Assessment Findings and Curricular Improvements

School of Engineering

Department of Biomedical Engineering
Department of Civil Engineering
Department of Electrical Engineering
Department of Mechanical Engineering

Undergraduate Program

Table of Contents

Assessment Findings and Curricular Improvements
Department of Biomedical Engineering
Undergraduate Program

1.0 Assessment Measures:

Following the unified assessment process adopted by the School of Engineering (SOE), the Department of Biomedical Engineering (BE) uses four processes for assessing its program educational objectives (long-term goals for graduates) and nine processes to assess its program outcomes (short-term targets for students upon graduation). Figure 1 shows a schematic of the closed-loop assessment process adopted by the SOE. An overview of the measurement processes, who administers them, and frequency of data collection are summarized in Tables 1 and 2 below.

While several measures are survey-based, the department does utilize external assessment tools for independent evaluation of our students. One such metric, the Fundamentals of Engineering (FE) Exam (Process 1) is a national exam administered by the National Society of Professional Engineers (NSPE). The FE Exam provides a quantitative comparison of our students' performance in numerous engineering-related topic areas. Another external measure used is the interview of graduating seniors by the Department's Advisory Board which consists of prominent members from federal agencies, industry, and other academic institutions.

In addition to the SOE's unified assessment process, the University as a whole uses select data from the National Survey of Student Engagement (NSSE) to assess its general education goals. The BE Department also uses NSSE information to assess our seniors versus seniors at CUA and at our Carnegie Peers.

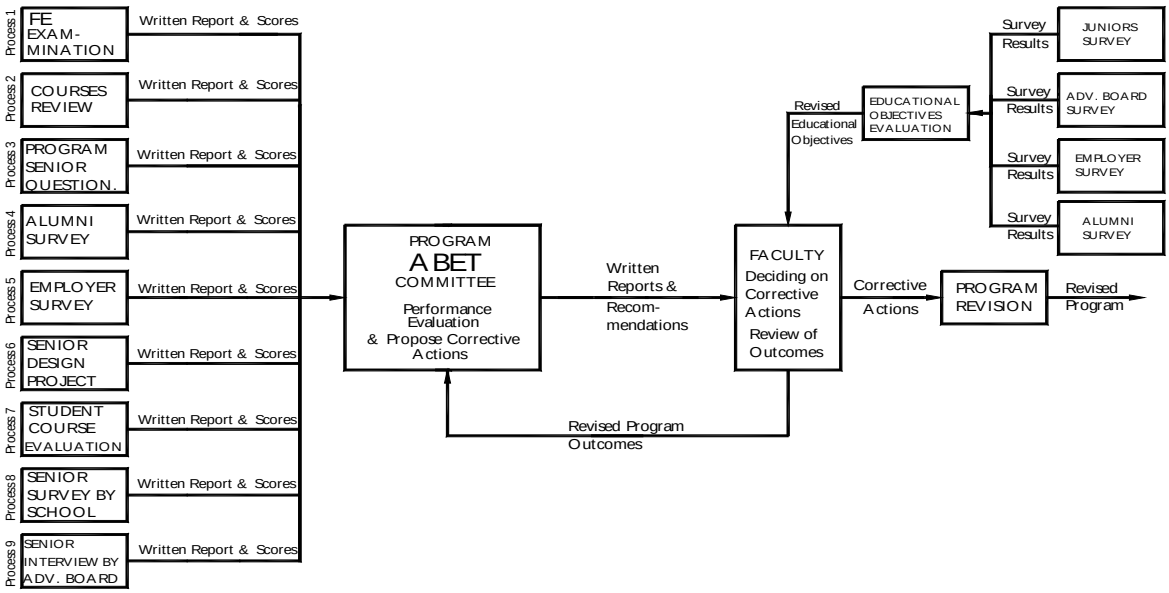


Figure 1: Schema for unified program assessment adopted by the School of Engineering.

Table 1: Processes used for assessing program educational objectives.

Process	Conducted by	Frequency
Process 1: Junior Survey	Dept	Every 3 yrs
Process 2: Alumni Survey	Dept	Every 3 yrs
Process 3: Employer Survey	Dept	Every 3 Yrs
Process 4: Advisory Board Survey	Dept	Every 3 Yrs

Table 2: Processes used for assessing program (learning) outcomes.

Process	Conducted by	Frequency
Process 1: Fundamentals of Engineering (FE) Exam	NSPE	Yearly
Process 2: Review of Required Courses	Dept	Yearly
Process 3: Program Graduating Senior Questionnaire	Dept	Yearly
Process 4: Alumni Survey	Dept	Every 3 yrs
Process 5: Employer Survey	Dept	Every 3 Yrs
Process 6: Senior Design Project Review	Dept	Yearly
Process 7: Student Course Evaluation	Dept	Yearly
Process 8: School Survey of Graduating Seniors	Dean's Office	Yearly
Process 9: Graduating Seniors Interview by Dept Adv. Board	BE Adv. Board (Dept)	Yearly

2.0 Assessment Findings:

Assessment findings and results are summarized here for both program educational objectives (2.1) and program outcomes (2.2).

2.1 Program Educational Objectives

As shown in Table 1, program educational objectives (PEOs) are assessed every 3 years per the SOE Assessment Handbook adopted by all engineering programs at CUA in Fall 2004. PEOs were last assessed by the program in AY 2004-05. For this cycle, the program surveyed current juniors, alumni and employers. Because the BE program holds its Advisory Board meetings in early Fall, the Advisory Board was not surveyed because the measurement tool was not yet available at the time. Figure 2 shows the composite scores for all 3 biomedical engineering department PEOs. The minimum desired level set by the program in 2004 was 3.0 out of 5.0 and clearly all composite scores exceeded the desired levels.

The department is currently in process of re-assessing PEOs. This assessment is expected to be completed during summer 2008.

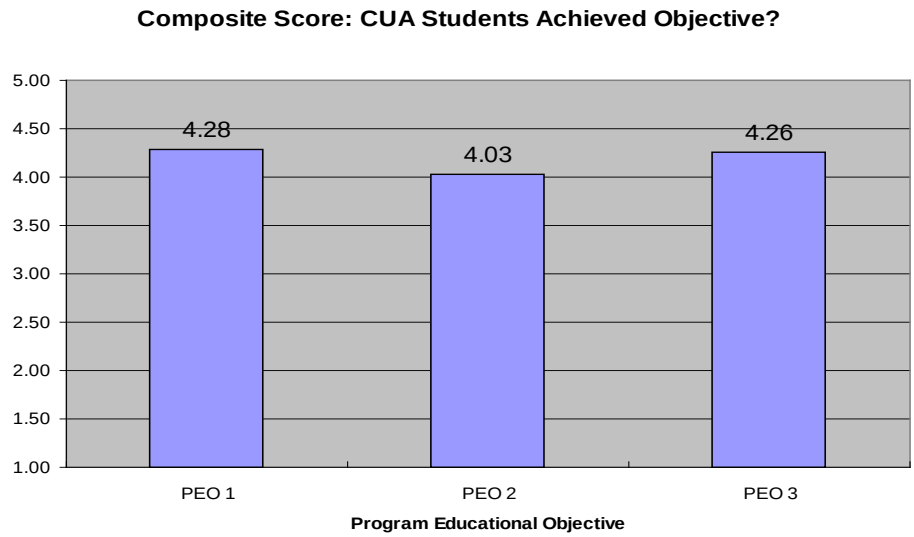


Figure 2: Composite score from PEO assessment measures for "*achievement* of PEOs".

2.2 Program Learning Outcomes

From 2001-2005, the BE program has utilized a 3.0 threshold (out of 5) as an acceptable level required for each outcome. This level was deemed by the BE ABET Committee to be a minimum level of achievement, below which "corrective" actions would be implemented. Between 3.0-3.5, the item would be "monitored" for potential action. Because in recent years CUA's BE program graduated between 6-10 students, there could be quite a bit of fluctuation in assessment data due to the small size of each class. As such, the BE ABET Committee has chosen to not "overreact" to data from any particular year and has set a relatively conservative 3.0 threshold level in this period. Additionally, the changes in the assessment process from a Department accreditation process (2001-2004) to a School-wide accreditation process (since 2004) has also played a role in maintaining a 3.0 desired threshold level for each assessed outcome until the full impact of the process changes have been observed.

In 2005, because of the program's satisfaction with the outcomes being assessed, the BE ABET Committee decided to increase the desired threshold levels from 3.0 to 3.5 in order to further increase the quality of the program's product, our students.

2.2.1 Summary Data for Program Outcomes Assessment-Cumulative & By Process

A summary of the assessment process for each of the 11 BE program outcomes for the past 3 years under the Schoolwide accreditation process is shown in **Figure 3**.

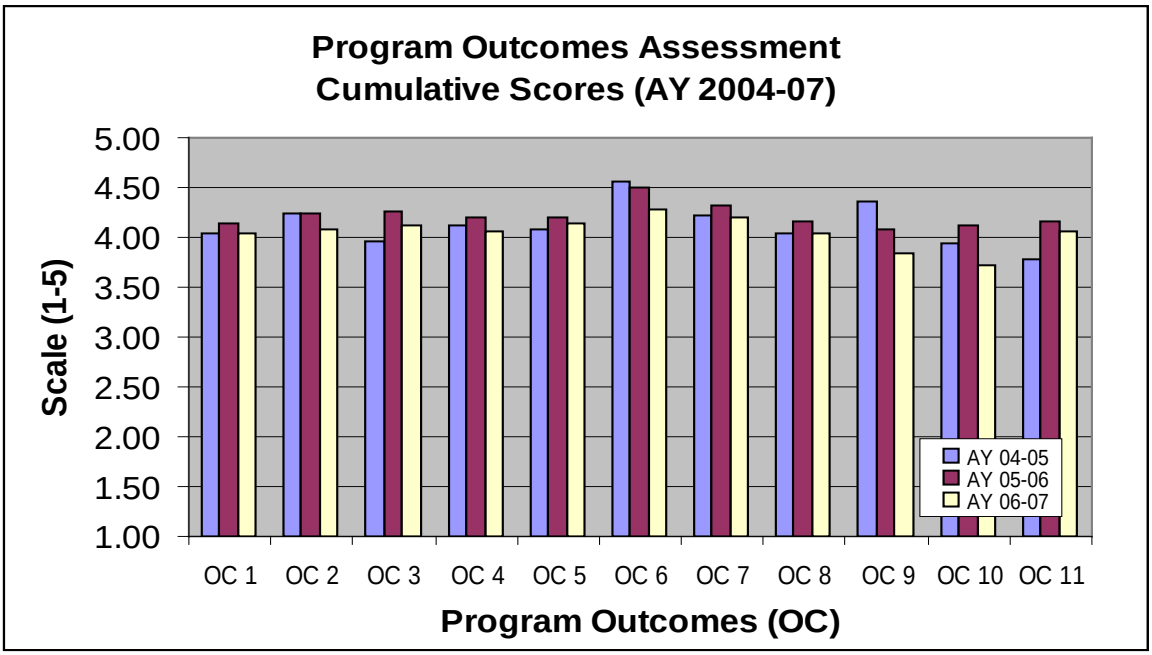


Figure 3: Cumulative scores for BE program outcomes using all assessment processes with applied weight factors for AY 2004-05, AY 2005-06 and AY 2006-07. Desired threshold = 3.5.

While Figure 3 depicts the cumulative assessment scores for each program outcome computed from all assessment processes, **Table 3** provides a detailed breakdown of the 3-year scores for each program outcome by process.

In some cases, data was not available for a particular process in AY 2004-05 because the SOE unified assessment structure had not yet adopted that process for AY 2004-05. For Process 1, the FE Exam was approved as a process for assessment in AY 2004-05, but not formally adopted until AY 2005-06 because of issues related to mass registration of all SOE seniors. These include where to take the exam (i.e. DC, MD, VA) and each state's unique requirements for registration, fees, transportation, etc.

It should be noted that data for Process 4 and Process 5 are collected once every 3 years along with PEO assessment and should remain unchanged during the 3-year period. In some cases (as in Process 4 AY 2004-05 and AY 2005-06, the data may change slightly if surveys are returned after the data has been processed. For process 4, an additional 2 surveys were returned after the AY 2004-05 data had been processed, hence the results for Process 4 vary slightly from that in the previous year.

Implementation of Process 9 into the assessment process did not occur for the BE program until AY 2005-06. This process was not adopted until late Fall 2004, by which time the BE Advisory Board had already convened (in October 2004).

Table 3: Summary Data for BE Program Outcomes for AY 04-05, AY 05-06, AY 06-07.

	Process 1: FE Exam			Process 2: Inst-Course Eval			Process 3: BE Sr. Survey		
	AY 04-05	AY 05-06	AY 06-07	AY 04-05	AY 05-06	AY 06-07	AY 04-05	AY 05-06	AY 06-07
PO1	-	3.70	3.39	3.83	3.90	4.81	3.95	4.50	4.29
PO2	-	3.68	3.93	4.40	4.24	4.27	4.40	4.50	4.43
PO3	-	-	-	4.10	3.89	4.65	3.85	4.67	4.29
PO4	-	-	-	4.10	3.93	4.32	3.90	4.33	3.86
PO5	-	-	-	3.95	3.84	4.67	4.10	4.33	3.86
PO6	-	4.20	3.80	4.13	4.00	4.22	-	4.50	3.86
PO7	-	-	-	4.21	3.75	4.41	4.03	4.67	4.14
PO8	-	-	-	-	-	4.25	3.57	4.50	3.71
PO9	-	-	-	3.69	3.74	4.38	4.70	4.50	4.71
PO10	-	-	-	4.31	3.80	4.61	-	4.50	3.71
PO11	-	3.52	3.61	4.03	4.07	4.56	3.30	4.33	3.86

	Process 4: Alumni			Process 5: Employer Survey			Process 6: Sr Design		
	AY 04-05	AY 05-06	AY 06-07	AY 04-05	AY 05-06	AY 06-07	AY 04-05	AY 05-06	AY 06-07
PO1	4.17	4.25	4.25	4.00	4.00	4.00	-	-	-
PO2	4.11	4.00	4.00	4.00	4.00	4.00	-	-	-
PO3	4.12	3.86	3.86	4.00	4.00	4.00	4.53	4.16	4.31
PO4	4.00	3.88	3.88	4.33	4.33	4.33	4.40	4.30	4.36
PO5	4.00	4.00	4.00	4.25	4.25	4.25	4.60	4.11	4.18
PO6	4.61	4.50	4.50	4.75	4.75	4.75	4.20	-	-
PO7	4.17	3.75	3.75	4.50	4.50	4.50	4.50	4.32	4.60
PO8	4.50	4.25	4.25	4.25	4.25	4.25	4.40	3.40	4.29
PO9	4.12	3.75	3.75	4.50	4.50	4.50	4.80	4.14	4.17
PO10	3.67	3.63	3.63	4.25	4.25	4.25	4.60	-	-
PO11	3.94	3.88	3.88	4.25	4.25	4.25	4.40	4.09	4.26

	Process 7: Student Course Eval			Process 8: SOE Sr Survey			Process 9: Adv. Board Survey		
	AY 04-05	AY 05-06	AY 06-07	AY 04-05	AY 05-06	AY 06-07	AY 04-05	AY 05-06	AY 06-07
PO1	3.83	3.90	3.94	4.31	4.67	4.25	-	4.75	4.00
PO2	4.40	4.24	3.97	4.23	4.67	4.00	-	4.75	4.00
PO3	4.10	3.89	3.84	3.92	4.83	4.50	-	5.00	4.33
PO4	4.10	3.93	3.78	4.23	5.00	4.75	-	5.00	4.00
PO5	3.95	3.84	3.97	4.15	4.67	4.25	-	5.00	4.67
PO6	4.13	4.00	3.68	4.54	4.83	4.50	-	5.00	4.50
PO7	4.21	3.75	3.79	4.23	5.00	4.75	-	5.00	3.67
PO8				3.85	4.50	3.50	-	5.00	4.00
PO9	3.69	3.74	3.19	4.62	4.50	3.75	-	4.75	3.67
PO10	4.31	3.80	3.67	3.85	4.17	3.00	-	4.75	4.00
PO11	4.03	4.07	4.00	3.85	4.33	3.75	-	4.75	4.33

2.2.2 Summary of Process-by-Process Results:

Process 1: FE Exam

In October 2005 (n=11) and October 2006 (n=11), BE students were required to take the FE Exam as part of the required SOE Senior Seminar course (ENGR 401). In 2005, 6 of 11 students passed the exam. In 2006, 4 out of 11 students passed the exam. While passing the exam provides some information about the students, it is more important to look at topic scores compared to peers at other institutions. Thus, scores are normalized relative to national averages by others taking the FE Exam with 100% of the average scaled to a 4 out of 5..

The difficulty with overweighting this particular process for BE is that while the FE Exam is widely taken and accepted by many engineering disciplines, many biomedical engineering program have not yet encouraged their students to take the exam. Overall only 32 BE students took the exam in 2005 (includes CUA's 11 students) and only 25 BE students nationwide took the exam in 2006 (includes CUA's 11 students). Because these samples for BE students nationally are relatively small, we decided instead to normalize the BE program's student scores to national averages for mechanical engineering. While we believe this to be the most appropriate normalization of the data, we are cautious in overreacting to the results because of the curricular differences. For example, our curriculum does not include formal courses in Dynamics, Strength of Materials, and Material Properties, all topics that are aggregated into the score for PO 1. In these particular topic areas, we expect our students to score lower than national averages for ME students. However, we did observe below average scores in "Thermodynamics & Heat Transfer" (our students take Thermo, but not Heat Transfer) and "Fluid Mechanics" (our students only take 1-course whereas most ME programs have 2-semesters of fluids). Instruction in these topic areas are being evaluated for changes by the SOE Undergraduate Committee.

Corrective Action- FE Exam:

In 2006, the Senior Seminar instructor coordinated refresher review sessions conducted by faculty to help prepare students for the FE Exam.

Two courses (Thermodynamics and Fluid Mechanics) are currently under review by the SOE Undergraduate Committee for instructional changes.

Process 2: Course Review with Instructors

Course reviews have been conducted by the Chair in consult with individual instructors since AY 2005. This is done usually at the end of each academic year for each course taught by BE faculty and includes completion of Form 11 (i.e. Course Evaluation) of the SOE Accreditation Handbook.

Overall, aggregate scores of all courses reviewed for each year for this process do not indicate any areas needing monitoring and review. In AY 2006-07, all scores were substantially above the 3.5 threshold level. This is most likely a result of continued refinement of the syllabi and course assessment process over the past several years of implementing the unified SOE accreditation process.

Corrective Action-Course Review:

In AY 2004-05 and AY 2005-06, instructors were transitioning to the new syllabi, formats, and expectations for assessment and evaluation of courses based upon the unified SOE accreditation process, namely the scoring on Form 11. These changes to the syllabi made it easier to evaluate courses in their ability to meet course objectives and how they relate to program and ABET outcomes. In AY 2006-07, scores for this process increased substantially as a result of 2 cycles of implementation of this process.

There are no corrective actions planned for AY 2007-08 for this process.

Process 3: BE Senior Survey

In the last semester of their senior year, BE students are surveyed using Form 5 (BE Graduating Senior Questionnaire). This was done for AY 2004-05 (n=6 out of 6 graduating seniors), AY 2005-06 (n=6 out of 12), and AY 2006-07 (n=8 out of 9). The Senior Questionnaire survey students' achievements of the program outcomes as well as soliciting open-ended responses for areas of improvement. This senior survey is conducted as a group and moderated by the BE Chair. The meeting is a forum for students to provide feedback for improving the program.

Overall, as seen in Table 3, scores for each of the program outcomes over the 3-year period were above the benchmark threshold. It should be noted that in AY 04-05, the threshold was at 3 out of 5 and starting in AY 05-06 was raised to 3.5 out of 5.

In addition to the program outcomes, students were asked to score other areas of the program including preparation for career, quality of engineering courses, BE courses, liberal study courses, design experience, faculty, and advising. This is summarized in the following Table 4.

