Chemical Engineering ABET Activity Report for 2006-2007

Mission, Objectives, Outcomes, Constituencies

Mission
The mission of the Department of Chemical Engineering is to cultivate an environment through teaching, research, and service that fosters the technical, critical thinking, and communication skills necessary for student and faculty to contribute to the engineering profession and to the well-being of society.

Educational Objectives
The department has the following educational objectives targeted toward its constituencies. These objectives describe the career and professional accomplishments that the program is preparing graduates to achieve.

1. Students will be able to analyze problems, design experiments, obtain solutions, evaluate information, and communicate results both individually and as part of a team.
2. The department will help students recognize the need for a broad education outside engineering and the importance of life-long learning.
3. The department will work closely with industry to ensure that students upon graduation are educated in fundamental and current issues in the Chemical Engineering profession and are prepared to use this education to improve society.
4. The department will provide a learning environment that fosters honesty, integrity and a strong engineering and work ethic.

Outcomes
The program outcomes are statements that describe what students are expected to know and to be able to do by the time of graduation. Students 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 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.

Constituencies
The Department has identified the following groups and institutions as its main
constituencies: students, industry, academe at large, alumni, and the State of
Utah.

Approach and Summary for 2006-2007

Approach
Table 1 summarizes our approach for assessment and preparation of annual
reports. The PICO is the “person in charge.” Changes to our program in
response to assessment occur through (1) ABET Committee Meetings, (2)
Undergraduate Committee Meetings, (3) Faculty Meetings, (4) Executive
Committee Meetings, (5) Staff Meetings, (6) Spring and Fall Teaching Retreats,
and (7) informal discussions between individuals.

Summary
The Department’s educational philosophy for undergraduates continues to be to
prepare students for employment by industry. The ABET process helps to
ensure the quality of our program for this purpose.

The keys points covered in this report for Criteria 1 – 9 are briefly highlighted
here.
- Criterion 1. Students. There is a fairly high turnover in the staff position of
  academic advisor. The impact of this turnover on students is somewhat
  softened by stability in the faculty position of undergraduate advisor. The
  Department needs to actively work to retain its academic advisor.
- Criterion 2. Objectives. Conversations with visitors from industry and
  academe as well as extensive input from the employers of our cooperative
  education students strongly support our stated educational objectives.
# Table 1

## Approach and assignments for assessment and reporting

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<th>Assessment Tools</th>
<th>PICO</th>
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<td>JoAnn</td>
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<td>Alumni surveys</td>
<td>Geof</td>
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<td>Visitors from Industry</td>
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<td>Visitors from Academe</td>
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<td>State Legislative Liaison (John C. Sutherland)</td>
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<tr>
<th>Outcomes</th>
<th>Assessment Tools</th>
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<td>Interview workshop/recruiter feedback</td>
<td>JoAnn</td>
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<tr>
<td>Instructor surveys (every semester)</td>
<td>Geof</td>
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<td>Senior Exit Interview</td>
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<td>April</td>
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<thead>
<tr>
<th>Feedback Reports / Annual Reports</th>
<th></th>
<th>Objectives</th>
<th>Outcomes</th>
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<tr>
<td>Annual curriculum report</td>
<td>Geof</td>
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<tr>
<td>Annual summary of faculty meeting minutes</td>
<td>Jeri</td>
<td>X</td>
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<tr>
<td>Annual report on IT</td>
<td>Brian</td>
<td>X</td>
<td></td>
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<tr>
<td>Annual report on advising</td>
<td>Jenny</td>
<td>X</td>
<td></td>
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<tr>
<td>Annual report on faculty (yearly mtg.)</td>
<td>JoAnn/Geof</td>
<td>X</td>
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</tr>
<tr>
<td>Annual report on U of U infrastructure</td>
<td>Geof</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Annual report on teaching labs</td>
<td>Bob/Geof</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Annual summary of UG committee minutes</td>
<td>Geof</td>
<td>X X</td>
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<tr>
<td>AIChE annual report</td>
<td>Ed</td>
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<td>Annual visitors and employers report</td>
<td>Geof/Jeri/JoAnn</td>
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<td>Grad School</td>
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<td>Annual summary on teaching retreats</td>
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<tr>
<td>Annual report on IAB/ENAC</td>
<td>JoAnn/Geof</td>
<td>X X</td>
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<tr>
<td>Annual report on course evaluations</td>
<td>Jenny</td>
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<tr>
<td>Annual report on CLEAR</td>
<td>Geof</td>
<td>X</td>
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<tr>
<td>Annual summary on FE Examination</td>
<td>Jenny</td>
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<tr>
<td>Annual report on industrial relations</td>
<td>JoAnn</td>
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<td></td>
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</table>
• Criterion 3. Outcomes. The results of the FE Examination, feedback from employers of our cooperative education students, the results of the 2006 Graduate Council Review, and the senior exit interviews indicate that we are successfully meeting most of our program outcomes. The continuous improvement process has, however, pointed out some areas where improvement may be needed: (1) The FE Exam shows that our students are scoring considerably below average in engineering probability and statistics. (2) Assessments by instructors suggest a continuing weakness in our students’ ability to perform research, learn new concepts, and find information. This weakness is also mentioned by a small number of employers of coop students (3) The Senior Exit Interviews and the response of the employers of coop students continue to point to a need incorporate more communication and teamwork activities earlier in our program.

• Criterion 4. Continuous Improvement. The Department has a vigorous and effective continuous improvement process that is summarized in Table 1 and Figure 1. The Fall 2006 Graduate Council summary notes that, “the Department has devised an effective system and outcomes assessment process for evaluating the quality of its programs and making appropriate changes.”

• Criterion 5. Curriculum. The Fall 2006 Graduate Council Review notes that the undergraduate curriculum is strong and well organized. It suggests including one or more biology courses earlier in our curriculum.

