate in national design competitions under the direction of faculty members who voluntarily sponsor teams (e.g., NASA Student Rocket Launch Initiative—1st place 2009, 1st place 2008; NASA Great Moonbuggy Race—1st place 2005; SAE Zero Emissions Snowmobile Challenge—1st place 2006; AIAA Design Build and Fly Competition—4th place 2005).
- The majority of our graders and lab assistants are undergraduate students. These experiences contribute significantly to the learning outcomes of these students.
- MAE provides undergraduate research fellows office space, and many of our undergraduates attend and present papers at national conferences. We also make travel grants available for undergraduates traveling to conferences.
- Professional society student chapters for ASME, AIAA, SAE, and SWE provide leadership development, service activities, and connections with local and national practicing professional. These student societies have been assigned meeting space within the department, and each unit has a faculty mentor. We also provide funding for chapter socials as well as some travel funding for professional experiences.
- ASME Old Guard is a poster competition held at local District Student Conferences and emphasizes the ability to deliver a visual presentation. An MAE student won at the state level in 2010, and over the past two years our students have been in the top three spots.

Peer involvement:
The department established a peer tutoring program in Fall 2006 to help alleviate the impacts of participation in large classes. Only our highest ranked senior students are hired as tutors. The tutoring program continues today with two tutors who maintain walk-in office hours for at least 20 hours per week. Students had the following to say about the program:

- *The tutors have been an excellent source of knowledge for me. I wouldn't be able to do well in my math class if they weren't here.*
- *The tutors are very needed in this program! I don't know how many times I have come to get help. Teachers' office hours aren't always at times students can go, so tutors provide a great addition to supplement our class discussions. Tutors have saved me countless hours of time. This helps me accomplish so much more in my studies allowing me to be much more productive and efficient.*
- *I don't know how I would be able to get through classes without tutors. Office hours aren't always good with my schedule and it is more time efficient to only have to stop at one place for help for all my classes.*

MAE has also involved Rhetoric Associates (RAs) over the past few years from the English Department. RAs, who are among many talented undergraduate English students, work with MAE student teams in MAE 4800 Design II on project reports. Use of such a resource speaks to MAE's commitment to ABET's program outcome (g) "Students will have the ability to communicate effectively." Though the department has not yet analyzed quantitatively the impact of RAs, for MAE 4800 Design II in Fall 2009, the teams that used RAs consistently received higher scores on both the written and oral presentations.

Technology involvement:
In academic year (AY) 2007-2008, the MAE Department began offering distance education courses using Macromedia Breeze (Adobe Connect Enterprise). These four courses included on-campus and distance education students concurrently. Since both faculty and student response was very positive, a significant increase in distance education course offerings for seniors and graduate-level students

has come online and is anticipated to increase during the next few years. For the current AY, MAE has 13 courses available via Breeze or Wimba through distance education.

The instruction and learning activities mostly follow the well established lecture/laboratory delivery format. MAE faculty members also make extensive use of

- Course web pages
- Blackboard Vista
- Tutorial sessions (online and live)
- Computer programming and analyses

Additionally, because most MAE required courses have about 100 students, to better communicate with students a number of our faculty members use a tablet PC as a whiteboard so that the actual lecture can be recorded and archived for later download using Breeze or Wimba.

Faculty involvement:
All MAE faculty members are eager to maintain professionally helpful relationships with students and are readily accessible at three levels of involvement: 1) help with individual courses, 2) curriculum advising, 3) career advisement

Although our required courses have high enrollment, the technical elective courses have much lower enrollment numbers with class sizes ranging from 5-50 students. Thus, as students start into the second half of their curriculum, they have the opportunity to become well acquainted with the faculty in the smaller classes. During Senior Exit Interviews, students consistently express appreciation for the ability to develop individual relationships with faculty members.

Each year the MAE students select (via nomination and student ballot) an Outstanding Advisor and an Outstanding Teacher. Professors receiving this award the past seven years are listed in Table 3. The fact that these two awards have been given to seven different faculty members over that time shows that the faculty are very much involved with the students on a one-on-one basis.

Table 3. MAE Outstanding Advisors and Outstanding Teachers

	Outstanding Advisor	Outstanding Teacher
2010	Heng Ban	David Geller
2009	Barton Smith	Thomas Fronk
2008	David Geller	Heng Ban
2007	Steven Folkman	David Geller
2006	Barton Smith	Wenbin Yu
2005	Thomas Fronk	Carl Wood
2004	Thomas Fronk	Carl Wood

Based on Senior Exit Interviews and feedback from alumni, student/faculty involvement for academic and career counseling has been effective and appreciated. MAE also realizes that without the professional advisors in the College Advising Center, faculty would not have the capacity to provide effective academic advising.

Although most MAE professors have heavy research commitments, they maintain an open door policy in addition to posted office hours. It is common to see numerous students visiting faculty throughout the day. Other commitment of faculty resources for students includes the following:

- About 30% of our graduates have worked with an MAE faculty member as a research assistant on a sponsored research project. This number increases to about 60% if their employment at SDL is counted. This is *hands on learning* at its best.

- MAE has received several pedagogical grants (see Appendix D) over the past few years that have added significantly to our teaching/learning mission in the following manner:
    - Computational engineering emphasis was an outcome
    - Summer research experiences for a total of 24 students over a three year period
    - 50 scholarships to improve retention and diversity
    - Enhanced understanding of K-12 students interested in engineering careers, especially female students
    - Faculty development and scholarships for a dozen students
    - Course in design and testing of a demonstration prototype for Lunar/Planetary Surface Landing Research Vehicle
- Extra help sessions for one of our more difficult and rigorous courses, MAE 3320 Advanced Dynamics, were held every Tuesday night from 7-9 p.m. Through extra help sessions provided by Dr. David Geller, students were able to attain a deeper understanding of the concepts, homework, and exams. Comments from student evaluations included
    - *I loved the study sessions; Study sessions helped a lot on the homework and exam preparation;, The help sessions were great, ….excellent, ….helpful, …very helpful;, I really appreciated the Tuesday night study sessions. I never would have learned or been able to do the homework without it; Those study sessions make a world of difference.*

  Additional study sessions have been implemented in MAE 6560 Space Navigation (Dr. David Geller) as well as MAE 2300 Thermodynamics I (Dr. Christine Hailey).