Overall Rating	AY 05-06	AY 06-07
Educ Preparation	3.96	3.91
Engr Classes	3.75	3.52
Biomed Classes	4.17	4.38
Lib Study Classes	3.54	***2.97***
Senior Design	4.38	5.00
Biomed Faculty	3.96	3.75
Advising	3.96	***2.50***

Table 4: Additional rating items on BE Senior Questionnaire.

Two important points should be highlighted from the AY 2006-07 seniors. First, students were dissatisfied with the liberal studies course options, namely the restrictions requiring 3 religion courses and also the policy not to count certain "skill-level" courses for meeting the liberal

studies requirement. As these are University wide requirements, no corrective actions are recommended.

The second key area of dissatisfaction was with the academic advising received from the AY 2006-07 group. This group felt that their advisor was not particularly helpful in the selection of program electives, liberal studies, and career advisement, as well as not generally available to respond to questions. The BE Chair has shared the aggregate comments and results from this group with the academic advisor, as well as to the entire BE faculty for the purpose of improving faculty-student advising. BE faculty advising students were asked to continue to work with students more actively to assist with course selection and assist with locating internships/job leads as appropriate.

Corrective Action-BE Senior Survey:

There are no corrective actions planned for AY 2007-08 for this process relating to program outcomes assessment.

The department plans to incorporate into the BE seminar sequence opportunities for additional faculty-student interaction so students can dialogue with faculty advisors. Additionally, the department will re-institute our department-wide Fall/Spring group advising sessions where students can meet one-on-one with faculty advisors, but also will have access to the BE Chair for any general questions that cannot be answered by faculty. Also, the BE Chair will meet with each class annually (similar to annual meeting with graduating seniors). This will provide more timely feedback and allow for corrective actions to be implemented, as needed.

Process 4: Alumni Survey

Alumni were surveyed during AY 2004-05. Approximately 150 surveys were sent out to alumni from 1991-2004. There were 22 responses (20 used for AY 04-05 analysis and 2 additional afterwards) returned and analyzed. An average of all surveys returned showed the program was achieving its program outcomes based upon this metric. There were very few additional comments.

Corrective Action-Alumni Survey:

There are no corrective actions planned for AY 2007-08 based upon this process.

Process 5: Employer Survey

Along with all surveys sent to alumni in AY 2004-05, alumni were asked to have their direct supervisors and employers complete the Employer Survey. This was deemed the most direct and effective way to contact employers and solicit their responses. Only 4 surveys from employers were returned for analysis.

Data from the analyses evaluated the appropriateness of the program outcomes (as well as program educational objectives) and also the level to which our alumni employed by the company achieved the program outcome. The average data presented in Table B.9 shows all program outcome scores were substantially above the threshold level.

Corrective Action-Employer Survey:

There are no corrective actions planned for AY 2007-08 based upon this process.

Process 6: BE Senior Design

The BE Department has held open presentations for the past 4 years in which Seniors present their design project to a general audience of faculty, students and invited guests. Since 2004, the presentations have been conducted in combination with the BE Junior Design course and external judges have been invited to review and score presentations for accreditation purposes. All BE faculty are present and score each of the design presentations (Senior & Junior) along with project advisors and the course instructor. Faculty from other departments are also invited to attend and participate in project scoring.

The 3-year scores for Process 6 (Senior Design) are provided in Table B.9. It should be noted that in AY 2004-05, the department utilized a different scoring form because the form for the unified SOE accreditation process had not yet been developed by the completion of the Fall 2004 semester. Most other departments have 2 semester senior design courses that culminate in the Spring semester and hence were able to adopt Form 10 for that academic year. Form 10 was adopted by BE in AY 2005-06 for the first time.

Upon review analyses of the results from AY 2005-06, it was deemed that the question on Form 10 relating to ABET outcome (h)/PO 8 (broad understanding of impact on engineering solutions in global, economic, environmental, and societal concept) was inappropriately narrow to focus only on legal issues and was the reason for the low PO 8 score in AY 2005-06. This observation was presented to the SOE Accreditation Committee and was modified to include other aspects appropriate for "broader impacts of design" such as "end-user needs, market size & needs, intellectual property, product safety, legal and liability issues." When appropriately posed, the low score for PO 8 in AY 2005-06 rose to 4.29, confirming that the score was due to poor wording of the question.

Corrective Action-BE Senior Design:

In AY 2005-06, the BE program adopted Form 10 of the unified SOE Accreditation process for the 1st time. After applying Form 10, it was discovered the question relating to PO 8 was inappropriately narrow in focus and needed to be reworded. This correction was made for implementation in AY 2006-07 and corrected the low score for this program outcome from the prior year. There were no other outcomes found to be below the expected threshold level.

There are no corrective actions planned for AY 2007-08 based upon this process.

Process 7: Student Course Evaluations

Student course evaluations are conducted by the University for all undergraduate level courses each semester. This method has been adopted as a part of the BE outcomes assessment process since before 2001. While subjective, it provides a student (identified as a program constituent) perspective of the course and its ability to achieve desired outcomes. Student course evaluation results are provided to departments chairs who review them and then pass them along to individual faculty members for their review and use for course improvement. All faculty have access to these results online at http://evaluations.cua.edu.

The summary of the aggregated student course evaluations by program outcome is provided in Table B.9. All data for each program outcome is above the threshold level except for that for PO9 ("lifelong learning") in AY 2006-07. First, it should be noted that for AY 2006-07 only includes data from Fall 2006 as Spring 2007 results are not yet available at the time of this report. This may account for some of the differences in the AY 2006-07 results from previous years as there are a number of courses that would influence the program outcome scores. Further, PO9 is weighted heavily due to the score from ENGR 401 (Senior Seminar) which did not receive favorable reviews from students taking the course. Students felt the ENGR 401 seminar was too narrowly focused on FE Exam preparations and did not provide seminars that would enhance the "appreciation for lifelong learning." The SOE Undergraduate Committee is reviewing ENGR 401 to correct this issue.

Corrective Action-Student Course Evaluations:

ENGR 401 is being reviewed by the SOE Undergraduate Committee for AY 2007-08 based upon this process. The committee chair and dean are working with the instructor to incorporate and invite more appropriate seminar presenters that would be appropriate for all engineering students.

Process 8: SOE Senior Survey

For the past several years, the Dean has conducted surveys of all graduating engineering students utilizing Form 6. The 3-year summary of data is provided under Process 8 of Table B.9. While data for AY 04-05 and AY 05-06 are substantially above the 3.5 threshold levels, in AY 06-07, two items were identified as needing attention.

PO 8 (ethics/religion) requires monitoring with a 3.5 score, barely meeting the expected threshold. Student feedback specifically focused on Phil 362 (Engineering Ethics). Students felt the course was too focused on Aristotalean philosophy/ethics and did not have enough relating to "engineering ethics" nor real practical problems in industry. This course is under review by the SOE Undergraduate Committee and discussions are taking place to modify this course with the department of philosophy who teaches the course.

More significantly, for AY 2006-07, PO 10 (contemporary issues in BE) received a score (3.0) below the expected threshold level. While some students commented that the BE 491 (BE

Seminar) courses was helpful in providing speakers in many different areas of biomedical engineering, they felt ENGR 401 did not provide much relating to contemporary issues. It seemed that students did not make a connection between the various program electives offered and taken with this program outcome. The department offers program electives in numerous topics such as medical imaging, rehabilitation engineering, gait and movement analyses and biomechanics, biomedical signal processing, cell and tissue engineering, biotechnology, clinical engineering, human computer interfaces, telemedicine, etc., all of which are intended to provide breadth of knowledge relating to contemporary issues.

Corrective Action-SOE Senior Survey:

Several corrective actions are planned for AY 2007-08 based upon this process.

Speakers for BE 491 will be selected to provide broad discussions in contemporary topics in biomedical engineering and will come from research, industry and other areas. In the past, students have commented that BE 491 speakers have been too "research focused."

ENGR 401 will incorporate speakers discussing contemporary issues with societal impacts (i.e. global warming, environmental engineering, stem cell research, etc).

Throughout the curriculum, students will be educated and reminded regarding how their courses relate to contemporary topics in biomedical engineering.

Process 9: Advisory Board Survey of Seniors

In AY 2005-06 and AY 2006-07, the BE Advisory Board began interviewing graduating seniors regarding the program. The BE Advisory Board usually meets in the Fall semester of each academic year and this process is completed as part of the board meeting.

As seen in the scores for Process 9 of Table B.9, all scores were above the expected threshold level of 3.5. There were two areas that score lower than 4.0 (PO7-communication and PO9-lifelong learning). While students have ample opportunities for written and oral presentations within the curriculum, students expressed a desire to have more technical writing training. This issue is being monitored by the program.

Corrective Action-Advisory Board Survey:

There are no corrective actions planned for AY 2007-08 based upon this process. The program is currently monitoring the need for increased technical writing training within the program. This is currently done several courses (i.e. ENGR 104, BE 202, BE 315, BE 398, BE 494 and BE 497), but there is no separate course for technical writing.

3.0 Overall Summary of Assessment and Program Improvements:

Over the past 3 years under the unified school-wide accreditation procedures, the BE program did not identify any outcomes below expected levels as shown in Figure 3. In 2005, the BE Accreditation Committee did agree to study where PO 11 ("modern engineering tools for practice") was targeted and addressed in our curriculum because it was the lowest cumulative score in AY 2004-05. Dr. Hidler of the faculty surveyed course instructors to assess the level of utilization of modern tools in the BE curriculum. The results of this survey were presented in the AY 2005-06 BE ABET report. In that report, it was deemed that there was adequate coverage and adoption of modern tools throughout all four years of the BE curriculum.

In 2005-06, the BE faculty implemented a laboratory component for ENGR 503 ("Controls") to enhance application of theory taught in the course. The School supported the effort through a $40,000 investment in 5 "controls" lab workstations.

Additionally, in summer of 2006, the BE Department implemented a 3rd revision of our BE Design Center to expand from 5 to 8 design stations in order to accommodate the growing UG student size. Each design station is comprised of a PC workstation, electronics instrumentation, tools, and miscellaneous equipment needed for design projects. Further the BE Design Center has fabrication and machine shop equipment needed for successful completion of projects.

In AY 2007-08, the BE Department began to utilize information from the National Survey of Student Engagement (NSSE), in addition to the existing unified ABET processes, to assess the our students ability to meet the University's general education goals. A review of the 2007 NSSE data for biomedical engineering seniors (from the previous year) shows:

1. BE students exceeded CUA's and Carnegie Peers in the category related to "proficiency in oral and written communication."
2. BE students exceeded CUA's and Carnegie Peers in the category related to "critical thinking and reasoned analysis."
3. BE students exceeded CUA's and Carnegie Peers in the category related to "understanding of scientific and quantitative reasoning."
4. BE students scored below CUA and Carnegie Peers in the category related to "ability to find information effectively using appropriate resources and technologies, critically assess information, and utilize it in ethical/legal ways."
5. BE students scored below CUA and Carnegie Peers in the category related to "demonstrating knowledge of different cultures and religions."

Because of the small size of each senior class (8-12 students), results may fluctuate considerably from year to year and we are cautious to over interpret data from any one year. The BE department will monitor items (4) and (5) from the NSSE results to better understand the issues related to these topics. Overall, these results are consistent with the department's own findings from the other ABET assessment processes as well as specifically the department's own Senior Exit surveys in which students recommend better access to online research materials (i.e. journals, conference proceedings, etc).

Overall, while there are some program outcomes that are below the threshold levels for individual processes of the unified ABET assessment processes set forth by the School of Engineering, there are no outcomes that in aggregate score below the 3.5 threshold level (see Figure 3). Overall, it seems the program outcomes assessment process is working and the program outcomes are being achieved.

Likewise, assessment of the program educational objectives revealed that the program had surpassed the desired levels and was sufficiently meeting its long-term program educational objectives.

Assessment Findings and Curricular Improvements
Department of Civil Engineering
Undergraduate Program

Assessment Measures

The Department of Civil Engineering uses nine processes to assess departmental learning outcomes as part of its ABET (Accreditation Board for Engineering and Technology) process:

Process	Conducted by	How Often
Process 1: FE Examination	Dean's office	Yearly
Process 2: Review of Required Courses	Program	Yearly
Process 3: Program Graduating Senior Questionnaire	Program	Yearly
Process 4: Alumni Survey	Program	Every 3 years
Process 5: Employer Survey	Program	Every 3 years
Process 6: Senior Design Project	Program	Yearly
Process 7: Student Course Evaluation	Program	Yearly
Process 8: School Survey of Graduating Seniors	Dean's Office	Yearly
Process 9: Graduating Seniors Interview by Advisory Board Members	Program	Yearly

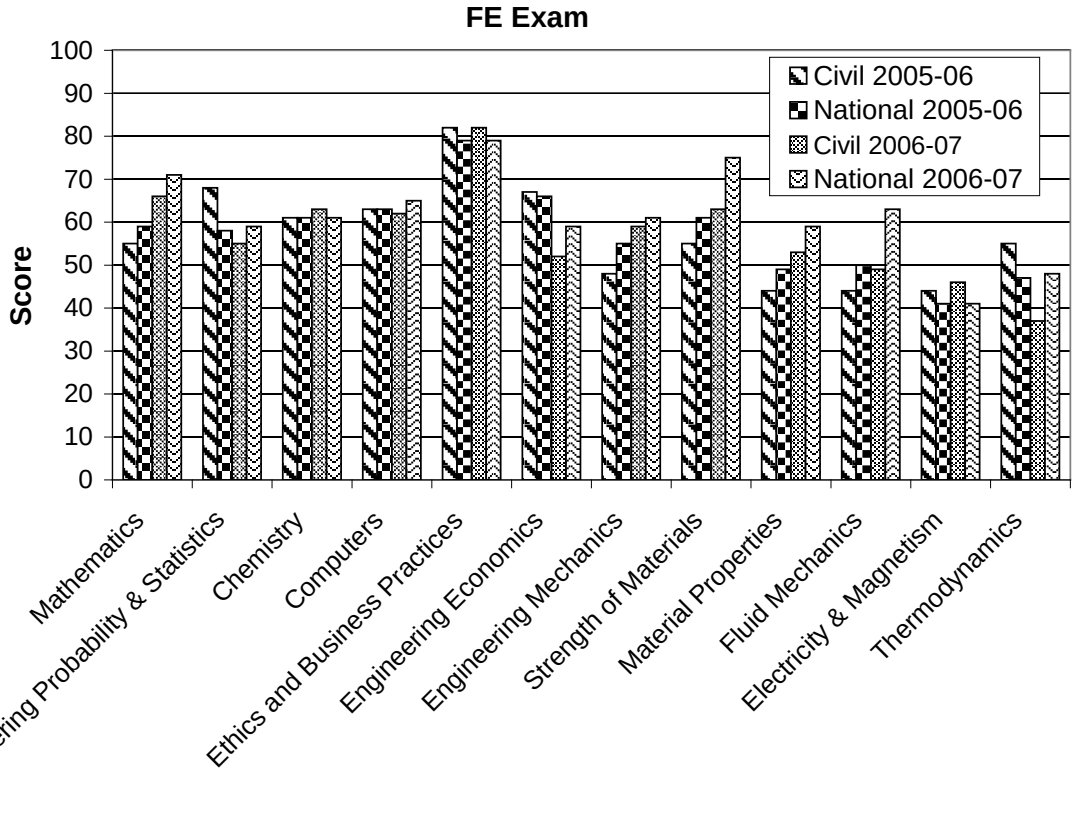
In addition, the University uses select data from the National Survey of Student Engagement (NSSE) to assess its general education goals. The Department of Civil Engineering has begun to use the NSSE data, in conjunction with the ABET processes, to assess the general education outcomes of its senior students in comparison with senior students at Catholic University and its Carnegie Peers.

3.8 Results of Assessments

3.8.1 Process 1-FE (Fundamentals of Engineering) Examination

The following bar graph shows the performance of the civil engineering students and the national performance. The scores for 2005-06 and 2006-07 are shown in Figure 3.2.

Figure 3.2. Comparison of performance of CUA civil engineering students with all students taking the FE Exam during 2005-06 and 2006-07.



Evaluation and Corrective Action

From the comparison in the above diagram, it is seen that our students tend to follow the trend of the national average in both years.

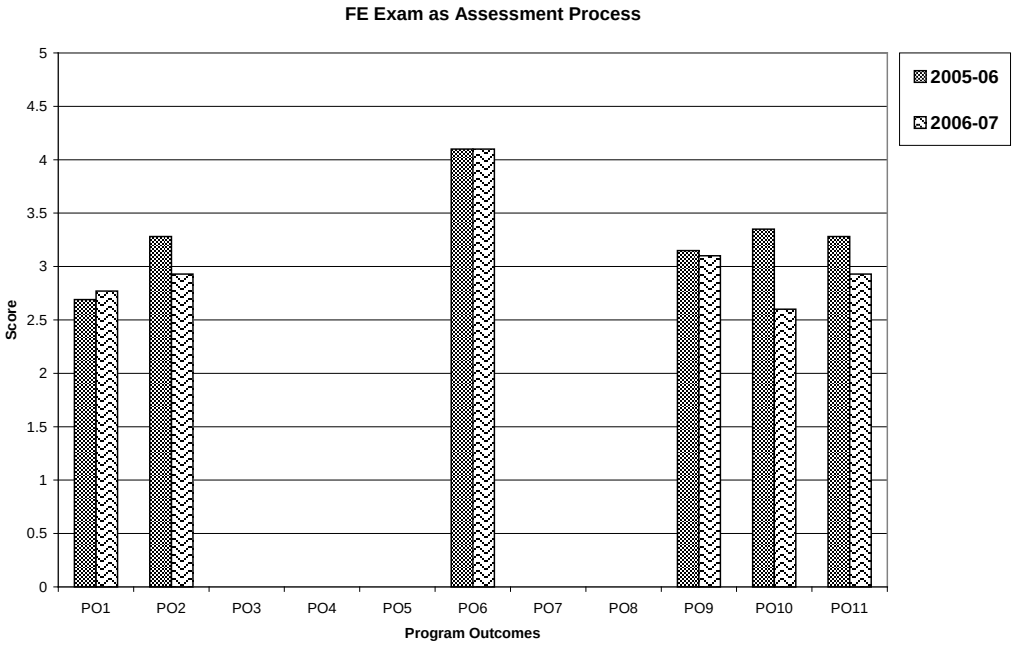
For these two years our students scored higher or similar to the national averages in Engineering Probability, Chemistry, Computers, Ethics and Business Practices, Engineering Economics, Electricity and Magnetism, and Thermodynamics.

However, our students' scores are lower than the national averages in Mathematics, Engineering Mechanics, Strength of Materials, Material Properties, and Fluid Mechanics. In the national examination, questions within Engineering Mechanics include both Statics and Dynamics. Our students were not required to take Dynamics in any of the branches of specialization (structural/geotechnical, construction, environmental engineering), and they may therefore have scored lower on the questions in Engineering Mechanics. A course on Dynamics has been introduced as a requirement in the structural/geotechnical engineering branch beginning with the juniors in the fall of 2006. In addition, our Theory of Structures course (CE 312) was augmented with a program elective on Theory of Structures II (CE 313) beginning with the spring of 2007, a course that will emphasize the behavior of indeterminate structures. This should enhance the

training and experience in the mechanics based subjects and improve the scores in these subjects on the FE exam.

Figure 3.3 shows the FE Exam AM portion results used as a process of outcome assessment.