• Criterion 6. Faculty. The internal reviewers for the Fall 2006 Graduate Council Review note that “at the previous review there was a wide spread and unchallenged perception that the department was ‘second tier’. This attitude appears to have been completely reversed since then. Faculty regard the standing of their department with pride and confidence.”

• Criterion 7. Facilities. (1) The Fall 2006 Graduate Council Reviewers recommend that the department “Develop and implement a plan to bring all faculty offices and laboratories together. This will help unite the department and serve the students better.” (2) The Department has embarked on a development plan to finance the remodeling of our senior projects laboratory.

• Criterion 8. Support. The Fall 2006 Graduate Council internal reviewers comment that, “not unique to this Department, the budget for non-personal costs has remained static since about the Carter administration while costs and needs continue to rise. For example, much of the physical undergraduate teaching laboratory equipment is old and out of date. The Department, together with the College, should look critically at finding a solution to rebalance needs and resources.”

• Criterion 9. Program Criteria. The Program Criteria for chemical engineering curriculum specifically mention biology as a basic science, but qualify this with the phrase, as “appropriate to the objectives of the program.” As noted above under Criterion 5, the Fall 2006 Graduate Council Review suggests including one or more biology courses earlier in our curriculum. The Department needs to decide if more biology is needed in the Undergraduate Curriculum.
**Criterion 1. Students**

**Advising and Curricular Matters**

There are two undergraduate advisors who serve students in the Chemical Engineering Department: a faculty member, Prof. and Associate Chair Geoff Silcox, and a staff member, Jenny Jones, Academic Advisor. The primary advisor for undergraduate students is Jenny. Both advisors are available to all students and students are encouraged to seek advising often. Jenny replaced the previous advisor, Leda Mareth, in March 2007. Leda was in her position for 2 years. There is a relatively high turnover in this position which can make it difficult to provide consistent advising. The Department needs to be attentive to the retention of our Academic Advisor.

The external reviewers who were part of our Fall 2006 Graduate Council Review noted that the departmental advising/mentoring system serves as a role model for the rest of the college. They went on to note that hiring a professional advisor to “keep all undergraduates and graduates” on track in terms of courses and paperwork combined with faculty mentoring of both undergraduate and graduate students is an effective system.

The seniors were asked about the quality of advising as part of the 2007 exit interview. Without exception, they felt it was good or excellent.

The Chemical Engineering Department offers an undergraduate major in Chemical Engineering. This major is a ‘closed’ major, meaning that students must apply for intermediate and major status. Students are required to meet with an academic advisor during certain points in their academic career. University of Utah policy requires all incoming freshman and transfer students to meet with an academic advisor. Most of these meetings take place during new student orientations. First semester freshman may elect to take part in the University of Utah ‘Freshman Priority’ program. This program allows students who have meet with an advisor during their first semester at the University of Utah to register for classes at a much earlier date than they would otherwise.

The department also requires transfer students to fill out a Transfer Agreement that is signed by the Chair of the Undergraduate Committee. The Agreement lists the transfer courses completed by the student and their equivalent courses at the U. Because the State of Utah maintains articulation agreements between all institutions, the Transfer Agreement is generally most important when admitting out-of-state students.

As part of the application for intermediate status, students are required to meet with a department academic advisor to review program requirements. Students usually apply for intermediate status during their freshman year or first semester of the sophomore year. Students must apply for major status at the end of their
sophomore year. While a formal advising appointment is not required as part of this application, the advisors do review the students’ records.

All students must meet with an advisor to apply for graduation approximately nine months before the expected graduation date. Seniors are also required to have an exit interview with the Chair or Associate Chair.

Two advising tools that were developed and used during the 2005 – 2006 academic year were continued in 2006 - 2007. These include a weekly newsletter and Degree Audit Reports (DARS). The weekly email newsletter is sent out during the fall and spring semesters to keep students informed of deadlines, scholarships, and job and internship opportunities.

The DARS is a University of Utah tool that is available to all departments and undergraduate students. DARS combines all university requirements, including general education and bachelor’s degree requirements, with the requirements for the major, and tracks student’s progress towards completing these requirements. The DARS allows students to have accurate information about which requirements are still needed to complete their degree. The DARS records exceptions and transfer information. The DARS is updated and maintained by Jenny. Students can generate a DARS at anytime and are encouraged to check their DARS frequently. The DARS is used during most advising appointments.

**Advising on Career Matters**

The Chemical Engineering Department is committed to helping students with job and internship placement. To assist with this, the department has developed and maintains a number of dynamic, on-line job and internship placement boards. New jobs, internships, and coops are posted on these websites as opportunities become available. Students are encouraged to check these sites regularly. New job and internship postings are also sent out in the weekly email newsletter.

The Department provides an annual Interview Workshop to assist students in developing the skills needed for a successful job search. The Interview Workshop is held in October on the same day as Career Services’ fall job fair.

**Outreach and Recruiting**

The advisors and the Student Advisory Committee represent the Department at a number of University of Utah events such as Preview Day, Expo Day, PlazaFest, and the Major Exploration. The College has been active in bringing junior high and high school students on campus to the College of Engineering.

The Department has two scholarships devoted to new students: the Alice & William Van Talge Transfer Scholarships. These are available only to students who are about to enter or have just entered the University of Utah.
Industrial Relations and Job Placement

During 2006-2007, we had an increase in the number of companies interested in recruiting our students. ATK, Micron, and Celanese showed great interest and held various sessions with them. We had multiple students placed at Micron (IM Flash) and Celanese. Student internships went well. Twelve of 26 seniors had at least one internship and 4 of 26 had research experience with one of the faculty. We initiated a web site for job placement for internships and permanent jobs which allowed the department to make students aware of these opportunities.