Staff involvement:
MAE's outstanding support staff is a major force within the department. They maintain a professional attitude and help fulfill the department mission while supporting students, faculty, and visitors. Their contributions to the quality of the department include maintaining the following:

- Engineering State is an event organized by the staff and held by the College of Engineering for high school juniors interested in attending USU. Potential students experience a hands-on, in-depth view of each department within the college and learn about careers in engineering while working with nationally acclaimed faculty.
- Group advising meetings are held once each semester for graduate students and once each year for undergraduate students. Staff also host two breakfasts each year for high GPA students to meet with faculty and advisors to discuss career and graduate opportunities.
- Student employment seminars are planned each year on topics including career development, job search, graduate study, etc.
- Student recruiting trips are scheduled for six to eight venues each year to recruit potential students. MAE's expectations and opportunities are discussed from the very beginning.

5. Linking discovery, creative activity, and engagement with teaching and learning for the benefit of students

A hallmark of the MAE educational experience is the ability of our students to gain excellent hands on experience in research projects working with individual faculty members. There is also a close relationship between MAE, students, and the Space Dynamics Lab (SDL). Over the years, SDL and MAE have grown at comparable rates; consequently, there has always been a steady flow of part-time employment opportunities for mechanical engineering students and research opportunities for faculty. This has been a mutually beneficial arrangement for both organizations with tremendous benefit to the students. Moreover, a large majority of MAE faculty members consistently hire undergraduates to work in their research labs. In fact, many of our graduate students are in graduate school primarily because of their undergraduate research experiences. Table 8 in Appendix E is a partial list of students working in faculty research labs.

Faculty Mentors: Dr. Heng Ban was selected by MAE students as the 2010 Outstanding Advisor. He involves many students including undergraduates in his research projects, and his informal counsel and teaching sessions have endeared him to the students. Also selected by students, Dr. David Geller is the department's Outstanding Teacher. Dr. Geller has taken a lead role in the department in distance education and electronic delivery and has provided many hours teaching other faculty members how to use the available electronic teaching aids. Since 2005, Dr. Geller's students have been invited to present papers at AAS GN&C, a professional National Conference.

Significantly, for two consecutive years (Dr. Barton Smith and Dr. Thomas Fronk in 2009; Dr. Heng Ban and Dr. David Geller in 2010), MAE faculty who were selected as Outstanding Advisor and Outstanding Teacher have been selected by a college level committee (including students and administrators) as the college's Outstanding Advisor and Outstanding Teacher.

Internship Program: Many of our students take advantage of internship opportunities. At least 75% of MAE students have an internship experience during their junior and/or senior year. During the past five years, about 50% of MAE graduates use internship credit to fill graduation requirements.

Capstone Design Experience: Design projects are introduced in the freshman year in MAE 1200. Additional design projects are added at the junior level in MAE 3040 and 3440. The senior level capstone design class, MAE 4800/4810, is now a two semester course in which students can choose to work on either an instructor selected design or participate in a design competition supervised by an engineering society (e.g., ASME, AIAA). During the first semester, teams of 4-6 students select from a list of design projects supplied by the instructors and complete the designs using a structured engineering design process. During the second semester, students build, test, and evaluate their designs. The projects for 2009-2010 are described in Appendix A.

Student performance can also be measured with respect to other academic programs through society sponsored design competitions. MAE has traditionally placed well in these events. A list of contests, including placement, is included in Table 4.

Table 4. National competition data summary (for ABET Program Outcome (c))

Competition	Sponsor	Year	USU students	Place	Number of Teams
Rocket Launch Initiative	NASA	2009	21	1	18
Rocket Launch Initiative	NASA	2008	15	1	15
Design-Build-Fly	AIAA	2005	18	6	44
Mini-Baja	SAE	2009	21	38 & 57	99
Mini-Baja	SAE	2008	16	45	122
Mini-Baja	SAE	2007	20	37 & 61	100
Mini-Baja	SAE	2006	12	53	85
Mini-Baja	SAE	2005	8	24 & 87	132
Space Mission Design	NASA	2005	4	1	20
Electric Snowmobile	SAE	2007	9	3	5
Electric Snowmobile	SAE	2006	6	1	3
Moonbuggy	NASA	2005	8	1	28
University Nanosat	AFRL	2006	11	2	11
Innovative Designs-Team 1	SME	2008	3	1 (tied)	NA
Innovative Designs-Team 2	SME	2008	3	1 (tied)	NA

In summation, MAE faculty have established a set of guiding principles; identified specific program outcomes; developed an ongoing assessment, evaluation, and continuous improvement process; and incorporated teaching improvement strategies founded on evaluation and analysis—all of which includes all the department's constituents to offer a high quality educational experience for its students. Significantly, this is accomplished with a relatively high (40:1) student/faculty ratio.

Evidence of recognition by others

Utah State University is one of four universities in the nation selected in 2009 by the U.S. Department of Energy's Idaho National Laboratory to conduct a nuclear energy experiment. Leading the USU experiment is Dr. Heng Ban, professor of mechanical and aerospace engineering.

Dr. Stephen A. Whitmore was selected as the 2009 Utah Engineering Educator of the Year. He has been nominated again for 2010 by the ASME Utah Section.

Dr. Wenbin Yu was selected as the 2009 Utah State University Technology Entrepreneur of the Year and the 2009 College of Engineering Outstanding Researcher of the Year.

Dr. Leijun Li received the American Welding Society Adams Memorial Award in 2006.

Utah State University Mechanical and Aerospace Engineering students, mentored by Dr. Stephen Whitmore, received the Grand Prize from NASA at the annual University Student Launch Initiative in Alabama for 2009 and 2008.

Dr. Barton Smith was named Entrepreneur of the Year April 3, 2008 by the Technology Commercialization Office.

Dr. Wenbin Yu received the Ferdinand P. Beer and E. Russell Johnston, Jr., Outstanding New Mechanics Educator Award from the Mechanics Division of the American Society of Engineering Education at the 2007 ASEE Annual Conference in Honolulu.