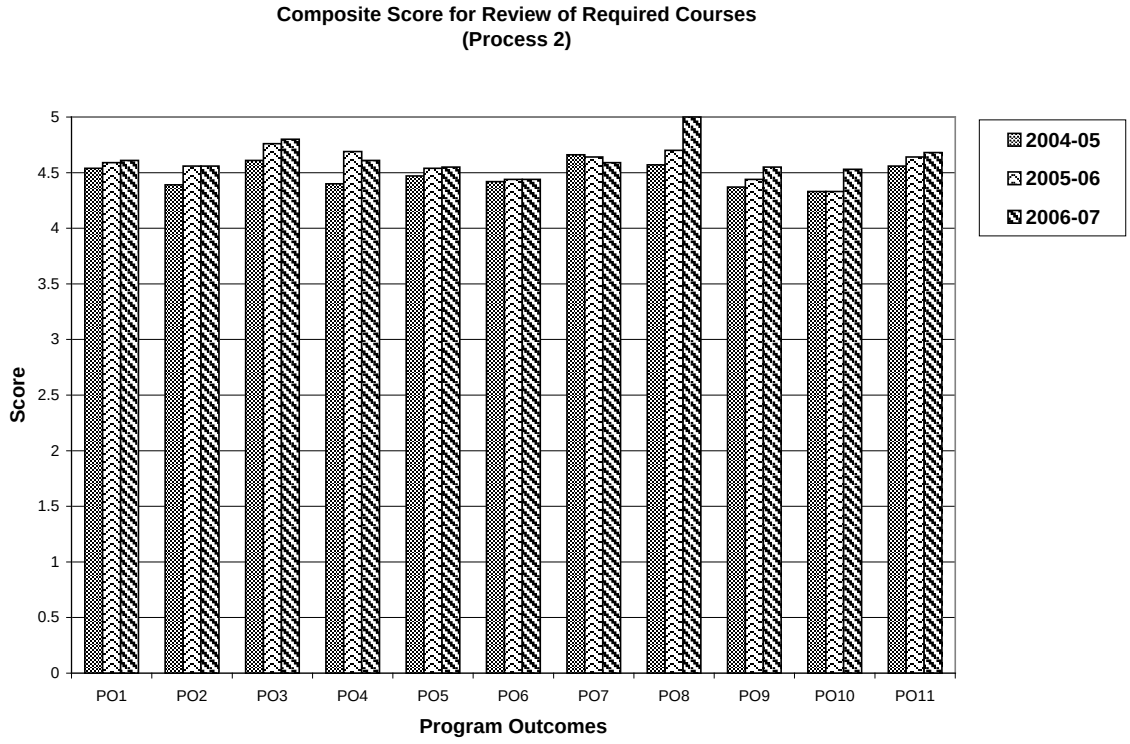
Figure 3.3. FE Exam scores related to and converted to Program Outcome scores.



3.8.2 Process 2-Review of Required Courses

Figure 3.4 shows the composite scores for 2004-05, 2005-06 and 2006-07.

Figure 3.4. Composite scores for review of courses for 2004-05, 2005-06 and 2006-07.



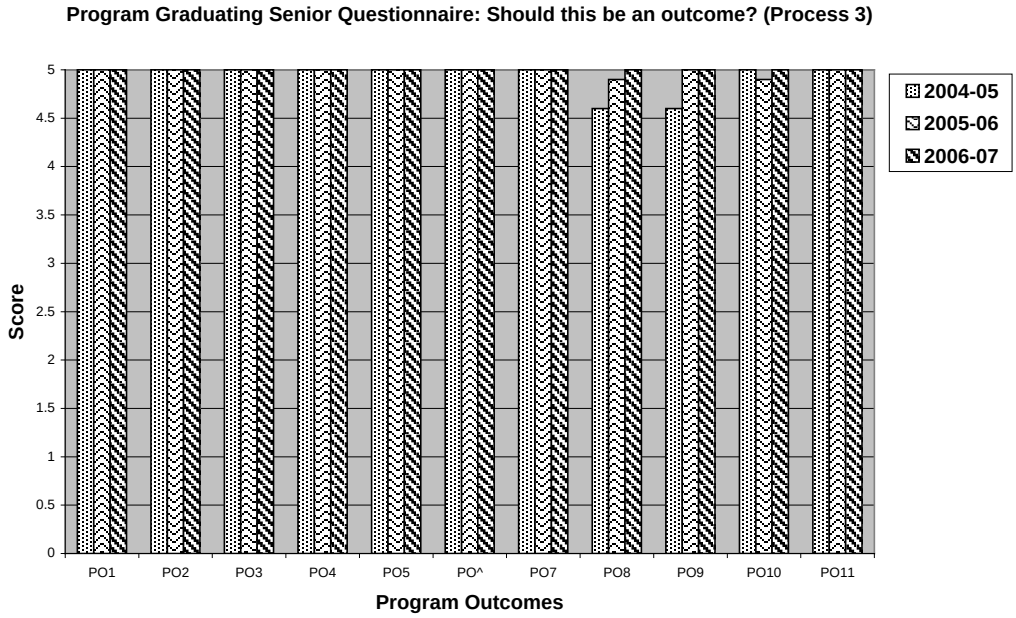
Evaluation and Corrective Action

The diagram shows that the scores have increased slightly for all Program Outcomes. This is a result of the initial review and modifications performed during 2004-05. Thus, all the courses have been reviewed and modified as found necessary resulting in an improved structure and rationale for each course in the context of the overall civil engineering program.

3.8.3 Process 3-Program Graduating Senior Questionnaire

Figures 3.5 and 3.6 show the composite scores for 2004-05, 2005-06 and 2006-07.

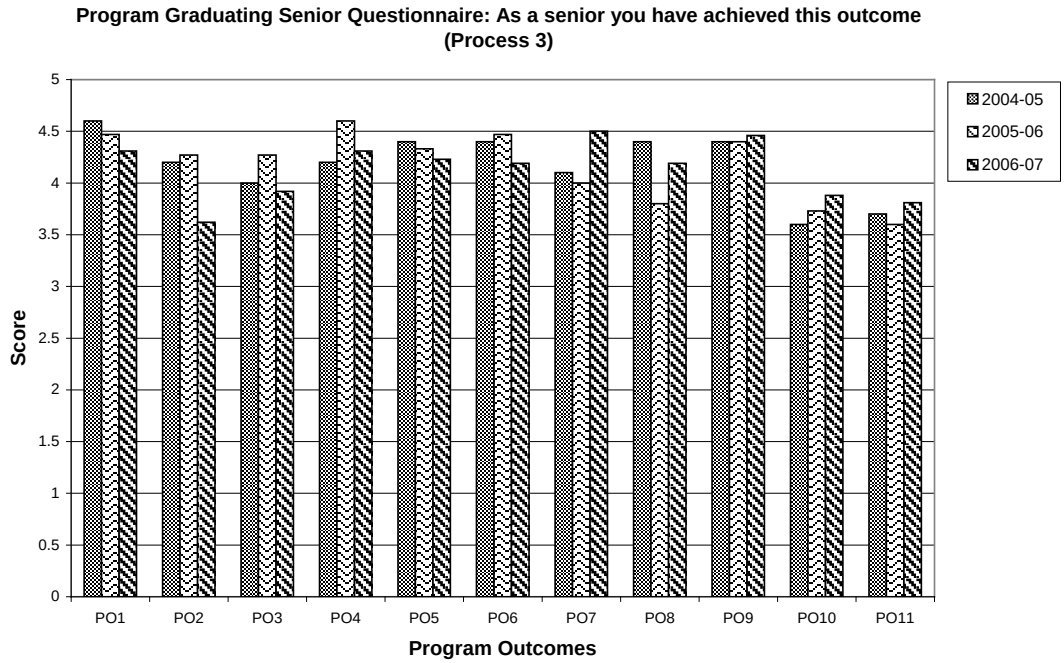
Figure 3.5. Composite scores for program graduating senior question: Should this be an outcome?



Evaluation and Corrective Action

The graduating seniors appear to agree that the eleven program outcomes are satisfactory, with a few comments indicated in connection with the second question the results of which are shown on Figure 3.6.

Figure 3.6. Composite scores for program graduating senior question: As a senior you have achieved this outcome?



Evaluation and Corrective Action

Comparison of the bar graphs from 2004-05, 2005-06 and 2006-07 indicates that similar patterns are obtained in the answers to the 11 program outcomes. Note that all scores for all Program Outcomes and all years are above 3.50 and most are above 4.0. Some scores need comments: For the most recent year of evaluation, AY 2006-07, two scores stood out as being different from those from the years before: Program Outcome #2 ("an ability to design and conduct experiments, as well as to analyze and interpret data") has previously received scores of 4.20 and 4.27 while a score of 3.62 was recorded for this year. Similarly, Program Outcome # 8 ("the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context") received a score of 3.80 for the year 2005-06, while the same outcome score was 4.40 the year before. The score for this outcome has rebounded to 4.19 for 2006-07, very similar to that of the survey in AY 2004-05. There is no obvious explanation for this difference. It appears that individual scores can fluctuate from year to year with no understandable explanation.

Figure 3.6 expresses a general satisfaction with the educational experience in civil engineering at CUA, since all scores are at 3.60 or above (out of 5). The lowest scores were obtained for the last two Program Outcomes for all years. Program Outcomes #10 ("a knowledge of contemporary issues") and #11 ("an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice"). The scores for these two outcomes are believed to express an uncertainty with regard to the learned capabilities, an uncertainty that hopefully will be alleviated with time and as the individual gains confidence in his/her abilities and preparedness

for practical engineering tasks. It is concluded that no modifications to the program are required on the basis of the evaluations presented above.

Comments and Observations by Graduating Seniors

A number of comments and observations were provided by the graduating seniors regarding their experiences relating to the civil engineering program at CUA. These are giver in summary form indicated as "Student Concern," and they are given verbatim in the individual annual reports for 2004-05, 2005-06 and 2006-07. The Department's responses and corrective action are also given below.

Department's Responses to Comments and Observations and Corrective Action

1. "Student Concern:" Why do we have a capstone design course in wastewater management for which we have little preparation?

"Department Response and Corrective Action:" The senior capstone design course (CE 576: Systems Design, emphasizing design of a water treatment facility) has been exchanged (spring 2006) with a structural/geotechnical engineering course, CE 520: Design of Structural Systems, for which the majority of CE students are better prepared.

2. "Student Concern:" There appears to be overlap in material between the construction courses.

"Department Response and Corrective Action:" Overlap of material in construction courses is continuously under review by our new faculty member in construction engineering and management.

3. "Student Concern:" Why do we have to take ENGR 102 and ENGR 104?

"Department Response and Corrective Action:" Courses ENGR 102: Introduction to Engineering Design and Professionalism and ENGR 104: Introduction to Engineering Laboratory are introduced in the first freshmen semester to motivate and interest the new students in engineering.

4. "Student Concern:" We are not exposed to topics indicated in Program Outcome #8.

"Department Response and Corrective Action:" ENGR 401: Senior Seminar I has been added to the School-wide curriculum to cover issues such those in Program Outcomes #8 ("the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context") and # 9 ("recognition of the need for, and an ability to engage in life-long learning"), as well as to prepare the seniors for the FE exam.

5. "Student Concern:" The computers are outdated and often don't work.

"Department Response and Corrective Action:" The computer facilities in the School were updated before the fall semester in 2005.

6. “Student Concern:” If I had known X, Y and Z earlier in my student life, then I would have done A, B and C! Why didn’t anybody tell me?

“Department Response and Corrective Action:” Following the collection of the evaluations from 2004-05, in which it was pointed out that freshmen would benefit from earlier advising, a meeting was called for all freshmen in the fall of 2005 and again in the fall of 2006 with the specific goal of informing them of all the matters that would be of concern to them throughout their years at Catholic University. A Student Advisory Council was established in the fall of 2005 to create and improve the connection between the undergraduate students and the CE Department, especially at the freshmen and sophomore levels, where the “estrangement” is most dominant. The common student projects, such as the concrete canoe and the steel bridge projects are very conducive to improving inter-student relations.

7. “Student Concern:” Why do we have to take a computer course in C^{++} (or Java) when we never use in any other course?

“Department Response and Corrective Action:” The computer course CSC 113: Computer Programming will emphasize Matlab beginning with the fall semester 2006. Matlab is as the computing tool in several courses.

8. “Student Concern:” The laboratory facilities appear to be old and not working well.

“Department Response and Corrective Action:” Laboratory facilities are constantly being updated as needed to teach the relevant laboratory exercises.

9. “Student Concern:” Why are we not learning technical report writing.

“Department Response and Corrective Action:” Several courses (examples: CE 302: Civil Engineering Systems Management, and CE 520: Design of Structural Systems) have “report writing” as part of the course requirements.

10. “Student Concern:” All adjunct professors were very qualified with minor exceptions.

“Department Response and Corrective Action:” The Department of Civil Engineering takes advantage of being present in the Nation’s capital, in which a large number of highly qualified civil engineers are practicing their profession in private companies and government agencies and laboratories. Thus, a number of adjunct faculty members are engaged in teaching the more practice oriented courses in our curriculum, while the full-time faculty takes care of the academic part of the undergraduate curriculum. Thus, the undergraduate students are exposed to the best of both worlds.

11. “Student Concern:” There are not enough courses given in environmental engineering.

“Department Response and Corrective Action:” The environmental concentration of the civil engineering program is being reviewed with the goal of improving (or possibly abandoning) it. Currently, the Department does not have a faculty member with an interest in the environmental program and the program has been suffering from lack of attendance. It has therefore been difficult to provide the courses necessary to maintain it.

12. “Student Concern:” There should be more structural electives.

"Department Response and Corrective Action:" A second Theory of Structures course was introduced in the spring of 2007 as a program elective. This course will emphasize indeterminate structures and cover topics that are used in the senior design course. This should also help give the students a better appreciation and more training in math and engineering mechanics topics.

13. "Student Concern:" The tracking sheets are useful as long as they are not changed half way through the 4-year plan.

"Department Response and Corrective Action:" A student may graduate with the civil engineering program (listed on the tracking sheet) in place at the time (s)he enters as a freshmen. As program changes occur, the student may choose to graduate according to a later program, but not according to a program earlier than that in place at the time of entrance. The management of tracking sheets has improved since a new Assistant to the Chair took over the position in the Department front office, and the tracking sheets should be more effectively managed in the future. Advising is done individually each semester as required at a large common (pizza and soft drink) meeting with the students. In addition, they are always invited to come and see the faculty on an individual basis, as needed, and at any time.

14. "Student Concern:" There should be more program electives to chose from.

"Department Response and Corrective Action:" Because of the small size of the program, it is not possible to have a large amount of program electives for the students to take. This is because each course has to have a minimum number of students in order to be given. Although the faculty constantly tries to develop new courses as well as repeating program electives with a certain amount of interest expressed from the students, it is necessary to limit the number of course offerings due to the low number of students in the classes.

3.8.4 Process 4-Alumni Survey

Figures 3.7 and 3.8 present the survey results from 2005 as contained in Form 2.

Figure 3.7. Composite scores for program alumni question: Should this be an outcome?

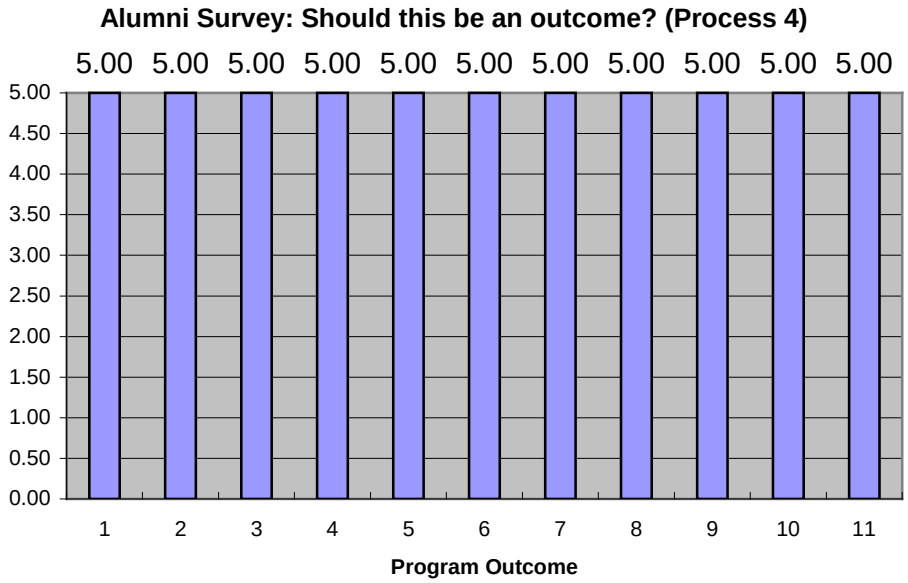


Figure 3.8. Composite scores for program alumni question: you have achieved this outcome?
Evaluation and Corrective Action

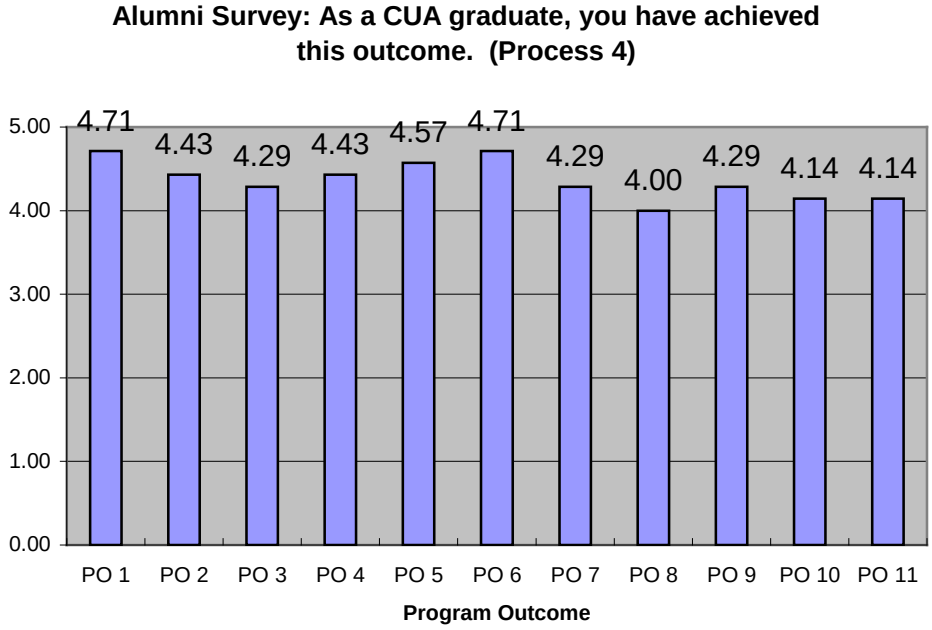


Figure 3.7 shows that all alumni agree that all 11 Program Educational Outcomes should be outcomes, while Figure 3.8 indicates that the alumni feel that they themselves have, in fact, achieved all the outcomes in their own practice. The lowest score of 4.0 was given for Outcome #8 ("the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context"), possibly indicating a lingering uncertainty regarding their understanding of the difficult and often "hard to gage" question regarding the future impact of their engineering solutions.

The following **comments** were supplied by the alumni:

1. "Alumnus comment:" Other program outcomes: Writing skills and loss prevention.

"Department Response and Corrective Action**:"** Several courses (examples: CE 302: Civil Engineering Systems Management, and CE 520: Design of Structural Systems) have "report writing" as part of the course requirements.

2. "Alumnus comment:" You should be able to use techniques, skills and modern tools to be successful in the construction industry.

"Department Response and Corrective Action**:"** Loss prevention is taught as part of the construction engineering and management program.

The faculty decided that no changes in program outcomes were necessary as a result of this review and evaluation.

3.8.5 Process 5-Employer Survey

Figures 3.9 and 3.10 present the survey results from 2005 as contained in Form 2.

Figure 3.9. Composite scores for employer question: Should this be an outcome?