In March and April 2007, the Chair and Associate Chair conducted Senior Exit Interviews with 26 students. Of those, 7 had job offers, 1 was planning on graduate school, and the rest were still looking or had not decided on offers received.

Undergraduate Seminar

Students are required to take four semesters of Undergraduate Seminar. Each semester, students are required to attend 7 seminars and go on a field trip. There are approximately 10 seminars offered during the semester. This is convenient for students since some of the topics are repeats from one year to the next. Distinguished Lecturers are added to the schedule. AIChE officers have the first seminar to introduce the chapter and the officers. Field trips are organized by the student section of AIChE.

UG seminar in Fall 2006 included speakers from industry and academe. Representatives from Barrick Mines, Sinclair Oil, Celanese, John Zink and Micron visited. The annual John Zink lecture included a scholarship ceremony and lunch. A lecture from Career Services outlined how to sign up for services and set up a resume, and included information on the fall career fair. In addition, first year graduate students formed a panel discussion on their experiences regarding applying for, deciding on, and accepting graduate positions. Research talks were given by John McDougall (Alberta Research Council), Scott Folger (Univ of Michigan), and Anthony Dean (Colorado School of Mines). A final seminar by Michael Noe, Marriott Library, Univ. of Utah, was poorly attended. This was due to the fact that, while only 7 seminars are required, 11 were offered.

In Spring 2007, a student presented her experiences from Alternative Spring Break during which she built houses in New Orleans. Prof. Silcox presented an ABET overview and Leda Mareth talked about available scholarships. Speakers included John Brady (CalTech), Tom Edgar (Univ. Texas, Austin), Matthew Tirrell (Univ. California, Santa Barbara), and Jennifer Sinclair Curtis (Univ. of Florida).

Criterion 2. Program Educational Objectives

Input from Visitors from Academe and Industry

The Department hosted several distinguished lecturers in 2006-2007: Jennifer Sinclair-Curtis (Chair, Chemical Engineering, University of Florida), Matthew
Tirrell (University of California, Santa Barbara), and Thomas Edgar (University of Texas at Austin). A roundtable discussion with interested faculty and staff was held with each guest.

The visit with Prof. Sinclair-Curtis focused on chemical engineering education but included discussions of visibility, career fairs, industrial relations, the undergraduate program, and the graduate program. With regard to the undergraduate curriculum, Jennifer noted that UF focuses on core topics in chemical engineering. A large group of the faculty support traditional chemical engineering education based on core subjects.

The roundtable with Prof. Tirrell centered on the life sciences in chemical engineering. He noted that his engineering college’s goal in the last twenty years or so has been for integration of life science in every engineering discipline/department, without the creation of a bioengineering department. When asked about biological education for undergraduate chemical engineers, Tirrell reported that UCSB requires one semester of cell biology.

The discussion with Prof. Edgar focused on computing in the chemical engineering classroom. He observed that the Utah curriculum is similar to that at UT Austin but point out that these two programs are not necessarily characteristic of other chemical engineering departments across the nation. One of the noted differences between Utah and UT is statistics. At Utah, statistics is embedded in lab courses and is an optional technical elective. UT has established a two credit hour statistics course, taught by Chemical Engineering, that is required before the junior year lab course. Another difference is in the laboratory experience. At Utah there are two labs in the senior year (4 and 3 credit hours respectively). At UT there is junior-level and a senior-level lab, each carrying two credit hours.

The Fall 2006 Graduate Council Review did not directly address our educational objectives. The external reviewers noted that “the undergraduate curriculum is especially strong and well organized” and that has a direct bearing on our ability to meet our objectives.

Response to Visitors from Academe
Our educational objectives appear similar to those of our peers.

Input from Alumni Surveys
We did not conduct an alumni survey in 2006-2007.

Input from Employers of Coop Students
Fourteen evaluation forms were completed by the employers of our students who participated in cooperative education and internship opportunities in 2006-2007. A summary of the employers’ comments follow.
1) Employers were asked about the technical skills that the students brought to their organization. Their responses suggest that our students are well prepared in basic chemical engineering and science.

2) Employers were asked to evaluate the personal attributes demonstrated by our students. Their responses indicate that our students (1) have a strong work ethic, (2) good organizational skills, (3) work well with others, and (4) are effective in teams.

3) Employers were asked how well the U of U educational experience has prepared students to be successful. Their responses are strongly favorable with several also indicating that the interns were able to learn new material to make up for any deficiencies. One employer suggested a technical writing course. Another suggested electrochemistry or analytical chemistry instead of physical chemistry.

4) Employers were asked to make suggestions regarding our curriculum. I have listed all of their comments below. The most common suggestions include more emphasis on communication skills and ensuring that students have the ability to continue learning,
   a) Include practical examples of how engineering principles are used in industry.
   b) Undergraduate ChE students should be required to have a semester-long introduction to materials science.
   c) The biggest challenges for most undergraduate students are efficient communication skills and an ability to solve open-ended, unstructured problems.
   d) No recommendations other than consider the development of a petroleum engineering program.
   e) Students need to know how to continue learning in an “on-the-job” situation. This is the reality of the situation - most companies cannot afford formal training of new employees. Young engineers must realize they are not through with their education - it is merely a foundation to build on.
   f) I would suggest more practice in writing technical reports and making short presentations.
   g) A technical writing course.
   h) Because Ceramatec focuses on ceramic processing and characterization, I would suggest some coursework on materials science.
   i) Continue to ensure strong skills in engineering material balances.
   j) Analytical chemistry instead of two semesters of physical chemistry. More applied courses and projects. Technical writing and presentation course.
   k) Basics always needed, but real life design and work experience always a plus.
   l) Not applicable.