Dr. Heng Ban was selected as organizer for the International Thermal Expansion Symposium.

Several MAE Faculty are invited to sit on National Review Boards for NASA, AFRL, and other government agencies' projects.

Our teaching excellence is further reflected by the number of our students who are competitively hired by Idaho National Laboratories, AFRL Labs, Johnson Space Center, Draper Laboratory, ATK, Lockheed Martin Space Systems, for internships at Jet Propulsion Laboratory, and many other leading companies.

Alumni Testimonials

Bobby Parson
BS - December 2008
Utah State University and its knowledgeable faculty and staff offered me the necessary problem solving skills to further benefit my life and prepare me for a career in the field of engineering.

Maria Camila Quezada
BS - 2007
As a woman (mother) engineer, it has not been easy to go through this major, but the faculty provide all the economical help in addition to encouragement through the TAs, tutors, and office hours.

Denton Johnson
BS/MS - Spring/Summer 2007
The MAE department at USU gave me the background I needed to get started as a Mechanical Engineer. Getting my engineering degree has taken a lot of work, but it was worth the effort. I feel USU has prepared me well for an interesting and rewarding career, and I would highly recommend the university.

Adam Richards
PhD in Spring 2006
Professors at USU are very focused on teaching the engineering fundamentals and theory. With such a solid foundation I have been able to adapt to any project I have been assigned. Even if I had not studied a particular topic previously, I knew the fundamentals and I knew how to research the topic to quickly become proficient. I have been able to exceed mangers' expectations because of the high standards I was held to by the professors at USU. They are very demanding, but they are very accessible and willing to explain the problems. The faculty and staff at Utah State made my engineering education bearable as well as one the best available in the country.

Brian Hansen
MS - 2005
When I first came to work for an aerospace company, I was a little bit nervous because it was in a specialty that I had little experience with. However, I quickly found that the problem-solving skills I developed while at USU would make it easy for me to come up to speed and succeed. I feel like I can solve or learn how to solve any problem they throw at me here.

Jeff Kwong
MS - May 2005
I truly believe that Utah State offers one of the best engineering educations of any school in the nation. The faculty really care about teaching and the coursework and projects prepare you for what you would expect in the real world.

Aaron Katz
BS - May 2004
MAE at USU prepared me well for graduate school. Most of the research I do now had beginnings and skill sets learned from my classes at USU. Something I took for granted while at USU was the accessibility of the professors. It was great to get to know the professors and learn from their experience. I have fond memories of my time there!

Nathan Bunderson
BS and MS - 2004
I'm very grateful for what I learned at Utah State. In preparing for graduate school at Georgia Tech, I was a bit nervous about competing with students from top engineering schools across the country. I was surprised to find myself well ahead of the curve in terms of a strong foundation in fundamental scientific and engineering principles, which was especially important as I switched fields from mechanical to bio-engineering. It seemed that many students from the top schools were not as prepared with foundational skills that would transfer between the disciplines. I would certainly recommend the Department to anyone.

Support Letters

Launch Systems
P.O. Box 707
Brigham City, UT 84302-0707

February 11, 2009

USU Departmental Teaching Excellence Award Committee
Logan, Utah

Dear Selection Committee:

As a member of the Mechanical and Aerospace Engineering (MAE) Department Advisory Board, I have to opportunity to observe the planning, preparation and statistics that go into managing this department. The MAE Department is outstanding in all areas. The curriculum is configured to maximize a student's understanding of fundamental engineering principles and prepares them to excel in the work place.

USU MAE students regularly score significantly above average on the National Fundamentals of Engineering Exam and they compete well when attending other Universities Graduate Programs. Not all engineering programs require their students to participate in senior design teams that somewhat simulate "real life" working environments like the MAE Department does. Through these experiences student's skills are further developed and often demonstrated at the national level by participating in competitions like NASA Student Rocket Launch Initiative where they took 1st place last year and Mini Baja. This provides an alternate view of how these students they rank in the national arena. Not only do MAE students receive strong academic exposure to broad-based engineering disciplines, but are encouraged to apply that knowledge in team competitions and environments that allow them to learn the practical side of engineering. As further testimony to the exceptional educational program offered by MAE, they recently passed, with flying colors, the ABET accreditation.

As a Department Manager at ATK Launch Systems I consider hiring new people into Science and Engineering to be one of my most significant responsibilities. It is difficult, and sometimes impossible, to get to know a candidate based on the interview process. I, and many others who hire new employees, rely on the academic institutions to prepare their students to be outstanding employees. Many times it has come down to comparing candidates' academic credentials when selecting between two or more qualified candidates. In the past, graduates from Universities like Purdue and MIT stood out as being consistently outstanding employees. USU's MAE Department has obtained that status for anyone who has hired their graduates or accepted their students into graduate programs. The MAE Department has set a consistent standard for excellence that once graduation is granted to a student, a potential employer can have confidence that they will become a productive employee.

As an MAE Advisory Board Member and as an Industry Employer responsible for hiring the best employees possible, I have no reservations recommending the MAE Department for the "USU Departmental Teaching Excellence Award". Their collective accomplishments qualify them as a worthy recipient.

If I can be of further assistance please call me at 435-863-6307.

Sincerely,

R. Scott Hyde
Manager, Research and Development

One of the things I really appreciated about the faculty in the MAE department was that they did not hand me everything on a silver platter. I had to stretch some and work on figuring things out on my own. At the time it wasn't always enjoyable to be stretched, but learning to figure things out on my own has helped me in my career because not everything has been handed to me on a silver platter here either.
I appreciated the support of the faculty and staff in the completion of my concurrent masters degree. It was a lot of work on my part, but I was assisted by professors who were willing to help me through the process and complete all of the requirements in only one additional year of schooling. Because I was able to earn my masters degree, I rose higher on interview lists and was offered higher compensation for the careers I was interested in.
Denton Johnson, denton.h.johnson@gmail.com