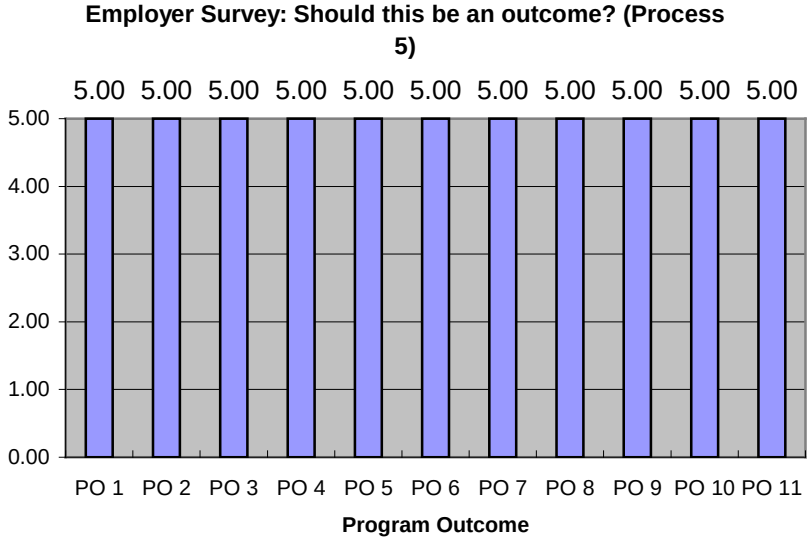
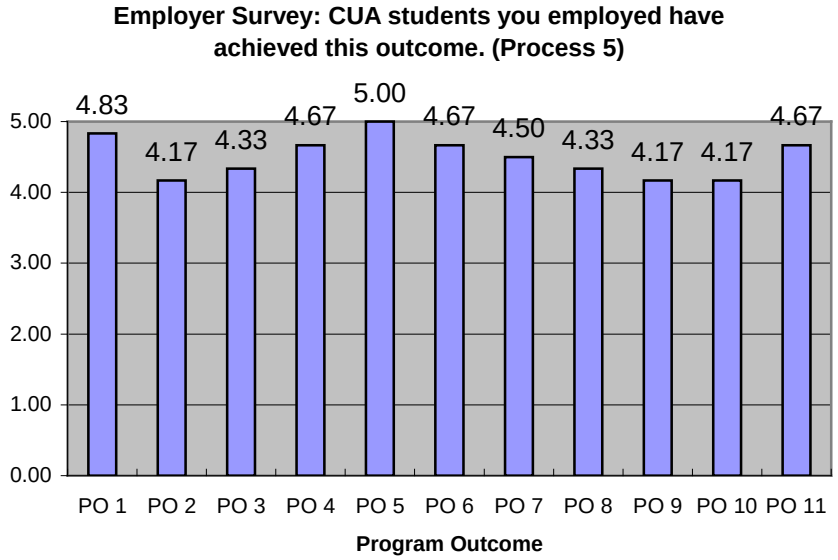


Figure 3.10. Composite score for employer question: CUA students you employed have achieved this outcome?



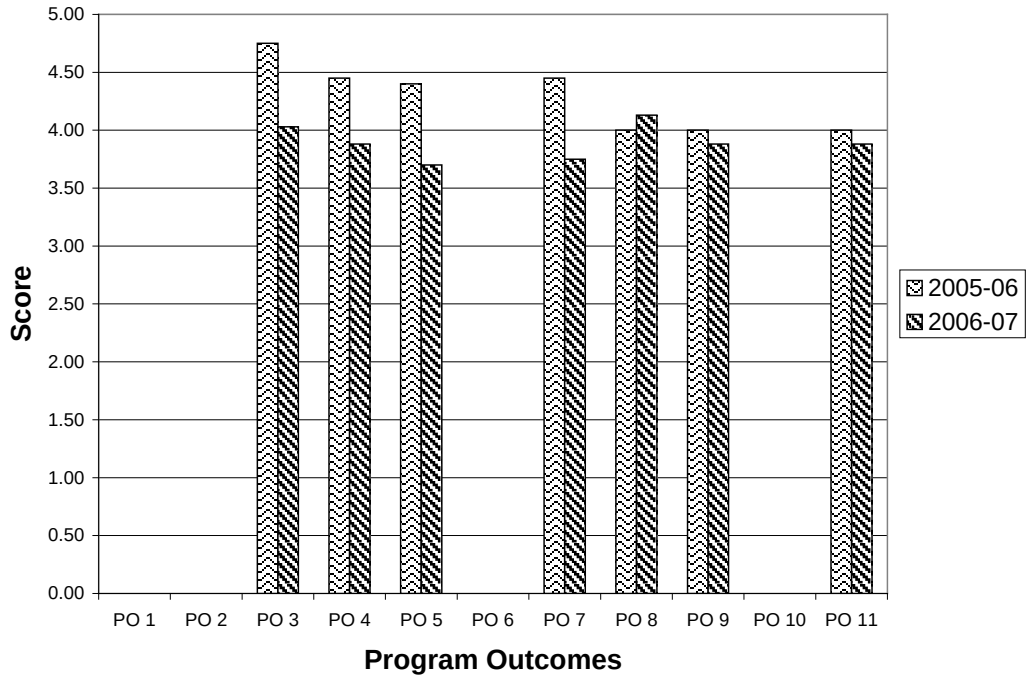
Evaluation and Corrective Action

Figure 3.9 shows that all employers fully agree that the 11 Program Educational outcomes are appropriate, while Figure 3.10 indicates that the employed CUA students have achieved this outcome. All scores on the latter diagram are well above 4.0 (on a 5 point scale).

The faculty decided that no changes in program outcomes were necessary as a result of this review and evaluation.

3.8.6 Process 6-Senior Design Project

Figure 3.11. Program Outcomes for Senior Design Course in 2005-06 and 2006-07.



Evaluation and Corrective Action

During the spring of 2004, the senior capstone design course was CE 576: Systems Design. Evaluations of CE 576 were performed using Exhibits 10A, 10B, and 10D, as listed below. However, the relationships between Learning Outcomes and ABET and Program Outcomes were not established for this course. These relationships are established by the instructor for the course, and cannot be created by other non-participating faculty members. The reason for not establishing the Program Outcomes for this course is that this course is no longer used as the senior capstone design course. It has been replaced by CE 520: Design of Structural Systems. Thus, it was not possible to complete Process 6: Senior Design Project for the spring of 2005.

The new capstone design course for the seniors, CE 520 – Design of Structural Systems, was given for the first time and by a new adjunct faculty member during the spring of 2006. Fifteen

seniors were enrolled in the course. They were divided into five teams with 3 students on each team, as chosen by the students themselves. Each team made the design for the same 4-story building, a portion of which consisted of reinforced concrete members and a portion consisted of steel members. In addition, the foundation had to be designed for the building. At the end of the course each team delivered a written report and each team delivered presentations of their design. Each member of each team presented an aspect of the team's design using individually prepared PowerPoint presentations.

The presentations occurred on the day before the Department's Advisory Board were to meet, and all members of the Advisory Board were invited to attend the presentations to be given by the seniors, who were to be interviewed by the Advisory Board at its meeting the following day. Further, the undergraduate juniors (who were to make their own presentations the following year) were invited together with all graduate students and all members of the faculty.

Among the attendees at the presentations were, in addition to the project director for the course, two members of the Advisory Board, one undergraduate student, two graduate students, and four faculty members. Besides, the members of all design teams, fifteen seniors in all were present at the presentations.

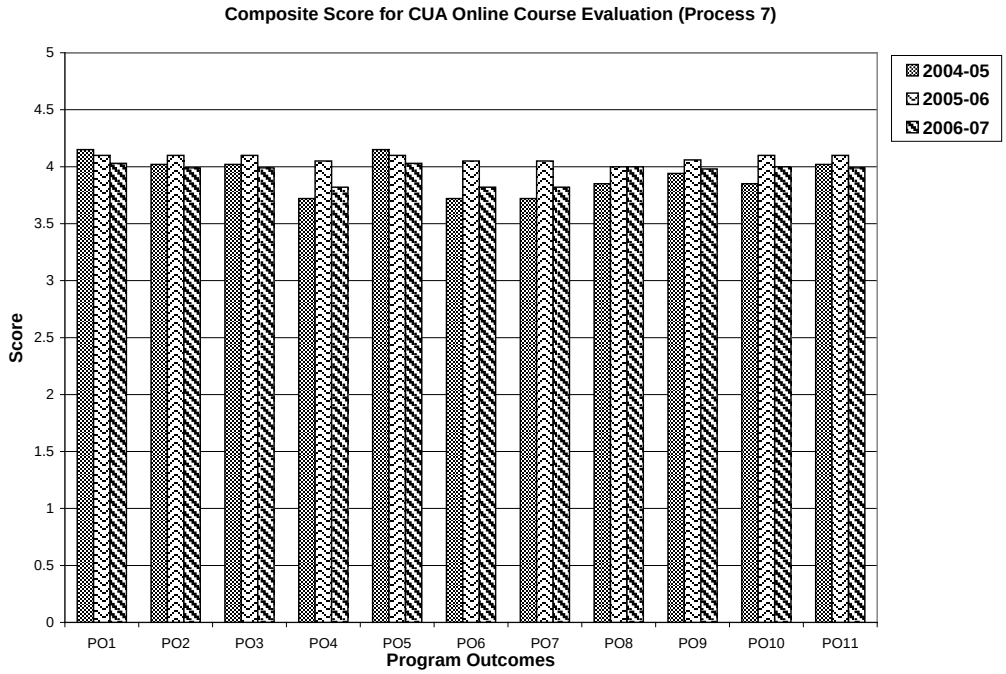
The new capstone design course was repeated in the spring of 2007 with a few adjustments to be made by the instructor. These include having somewhat different buildings to be designed by each team. Thirteen students signed up for the course in 2007. The same procedure was followed and the same evaluation forms were employed as the year before.

The students expressed great satisfaction with this new course, and the instructor was very pleased with the students' performance, especially for AY 2005-06, as may be seen in Figure 3.11. Some points of missing background will be remedied in the new course on Theory of Structures II introduced in the spring of 2007.

The Department is very pleased with the new capstone design course in the area of structural/geotechnical engineering in which most of the students have proficiencies and interests.

3.8.7 Process 7-Student Course Evaluation

Figure 3.12. Composite Scores for Student Course Evaluations for 2004-05, 2005-06 and 2006-07.



Evaluation and Corrective Action

The diagram shows fluctuating scores for some Program Outcomes and more steady scores for others. The scores for 2005-06 are steadier than those for 2004-05 and 2006-07. They reflect the students' evaluations of their own capability, and as such they partly express their uncertainty with regard to their own competence. In view of the fact that it is often difficult to express with confidence one's own unfaltering capacity (due to a natural human modesty), the outcome of this evaluation, in which the scores hover around the score of 4.0 (out of 5), is considered to be satisfactory.

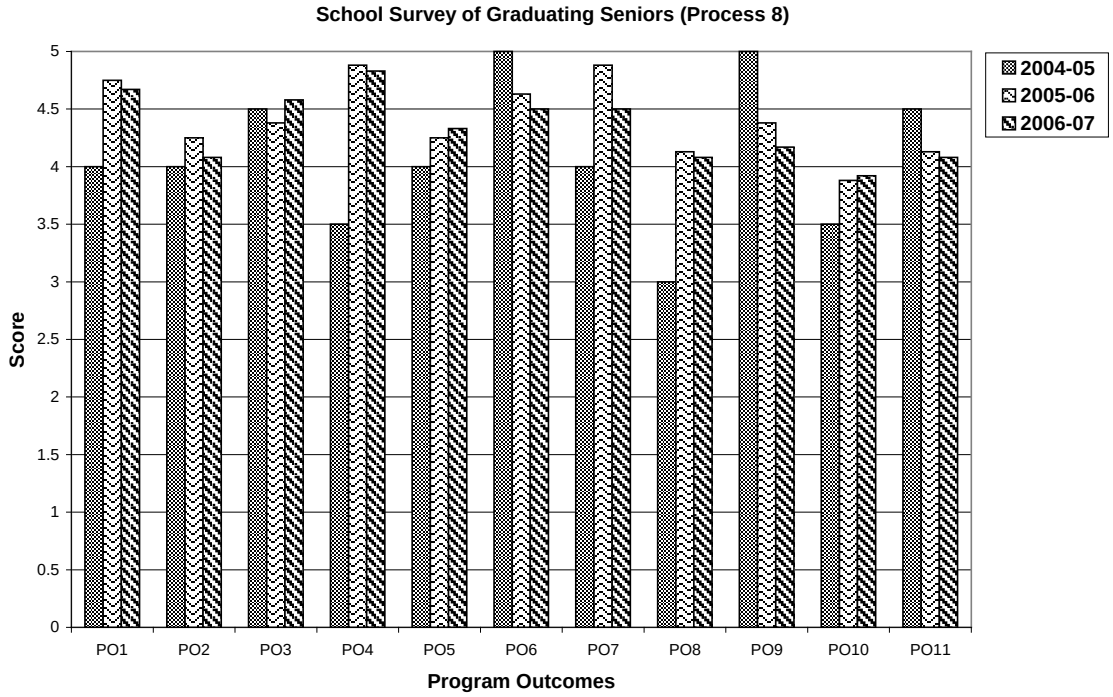
The lowest score of 3.72 for 2004-05 is shared between Program Outcomes #4 (In this course I gained an ability to function on multi-disciplinary teams), #6 (I gained an understanding of professional and ethical responsibility) and #7 (I gained an ability to communicate effectively). Others may be better able to impartially evaluate this particular set of questions.

However, the scores for the eleven program outcomes for students graduating in 2006 varied in a narrow range just above 4.0 indicating the student satisfaction with the contents of the courses, the way they are being taught, and their ability to gain knowledge from the courses.

This evaluation by the students does not appear to raise any particular concerns. It is concluded that no modifications to the program are required on the basis of the evaluations presented above.

3.7.8 Process 8-School Survey of Graduating Seniors

Figure 3.13. Composite Scores for Program Outcomes of School Survey of Graduating Seniors for 2004-05, 2005-06 and 2006-07.



Evaluation and Corrective Action

Two senior civil engineering students participated in the evaluation performed by the Dean at the end of 2004-05, eight seniors were interviewed in 2005-06, and six seniors were interviewed in 2006-07.

Figure 3.13 indicates the scores for the 11 Program Outcomes. The scores fluctuate considerably from year to year, but seem to increase over the last two years. The scores are more steady for 2005-06 and 2006-07 than those from 2004-05, because they represent averages for 8 and 6 students, respectively, rather than for 2 students as in 2004-05. Notably, PO #8, PO #4, and PO #10 indicate low scores for this year. However, the very small sample of two students makes any conclusion inappropriate. All except one score are above 4.0. Program Outcome # 10 ("knowledge of contemporary issues") shows a score of 3.88. This is higher than 3.50 for 2004-05, but it appears to indicate that the students feel less confident about their knowledge of contemporary issues, either because they do not follow them in the media or because they don't get exposed to them at the university.

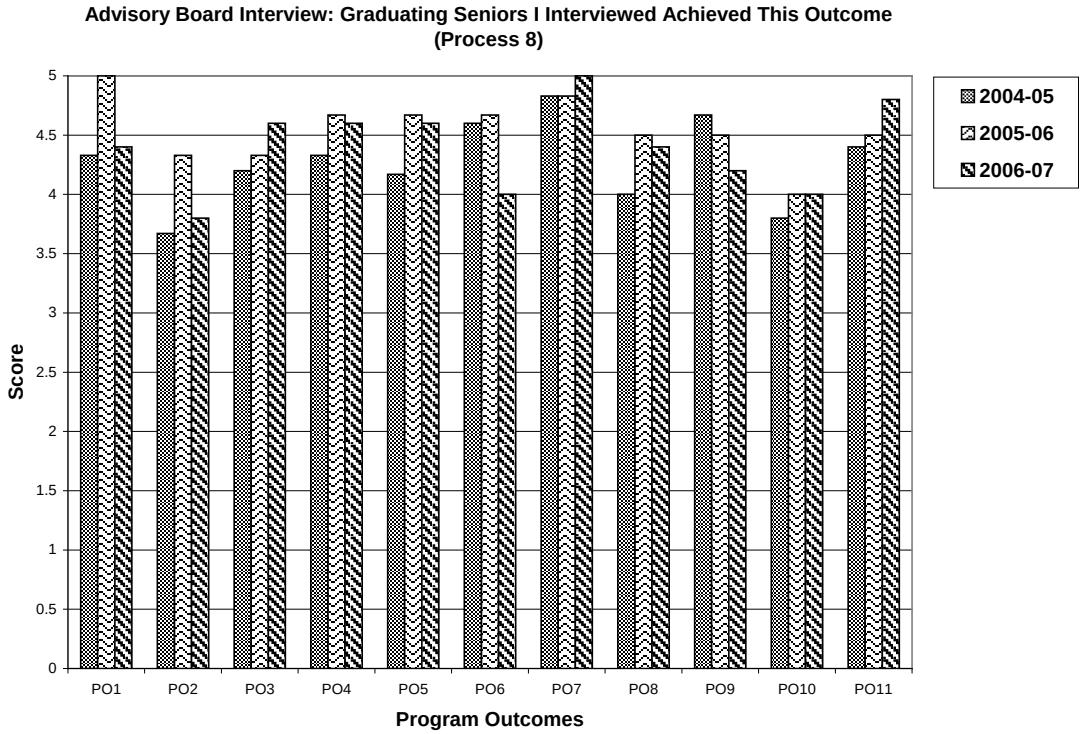
All Program Outcomes have scores for one, two or three years above 4.0 except Program Outcome # 10 ("knowledge of contemporary issues")which consistently shows scores below 4.0. It appears to indicate that the students feel less confident about their knowledge of contemporary

issues, either because they do not follow them in the media or because they don't get exposed to them at the university.

The faculty decided that no changes in Program Outcomes were necessary as a result of this review and evaluation.

3.8.9 Process 9 -Graduating Seniors Interview by Advisory Board Members

Figure 3.14. Composite Scores for Advisory Board Interviews of Graduating Seniors in 2004-05, 2005-06 and 2006-07.



Evaluation and Corrective Action

While most scores tend to be of similar magnitude from year to year, there are clearly some anomalies. All scores are at 4.0 or higher for all years and for all but two Program Outcomes. The lowest scores of 3.67 in 2004-05 and 3.80 in 2006-07 are indicated for Program Outcome #2 (an ability to design and conduct experiments, as well as to analyze and interpret data), while a score of 3.80 is given in 2004-05 for Program Outcome #10 (knowledge of contemporary issues).

The students clearly feel less confident about designing and conducting experiments, both of which are tasks that are not emphasized in the curriculum. Significant training in respect to

Program Outcomes # 2 is missing, because only few laboratory courses are required in the program.

It is interesting to note that the highest scores of 4.83 and 5.0 are given for PO #7 (an ability to communicate effectively), indicating the ability of the seniors to communicate effectively with the members of the Advisory Board, an outcome that the students themselves have not previously expressed.

In general, the Advisor Board scored the Program Outcomes for the graduating seniors relatively highly, and they have expressed satisfaction with the Civil Engineering programs as they exist at present time (see especially the annual report for 2006-07). Thus, the evaluations by the Advisory Board do not seem to call for any modifications in the civil engineering program.

Comments and Observations by Members of Advisory Board

Written comments were provided by the Advisory Board members. These are summarized below and given verbatim in the appendices to the individual annual reports. The Department's responses and action are also given below.

1. "Advisory Board Member Concern:" There should be more program electives for the students to choose from.

"Department Response and Action:" It is agreeable that it would be desirable to have more elective courses available, as expressed by several Board members. The faculty likes to introduce new courses, but their survival is limited by the small population in each such course. New elective courses are often considered and introduced. Since there are a limited number of CE students who can take these courses, there are a limited number of courses that can survive each year.

2. "Advisory Board Member Concern:" There were no presentations, discussions or examples given of professional ethics in the ENGR 401, Senior Seminar in fall 2006.

"Department Response and Action:" The professional ethics course needs to be enhanced with examples from engineering practice. The department chairs are aware of this shortcoming and are discussing how to remedy this situation.