5) Employers were asked how our students compare to their existing employee standards and whether they would be willing to offer them a full-time position, if one were available. Without exception, all employers responded that the students would be offered a position.
6) Employers were asked to provide advice to prepare the students for a chosen career. The most common advice included (1) continuing to learn and (2) being effective in written and oral communication. Additional comments stressed the importance of technical depth, economic considerations, being able to work on multiple projects, providing innovative solutions, and completing assignments on time.

Response to Employers of Coop Students
Even though the comments of the employers are for students who are still in our program, they are a strong indication of the career and professional accomplishments that employers are seeking. Our educational objectives closely reflect their advice and recommendations.

Criterion 3. Program Outcomes and Assessment

Assessment by Instructors
Beginning Spring Semester 2006 the Department started assessing outcomes by having instructors complete a simple survey. This survey replaced the Course Management Surveys that we used in previous years. A summary of the survey for core, lecture courses is given below in Table 2. Similar surveys are completed by instructors in the design and lab undergraduate classes.

The 2006-2007 results are generally strong in all areas except for the ability to perform research, learn new concepts, and find information. This conclusion is reflected in Table 2 where the average score for this outcome is 1.5 on a three-point scale with 3 being strong, 2 being acceptable, and 1 being weak. Similar findings are indicated by the instructors for Design and the Projects Lab. The instructors for the latter also found some weakness in written communication skills with a score of 1.67.

Response to Instructors
A possible corrective response would be to encourage instructors in courses other than lab and design to assign more writing assignments and more open-ended problems that require the development of critical thinking skills, problem solving skills, and the ability perform research. Students will find such assignments time-consuming and instructors would need to make adjustments to account for this. We believe that some of the apparent weakness in the ability to perform research, learn new concepts, and find information is a reflection of students’ limited time.
Table 2. Summary of results for instructors of core lecture courses for assessment of outcomes.

<table>
<thead>
<tr>
<th>Outcomes - Core Classes</th>
<th>Score (3 = strong, 2 = acceptable, 1 = weak)</th>
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<tbody>
<tr>
<td></td>
<td>3553</td>
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<tr>
<td>1) Ability to apply math, engineering, and science - problem solving skills.</td>
<td>3</td>
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<tr>
<td>2) Ability to design a process to meet desired needs within constraints.</td>
<td>3</td>
</tr>
<tr>
<td>3) Ability to communicate in writing.</td>
<td>2</td>
</tr>
<tr>
<td>4) Ability to communicate orally.</td>
<td>1</td>
</tr>
<tr>
<td>5) Ability to work in teams.</td>
<td>2</td>
</tr>
<tr>
<td>6) Ability to understand the role of engineering in society.</td>
<td>3</td>
</tr>
<tr>
<td>7) Ability to perform research, learn new concepts, and find information.</td>
<td>2</td>
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Results of Fundamentals of Engineering Examination

Students in Chemical Engineering are required to pass the FE Exam to graduate. The general (morning) and chemical engineering (afternoon) exams are required. Most students take the exam as seniors in October or April. The College of Engineering and the Department hold review sessions for approximately eight weeks leading up to the exam. The National Council for Examiners for Engineering and Surveying (NCEES) provides the College with summaries of FE pass rates and discipline-specific results for Utah and the nation. Those results are discussed in this section.

For the 2006-2007 ABET report, the department reviewed the results of the October 2006 FE Exam. Twenty-five U of U students took the exam and 23 passed (92%). The national number of students who took the exam was 225 with 192 passing (85%).

The Chemical Engineering department reviewed how our students did on each subject and compared the results with the national averages. The areas in which U of U students performed better than the national average are given in Table 3. The areas in which our students performed below the national average are summarized in Table 4.
Table 3. Areas in which U of U students performed better than the national average for the October 2006 FE Exam.

<table>
<thead>
<tr>
<th>Subject</th>
<th>U of U</th>
<th>National Ave.</th>
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<tbody>
<tr>
<td>% Correct</td>
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<td>% Correct</td>
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<tr>
<td>Engineering Mechanics</td>
<td>55</td>
<td>52</td>
</tr>
<tr>
<td>Strength of Materials</td>
<td>66</td>
<td>56</td>
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<tr>
<td>Material Properties</td>
<td>60</td>
<td>57</td>
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<tr>
<td>Fluid Mechanics</td>
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<tr>
<td>Thermodynamics</td>
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<td>Chemistry</td>
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<td>76</td>
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<tr>
<td>Material/Energy Balances</td>
<td>63</td>
<td>61</td>
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<td>ChemE Thermodynamics</td>
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<td>67</td>
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<tr>
<td>Fluid Dynamics</td>
<td>51</td>
<td>43</td>
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<tr>
<td>Mass Transfer</td>
<td>61</td>
<td>59</td>
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<tr>
<td>Chemical Reaction Eng.</td>
<td>59</td>
<td>58</td>
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<tr>
<td>Process Design and Economic Optimization</td>
<td>71</td>
<td>69</td>
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<tr>
<td>Computer Usage and ChemE</td>
<td>64</td>
<td>59</td>
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<tr>
<td>Process Control</td>
<td>76</td>
<td>56</td>
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<tr>
<td>Safety, Health, and Environment</td>
<td>52</td>
<td>46</td>
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</table>

Table 4. Areas in which U of U students performed below the national average for the October 2006 FE Exam.

<table>
<thead>
<tr>
<th>Subject</th>
<th>U of U</th>
<th>National Ave.</th>
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<tbody>
<tr>
<td>% Correct</td>
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<tr>
<td>Mathematics</td>
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<td>78</td>
</tr>
<tr>
<td>Eng. Probability &amp; Stat.</td>
<td>56</td>
<td>64</td>
</tr>
<tr>
<td>Engineering Economics</td>
<td>60</td>
<td>62</td>
</tr>
<tr>
<td>Electricity &amp; Magnetism</td>
<td>46</td>
<td>49</td>
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</table>

Our students are particularly strong in Strength of Materials; Engineering Thermodynamics; Fluid Dynamics; Process Control; and Safety, Health, and Environment. We are notably weak in Engineering Probability and Statistics.