I have spent three of the most wonderful years of my academic career during my stay as a PhD student in the Mechanical and Aerospace Engineering (MAE) department of Utah State University. The most important thing I learned during my graduate education is "how to be independent". From course works to research everywhere, MAE teachers used to encourage us for self-learning, to learn through experience-not to worry about mistakes, rather learn from it. MAE curriculum was also very flexible and conducive for diversification. Beyond our specialization, we had plenty of opportunities to take courses from other disciplines to broaden our knowledge. Lastly, I want to mention about MAE's student friendly atmosphere. In spite of being an international student, I always used to feel as an integral part of the department.
Sitikantha Roy, sitikantha.roy@aggiemail.usu.edu

My education at Utah State University laid a strong foundation for success in my chosen career. Not only were my professors well versed in the subjects they taught, but in most cases they were actively pursuing research related to what they were teaching, and could bring that added perspective into the classroom. In each course that was taught, the faculty focused on the fundamental aspects of the subject material, weaving a tapestry of connected ideas that formed a comprehensive view of the technical engineering theories necessary to produce innovative and successful designs. Because of this solid base that was laid for me, I found that I could easily become an active contributor when I entered the work force, even though I had little formal training in the industry in which I currently work.
Eric Callister, ATK, usudragon@yahoo.com

I remember the mixed emotions I felt while trying to decide where to pursue a PhD. The top "selfish" choices for my chosen area of emphasis were Stanford and Berkeley. But, out of consideration for my growing family (wife and 3 children) and an existing first-rate job at Thiokol, I chose to go to USU while still working at Thiokol. What a pleasant surprise it was to experience the outstanding quality of graduate-level education in the MAE department! My MAE advisor did much of his graduate work at Stanford, and through word and example had me readily believing that the level of teaching and research at USU was on par with the elite schools. Four years later, I was firmly convinced of the MAE excellence as I received my PhD with a 4.0 GPA, having been highly motivated by some outstanding professors. The level of my USU education was every bit as high as my previous graduate work. I was also very impressed with the willingness of the department and my committee to approve an area of research which was also of value to my employer. This quality education has since resulted in 25 published papers and 4 patents, not to mention a most enjoyable career of exciting research and development.
Now, as the group leader of Mechanical & Thermal Engineering at SDL, I continue to be the beneficiary of collaboration with the USU MAE Dept. I serve as an adjunct professor in the department, as well as a member of the Industry Advisory Board, and truly enjoy working with the dept. chairman and staff. I also often have the opportunity to work closely with various professors on projects here at SDL, and am impressed with their world-class knowledge and their creativity. In addition, I regularly hire and work with part-time employees who are MAE students and full-time employees who are MAE graduates, and am pleased with their technical knowledge, work ethic, and enthusiasm. Our employment policy is to advertise and compete each full-time position nationally, which we do, and of course to hire the best candidate. We pride ourselves in feeling that we have some of the best

mechanical engineers in the industry, and it is a tribute to the MAE dept. that, of the 18 full-time engineers in our group, 16 of them have either undergraduate or graduate degrees from USU.
Dr. Steve Wassom, Space Dynamics Lab, steve.wassom@sdl.usu.edu

For me, a measure of the quality of the USU mechanical engineering program comes from comparing the skills and capabilities of its graduates with those who come from other programs. I never meant for this comparison to be intentional or competitive, but instead found it a natural observation in working with others. When working within a team on tough engineering challenges, it is apparent who has had solid training in engineering fundamentals and can hold their "technical ground". I am happy to say that in observing comparisons with great people who attended a large variety of institutions, I always felt proud of my USU education as I could see that my education was second to none.
As my career moved along and I entered the engineering management track, the same unintentional comparisons continued, only now not comparing myself and my own comfort level, but many other USU graduates compared to a large number of strong engineers who were educated at some of the most famous universities in the US. After interviewing, hiring, and working with many of these people, I reach the same conclusion I reached when comparing myself: USU mechanical engineering graduates are well prepared and perform strongly in industry. They have a sound grasp of engineering fundamentals, a strong work ethic, and generally demonstrate a get-it-done attitude. We at Iomega were always pleased to pursue USU graduates. Many of Iomega's top engineering performers wore Aggie blue!
Dave Griffith, Iomega Corp, dgriff331@gmail.com

My education is something that I have been thinking about Lately. I have seen in the short time since I have graduated that you can never stop learning. Even though you may have taken a class on a subject, this is still much, much more to learn about that subject. In addition I have found that in the real world not only am I required to come up with the answers, but many times I have to first figure out the questions. I am grateful to the faculty and staff of the MAE department that provided an atmosphere of learning. Not only for learning engineering fundamentals and technical subjects, but also the skills and techniques required for solving real life problems.
Scott Jenkins, CS Draper Laboratory, sjenkins@draper.com

In the current age where many engineering departments are often pressured to bring in large research grants and projects, an inevitable consequence is that the quality of teaching suffers to accommodate to these high demands. Engineering professors are expected to run a small business that brings revenue to the school, serve on various committees to better the community, and also carry the heavy load of teaching and running relevant courses for the students. Ultimately, a compromise must be made requiring a delicate balance between running an enterprise and teaching the up and coming generation. If done right, these two aspects actually compliment and support one another. If not, the excellence in the educational experience drops. Either professors neglect their role as an educator to magnify their obligation to bring in research dollars or they provide little research experience to their students to compliment their course instruction.
From my experience, I felt the Mechanical and Aerospace Engineering department at Utah State University found a proper balance that proved advantageous to their students. As a recent graduate, I found the course work relevant and effectively taught to provide the theoretical foundation to succeed in both the research and practical application of these ideas. I believe that they have excellent facilities and faculty with the expertise and capability to motivate, encourage, support, instruct, and guide future engineers in their respective fields of interest. I feel very fortunate to have had the privilege of learning in such a conducive academic environment.
David Woffinden (2008 Ph.D. graduate)

Appendix A: Evidence of Continuous Improvement

A number of changes have been made in the mechanical engineering program since the last ABET general review in 2002. They are described within the following categories:

- Curriculum Changes
- Program Assessment Changes
- Laboratory Safety Changes
- Departmental Structure Changes
- Laboratory and Facilities Changes

The curriculum and program assessment changes are listed here.