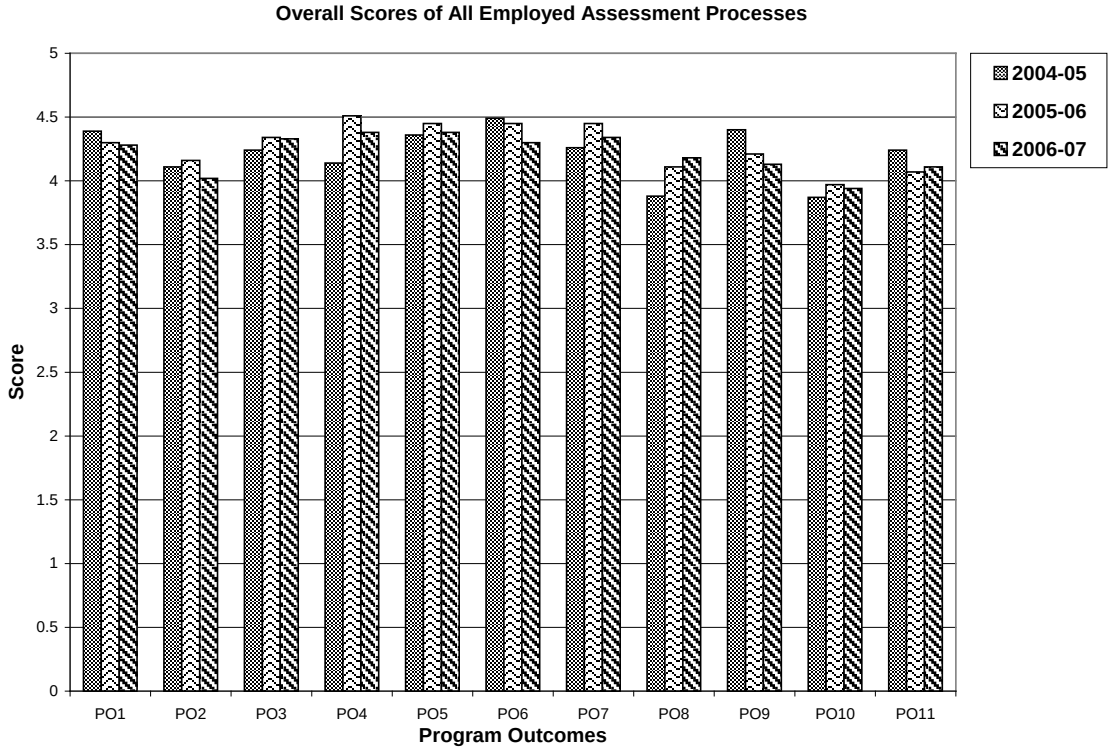
3. "Advisory Board Member Concern:" The Department need a faculty member in the area of environmental engineering/hydraulics/hydrology.

"Department Response and Action:" It is fully agreed that the Department of Civil engineering needs a faculty member in the area of environmental engineering/hydraulics/hydrology, because none of the present Department faculty expresses any interest in this area.

Many fewer concerns have been expressed in the last two years of evaluation than in the first year, 2004-05. In fact, several Board members expressed that there were no need to change anything in the civil engineering program, with exception of the points explained immediately above.

3.9 Composite Score Computation of All Assessment Processes

Figure 3.15. Overall Scores of All Employed Assessment Processes for 2004-05, 2005-06 and 2006-07.



Evaluation and Corrective Action

The Composite Score Computation includes Processes 4 and 5 from 2004-05, while all other processes were carried out each of the academic years 2004-05, 2005-06 and 2006-07. Based on the evaluation of the civil engineering program presented here, the assessment process does not identify any major program weaknesses at this time. It is clear that the overall scores are somewhat above the score of 4.0 (out of 5) with the exception of two scores. The shortcomings identified in the 2004-05 report in Program Outcomes #10 (knowledge of contemporary issues) and #8 (the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context) were identified early in the School of Engineering, and a course, ENGR 401: Senior Seminar I, was introduced already in the Spring of 2004 to remedy these shortcomings.

A course on Dynamics (ENGR 202: Engineering Mechanics II) was introduced as a required course at the junior level in the stem specializing in structural/geotechnical engineering effective from the academic year 2006-2007. The subject of Dynamics is covered on the FE exam, but it has not been part of the civil engineering program in recent years. This has now been remedied. In addition, our Theory of Structures course (CE 312) has been augmented with a program elective on Theory of Structures II (CE 313) beginning with the spring of 2007. This course emphasizes the behavior of indeterminate structures. This should produce additional training and experience in the mechanics based subjects and improve the scores in these subjects on the FE exam.

During 2007-2008 the Department of Civil Engineering adopted the National Survey of Student Engagement (NSSE) in conjunction with the existing ABET processes to assess the University's general education goals.

The NSSE data appear to be consistent with data collected from the Department's existing nine ABET processes.

For the outcomes of critical thinking and reasoned analysis, the scores are generally below (in memorizing, synthesizing, making judgments) or comparable (in analyzing, and applying) with those for the University and the Carnegie Peers.

For the outcome of understanding of scientific and quantitative reasoning, the Department is even with or slightly ahead of the University and the Carnegie Peers.

For the outcome of ability to find information effectively using appropriate resources and technologies, the Department needs some improvement.

For the outcome of demonstrating knowledge of and respect for different cultures and religions, the Department does not compare as favorably as it should with the University and its Carnegie Peers.

It is not clear how many civil engineering students participated in the survey. A small study group may result in fluctuations from year to year. However, it is clear that improvements would be desirable in several categories, as indicated above. The Department will observe and monitor these shortcomings in the following years to better understand and improve on these issues.

Assessment Findings and Curricular Improvements
Department of Electrical Engineering
Undergraduate Program

The Department of Electrical Engineering uses nine processes to assess departmental learning outcomes:

Process	Conducted by	How Often
Process 1: Fundamentals in Engineering Examination	Dean's office	Yearly
Process 2: Review of Required Courses	Department	Yearly
Process 3: Program Graduating Senior Questionnaire	Department	Yearly
Process 4: Alumni Survey	Department	Every 3 years
Process 5: Employer Survey	Department	Every 3 years
Process 6: Senior Design Project	Department	Yearly
Process 7: Student Course Evaluation	Department	Yearly
Process 8: School Survey of Graduating Seniors	Dean's Office	Yearly
Process 9: Graduating Seniors Interview by Advisory Board Members	Department	Yearly

Summary of Activities Conducted for Assessment Processes for AY 2005-2006 and 2006-2007

This section is devoted to the summary of activities that were conducted for each of the 9 assessment processes in AY 2005-2006 and 2006-2007. We have introduced 9 program outcomes as follows:

1. An ability to apply knowledge of mathematics science and engineering;
2. An understanding of moral, ethical and professional responsibility;
3. An ability to enter the practice the field of electrical engineering and to pursue graduate studies;
4. An ability to effectively treat complex electrical/electronic systems and signals through modeling, simulation, experimentation and interpretation and analysis of data;
5. An ability to design a component, a system or a process to meet desired needs, and to design a process to produce desired outputs;
6. An ability to identify, formulate and solve engineering problems through the use of analytical techniques, proven design practices and modern engineering tools;
7. An ability to function as a productive inter-disciplinary member in a team and as an effective communicator;

8. An understanding of global impact of engineering solutions;
9. **An understanding of contemporary issues and an ability to engage in life-long learning.**

It should be pointed out that the University as a whole uses select data from the National Survey of Student Engagement (NSSE) to assess its general education goals. The Department of Electrical Engineering and Computer Science has begun to use the NSSE data, in conjunction with its ABET processes, to assess the general education outcomes of its senior students against senior students enrolled at Catholic University and its Carnegie Peers.

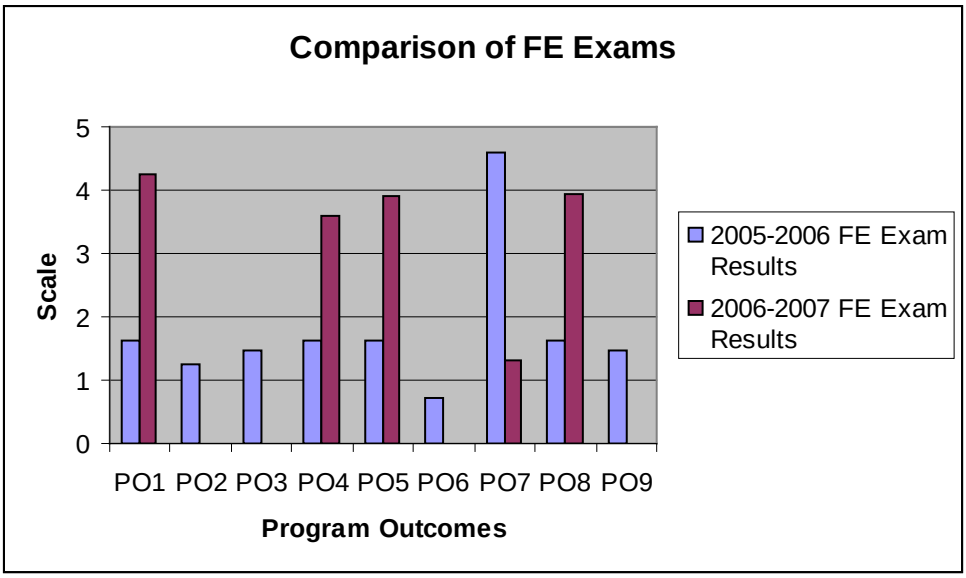
Process 1: Fundamentals of Engineering Exam

In 2005-06, the SOE required seniors to register for and to take the F.E. exam as part of the ENGR 401 course. All EE students, except one, took the exam.

In AY 2005-06, 5 EE students took the FE exam and 2 passed (40%). Also, in AY 2006-07, 11 EE students took the exam and 4 passed (36.4%). Both results were provided by NCEES who administered the exam.

Average student scores were normalized to respective national averages in each of the categories in the NCEES report.

Each of the topics was then grouped according to the appropriate program outcome (PO's). The FE Exam mapped directly to ABET PO's 1, 2, 6, and 11 with most significance to PO #1 (fundamentals). It was then transformed to the nine EE Program Outcomes. The results were averaged according to appropriate topics matched to our curriculum. Only the morning exam was used for analysis as the afternoon exam topics varied depending on which topics students chose. The following figure shows the EE Program Outcomes on the scale of 1 to 5 for 2005-2006 and 2006-2007 annual years.



Corrective action: None at this time based upon results from this instrument.

Process 2: Review of Required Courses

The Evaluations were conducted for the following core courses for two consecutive annual years; namely, AY 2005-2006 and AY 2006-2007:

- EE311 - Signals and Systems
- ENGR321 - Electronic Circuits I
- EE322 - Electronic Circuits II
- EE326 - Switching Circuits
- EE342 - Electromagnetics
- EE362 - Analog and Digital Signal Processing
- EE412 - Microprocessor Programming and Design
- EE455 - Electrical Laboratory III
- EE502 - Optical Systems and Devices
- ENGR212 - Electric Networks
- CSC113 - Computer Programming

Materials for each course mentioned above were reviewed by one or two independent faculty members, neither of whom were the teacher of the course. The materials used for course evaluation included the samples of the homework, quizzes, examinations, projects, self-assessments, and syllabus. Each course was evaluated with respect to the following Evaluation Statements shown in Form 11.

Evaluation Statement 1: The topics listed in the course syllabus are appropriate for the course title and for the program.

Evaluation Statement 2: The course objectives stated in the course syllabus are appropriate for the course content.

Evaluation Statement 3: The stated contributions of the course to meeting the professional components are appropriate.

Evaluation Statement 4: The Expected Learning Objectives stated in the course syllabus are appropriate for the course objectives.

Evaluation Statement 5: The matrix relating the Course Outcomes and the ABET Outcomes is accurate.

Evaluation Statement 6: The stated Evaluation Statement methods for the Learning Outcome Assessment are appropriate.

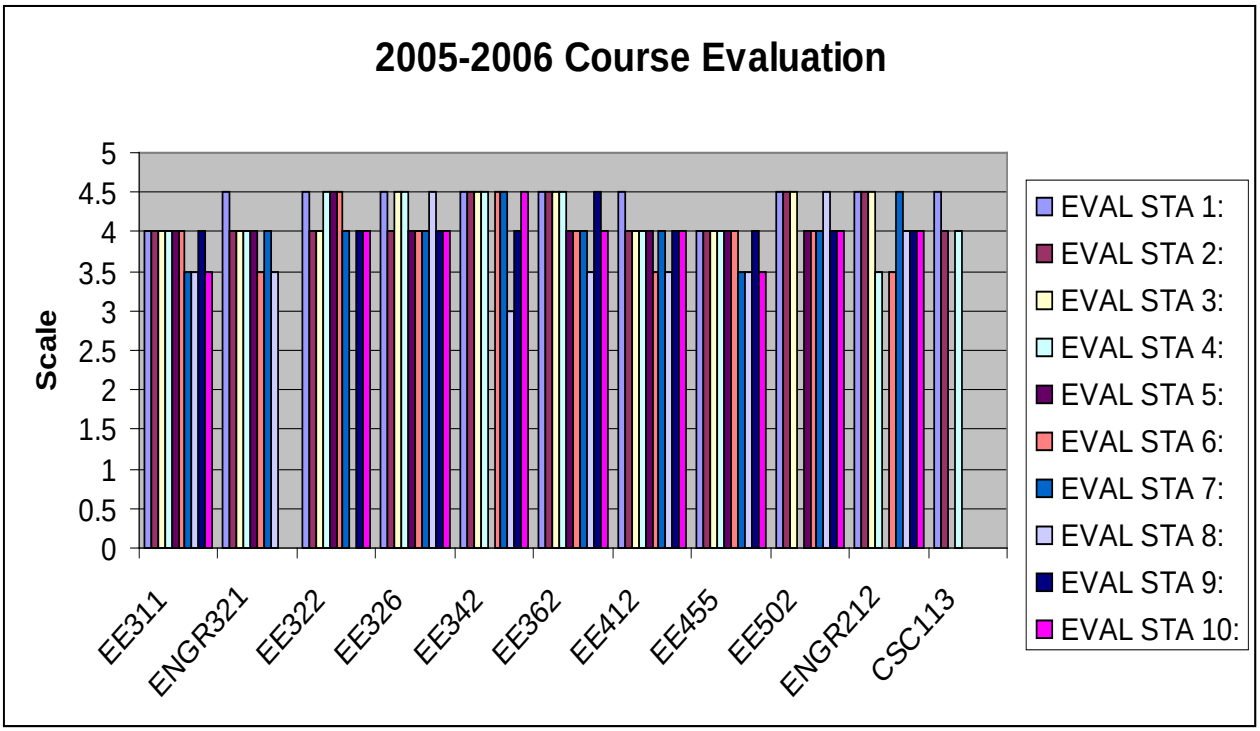
Evaluation Statement 7: The stated Evaluation Statement methods have been employed fully to assess the learning outcomes.

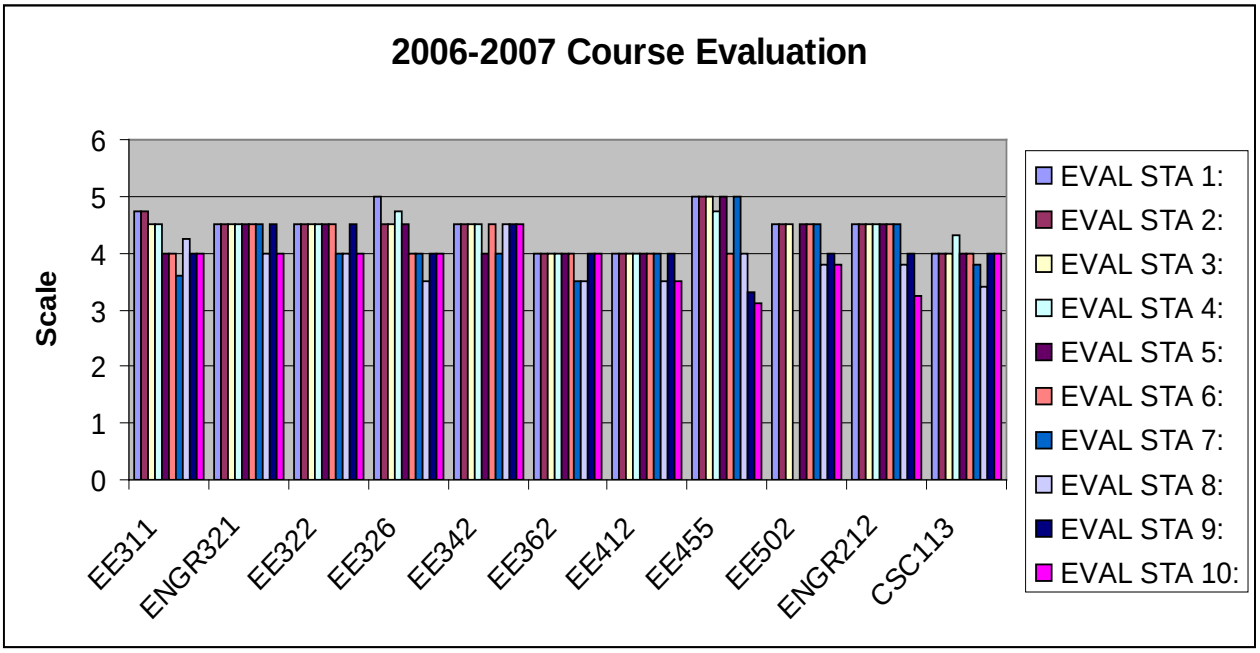
Evaluation Statement 8: Overall the course achieved the Expected Learning Outcomes.

Evaluation Statement 9: The stated process of improvement is appropriate.

Evaluation Statement 10: The stated process of improvement has been employed fully to improve the course.

The Evaluation Statements were rated on a scale of 1 (completely disagree) to 5 (completely agree)
The evaluation scores for the evaluation statements for the above core courses for the academic years 2005-2006 and 2006-2007 are shown in the following graphs.





It is seen from the above graphs that the ratings obtained by all the Evaluation Statements for all courses evaluated were 3.5 or above

Based on the course evaluation performed in 2005-2006, some corrective actions were undertaken for some courses. The resulting evaluation data was observed in 2006-2007.

Corrective Actions: A comparison of the corresponding results for 2005-2006 and 2006-2007 show:

EE 311: The scores for statements 7, 8 and 10 that needed improvement have improved in 2006-2007

ENGR 321: The unsatisfactory scores in 2005-2006 for statements 6, 8, 9 and 10 have improved in 2006-2007.

EE 322: the unavailable score in 2005-2006 for statement 8 has been available and is satisfactory.

EE 326: The scores for all statements were satisfactory and hence no corrective action was taken. However, in 2006-2007 the score for statement 8 has come down. Corrective action should be taken in 2007-2008.

EE 342: The missing data for 2005-2006 for statement 5 has been available and is satisfactory. Also the data for statement 8 has improved considerably.

EE 362: The result for statement 7 has gone slightly down. The result for statement 8 has stayed the same. Further corrective actions need to be taken in 2007-2008.

EE 412: The unsatisfactory result for statement 6 has become satisfactory in 2006-2007. The result for statement 8 has remained the same. Further corrective action should be taken in 2007-2008.