**Response to FE Results**

Our primary weakness is understandable; ChE students at the U are not required to take a course in probability and statistics. The Department will continue to monitor the results of the FE exam and will make the results available to all ChE
Communication and Teamwork

The College Of Engineering’s Center for Engineering Leadership (CLEAR), has helped the Department strengthen the teamwork and communication components of its program. CLEAR’s involvement with the Department extends over years one to four but is concentrated in year four where CLEAR is heavily involved in our projects laboratories (CH EN 4903, 4905). CLEAR is staffed by graduate students from the Department of Communication and the Writing Program. Two graduate students are assigned to our department for two or three years. One student focuses on written communication while the other specializes in team work and oral communication.

The Spring 2007 Senior Exit Interviews indicate that the CLEAR staff are generally helpful in written and oral communication. A recurring comment is that more experience with communication is needed earlier in the program. Some students also note that better coordination is needed between the CLEAR staff and our instructors. They occasionally give conflicting instructions.

Teamwork is part of most of our courses and several seniors commented that teamwork and projects were important factors in helping them to learn.

Response on Communication and Teamwork

The lab instructors and CLEAR have consistently held meetings before the start of fall semester to help ensure coordinated efforts. Because of the merging of Instrumental Analysis (5503) and the Projects Lab I (4903), coordination was more difficult this year.

To help incorporate more communication and teamwork activities throughout our program, the Undergraduate Committee is working with CLEAR to develop a list of courses that will include these elements.

Input from Employers of Coop Students

Fourteen students participated in our cooperative education class, CH EN 4977, primarily during their sophomore and junior years. Their employers were asked to comment on the preparation of our students and to suggest changes in the curriculum. A summary of the employers’ comments follow.

1) Employers were asked about the technical skills that the students brought to their organization. Their responses suggest that our students are well prepared in basic chemical engineering and science.

2) Employers were asked to evaluate the personal attributes demonstrated by our students. Their responses indicate that our students (1) have a strong work ethic, (2) good organizational skills, (3) work well with others, and (4) are effective in teams.
3) Employers were asked how well the U of U educational experience has prepared students to be successful. Their responses are strongly favorable with several also indicating that the interns were able to learn new material to make up for any deficiencies. One employer suggested a technical writing course. Another suggested electrochemistry or analytical chemistry instead of physical chemistry.

4) Employers were asked to make suggestions regarding our curriculum. I have listed all of their comments below. The most common suggestions include more emphasis on communication skills and ensuring that students have the ability to continue learning,
   a) Include practical examples of how engineering principles are used in industry.
   b) Undergraduate ChE students should be required to have a semester-long introduction to materials science.
   c) The biggest challenges for most undergraduate students are efficient communication skills and an ability to solve open-ended, unstructured problems.
   d) No recommendations other than consider the development of a petroleum engineering program.
   e) Students need to know how to continue learning in an “on-the-job” situation. This is the reality of the situation - most companies cannot afford formal training of new employees. Young engineers must realize they are not through with their education - it is merely a foundation to build on.
   f) I would suggest more practice in writing technical reports and making short presentations.
   g) A technical writing course.
   h) Because Ceramatec focuses on ceramic processing and characterization, I would suggest some coursework on materials science.
   i) Continue to ensure strong skills in engineering material balances.
   j) Analytical chemistry instead of two semesters of physical chemistry. More applied courses and projects. Technical writing and presentation course.
   k) Basics always needed, but real life design and work experience always a plus.
   l) Not applicable.

5) Employers were asked to provide advice to prepare the students for a chosen career. The most common advice included (1) continuing to learn and (2) being effective in written and oral communication. Additional comments stressed the importance of technical depth, economic considerations, being able to work on multiple projects, providing innovative solutions, and completing assignments on time.

Response to Employers of Coop Students
The comments of the employers are a strong indication that our program outcomes are appropriate. Areas in which we need to improve include (1) written and oral communication, (2) providing more experience solving open-ended
problems, and (3) providing more examples of how engineering principles are applied in industry.

**Fall 2006 Graduate Council Review**
The external reviewers noted that “the undergraduate curriculum is especially strong and well organized.”

**Criterion 4. Continuous Improvement**
The actions of the Undergraduate Committee, the Department ABET Committee, and the faculty are effective in monitoring our students and graduates to determine if they are meeting our objectives and outcomes. The process of continuous improvement is shown in Figure 1. At the heart of the process are direct and indirect assessment tools. Notable among the direct evaluation tools are the FE Examination and feedback from employers of our cooperative education students. The use of these is illustrated in previous sections on Criteria 2 and 3.

![Figure 1 Process for continuous improvement.](image-url)

The Fall 2006 Graduate Council summary notes that, “the Department has devised an effective system and outcomes assessment process for evaluating the quality of its programs and making appropriate changes.”
**Criterion 5. Curriculum**

**Summary of Changes in Curriculum for 2006-2007**

The following notes summarize curriculum changes in 2006-2007 and are abstracted from the minutes of the Undergraduate Committee meetings.

1. **Restructuring and reduction in credit hours for CH EN 3603, Mass Transfer and Separations.**
   The committee approved changing 3603 from five credits to three. Prof. Roper explained that this would be accomplished by deemphasizing derivations while keeping the topics the same. The students would be referred to the text for derivations. Prof. Roper also plans to develop short guidelines that lead students through the material and text and that provide key definitions with all units defined. This change was motivated by the desire to develop a more balanced curriculum.