AY 2002-03 Undergraduate Program (Changes 1-7)

The 2002 assessment and evaluation process resulted in a significant change to the mechanical engineering program curriculum as driven by a university-wide change from quarters to semesters. The total number of course hours was capped. The faculty noticed an imbalance in courses, which underrepresented the fundamentals in mathematics and vibrations while overemphasizing student design course work. As a result, the following changes were made:

1. MAE 5300 Mechanical Vibrations became a required course.
2. A new advanced engineering math course (MATH 4700 Engineering Mathematics & Statistics) was added as a required course.
3. Statistics is given greater emphasis in several required classes.
4. The required capstone design sequence (MAE 3800 Design I & MAE 4800 Design II) was reduced from 7 credits to 5 credits.
5. MAE 4300 Machine Design, required course, was reduced from 4 to 3 credits.
6. Hands-on lab experience was added to MAE 5630 Machining Theory and Applications.
7. The HVAC MAE 5410 course was broadened to be more generally applicable by changing the title to MAE 5410 Design and Optimization of Thermal Systems.

AY 2003-04 Undergraduate Program (Changes 8-12)

The Senior Exit Surveys from 2003-2004 indicated that the students desired more senior design project options and that the current scheduling of the design courses was impeding their graduation dates. The faculty review of the design process indicated that the student designs were often lacking in sufficient analysis and professional documentation. To address these comments, the faculty implemented the following changes:

8. MAE 4800 Design II is now offered Fall and Spring Semesters to better accommodate student graduation schedules. Senior design projects must emphasize teamwork, engineering analysis, critical design presentation, final report, and design and shop drawings. Students have two options for completing MAE 4800 Design II: professional society competition or senior design project in a class setting. These competitions inspire and motivate the students.
9. A review of the need to incorporate use of modern engineering tools within the MAE program indicated that computational skills were needed earlier in the curriculum. It was decided that MAE 2200 Engineering Numerical Methods I be made a co-requisite to MAE 3400 Thermodynamics II and MAE 3320 Advanced Dynamics.
10. MAE 2650 Manufacturing Processes was changed from 4 credits to 3 credits.
11. For the Aerospace Emphasis, students must take MAE 5500 Aerodynamics and MAE 5520 Elements of Space Flight.
12. For the Manufacturing Emphasis, students must take five courses from the following list: MAE 5020, MAE 5310 or MAE 5620, MAE 5600 or STAT 5300, MAE 5630, MAE 5640, MAE 5650, MAE 5660, MAE 5680, MHR 5350, STAT 5200. Three courses (MAE 5630, MAE 5650, and MAE 5020) were added to the list to provide a better balance of interests.

AY 2004-05 Undergraduate Program (Change 13)

13. Recognizing the importance of modern software engineering tools, the faculty added Computational Engineering as an emphasis area within the BS Mechanical Engineering Program.

AY 2005-06 Undergraduate Program (Changes 14-16)

14. After reviewing the high, median, and low performance of student work, the faculty voted to allow students in the MAE Professional Program only one opportunity to repeat a course. This was done to address the concern that a number of MAE students were repeating too many classes. This new policy is more stringent than either the university or college policies.
15. Based on the evaluation of program outcome (a) using FE exam and student performance in courses (for which ECE 2200 was a prerequisite), the responsibility for this course has been transferred to the ETE Department with improved results.
16. Based on the evaluation of program outcomes (h) and (j), faculty determined that student performance in broad societal education and contemporary issues resulted in a poor evaluation. To help address this and encourage lifelong learning skills, an assignment in MAE 3400 Thermodynamics II required students to independently identify the energy costs associated with different sources and compare the "advertised" efficiencies to estimates generated from fundamental principles.

AY 2006-07 Undergraduate Program (Changes 17-19)

17. A review of student performance with respect to professional and ethical issues indicated that this outcome was *poorly met*. The MAE faculty strengthened students' exposure to professional/ethical issues in the curriculum by requiring its inclusion in three courses.
    - An ethics and professionalism lecture has been included in MAE 1200 Engineering Graphics. This course is taken by all MAE freshmen and many transfer students. A case study homework assignment was included to assess the learning outcomes.
    - A more comprehensive treatment of ethics/professionalism with homework/quiz was given in MAE 3800 Design I.
    - Starting in the 2007 Spring Semester, the final design report for MAE 4800 Design II included a section wherein the students discuss how ethics and contemporary issues relate to their designs.
18. The evaluation of program outcome data for (f)-(j) as associated with professionalism indicated that the outcomes were *poorly met* to *adequately met*. In teamwork with our ECE partners, MAE revamped the curriculum in MAE 3800 to include these objectives:
    - To address communication, lectures and quizzes were added covering topics in Requests for Proposals (RFPs), proposal response, report format, conceptual design reviews, professional documentation and presentations. Additionally, a written interdisciplinary team report was required. Professionalism in the design process included lectures and quizzes on the design process, project management, systems engineering, quality, manufacturing, testing, product and field service engineering.
    - To address the broad impact of engineering on society, lectures on globalization, volunteerism through Engineers without Borders, and gender in the workplace were included.
    - To support lifelong learning, students were required to search for commercially available components and subsystems to be integrated into projects during the design phase.
19. The evaluation of program outcomes (c) and (l) also indicated that design realization was not being addressed consistently in the senior design courses. A rapid prototyping system was integrated into the course in the 2007 spring semester, but problems prevented its use. This system was used in the Fall 2007 and Spring 2008 senior design courses.

AY 2007-08 Undergraduate Program (Change 20)

20. The review for the experimentation program outcome (c) indicated that students did not have the opportunity to design an experiment. This was addressed by adding an experiment requiring student design in MAE 4400 in the 2007 Fall Semester.

AY 2008-09 Undergraduate Program (Change 21)

To improve all program outcomes ranked below *satisfactory*, the MAE faculty have considered the following changes:

21. The evaluation of program outcomes (f) through (j) indicated that our program was *adequate* in relation to professionalism. The faculty wanted to improve the achievement of these program outcomes. At its Spring 2008 faculty retreat, the MAE faculty agreed to establish a separate course for professionalism [(g) through (j)] and ethics (f). The first offering of this new course will start in the Fall 2010.