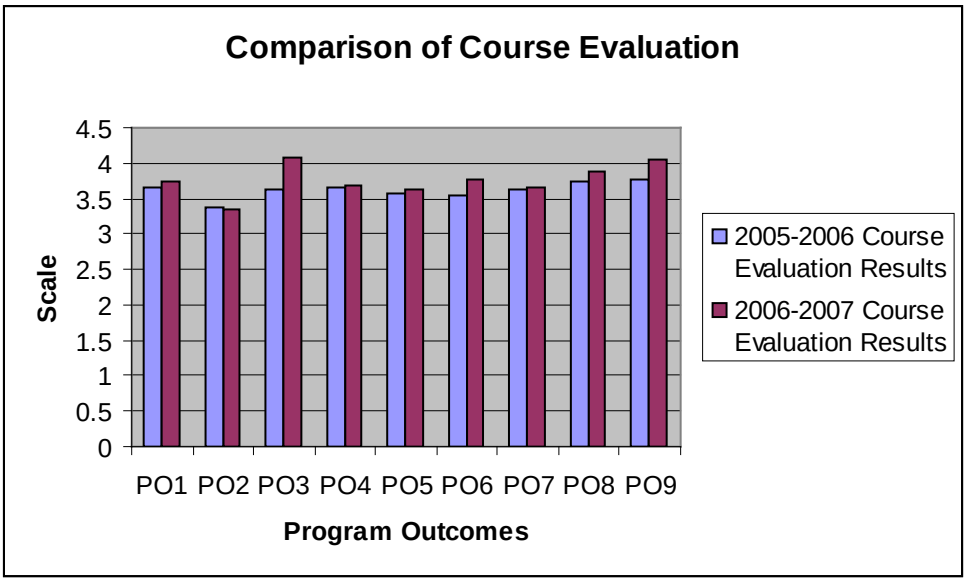
EE 455: The unsatisfactory score for statement 7 has improved considerably. The results for statements 9 and 10 need further improvement. Further corrective action should be taken in 2007-2008.

EE 502: The results for statements 8 and 10 have gone down slightly. However they are still satisfactory. The result for statement 4 is missing. Further corrective actions will be taken in 2007-2008.

ENGR 212: The unsatisfactory results for statements 4 and 6 have become satisfactory in 2006-2007. The unavailable result for statement 5 has been available in 2006-2007 and it is satisfactory.

CSC 113: This course was not properly evaluated in 2005-2006. However, in 2006-2007 the scores are satisfactory for all statements except statements 7 and 8. Corrective actions will be taken in 2007-2008.

The following graph compares the overall course evaluation for satisfaction of the program outcomes. Comparison of the results for the two years indicates that, except PO2, all other program outcomes have gained a modest and consistent improvement.



Results of Average Ratings of Program Outcomes from Course Evaluation Statements in Form 11

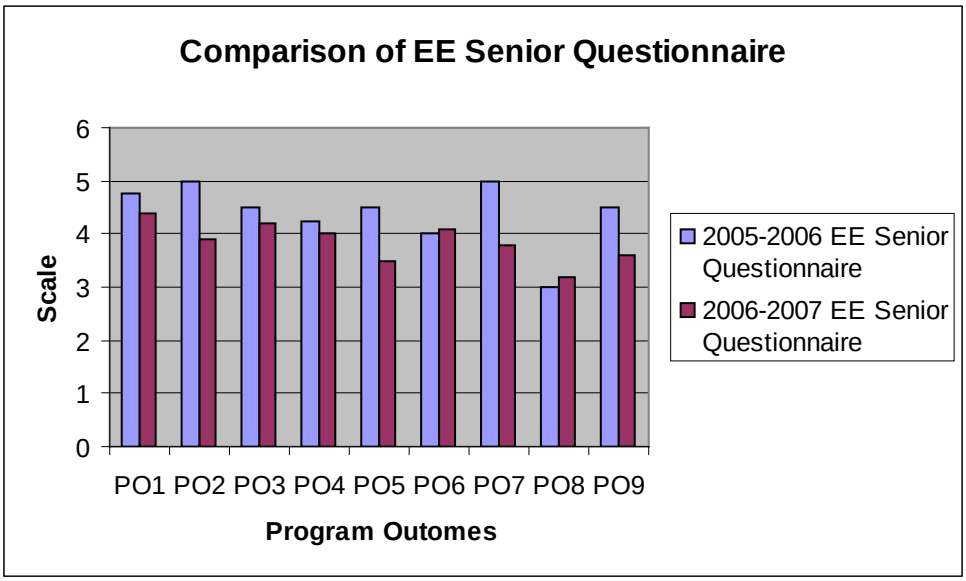
Analysis of Overall Evaluation of satisfaction of the Program Outcomes

It is seen from the above bar graph that all Program Outcomes are satisfied with a rating of 3.5 or better except Program Outcome 2. The ratings of Program Outcome 2 are slightly below 3.5 but above 3. The Program Outcome 2 involves moral, ethical and professional responsibilities. This aspect is not included in all core courses. In fact there is a course, Phil 362 that specifically addresses this aspect. This course is taken by all EE students but it is not part of the core courses.

It is also observed from the above graph that the scores for Program Outcomes 3, 6 and 9 have improved considerably from 2005-2006 to 2006-2007. PO3 relates to the ability of the students to enter the practice of the field of electrical engineering and graduate studies. Our program teaches the students basic fundamentals of electrical engineering and also courses in the real life fields of computers, communications, controls, signal processing and optics. They can also work with our research faculty to participate in research projects. Actually, several of our graduates have stayed on for graduate studies in our department. PO6 relates to ability to formulate and solve engineering problems by applying analytical and other engineering tools. PO6 has improved because our seniors are allowed to take the senior design courses and some graduate courses that deal with analytical and simulation techniques. PO9 deals with contemporary issues and life-long learning. The exposure of our students to contemporary subjects like networking, communications, optical systems and micro technology has contributed to the improvement in PO9.

Process 3: Program Graduating Senior Questionnaire

This questionnaire was collected from EE seniors using Form 5. The results are shown below.

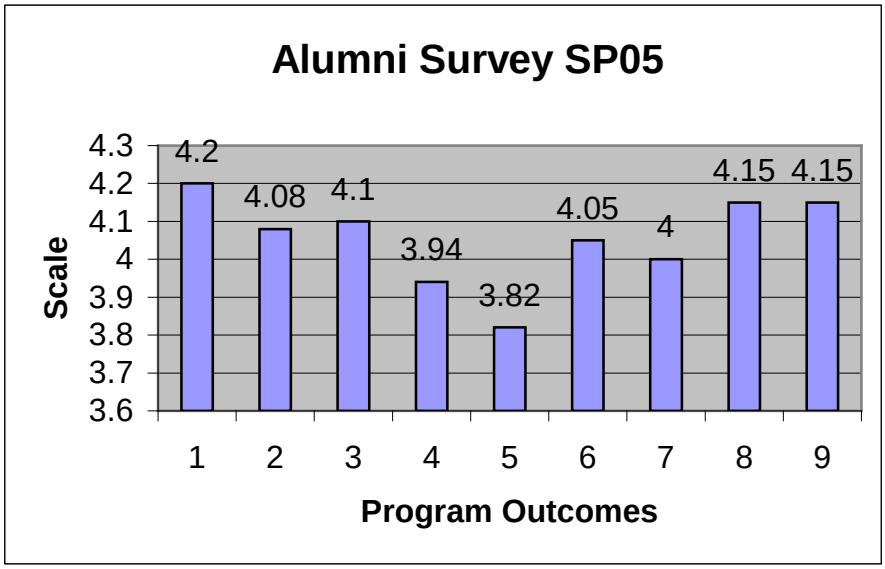


Senior Questionnaire

For each Program Outcome, the respondent was asked if, as a senior, you have achieved this outcome on a scale of 1 to 5 (1 meaning complete disagreement and five meaning complete agreement). The cumulative averages of the responses for all Program Outcomes are shown graphically in the figure above. It is seen that the responses are mostly positive. In fact the cumulative average of the responses is above 3 for all program outcomes. The results also indicate that the six EE graduating seniors of 2006 were relatively more positive than their eleven 2007 counterpart.

Corrective action: None at this time based upon results from this instrument.

Process 4: Alumni Survey

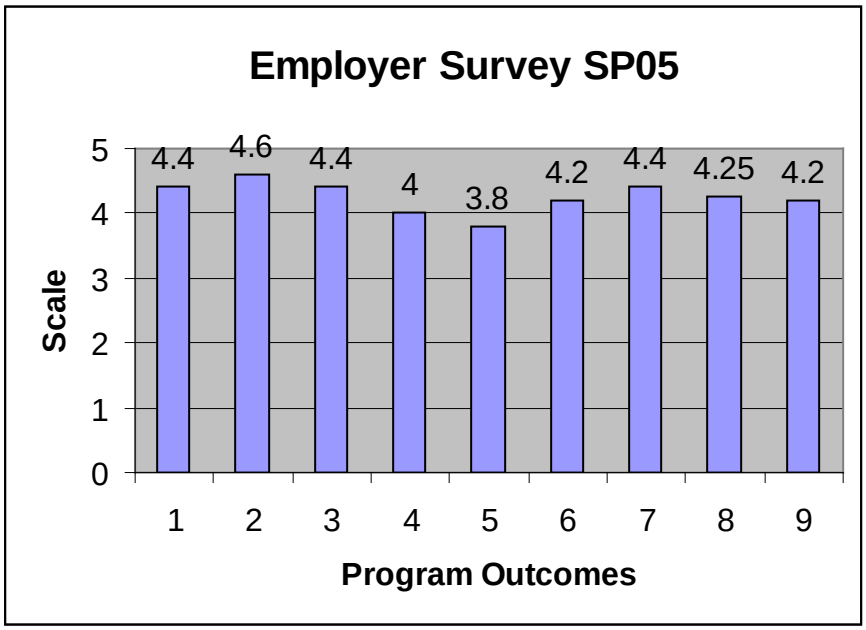


Alumni Survey

For each Program Outcome, the respondent was asked, as a CUA graduate, have you achieved this outcome on a scale of 1 to 5 (1 meaning complete disagreement and five meaning complete agreement). The cumulative averages of the responses for all Program Outcomes are shown graphically in the figure above. The graphical data shows the cumulative average of all the responses for the outcomes 1 to 9. It is seen that the responses are mostly positive. In fact the cumulative average of the responses is above 3.82 for all program outcomes. This survey was performed in spring 2005 and will be repeated in spring 2008.

Corrective action: None at this time based upon results from this instrument.

Process 5: Employer Survey



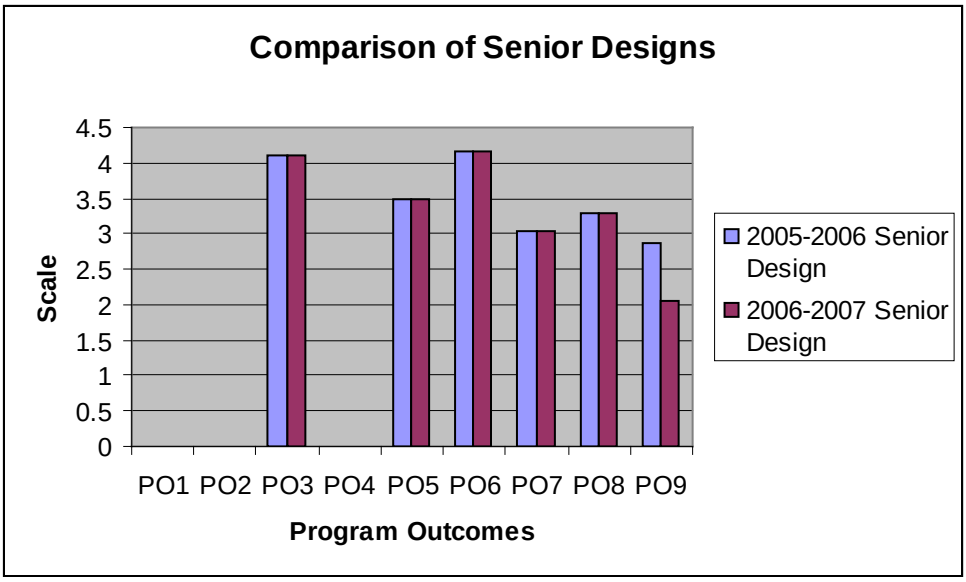
For each Program Outcome, the respondent was asked if the CUA students they have employed have achieved this outcome on a scale of 1 to 5 (1 meaning complete disagreement and five meaning complete agreement). The cumulative averages of the responses for all Program Outcomes are shown graphically above.
It is seen from this figure that the responses are mostly positive. In fact the cumulative average of the responses is above 3.8 for all program outcomes. This survey was performed in spring 2005 and will be repeated in spring 2008.
Corrective action: None at this time based upon results from this instrument.

Process 6: Senior Design Project

Our capstone courses in senior design (EE 491 and EE 492) provided assessment data relevant to seven (listed below) of the 11 ABET Program Outcomes (a)-(k):

(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
(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
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Employing the assessment tools described in section before, the seven outcomes listed above were quantitatively evaluated. The results were then transformed into the nine EE Program Outcomes for the AY 2005-2006 and AY 2006-2007 (see figure below). In addition, the department chairman solicited more qualitative observations from the faculty involved in the senior design courses to identify specific areas for improvement.



Corrective action: Based on the Outcomes Assessment Process in Senior Design (EE 491 and 492) for the academic years 2004-2005, 2005-2006 and 2006-2007 the following corrective actions were made.

1. During the evaluations of senior design presentations during 2004-2005 it was concluded that the student's needed more experience organizing and orally presenting their project ideas (ABET Outcome g). This was concluded based on the quantitative survey data and comments made by faculty and external audience members. In response, during the 2005-2006 and 2006-2007 academic years we have increased the number of student presentations from 2 to 4. We also required dry runs in front of a limited number of faculty members for all presentations. The goals of these changes were to provide students more practice presenting their ideas in front of an audience and more opportunities for faculty to provide constructive criticism /suggestions.

2. This change appears to have been successful. The student's presentation skills in 2005-2006 were markedly better than in 2004-2005. In fact, the survey data related to presentation skills increased from 3.67/5.0 (average) to (4.01/5.0) average. In addition, during the 2006-2007 academic year we made a concerted effort to keep the format of the presentations consistent with the format of "professional conferences". We feel that this was a valuable learning experience for the students, as they will soon be presenting their own work at such conferences. We also feel that this fact lead students to take the presentations more seriously. The students put more time and effort into the presentations, and in some cases, did multiple "practice runs" in order to polish both the presentations and the "delivery". This appears to have been very successful in sense that the 2006-2007 presentations were some of the best presentations we have seen in recent years. This comment is also reflected in the quantitative data from the audience and faculty surveys. During 2006-2007 the data related to presentation skills increased again to (4.13/5.0) average.

3. During the 2003-2004 senior design presentation it was concluded based on faculty and audience comments that the quality of the senior design projects had decreased significantly from previous years. In response the general format of the senior design projects was changed during the 2004-2005 academic year. The change was to select projects more research oriented and to assign each group a faculty advisor to provide student guidance. Since this change the quality of the senior design projects has improved remarkably. In fact, two groups out the four in 2006-2007 did work that is worthy of publication. One group has already had their work published in "The Proceedings of the 23rd Southern Biomedical Engineering Conference". The work of the other group will be published in a peer reviewed journal within the next few months. The manuscript is currently in preparation, with plans to be submitted to "Microwave and Optical Technology Letters". During the 2005-2006 academic year one of the projects has recently been published as a journal article *(Microwave and Optical Technology Letter, Vol. 49, No. 8 August 2007)*

Process 7: Student Course Evaluation

The student evaluations were gathered on-line, at http://evaluations.cua.edu, relating to the questions in Form 9, each rated on a scale of 1 to 7 (1 = strongly disagree, 7 = strongly agree), for the following courses of the Fall 2006 semester:

AY 2006-2007:

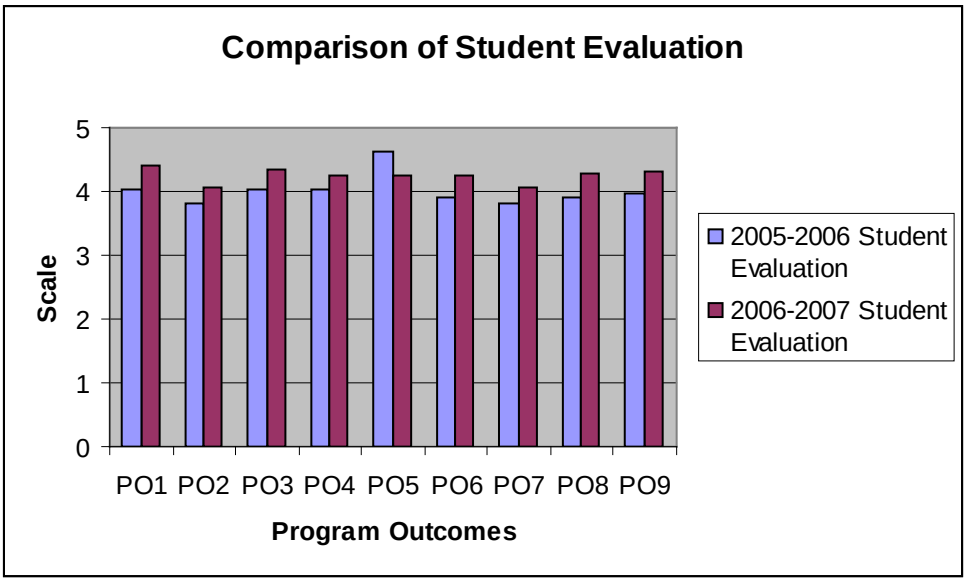
EE 311	Signals and Systems	P. Regalia
EE 326	Switching Circuits and Logic Design	D. Tremper
EE 413	Communication Systems and Networks	M. Arozullah
EE 455	Electronic Laboratory III	O. Kilic
EE 491	Engineering Practice and Design	M. Mirotznik
EE 531	Data Communication Networks	M. Arozullah
EE 542	Antennas and Propagation for Comms	O. Kilic
EE 546	Electrical Properties of Materials	S. Mathews
EE 561	Random Signal Theory	N. Namazi

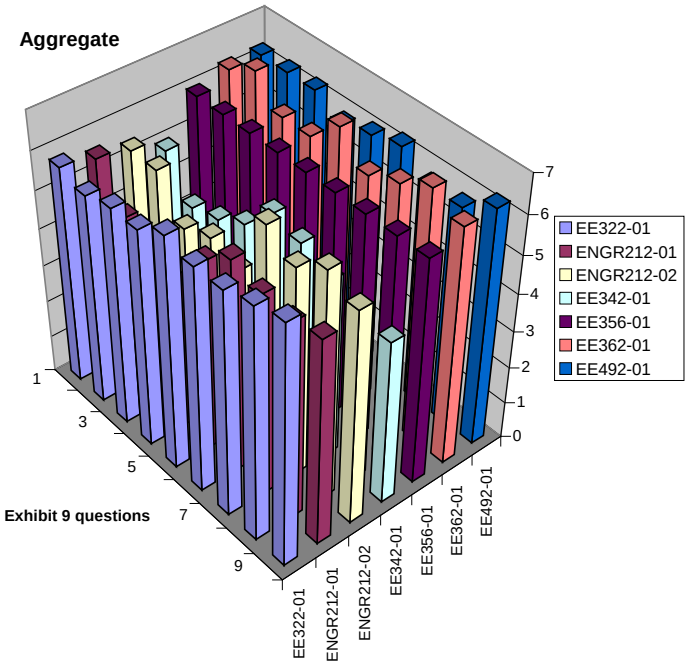
AY 2005-2006:

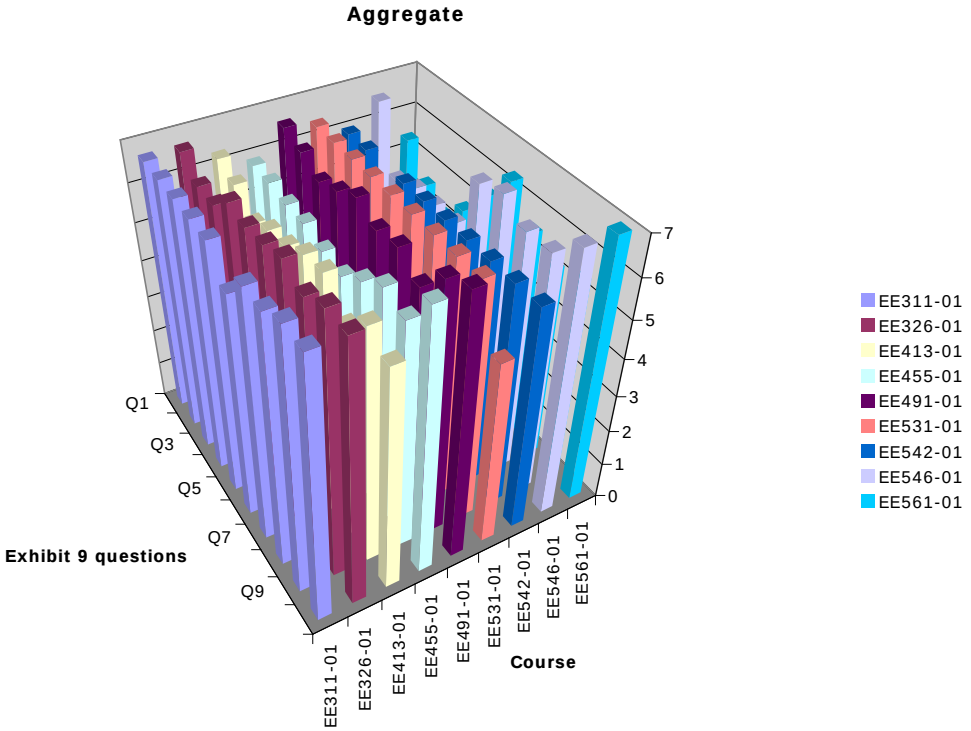
EE 322	Electronic Circuits II	S. Mathews
ENGR212-01	Electric Networks	M. Mirotznik
ENGR212-02	Electric Networks	N. Namazi
EE 342	Electromagnetic Fields and Waves	O. Kilic
EE356	Electrical Laboratory II	L. Schuette
EE 362	Analog & Digital Signal Processing	P. Regalia
EE 492	Engineering Practice and Design II	M. Mirotznik

Of the total data related to Form 9 respondents, better than 96% of the responses were rated 5 or better for the fall 2006 semester.