2. **Acceptance of MATH 2210, Calculus III, (multivariable calculus), as a technical elective.**
   The committee approved accepting MATH 2210 as a technical elective. This was done to encourage those who are not taking the MATH 1250/1260 (Calculus of AP Students) or 1270/1280 (Engineering Calculus) series to take multivariable calculus. It will also help transfer students, many of whom take MATH 2210. MATH 2210 does not replace our existing upper-division math requirement and it will not be accepted if students have also taken MATH 1250/1260 or 1270/1280. The MATH 1250/1260 and 1270/1280 series include multivariable calculus. MATH 2210 is intended as an elective for students who have taken MATH 1210/1220.

3. **Acceptance of International Requirement (IR) Courses as technical electives.**
   The committee approved the following IR Courses as technical electives. They were added to our Management, Policy, and Law Option. This was done to help our students accommodate the new IR that affects all students who enter the U Fall 2007 and after.
   - 1) MGT 4900 – International Management.
   - 2) MKTG 4840 – International Marketing.
   - 3) ECON 3500 – International Economics.

4. **The second semester of physical chemistry (CHEM 3070) was dropped from our curriculum.** This course covered thermodynamics and kinetics and was viewed as redundant. This change follows from several years of input from the senior exit interviews. The Department will continue to accept CHEM 3070 as a technical elective to help those students who want to earn a minor in Chemistry.

5. **Biochemical Engineering (CH EN 5103) was moved from the senior year to the junior year without changing its content.** This was in response to suggestions made in the senior exit interviews. The seniors felt that the content of 5103 fit with the junior-level curriculum because of its application of reaction engineering, mass transfer, and separations. This change also partly addresses the review of the 2006 Graduate Council Review that suggested the department incorporate more biology earlier in our program.
6. The deletion of CHEM 3070 and the shortening of CH EN 3603 from 5 credits to 3 freed 4 hours in our curriculum. These units were moved to our pool of technical elective course. Prior to this change the Department required 15 hours of electives. Under the revised curriculum there are 18 hours of electives: 9 in Chemical Engineering and 9 in other approved courses.

7. Our Instrumental Analysis Laboratory, CH EN 5503, was combined with Projects Laboratory I, CH EN 4903. The former was a two-credit course, the latter also two-credits. They were combined to form a four-credit course, CH EN 4903, Projects Laboratory I. The courses were combined for two reasons: (1) the loss of the space that formerly housed Instrumental Analysis and (2) the desire of the UG Committee to more tightly integrate the Projects Laboratories with Instrumental Analysis.

General Education Courses
The University of Utah started a new General Education requirement that applies to students entering the program Fall 2007:

The Upper Division International Course Requirement will give students a broad base of knowledge about global issues and about global perspectives in a comparative context. It will introduce students to international frames of reference so that they may think critically about long-standing and newly emerging issues. It will help students accept and appreciate the interdependence of nations and the viewpoints of other nations, and give them the ability to communicate with people across international borders."

To respond to this change, the Undergraduate committee approved three technical elective courses that also satisfy The International Requirement (IR): ECON 3500, International Economics; MGT 4900, International Management; and MKTG 4840, International Marketing. The new international requirement helps us address Outcome h: “programs must demonstrate that their students attain the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.”

Engineering Ethics
Our technical elective options allow students to count PHIL 4540, Engineering, Ethics, and Society, as a General Education course and as a technical elective. This was done to encourage students to take the course and to allow students more flexibility in meeting U of U and Department requirements.

Curriculum Input from 2006 Graduate Council Review
The Fall 2006 Graduate Council Review notes that the undergraduate curriculum is strong and well organized. It goes on to suggest including one or more biology courses earlier in our curriculum. The only biology intensive course that is currently required is Chemical Engineering 5103, Biochemical Processing. That course has traditionally been required in the last semester of the senior year. As noted at the beginning of this section, it has been moved to the last semester of the junior year and will be taught to juniors beginning Spring Semester 2008.
**Criterion 6. Faculty**

The internal reviewers for the Fall 2006 Graduate Council Review note that “at the previous review there was a wide spread and unchallenged perception that the department was ‘second tier’. This attitude appears to have been completely reversed since then. Faculty regard the standing of their department with pride and confidence.” The Graduate Council summary points out that the “Faculty are dedicated to improving the well being of their students and to enhancing the quality of their education. Students express great satisfaction at the work of the department.”

The department lost one faculty member during the 2006-2007 year because tenure was not received. The Department plans to fill the position with someone in biochemical engineering.

**Informal Reviews**

The Chair (JoAnn Lighty) and Associate Chair (Geoff Silcox) conducted informal reviews of individual faculty in May/June 2007. Pay increases were announced at that time and an open discussion was held over research, teaching, service and concerns. Faculty were asked to comment on what they thought was unique about our program. A short summary of each meeting follows.

**Eric Eddings – May 23, 2007**

Eric desires to step down from the Graduate Committee (5 year service); he is currently on the Executive Committee of the Academic Senate (completed). He is planning on seeking promotion next year (associate to full professor). He would like to continue teaching kinetics and fluids. In terms of research, he was involved in the PSAAP proposal, would like to focus on oxy-coal and shale. He has new programs in oxy-coal with Praxair. He would like to stay involved with smaller projects and supervising the technical people. He plans to publish more. He would like to see the combustion course and CFD taught every year. He feels that the unique aspects of the department include strong connections to industry and our ability to provide industry with students with practical experience.

**Keith Roper – May 30, 2007**

Keith teaches mass transfer and separations, process design I, and lab (Fall). Mass has been changed to three credit hours. He has increased his number of graduate students (7) and funding. He is working with Henry White, Dennis Parker, and David Jones. In terms of service, he is co-investigator on the STEP outreach program funded by NSF. He feels that the unique aspects of our program are student-orientated teaching and the focus on combustion, with a renewed interest in energy.
Geof Silcox – May 30, 2007
Geof has been teaching engineering thermodynamics (2300) which is really like teaching two classes due to its size. He also taught air pollution. He was not happy with the way the Law, Engineering, and the Environment course was taught. He will teach process engineering in the summer. His research involves mercury oxidation in combustion systems. He feels the unique aspects of the department are the commitment to UG education and the involvement of students in research.