AY 2009-10 Undergraduate Program (Change 22-23)

22. Provide a design realization experience by expanding the capstone senior design course to a two semester course. The evaluation of program outcomes (c) and (l) indicated that our program was *adequate* to *satisfactory* in achievement of appropriate design experiences; however, the design realization component was determined to be limited for many students. The senior capstone design course was changed beginning Spring 2010 to provide a richer experience in design realization. Table 5 shows the student design projects for 2010.
23. The assessment data showed that the students could benefit from having a greater understanding of MATLAB, a numerical computing environment and fourth generation programming language. Beginning in Fall 2009, MAE 2200 was increased from a 2 to 3 credit course with the extra credit devoted to instruction and lab work with MATLAB.

Table 5. Capstone design projects for 2010 Design I and Design II

Design Project	Team Members	Sponsor
Human Powered Aircraft	5	Instructors
Wind Powered Land Yacht	6	Instructors
Heat Flux Meter Calibration Device	5	Dr. Barton Smith
Human Powered Vehicle	6	Instructors
Human Powered Vehicle for speed	5	Instructors
Mechanism that will allow persons with disabilities to work on a vehicle by moving them from a sitting position to a prone position	5	USU Center for Persons with Disabilities (CPD)
Mechanism for loading a collapsable wheelchair into a car trunk	4	USU CPD
Mechanism for loading a collapsable wheelchair into a car trunk	3	USU CPD
Redesign of a robot arm used in manufacturing	4	Invenscience LC, Logan, UT
Low mass carbon dioxide compression and liquefaction system	7	Idaho National Laboratory

Program Assessment Changes 2002-2008

The MAE program has implemented the following general assessment changes to improve overall program performance:

1. The MAE Mission Statement and program objectives were reaffirmed in 2004-05 and again in 2007-08 by the Industrial Advisory Board.
2. The use of the following assessment tools were reaffirmed in 2004-05: Senior Exit Interviews and Surveys, FE Exam subject results, student teacher/course ratings, external review of senior design, and qualitative input from the Industrial Advisory Board.

3. The 40 program outcomes listed in the 2002 ABET general review were incorporated into 12 program outcomes - 11 of which are the ABET required program outcomes.
4. Prior to Fall 2007, the internship program followed the university guidelines but it did not provide the level of assessment data the faculty wanted. Since then, the internship report and assessment process has been changed. Starting in Fall 2008, internship data will be gathered using student responses specific to the program outcomes (a)-(l) and oral presentations delivered by student-interns at an open meeting. The open meetings will be conducted primarily to stimulate interest in internships, to encourage more students to take advantage of internship opportunities, and to provide assessment data on oral communication.
5. All surveys from our program constituents are based on our program outcomes (a)-(l). In order for survey respondents to better understand the context for which the survey data are collected, all surveys now begin with a listing and definitions for program educational objectives and program outcomes. This change occurred beginning in Fall 2006.

The MAE offices have been conveniently clustered on the new Engineering Building (ENGR) fourth floor providing student accessibility and faculty collaboration. Beginning in the 2003 Fall Semester, the MAE teaching labs were also moved to ENGR. This provided the opportunity to upgrade the labs. Major upgrades included the following:

MAE 2160 Material Science Lab has ample space to accommodate at least six student groups at a time. This space and new furniture provide for improved safety practices and enhanced student interactions. Since AY 2003-04, the lab was equipped with new computers including software for cooling cure measurements and a universal tensile machine. During 2008-09, the lab acquired a new digital microscope for observations of material microstructure and upgraded the hardness tester.

MAE 3340 Instrumentation Lab: In 2003, the MAE Instrumentation Lab underwent a fundamental change to upgrade to digital data acquisition based on National Instruments hardware and LabView® software. The change allowed MAE to continue to use its extensive suite of analog instrumentation and allowed students to explore the challenge and benefits on interfacing such equipment to their PCs through analog to digital conversion. The lab was outfitted with new furniture to provide for six complete laboratory workstations.

MAE 4400 Thermal Fluids Lab: No new equipment was purchased for this laboratory as part of the move to the new engineering building. The available equipment was purchased just prior to the last ABET visit and *strongly* meets our current program needs.

MAE 1200 Computer Lab: Before the last ABET general review, the MAE Department operated and maintained its own computer lab using 21 SGI work station computers. Beginning in January 2004, the Engineering PC classroom became fully operational with an excellent teaching lab equipped with 44 PC stations. The MAE 1200 Engineering Graphics course was moved to the new PC lab. This has had a very positive impact on our students' experiences.

Appendix B: Mapping of Learning Objectives and Expectations

Table 6 illustrates the mapping of the program outcomes most essential for the achievement of the program educational objectives. It follows from the assessment data that achievement of all the program outcomes leads to the achievement of all of the program educational objectives.

Table 6. Mapping program educational objectives with program outcomes

Program Outcome	PROGRAM EDUCATIONAL OBJECTIVES					
	(1) Employment success	(2) Graduate Degrees	(3) Problem Solving	(4) Computer Skills	(5) Communication Skills	(6) Independent Learning
a) Apply M-S-E	✓	✓	✓	✓		✓
b) Experiments	✓	✓		✓	✓	
c) Design constraints	✓	✓			✓	✓
d) Team work	✓	✓	✓		✓	
e) Problem solving	✓	✓	✓	✓		✓
f) Professional ethics	✓	✓		✓	✓	✓
g) Communication	✓	✓			✓	
h) Global impacts	✓		✓		✓	
i) Life-long learning	✓	✓	✓			✓
j) Contemporary issues	✓		✓			✓
k) Engineering tools	✓	✓	✓	✓		✓
l) Thermal and Mechanical systems	✓	✓	✓	✓		✓

Relationship of Courses in the Curriculum to the Program Outcomes

Syllabi have been created for each course in order to provide program consistency. Table 7 shows a mapping sample for courses relative to program outcomes. Only required courses are included in this mapping in order to verify that all students have the opportunity to achieve the program outcomes. This allows the faculty to evaluate the program outcomes as the aggregate sum from the courses. Conversely, deficiencies in the program outcomes can be fed back directly to improve courses.