By averaging the results over all courses, and scaling the values to a maximum of 5, we obtain the following graph:


Comparison of Student Evaluation
Scale
5
4
3
2
1
0
PO1 PO2 PO3 PO4 PO5 PO6 PO7 PO8 PO9
Program Outcomes
2005-2006 Student Evaluation
2006-2007 Student Evaluation

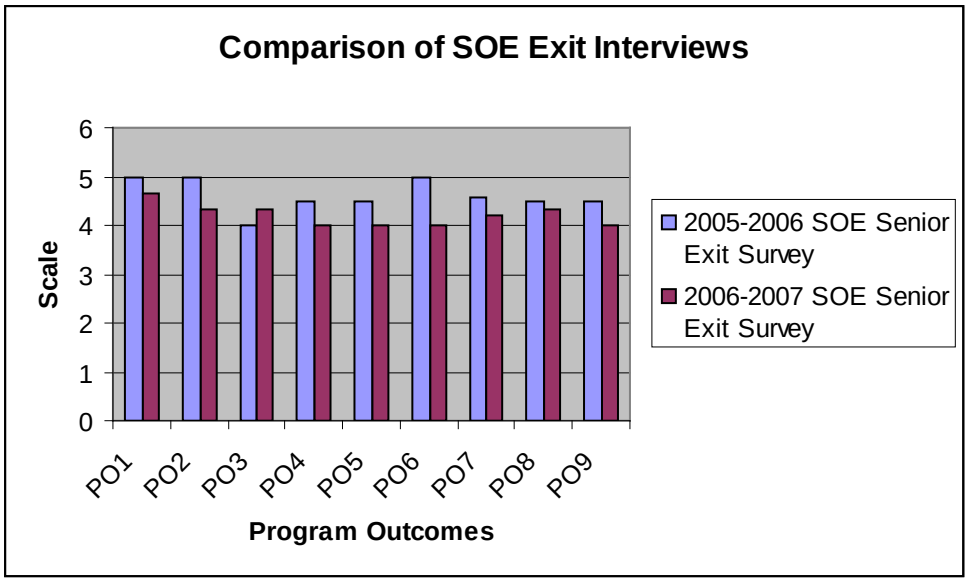

Aggregate
Exhibit 9 questions
1
3
5
7
9
0
1
2
3
4
5
6
7
EE322-01
ENGR212-01
ENGR212-02
EE342-01
EE356-01
EE362-01
EE492-01



The data show that all measures have improved slightly, save for PO5 which exhibits a very small drop. Considering the student population size, however, the numerical differences between successive years lie comfortably within standard deviation bounds. As such, the subtle changes in scores over successive years do not appear statistically significant. Rather, the overall trend apparent from the data is the favorable assessment provided by the students, as evidenced by nearly all scores from AY 2006/2007 lying at four or above on a five-point scale.

Process 8: School of Engineering (SOE) Senior Exit Surveys:

Each of the School's graduating seniors was interviewed by the Dean's office independent of the senior surveys being done by the EECS Department. Each was asked whether or not specific ABET outcomes were being *achieved*. Figures below summarize the average of responses from EE respondents.

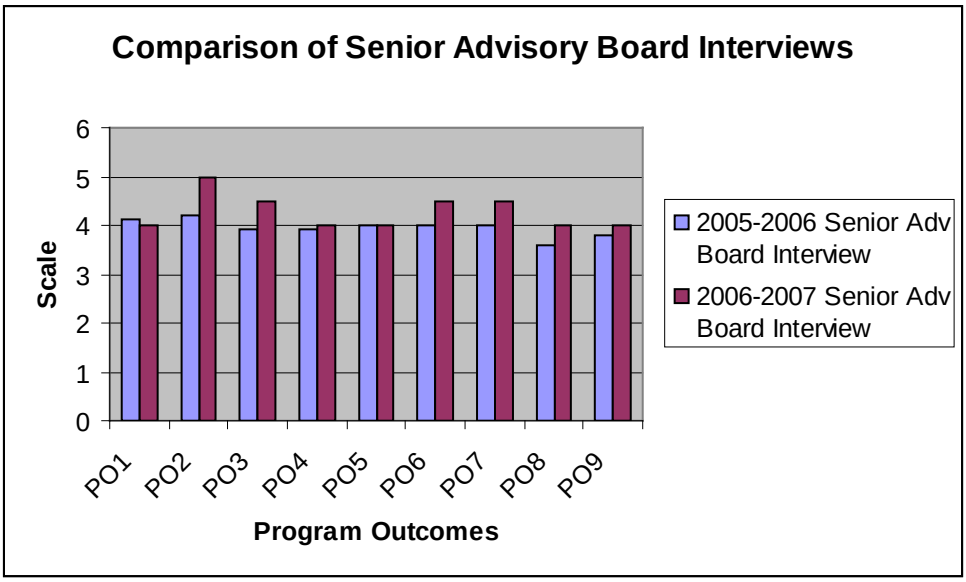


Score for Process 8

In the figure above, the data is reported specific to responses by EE students. All summary data shown in the figure for each of the program outcomes were well above the cut-off newly adopted level of 3.5.

Corrective action: None at this time based upon results from this instrument.

Process 9: Graduating Seniors Interviewed by Advisory Board Members

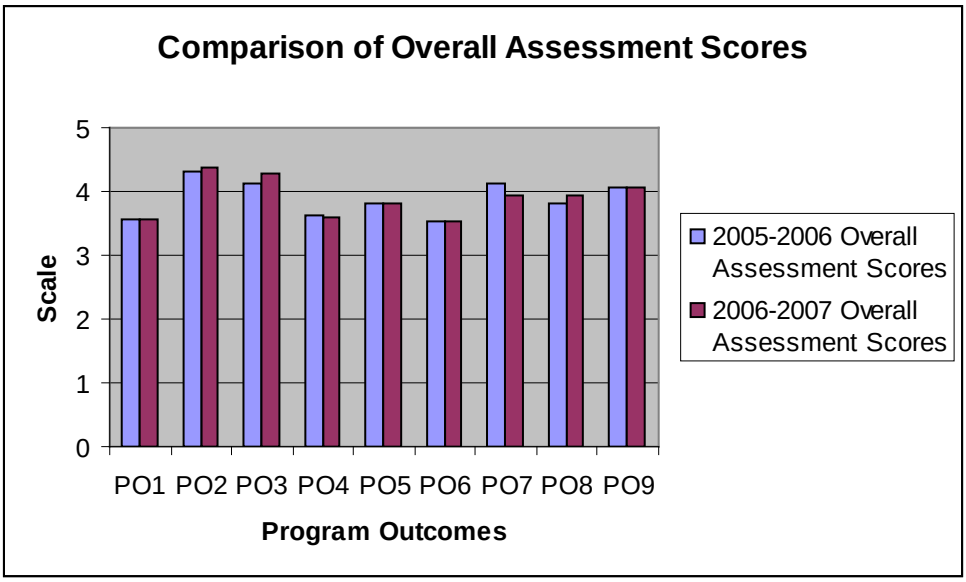


All summary data shown in the figure for each of the Program Outcomes were well above the cut-off newly adopted level of 3.5. The data show that all measures have improved slightly, save for PO1 and PO5 which exhibit a small drop. Considering the student population size, however, the numerical differences between successive years lie comfortably within standard deviation bounds. As such, the subtle changes in scores over successive years do not appear statistically significant. Rather, the overall trend apparent from the data is the favorable assessment provided by the students, as evidenced by nearly all scores from AY 2006/2007 lying at four or above on a five-point scale.

Corrective action: None at this time based upon results from this instrument.

Overall Program Outcome Results and Corrective Actions

This section presents the overall program outcome results using nine assessment tools described before. By applying a composite measure devised by the School of Engineering (DPP) to the results shown by the following tables, we obtain the following chart for the 9 Program outcomes:



The data show that PO1, PO2, PO4, PO5, PO6, PO8 and PO9 have remained practically the same for the two consecutive years. It is observed a more noticeable improvement in PO3 which deals with an ability to enter the practice of the field of electrical engineering and to pursue graduate studies. The department has been instrumental in offering more up-to-date elective courses. In addition, we have been more successful in attracting our own graduating seniors into our graduate program. PO7, although acceptable, appears to be decreasing in the current year. This is an ability to function as a productive inter-disciplinary member in a team and as an effective communicator.

The last figure indicates that all summary data for each of the program outcomes exceeded the threshold of 3.5 (out of 5); therefore, no immediate changes are required based on the results of the aforementioned surveys.

Comparison of the results of AY 2005-2006 and AY 2006-2007 indicate a minor change. This indicates that the corrective actions stated in the annual ABET Report 2005-2006 is still valid and we should pursue them; that is, continue to:

- Modernize the laboratories with more up-to-date computers and instrumentation.
- Update the electronics workbench software in the EE Laboratories.
- Monitor and update all laboratory experiments for senior and junior laboratories.
- Maintain the current format for senior design projects, which includes faculty fundamental research interests.
- Encourage and secure internships in local industries early on in the curriculum in the R&D sector to expose students to the real world of engineering. Consider awarding course credit for independent study with faculty oversight.

During the evaluations of senior design presentations 2004-2005 it was concluded that the student's needed more experience organizing and orally presenting their project ideas. In response, during the following years, we increased the number of presentations from 2 to 4. We also now require dry runs in front of a limited number of faculty members for all presentations. This appears to have been successful. The student's presentation skills in 2005-2006 and 2006-2007 were markedly better than in 2004-2005.

The department adopted the National Survey of Student Engagement (NSSE); in conjunction with its existing ABET processes, to assess the University's general education goals.

In general, the NSSE data is consistent with data collected from the department's existing nine ABET processes.

For the outcomes regarding critical thinking and reasoned analysis, the department should make improvement in memorizing and is comparable with the University and its Carnegie Peers in analyzing, synthesizing, making judgment, and applying. For the outcome of understanding of scientific and quantitative reasoning, the department compares favorably in thinking critically and analytically as well as analyzing quantitative problems.

For the outcome of ability to find information effectively using appropriate resources and technologies, the department needs some improvement on working on a paper or project that required integrating ideas or information from various sources, and performs unfavorably on including diverse perspectives, in class discussions or writing assignments.

For the outcome regarding knowledge of and appreciation for different cultures and religions, the department does not compare as favorably as it should with the University and its Carnegie Peers.

The department will observe and monitor these shortcomings in the following academic years to better understand and improve the issues.

Assessment Findings and Curricular Improvements
Department of Mechanical Engineering
Undergraduate Program

Assessment Measures

As part of its ABET (engineering accreditation body) process, the Department of Mechanical Engineering uses nine processes to assess departmental learning outcomes:

Process	Conducted by	How Often
Process 1: Fundamentals in Engineering Examination	Dean's office	Yearly
Process 2: Review of Required Courses	Department	Yearly
Process 3: Program Graduating Senior Questionnaire	Department	Yearly
Process 4: Alumni Survey	Department	Every 3 years
Process 5: Employer Survey	Department	Every 3 years
Process 6: Senior Design Project	Department	Yearly
Process 7: Student Course Evaluation	Department	Yearly
Process 8: School Survey of Graduating Seniors	Dean's Office	Yearly
Process 9: Graduating Seniors Interview by Advisory Board Members	Department	Yearly

In addition, the University as a whole uses select data from the National Survey of Student Engagement (NSSE) to assess its general education goals. The Department of Mechanical Engineering has begun to use the NSSE data, in conjunction with its ABET processes, to assess the general education outcomes of its senior students against senior students enrolled at Catholic University and its Carnegie Peers.

Assessment Findings

- During AY 2004-2005:
  - Process 1 – FE Exam: Not required; exam first required for seniors in AY 2005-2006
  - Process 2 – Required Course Review: The faculty, during the early part of the fall semester of 2005, finalized the table, "Correlation Between the Required Courses and The Program Educational Objectives" and the table, "Correlation of Selected Required Courses to Program Outcomes". The faculty revised and updated the syllabi for all courses taught during Spring 2005, and the department chair requested all faculty to do the same for courses taught during Fall 2005. The faculty collected sample course materials for all "core" courses taught during Spring 2005, and were instructed by the department chair to do the same during Fall 2005. In particular, during Spring 2005, the department collected course materials for ENGR 202 – Engineering Mechanics II, ENGR 211 – Thermodynamics, ME 342 – Junior Design, ME 362 – Heat Transfer, ME 392 – Dynamics Laboratory, ME 441 – Senior Project, and ME 503 – Structural Mechanics. Each of the courses was evaluated by the faculty. The faculty met to discuss the results of the course review, and decided no changes in program outcomes were needed as a result; however, individual faculty members incorporated into their courses and syllabi suggestions made by the committee, as deemed appropriate by the instructor.
  - Process 3 – Graduating Senior Questionnaire: The senior exit interview was provided to each graduating senior during the middle of the spring semester. Then, during the last week of the semester, the department chair met individually with each student for approximately 30 minutes to discuss the survey, and to allow the students to make any other comments, provide additional suggestions, and so on. In response to the question, "Should this be an outcome?" all respondents believed the PO were acceptable as program outcomes. In response to the statement, "As a senior, you have achieved this outcome" the data ranged from 3.4 to 4.5 (scale of 1-5), with a target minimum score of 3. Note that the lowest scores were for POs 3 and 5. A summary of general comments from the surveys and discussions were: satisfied with advising; more or less satisfied with the full-time faculty; very satisfied with the availability and interaction with the

full-time faculty; satisfied with the part-time faculty; believe that G34 needs to be upgraded; very satisfied with administrative assistant; believe that the laboratories were adequate, but believe they probably need to spend more time in them; very satisfied with the overall design experience; very appreciative of the small size of the department and the personalized attention; overall, quite satisfied with the CUA experience and would "do it all over again".

- Process 4 – Alumni Survey: During the fall semester of 2004 and the spring semester of 2005, alumni surveys were conducted. Two versions of the survey were used. First, the survey form adopted during 2000 was sent during the fall semester of 2004 to 125 alumni that graduated during the period 1990 through 2004. Then the new survey form adopted as part of the school's uniform process during the spring semester of 2005 was sent to the 20 alumni who had responded to the first survey request, with eventually 9 being returned in stamped, self-addressed envelops. In response to the question, "Should this be an outcome?" the respondents did not believe that PO 5 is appropriate. In response to the statement, "As a CUA graduate, you have achieved this outcome" scores ranged from 3.9 to 4.6 (scale of 1-5), with a target minimum score of 3.
- Process 5 – Employer Survey: During Spring 2005, employer surveys were mailed to alumni, together with the alumni surveys, and the alumni were asked to provide the survey to their employers. A total of 4 surveys were returned. In response to the question "Should this be an outcome?" all respondents believed PO 5 is inappropriate. In response to the statement, "This outcome satisfies the needs of your company" scores ranged from 1.7 to 4.8 (scale of 1-5), with a minimum target minimum score of 3, indicating belief, as stated before, that PO 5 is inappropriate as a program outcome. In response to the statement, "CUA students in your employ have achieved this outcome" scores ranged from 2.7 to 4.8, with a minimum target score of 3, indicating a gap between the importance of PO 4 and the obtained level.
- Process 6 – Senior Design Project: The senior design instructors evaluated the mechanical engineering design team during the spring semester of 2005. The six students formed themselves into one mini-Baja design team and designed, built, and tested a mini-Baja vehicle, and then competed in the East Coast mini-Baja Competition in early May 2005. The instructors' evaluations ranged from 3.0 to 5.0 (scale of 1-5), with a target minimum score of 3. The items that had the lowest scores were related to ABET Outcomes e and k. During the final design project presentation, several reviewers (six program faculty and three advisory board members) evaluated the oral presentations, with scores ranging from 3 to 4.2 (scale of 1-5), with a target minimum score of 3. The primary reaction from the evaluators was the students need to be better informed of what is expected of them during the project presentation, and secondly the students' oral presentation seemed to be not as prepared as it should have been (they were desperately trying to complete the construction of their mini-Baja before leaving for competition a few days after the project presentation).
- Process 7 – Student Course Evaluation: Student course evaluations from Spring 2005 for ENGR 202 – Engineering Mechanics II, ENGR 211 – Thermodynamics, ME 342 – Junior Design, ME 362 – Heat Transfer, ME 392 – Dynamics Laboratory, ME 442 – Senior Project, and ME 503 – Structural Mechanics resulted in data ranging from 4.14 to 4.38 (scale of 1-5), with a target minimum score of 3.
- Process 9 – Advisory Board Interview: Three Advisory Board members interviewed the graduating seniors at the end of the spring semester of 2005 in regards to their achievements of the PO, with the resulting data ranging from 3.5 to 4.5 (scale of 1-5), with a target minimum score of 3.

- During AY 2005-2006:
  - Process 1 – FE Exam: In the State of Virginia on Saturday, October 29, 2005, ten mechanical engineering students took the exam and six passed (60 %). Note: all ten students took the general exam in the afternoon. The biggest topical discrepancies between the CUA mechanical engineering students and the national averages were with mathematics, computers, engineering mechanics, strength of materials, material properties, fluid mechanics, and thermodynamics. Since the department chair had access to detailed results of those not passing the exam (the students provided them to him), the averages for the six students who passed the exam also were calculated. The biggest discrepancies between the six CUA mechanical engineering students who passed the exam and the national averages were with engineering mechanics, strength of materials, and fluid mechanics.
  - Process 2 – Required Course Review: The faculty finalized the table, "Correlation Between the Required Courses and The Program Educational Objectives" and the table, "Correlation of Selected Required Courses to Program Outcomes". The faculty revised and updated the syllabi for all courses. The faculty collected sample course materials for all "core" courses taught during Fall 2005 and Spring 2006. A

summary of general comments were: the students would do better were they to use a "standardized" problem solving methodology; the students need more practice and instruction in technical writing.