Misha Skliar – May 31, 2007
Misha has been teaching graduate seminar, grad fluids, control, and state space methods. He would like to see a unified curriculum in terms of control. In addition, he would like to see a reduction in teaching for faculty. For retention, promotion and tenure, he would like to see the evaluation of research revisited. The emphasis is on funding but the number of graduate students should also be included. He would like to see the department become one of the top rated departments in the Rocky Mountain area.

Jost Wendt – June 7, 2007
Jost has been teaching graduate heat transfer and has noticed that attendance is low. He would like to see “buy-back” as an aid in funding graduate fellowships. A buy-back amount of 12.5% of the annual salary for a 3-credit hour course was the practice at Univ. of Arizona. He also encourages the teaching of fewer courses per faculty. For research, he is initiating oxy-coal combustion efforts at the U. He would like to add arsenic and selenium to his trace metals work. He is considering reducing his consulting work and spending more time at the U. Jost is the RPT chair and runs the Distinguished lecture series. Jost sees the unique aspect of the department as the fact that large groups of people are working together.

Milind Deo – June 8, 2007
Milind is teaching a new class, Green Engineering, instead of Environmental Applications of Chemical Engineering. He would like to include life cycle analysis. For research, he is looking at aspects of oil flow in new fields. He would like to initiate a Heavy Oil Consortium and involve Terra Tek. Milind believes our strengths are energy but a critical issue is the quality of graduate students. Having experiments at different scales, complemented by simulations is a strength of our program.

Kevin Whitty – June 8, 2007
Kevin has been teaching 2800 and would like to work with the CLEAR program to develop better collaboration. He started a general education class on alternative energy. Case studies were included. Senior lab is the third class he is teaching. In research, he would like to keep his gasifiers occupied and work on gas clean up from biomass. He would like to broaden his work to include catalytic
systems for developing liquid fuels from syngas. He feels that a unique aspect of the department is that we are relatively young.

**Phil Smith – June 7, 2007**
Phil has no teaching responsibility but is scheduled to teach senior lab. He believes the lab should have industrial, hands-on experience with pilot-scale facilities with a strong focus on energy. For research, the outlook for new coal/oil center money was looking positive. In addition, the PSAAP proposal was to come out.

**Jaye Magda – June 11, 2007**
Jaye’s teaching has been graduate thermodynamics, transport (in MSE), and the projects lab. He organized the annual rheology meeting (to be held in Oct 2007). The meeting will involve 300-400 people. For research he has several students and funded projects. He is working with NIH and has a joint project with Milind in oil. He is also working with Prof. Florian Sozbacher of Electrical Engineering on sensors. He views the unique quality of the department as the strong emphasis on combustion and fuels. He believes that we do an unusual amount of undergraduate teaching and feels the emphasis on computer software for process design is larger than in other chemical engineering departments.

**Ed Trujillo – June 11, 2007**
Ed has taught senior lab, bioengineering, and grad kinetics. His research has been funded by industry (MolyCorp) for 2 years under a phased program. One laboratory was remodeled. He believes that we need good students and publications. His service activities include advising the AIChE student chapter and serving on the diversity committee. He sees the unique aspect of our department as the industrial emphasis, although we need more company input. We require the FE and our distillation column is unique.

**James Sutherland – June 11, 2007**
James has taught graduate Mass Transfer (6603), Engineering Computing (1703), and Numerical Methods (2703). He has written several proposals. The unique aspects of our department include our strength in combustion, advanced computing. He would like to “raise the bar” for both undergraduates and graduate students.

**Terry Ring – June 13, 2007**
Terry has taught the projects lab, instrumental analysis, and design II. He is also in charge of coop and the design course for ATK students. He is considering a sabbatical and will let us know by the end of June regarding this status. He would like to see Silicon Chip Processing become an interdisciplinary course. For research, he is working on a book and developing capabilities for using lasers for flame diagnostics. He also has projects with ARUP and Dugway. His service includes the Chemical Council leadership on the government relations committee.
He feels the unique aspects of our department include the pilot-scale, teaching laboratory opportunities with automatic control available.

**Milinda Krahenbuhl – June 13, 2007**
Melinda is a research associate professor with a joint appointment in CVEE. She is on the Governor’s Energy Subcommittee and would like to have a tenure-track position. She is chair of the Radiation Safety Committee. She has taught several courses in the Nuclear Program.

**Frank Hanson – June 28, 2007**
Frank will teach catalysis in Spring '08. He will work on a catalysis experiment for the Senior Projects lab and when he visits Notre Dame will look into their capabilities. He is doing research with Dugway with help from Adjunct Prof. Bruce Oblad. He believes the uniqueness of the department is the industrial funding of projects.

**Chemical Engineering Fall 2006 Teaching Retreat for Instructors**
The fall 2006 teaching retreat focused on computing tools and their use in teaching and review of graduate student applications. The participants included Phil Smith, Ed Trujillo, Eric Eddings, Misha Skliar, Geof Silcox, Bonnie Tyler, Terry Ring, Keith Roper, James Sutherland, and Kevin Whitty.

The retreat began with an introduction to of ApplyYourself, the system for on-line, graduate application adopted by College of Engineering. It allows faculty to review the applications of students who have submitted a completed application and of those that have begun to apply but have not yet completed and submitted the application. Faculty were encouraged to view applications on-line so that the paper-file distribution method can be completely replaced. Leda Mareth and Eric Eddings will continue screening applications and providing faculty with a summary spreadsheet of key information on applicants, but the actual application material is now available to them electronically.