Table 7. Mapping of course objectives to program outcomes

Course#	Course Title	a	b	c	d	e	f	g	h	i	j	k	l
2010	Statics	✓											
2030	Dynamics	✓											
1200	Engineering Graphics			✓		✓	✓					✓	✓
2140	Strength of Materials	✓		✓		✓							
2160	Material Science	✓	✓					✓				✓	✓
2200	Engineering Numerical Methods 1	✓				✓						✓	
2450	Engineering Numerical Methods II	✓				✓						✓	
2300	Thermodynamics 1	✓				✓						✓	
2650	Manufacturing Processes	✓		✓		✓						✓	✓
3040	Mechanics of Solids	✓		✓		✓						✓	
3320	Advanced Dynamics	✓				✓						✓	
3340	Instrumentation and Measurements	✓	✓			✓						✓	✓
3400	Thermodynamics II	✓		✓		✓		✓	✓		✓	✓	✓
3420	Fluid Mechanics	✓				✓						✓	✓
3440	Heat and Mass Transfer	✓		✓		✓						✓	✓
3800	Design I	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4300	Machine Design	✓		✓		✓						✓	✓
4400	Fluids/Thermal Laboratory	✓	✓	✓				✓				✓	✓
4800	Design II			✓	✓			✓	✓	✓	✓	✓	✓
4700	Engineering Mathematics and Statistics	✓										✓	
5300	Vibrations	✓				✓						✓	

Appendix C: Capstone Design Experiences

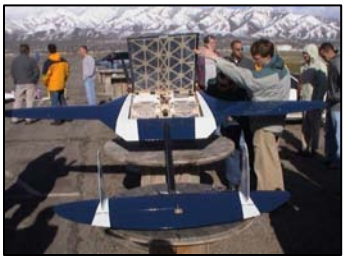
The **NASA University Student Launch Initiative** challenges students to design, build and fly a reusable rocket with a scientific payload to exactly one mile in altitude. In addition to launching, students submit a design report prior to and a final report after launch. Some students have received job offers directly related to the experience of working on the rocket competition. MAE student teams were awarded 1st Place in both 2008 and 2009—the prize for which is front row seats at a NASA Shuttle Launch. Seventeen current and former MAE students and Dr. Whitmore just recently returned from the Space Shuttle STS-130 launch at Kennedy Space Center on February 8, 2010, the last night launch of the shuttle system (photo top right courtesy of Dr. Whitmore).

Clean Snowmobile Challenge™ is an intercollegiate engineering design competition that challenges engineering students to reengineer an existing snowmobile for improved emissions and noise while maintaining or improving the performance characteristics of the original snowmobile. The modified snowmobiles are also expected to be cost-effective. It is a great way to enjoy the winter!

Mini Baja is an intercollegiate engineering design competition for engineering students. The goal is to design and build a prototype of a rugged, single seat, off-road recreational vehicle intended for sale to the non-professional weekend off-road enthusiast. The vehicle must be safe, easily transported, easily maintained, and fun to drive. It should be able to negotiate rough terrain in all types of weather without damage. The Mechanical and Aerospace Engineering Department at Utah State University has been competing for the last several years and has had many successes.

Wright Flyer In August of 2001 a team of Mechanical and Aerospace Engineering students with Engineering and Technology Education students from USU set out to research the 1905 Flyer. Their goal was to identify what would be required to design and build an aircraft that would retain the aesthetics of the original Flyer while possessing flight characteristics that would be considered safe by today's standards. Eighteen months later, their design flew flawlessly over the desert near Wendover, Utah.

Design Build Fly, sponsored each year by AIAA and Cessna, is an annual international competition. Universities design, construct, and demonstrate the flight capabilities of an unmanned, radio controlled aircraft that can complete missions predeterminded by the contest organizers. This contest offers a real-world aircraft design experience for our engineering students.



Appendix D: Pedagogical Grants

Nuclear Regulatory Commission, Nuclear Engineering Scholarship, 08/09 to 08/11, $199,341

Project Title: US NRC Scholarship Education Grant
Number of Students Involved: 12
PI: Barton Smith
Project Summary: Utah State University will offer scholarships in the amount of $10,000 per year to six Junior and six Senior students. Assuming they are able to continue to meet the program criteria (e.g., minimum GPA), the Juniors will receive the same award in their Senior year. In return, each student will make a commitment to serve six months in the nuclear industry for each year of support. Each student will be provided with the opportunity to perform nuclear-related research with faculty from the Mechanical and Aerospace Engineering Department. The students will travel annually to Idaho National Laboratory and partake in a seminar series at USU.

NASA, Development of an Exploration Systems Mission Directorate Senior Design Course, 12/08 to 06/11, $55,000

Project Title: Lunar and Planetary Landing Research Vehicles
Number of Students Involved: 24 undergraduate, 4 graduate
PI: Tony Whitmore
Project Summary: This course is developed as partial fulfillment of the requirements of a grant funded by the NASA Office of Education. The project's final outcome will be a "packaged" senior design course that can be "moved laterally" and incorporated into universities across the nation. Course materials will adhere to the standards of ABET.

This project will develop concepts for a Lunar or Planetary Surface Landing Research Vehicle (LPSRV). Per NASA specifications concepts must account for reduced lunar or planetary gravity, and allow simulated terminal stage of lunar descent to be flown either by remote pilot or autonomously. The design project will challenge students to apply systems engineering concepts to define research and training requirements for a terrestrial-based lunar landing simulator. The free-flying platform will allow for both sensor evaluation and pilot training. The concept allows a small-scale prototype-demonstrator to be constructed within time and budget constraints of a university-based senior design project. A prototype of the system concept will be constructed and flight-tested.

National Center for Engineering and Technology Education

MAE is fortunate to have one of its faculty members, Dr. Christine Hailey, as the PI for the National Center for Engineering and Technology Education (NCETE). NCETE is investigating ways to introduce engineering as a school subject into K-12 educational settings. Motivation for these efforts includes increasing the size, diversity and quality of the U.S. workforce in engineering and science as well as improving the technological literacy of all U.S. citizens. Furthermore, some engineers and educators feel there is value in introducing engineering design thinking in K-12 to improve problem solving skills of all students and to introduce innovation and entrepreneurial thinking at an early age.