- Process 3 – Graduating Senior Questionnaire: The finalized program outcomes were incorporated into the senior exit interview, which was then provided to each graduating senior during the middle of the spring semester. Then, during the last week of the semester, the department chair met individually with each student for approximately 30 minutes to discuss the survey, and to allow the students to make any other comments, provide additional suggestions, and so on. In response to the question, "Should this be an outcome?". All respondents believe all the PO were acceptable as program outcomes. In response to the question, "As a senior, you have achieved this outcome", the data range from 4.25 to 5.0 (scale of 1-5), with a target minimum score of 3.0. A summary of general comments from the surveys and discussions were: quite satisfied with advising; more or less satisfied with the full-time faculty; very satisfied with the availability and interaction with the full-time faculty; satisfied with the part-time faculty**;** believe that the computers in G34 need to be updated and better maintained; very satisfied with administrative assistant**;** believe that the laboratories needed to be cleaned, organized and updated; satisfied with the overall design experience; very appreciative of the small size of the department and the personalized attention; overall, quite satisfied with CUA experience and would "do it all over again".
- Process 4 – Alumni Survey: No new data; next survey to be conducted during AY 2007-2008
- Process 5 – Employer Survey: No new data; next survey to be conducted during AY 2007-2008
- Process 6 – Senior Design Project: The senior design instructors evaluated the mechanical engineering design team during the spring semester of 2006. The ten students formed themselves into one team and designed, built, and tested a two-person hovercraft, and then successfully tested it in early May 2006 on a lake and farmland with rolling hills located in northern Montgomery County, Maryland. The instructors' evaluations ranged from 3.0 to 3.50 (scale of 1-5), with a target minimum score of 3. During the final design project presentation, several reviewers (six program faculty and five advisory board members) evaluated the oral presentations, with the evaluations ranging from 2.80 to 4.29 (scale of 1-5), with a target minimum score of 3. The primary reaction from the evaluators was the students need to be better informed of what is expected of them during the project presentation, and secondly the students' oral presentation seemed to be not as prepared as it should have been. The faculty believe the students need more practice and instruction in preparing and delivering oral presentations, and believe that the students need to spend more time in future years documenting their designs, rather than concentrating their efforts on the construction of hardware.
- Process 7 – Student Course Evaluation: The average scores from the student course evaluations from Fall 2005 and Spring 2006 for ENGR 102 – Engineering Design and Professionalism, ENGR 201 – Engineering Mechanics I, ENGR 202 – Engineering Mechanics II, ENGR 211 – Thermodynamics, ME 342 – Junior Design, ME 344 – System Dynamics, ME 362 – Heat Transfer, ME 392 – Dynamics Laboratory, ME 441 – Senior Design, ME 496 – Thermal Sciences Laboratory, ME 530 – Applied Energy Systems, and ME 503 – Structural Mechanics were determined. The data range from 3.92 to 4.14 (scale of 1-5), with a target minimum score of 3.
- Process 9 – Advisory Board Interview: Two Advisory Board members interviewed the graduating seniors at the end of the spring semester of 2006 in regards to their achievements of the PO, with the resulting data ranging from 3.5 to 5.0 (scale of 1-5), with a target minimum score of 3.

- During AY 2006-2007:
  - Process 1 – FE Exam: In the State of Virginia on Saturday, October 29, 2006, twelve mechanical engineering students took the exam and nine passed (75 %). Note: all twelve students took the mechanical engineering specific exam in the afternoon. The biggest topical discrepancies between the CUA ME students and the national averages for the AM subjects were with probability and statistics, engineering economics, strength of materials, material properties, fluid mechanics, and thermodynamics. The biggest topical discrepancies between CUA ME students and the national averages for the PM subjects were with mechanical design and analysis and materials processing; however, all of the areas were lower than the national averages. One comment to note is that the students took the exam during the middle of their first semesters of their senior years; whereas, nationally most students take the exam during their second semesters of their senior years. We believe the CUA students would improve in all discipline-specific topical areas were they to take the exam later in their studies; however, for internal reasons we want our students to take the exam during their first semesters of their senior years. We will continue to monitor their performances in time. Since the department chair had access to detailed results of those not passing

the exam (the students provided them to him), the averages for the same topical areas were calculated for the nine students who passed the exam. The biggest discrepancies for the AM subjects between the nine CUA ME students who passed the exam and the national averages were with engineering mechanics, material properties, and strength of materials, and fluid mechanics. Note: these topical areas are the same as last year's students (this is the second year that we required our students to take the exam), with the exception that engineering mechanics is not on the list this year.

- Process 2 – Required Course Review: The faculty revised and updated the syllabi for all courses. The faculty collected sample course materials for all "core" courses taught during Fall 2006 and Spring 2007. In particular, the department collected course materials for ENGR 102 – Introduction to Engineering Design and Professionalism, ENGR 201 – Engineering Mechanics I (Statics), ENGR 202 – Engineering Mechanics II (Dynamics), ENGR 211 – Thermodynamics, ENGR 331 – Fluid Mechanics, ME 342 – Junior Design, ME 344 – System Dynamics, ME 362 – Heat Transfer, ME 392 – Dynamics Laboratory, ME 441 – Senior Project, ME 442 – Senior Project, ME 496 – Thermal Sciences Laboratory, ME 503 – Structural Mechanics, and ME 530 – Applied Energy Systems. Each of the courses was evaluated by the faculty.
- Process 3 – Graduating Senior Questionnaire: The senior exit interview was provided to each graduating senior during the middle of the spring semester. Then, during the last week of the semester, the department chair met individually with each student for approximately 30 minutes to discuss the survey, and to allow the students to make any other comments, provide additional suggestions, and so on. In response to the question, "Should this be an outcome?". all respondents believed the PO were acceptable as program outcomes. In response to the statement, "As a senior, you have achieved this outcome", the data ranged from 3.7 to 4.7 (scale of 1-5), with a target minimum score of 3. A summary of general comments from the surveys and discussions were: satisfied with advising; more or less satisfied with the full-time faculty; very satisfied with the availability and interaction with the full-time faculty; satisfied with the part-time faculty; believe that the computers in G34 need to be updated and better maintained; believe the number of computers in G34 should be increased; very much like the fact of having a place like G34; were very happy with their exposure to LabVIEW, ABAQUS, EES, MATLAB, and SolidWorks; very satisfied with administrative assistant; were satisfied with their laboratory experiences; enjoyed the hands-on experiences and believe they learned a lot regarding the taking of data and documentation; believe the dynamics laboratory has been changed significantly for the better over previous years; believe the thermal sciences laboratory was a very good experience but believe the laboratory needs to be cleaned, organized and updated; were satisfied with the overall design experience; believe freshmen design is quite good and senior design is quite good; believe junior design should include more "design" and that other design should be introduced in the sophomore and junior years; very appreciative of the small size of the department and the personalized attention; overall, quite satisfied with CUA experience and would "do it all over again".
- Process 4 – Alumni Survey: No new data; next survey to be conducted during AY 2007-2008
- Process 5 – Employer Survey: No new data; next survey to be conducted during AY 2007-2008
- Process 6 – Senior Design Project: The senior design instructors evaluated the mechanical engineering design team during the spring semester of 2007. The students formed themselves into two teams: (1) one who designed and built a thermal/fluid test bed intended for departmental use in the thermal/fluid sciences laboratory and (2) the other who designed and constructed a hovercraft platform capable of deploying mine detection equipment in a mined area. The instructors' evaluations ranged from 2.58 to 5.0 (scale of 1-5), with a target minimum score of 3. During the final design project presentation, several reviewers (program faculty, advisory board members and other outside guests) evaluated the oral presentations with results ranging from 3.13 to 4.25 (scale of 1-5), with a target minimum score of 3.
- Process 7 – Student Course Evaluation: The average scores from the student course evaluations from Fall 2006 (Spring 2007 data were not available yet) for ENGR 102 – Engineering Design and Professionalism, ENGR 201 – Engineering Mechanics I, ME 344 – System Dynamics, ME 441 – Senior Design, ME 496 – Thermal Sciences Laboratory, and ME 530 – Applied Energy Systems range from 3.82 to 4.07 (scale of 1-5), with a target minimum score of 3.
- Process 9 – Advisory Board Interview: Three Advisory Board members interviewed the graduating seniors at the end of the spring semester of 2005 in regards to their achievements of the PO, with the resulting data ranging from 3.5 to 5.0 (scale of 1-5), with a target minimum score of 3.

- During AY 2007-2008:
  - The department adopted the National Survey of Student Engagement (NSSE), in conjunction with its existing ABET processes, to assess the University's general education goals.
  - In general, the NSSE data is consistent with data collected from the departments existing nine ABET processes.
  - For the outcome regarding written and oral communication, the department compares favorably with the University and its Carnegie Peers in terms of the quantity of reading and writing required; however, compares unfavorably in terms of the extent to which the institution has contributed to the students' knowledge. Note: this finding is consistent with existing data from the department's nine ABET processes and is being addressed by the department (see discussion above).
  - For the outcomes regarding critical thinking and quantitative reasoning, the department compares very favorably with the University and its Carnegie Peers, except in questions regarding memorizing, analyzing, and judging. The department will monitor this in coming academic years to better understand the issue.
  - For the outcome regarding knowledge of and appreciation for different cultures and religions, the department does not compare as favorably as it should with the University and its Carnegie Peers. The department will monitor this in coming academic years to better understand the issue.
  - At the time of the preparation of this document, the department is in the process of collecting and analyzing data from its nine ABET processes.

Actions based on Assessment Findings

Over the last three-year period the achievement of each PO is above the target threshold of 3.0 out of 5.0 and thus no specific action is required for any of the PO; however, the faculty strives continuously to improve the undergraduate program. To this end, the faculty regularly meets (1) to discuss the assessment data (both quantitative and qualitative) and (2) to decide upon specific action items to improve the program. The bullet items listed below in summary form describe the various actions taken by the department during the past three academic years to address the results (quantitative and qualitative). Although not all the action items listed below are specific to outcomes, they all—in some way—directly impact the achievement of PO. (Note: the actions are grouped by AY; however, some items appear in multiple AY since they are on-going and regular discussions and actions.)

- During AY 2003-2004:
  - The school's undergraduate committee decided to implement ENGR 401 – Senior Seminar beginning with Fall 2004 (1) to prepare students to take the F.E. Exam, (2) to have the students take the F.E. Exam in Virginia in late October, and (3) to present to the students several technical seminars, particularly addressing ABET Outcomes (f), (g), (h), (i), and (j).

- During AY 2004-2005:
  - The mechanical engineering faculty reaffirmed the departmental mission. (Action based on Processes 4 and 5)
  - The mechanical engineering faculty reaffirmed the PEO. (Action based on Processes 4 and 5)
  - The mechanical engineering faculty adopted twelve PO, replacing the five PO that had been in place since the previous ABET visit in October 2001. (Action based on Processes 4 and 5)
  - The syllabi of all mechanical engineering (ME) courses and the syllabi of all general engineering (ENGR) courses taught by mechanical engineering faculty were reviewed and updated. (NOTE: ENGR course syllabi for courses not taught by mechanical engineering faculty also were reviewed and updated by the responsible departments.) (Action based on Process 2)
  - All course (catalog) descriptions referred to in the previous bullet item were reviewed and updated. (Action based on Process 2)
  - The school's curriculum committee (the engineering department chairs comprise the committee) has had regular and frequent contact with the department heads and some faculty from the departments of chemistry, physics, mathematics, and biology, and the deans of the schools of theology and religious studies and philosophy. These discussions have focused on (1) ensuring up-to-date and relevant syllabi for

their various courses, (2) the evaluation of and transfer of non-CUA courses, and (3) the education of these non-engineering department chairs regarding ABET accreditation. (Action based on Process 2)

- The mechanical engineering faculty decided to emphasize technical writing in ME 392 – Dynamics Laboratory and ME 496 – Thermal Sciences Laboratory beginning with AY 2005-2006. (Action based on Processes 2, 3, 4, and 6)
- The mechanical engineering faculty decided to emphasize oral presentations in ME 342 – Junior Design, ME 441 – Senior Design, and ME 442 – Senior Project beginning with AY 2005-2006. (Action based on Processes 2, 3, 4, and 6)
- The mechanical engineering faculty discussed and decided that, as a minimum, students need to be exposed to MATLAB (a computational and programming environment), AutoCAD (designer software), and a finite element package (currently, the school has a license for ABAQUS). In addition to these, the faculty believes strongly that the students should be exposed to several other modern engineering tools. Currently, these include LabVIEW (a graphically-based data acquisition package), EES (an equation solver particularly suited for thermal/fluid sciences problems), CATT (a package capable of predicting thermodynamic properties), SolidWorks (a 3D solid modeling package), Microsoft Project (a project management package), and beginning with AY 2007-2008, Working Model 2D (a motion simulation package). (Note: the faculty regularly reviews and updates the list of appropriate modern engineering tools.) (Action based on Processes 2, 3, 4, and 6)
- The mechanical engineering faculty discussed various proposals for modifying the design sequence of ME 342 – Junior Design, ME 441 – Senior Design, and ME 442 – Senior Project. (Action based on Processes 2, 3, and 6)

- During AY 2005-2006:
  - The mechanical engineering curriculum was reviewed and compared to the curricula of 20 other mechanical engineering programs. Generally, the existing curriculum was consistent with the benchmark institutions and thus the faculty decided that no major curriculum overall was necessary. (Action based on Process 2)
  - The syllabi of all mechanical engineering (ME) courses and the syllabi of all general engineering (ENGR) courses taught by mechanical engineering faculty were reviewed and updated. (NOTE: ENGR course syllabi for courses not taught by mechanical engineering faculty also were reviewed and updated by the responsible departments.) (Action based on Process 2)
  - All course (catalog) descriptions referred to in the previous bullet item were reviewed and updated. (Action based on Process 2)
  - The school's curriculum committee (the engineering department chairs comprise the committee) has had regular and frequent contact with the department heads and some faculty from the departments of chemistry, physics, mathematics, and biology, and the deans of the schools of theology and religious studies and philosophy. These discussions have focused on (1) ensuring up-to-date and relevant syllabi for their various courses, (2) the evaluation of and transfer of non-CUA courses, and (3) the education of these non-engineering department chairs regarding ABET accreditation. (Action based on Process 2)
  - The mechanical engineering faculty approved the implementation of instruction in programming using MATLAB (a computational and programming environment) in CSC 113 – Computer Programming I beginning with AY 2006-2007. This curriculum change was later approved by the school's undergraduate committee during the same AY and was implemented for the first time during Fall 2006. (Action based on Process 2)
  - The mechanical engineering faculty decided to encourage the students to take the ME-specific afternoon section of the F.E. Exam beginning with AY 2006-2007. (Action based on Process 1)
  - The mechanical engineering faculty decided that, as in years past, there would continue to be a single course instructor for the senior capstone design sequence (ME 441 – Senior Design and ME 442 – Senior Project). This instructor, however, will be assisted by part-time instructor(s), and the other mechanical engineering faculty will be involved by providing informal guidance to students and by participating in regular (more or less bi-monthly) design reviews with the students. (Action based on Processes 2 and 6)
  - The mechanical engineering faculty decided to emphasize in the senior capstone design sequence (ME 441 – Senior Design and ME 442 – Senior Project) the need for the students to better document their design projects throughout the course of the academic year, and to focus more on the overall design process and less on simply "building" beginning with AY 2006-2007. (Action based on Processes 2, 6, and 9)

- The mechanical engineering faculty discussed and decided that, as a minimum, students need to be exposed to MATLAB, AutoCAD (designer software), and a finite element package (currently, the school has a license for ABAQUS). In addition to these, the faculty believes strongly that the students should be exposed to several other modern engineering tools. Currently, these include LabVIEW (a graphically-based data acquisition package), EES (an equation solver particularly suited for thermal/fluid sciences problems), CATT (a package capable of predicting thermodynamic properties), SolidWorks (a 3D solid modeling package), Microsoft Project (a project management package), and beginning with AY 2007-2008, Working Model 2D (a motion simulation package). (Note: the faculty regularly reviews and updates the list of appropriate modern engineering tools.) (Action based on Processes 2, 3 and 6)
- The mechanical engineering faculty discussed various proposals for modifying the design sequence of ME 342 – Junior Design, ME 441 – Senior Design, and ME 442 – Senior Project. (Action based on Processes 1, 2, 3, and 6)

- During AY 2006-2007:
  - The mechanical engineering faculty discussed and developed a technical writing module for use in courses taught by mechanical engineering faculty beginning with AY 2007-2008. Its purposes are (1) to provide students with a consistent and clear message of the importance of good writing and (2) to provide students with consistent guidelines on how to write well. The faculty decided not to "force" the implementation of this instrument in all courses, but instead decided to leave it to the discretion of each faculty member of whether to implement it or not. (Based on Processes 2, 3, 6, and 9)
  - The mechanical engineering faculty discussed and developed an oral presentation module for use in courses taught by mechanical engineering faculty beginning with AY 2007-2008. Its purposes are (1) to provide students with a consistent and clear message of the importance of good oral communication and (2) to provide students with consistent guidelines on how to present material orally. The faculty decided not to "force" the implementation of this instrument in all courses, but instead decided to leave it to the discretion of each faculty member of whether to implement it or not. (Based on Process 2, 6, and 9)
  - The mechanical engineering faculty discussed and developed a general problem solving methodology for use in courses taught by mechanical engineering faculty beginning with AY 2007-2008. Its purpose is to help improve students' problem solving skills by providing a step-by-step procedure to "attack" unknown problems in a systematic way. The faculty decided not to "force" the implementation of this instrument in all courses, but instead decided to leave it to the discretion of each faculty member of whether to implement it or not. (Based on Process 2)
  - The dynamics and mechanical systems laboratory was completely renovated, modernized, and upgraded. The modernized laboratory was used for the first time in Spring 2007 in ME 392 – Dynamics Laboratory. (Based on Processes 2 and 3)
  - The senior design room (Pangborn G34) was refurbished with new furniture, computers, large format printer, and network printer. (Based on Processes 2, 3, and 6)
  - The mechanical engineering faculty decided to limit the number of team members to a maximum of five per project in the senior capstone design sequence (ME 441 – Senior Design and ME 442 – Senior Project) beginning with AY 2007-2008. (Based on Processes 2 and 6)
  - The mechanical engineering faculty decided to provide more review during the fall semester each year for thermodynamics and fluid mechanics beginning with AY 2007-2008. (Based on Process 1)
  - The mechanical engineering faculty discussed and decided that, as a minimum, students need to be exposed to MATLAB (a computational and programming environment), AutoCAD (designer software), and a finite element package (currently, the school has a license for ABAQUS). In addition to these, the faculty believes strongly that the students should be exposed to several other modern engineering tools. Currently, these include LabVIEW (a graphically-based data acquisition package), EES (an equation solver particularly suited for thermal/fluid sciences problems), CATT (a package capable of predicting thermodynamic properties), SolidWorks (a 3D solid modeling package), Microsoft Project (a project management package), and beginning with AY 2007-2008, Working Model 2D (a motion simulation package). (Note: the faculty regularly reviews and updates the list of appropriate modern engineering tools.) (Action based on Processes 2, 3 and 6)
  - The mechanical engineering faculty discussed the design sequence of ME 342 – Junior Design, ME 441 – Senior Design, and ME 442 – Senior Project and adopted in AY 2006-2007 the following changes for students entering in Fall 2007 (Action based on Processes 1, 2, 3 and 6):
    - Move ENGR 201 – Engineering Mechanics I (statics) to the spring semester of the first year.

    - Change PHYS 215 – University Physics I from a prerequisite to a co-requisite for ENGR 201 – Engineering Mechanics I (statics). (Note: this change was approved by the school's undergraduate curriculum committee during AY 2006-2007.)
    - Introduce ENGR 301 – Solid Mechanics during the fall semester of the sophomore year.
    - Reduce the number of semester credit hours (SCH) for ME 342 – Junior Design from 4 to 3.
    - Rework the syllabi for ME 342 – Junior Design, ME 441 – Senior Design, and ME 442 – Senior Project.
    - Increase the net number of required SCH for the Bachelor's degree from 128 to 130.

- During AY 2007-2008:
    - The department adopted the National Survey of Student Engagement (NSSE), in conjunction with its existing ABET processes, to assess the University's general education goals.
    - At the time of the preparation of this document, the department is in the process of collecting and analyzing data from its nine ABET processes.