In the Fall Retreat 2005, Keith Roper presented an introduction to the use of ASPEN-PLUS in the classroom. The Fall 2006 retreat was a hands-on walk-through of several examples to demonstrate features. Faculty were encouraged to consider using some of these features in the junior year. ASPEN-PLUS is currently used primarily in Design I (Keith Roper) and Design II (Terry Ring) – both senior courses.

An interactive, hands-on demonstration of the use of Polymath was led by Ed Trujillo. Polymath is a product sponsored by CACHE/AICHE. Ed encourages the use of Polymath instead of MATLAB in early instruction because it is easier to learn and use.

Terry Ring made a similar presentation on the use of MathCAD. It is also relatively easy and intuitive to use.
Academic licenses for ASPEN, Polymath, and MathCAD have been purchased and are available to students over the student server and may be installed on instructor's computers for academic use only.

**Criterion 7. Facilities**
The Fall 2006 Graduate Council Reviewers recommend that the department “Develop and implement a plan to bring all faculty offices and laboratories together. This will help unite the department and serve the students better.” The entire College is struggling with the complicated problem of space.

**Remodeling of Senior Projects Laboratory**
The Department has embarked on a development plan to finance the remodeling of our senior projects laboratory. The main goals of the effort are to (1) upgrade or replace aging equipment and instruments, (2) contribute to good pedagogy by enabling demonstrations and lab experiments in core ChE courses, (3) combine several areas of instruction (experiment, simulation, and control), (4) help integrate our curriculum, (5) promote interactions with industry, and (6) take a systems approach to chemical engineering.

**Improvements to ChE Laboratory**
The teaching laboratory is being continuously upgraded and maintained as funding becomes available. The following improvements were made in 2006-2007.
- pH control apparatus redesigned to add improved mixing and flow control.
- Analog pressure gauges added to liquid flow bench.
- New Opto22 control system with improved PID control added to heat control process.
- New UV-VIS spectrometer installed in instrument analysis lab.
- Opto22 temperature data logging added to glass lined reactor.
- Gas humidifier and heater installed on fuel cell to improve performance.
- New crane and liquid flow control experiments installed.
- New HPLC installed in instrumental analysis lab.
- The laboratory ventilation system was isolated from the HEDCO micro fabrication laboratory to prevent toxic compounds from contaminating the project lab.

**Information Technology**
Student computing facilities in Chemical Engineering comprise 45 computers in 3 locations in Merrill Engineering Building. The ICC Classroom is accessible 24/7 via University ID card while the other facilities are accessible in person 9am – 5pm during the work week and remotely 24/7 (via VPN and remote desktop). Each registered student is provided access to these facilities including personal data storage, centralized group storage, classroom storage an e-mail address, and unlimited free printing. In addition, each workstation is installed with all the
software required to complete coursework including Aspen, Control Station, Matlab, Mathcad, Fluent, Comsol, and the Microsoft Office suite.

We are on a 3 year replacement cycle for all lab hardware and summer 2007 we will be upgrading 17 machines in the ICC lab. Over the next year (2007-2008) the upgrade will include 17 student lab computers and the file server where the student profiles are stored.

**Criterion 8. Institutional Support and Financial Resources**

**Budget for Non-personnel Costs**
The Fall 2006 Graduate Council internal reviewers comment that, “not unique to this Department, the budget for non-personal costs has remained static since about the Carter administration while costs and needs continue to rise. For example, much of the physical undergraduate teaching laboratory equipment is old and out of date. The Department, together with the College, should look critically at finding a solution to rebalance needs and resources.” This difficulty, particularly with regard to student laboratory equipment, has been partly addressed by funding from the State Legislature. The Base Engineering Equipment Fund (BEEF) was created through a special appropriation to the College of Engineering to provide ongoing funding to support and enhance the teaching mission of the College with a focus on undergraduate teaching laboratories. BEEF grants are available up to a maximum of $99,000 and are comprised of 1/3 BEEF funds, 1/3 private match from the submitting department, and 1/3 administrative match from the College and Senior Vice President. Department matches may come from donations, in-kind equipment grants, educational discounts over and above the normal discounts, or other non-state funds. Chemical Engineering has consistently been able to qualify for maximum funding under BEEF.

**Warnock Engineering Building**
The Warnock Engineering Building is scheduled to open Fall 2008. The new building is remarkable for its state-of-the-art lecture halls, tutoring center, and study space for students.

**Marriott Library**
The Marriott Library is being upgraded to include high-tech classrooms, a technology intensive center staffed with librarians, and small group study areas. The remodeling is improving seismic stability and bringing the building up to code.

**Criterion 9. Program Criteria**

**Fundamentals of Engineering Examination**
The FE Examination allows comparison of the performance of U of U students and their peers from across the country in most of the areas included in the Chemical Engineering Criteria. The results from the October 2006 exam are
summarized in Tables 3 and 4 (see p. 12). Table 3 shows areas where U of U students performed better than the national average. Table 4 shows areas where U of U students performed below the national average. The only area of real weakness is in engineering probability and statistics. This is understandable given that statistics is a technical elective and many of our students do not select it.

**Biology and the Fall 2006 Graduate Council Review**

The Program Criteria for chemical engineering curriculum specifically mention biology as a basic science, as “appropriate to the objectives of the program.” As noted above under Criterion 5, the Fall 2006 Graduate Council Review suggests including one or more biology courses earlier in our curriculum. The members of the faculty have not yet decided how to address this issue. If we add a course to the second year, we will need to drop something. One possible candidate would be ME EN 1300, Statics and Strength of Materials. Statics and strength of materials, however, are heavily weighted in the general portion of the FE Examination, which we require all of our students to pass in order to graduate.