The Center's mission is to build capacity in technology education and to improve understanding of the learning and teaching of all high school students and teachers as they apply engineering design processes to technological problems. USU is the fiscal home of NCETE.

Nine other universities across the country are participating partners:

- PhD granting partners include the University of Georgia, University of Illinois at Urbana-Champaign, University of Minnesota, and the Utah State University.

- Technology teacher education partners include Brigham Young University, California State University Los Angeles, Illinois State University, North Carolina A&T State University, and the University of Wisconsin-Stout.

NCETE Publications

Cullum, J., Hailey, C., Householder, D., Merrill, C., Dorward, J., "Formative Evaluation of a Professional Development Program for High School Teachers Infusing Engineering Design Into the Classroom," 2008 Annual ASEE Conference and Exposition, Pittsburgh, PA, June 22-25, 2008.

Hailey, C., "Technology Education for all American Students," Mississippi Valley Technology Teacher Education Conference, Chicago, IL, November 8-9, 2007.

Reeve, E., and Hailey, C., "Evaluating and Improving Untenured Faculty Teaching in a College of Engineering," 2006 Annual ASEE Conference and Exposition, Chicago, IL, June 18-21, 2006. (Presentation only.)

Hailey, C., "Pilot Study of a 'Women in Engineering Seminar' That Is Responsive to Regional Attitudes," 2006 Annual ASEE Conference and Exposition, Chicago, IL, June 18-21, 2006.

Becker, K., Hailey, C., and Thomas, M., "Chapter 8: Developing Connections with the Engineering Community," Engineering and Technology Education, eds. R.L. Custer and T.L. Erekson, 57th Yearbook, 2008, Council on Technology Teacher Education, McGraw-Hill Glencoe, 2008.

National Science Foundation, CCLI A&I Program, $68,224, 10/03 to 09/05

Project Title: Enhancement of Computational Engineering within the Mechanical Engineering Curriculum
Number of Students Involved: Several per year as research assistants
PI: Robert Spall; Co-PI: Thomas Hauser
Project Summary: This Type I Adaptation and Implementation project addressed concerns on undergraduate education at research universities highlighted in the 1998 Boyer Commission Report by incorporating advances in information technology into the curriculum. This was accomplished by developing an option to the department's undergraduate Mechanical Engineering degree in the area of Computational Engineering. The PI's also built a PC Beowulf cluster consisting of 5 server and 20 compute nodes to support the option. Undergraduate students were exposed to cluster designs and programming models through a week long seminar which was offered each summer during the project duration. Broader impacts for this work include increasing the number of graduates prepared to advance scientific discovery through high performance computing, and an increase in the number of students going on to study computational engineering in graduate school.

National Science Foundation, Computer Science, Engineering, and Math Scholarship Program (CSEMS), 01/03 to 12/06, $400,000

Project Title: Undergraduate Scholarships in Engineering to Improve Retention and Diversity
Number of Students Involved: 30 per year over a four year period
PI: Robert Spall; Co-PI: Donna Crow
Project Summary: Significant increases in the number of engineering and related technology graduates from the Utah State System of Higher Education will be required over the next several years to

advance the intellectual and economic well being of the state and its citizens. The faculty within the College of Engineering believe that efforts to improve retention, and to increase enrollment opportunities for students from underrepresented minorities, will contribute significantly toward that goal.

Central to this are ongoing efforts to increase the number of scholarship opportunities available to engineering students within each of the 5 departments in the College of Engineering. Toward that end, this award provided, for each year of the four year duration of this proposal, 30 need-based scholarships at $3,125 each. The scholarships allowed students to spend more time on academic pursuits, and less time employed outside the University.

Requirements for scholarship recipients included: 1) be U.S. citizens, 2) enroll full time within the College of Engineering, 3) demonstrate financial need as defined by the U.S. Department of Education rules for Federal Financial aid, and 4) show academic potential or ability.

National Science Foundation, Research Experience for Undergraduates (REU) Program, 06/01 to 05/04, $147,015

Project Title: Space Related Research within the Department of Mechanical and Aerospace Engineering at Utah State University
Number of Students Involved: 8/yr. (24 total)
PI: Robert Spall
Project Summary: A Research Experience for Undergraduates (REU) site at Utah State University (USU) in the area of space engineering was supported through the National Science Foundation. During each summer of the three year duration of the program, eight outstanding undergraduate students resided at USU for an intensive 10 week research experience. The program targeted students from groups under-represented in engineering, and from those schools with less established mechanical and aerospace engineering research programs. The experience introduced students to the exciting opportunities available in space-related research, and acted as a catalyst for the students to subsequently consider graduate level education. The primary component of the project required students to complete a space related research project (or component of a larger, ongoing project) under the direction of a faculty advisor. Much of the research was conducted at the USU Space Dynamics Laboratory. Students also participated in weekly seminars where topics included aerospace research, technical writing and oral presentations, and graduate school. The program culminated with attendance at the AIAA/USU Annual Small Satellite Conference at which the students had an opportunity to present the results of their work.

Appendix E: Undergraduate Research Experiences

Table 8. Recent undergraduates working in research labs

Faculty	Students	Project
T. Fronk	Jared Willings Chris Ransom Skyler Buck Eric Clark Michael Lambert Dan Swenson	Developing technology for measuring the mechanical properties of composite materials at cryogenic temperatures
D. Geller	Jessica Anderson Derrick Crocket Myles Harvell Stan Rosen Nick Staker James Wilson	Develop computer simulations and/or animations for sponsored research (NASA and AFRL) on guidance, navigation, and control. These undergraduate students worked closely with graduated students in a student-to-student mentoring situation.
B. Smith	Will Fish Katie Mabey Samuel Tingey Brian West	Development of new, patent pending, flow control technologies for use in manufacturing and coating processes.
	Tim Laslo Adam Norris Blake Lance Jeff Harris	Working on nuclear computational fluid dynamics validation experiments
B. Wood	Curtis Carrigan Nathan Phillipps Joshua Pack Jonathan Petersen	Worked closely with graduate students in design and building bioreactors for growing algae that can be used as a feedstock for liquid biofuels and doing renewable energy studies for the State of Utah