Cal Poly Engineering Assessment Center - How It Works

Kena Burke, Paul E. Rainey
College of Engineering,
California Polytechnic State University, San Luis Obispo

Abstract
The eleven engineering programs at Cal Poly had their accreditation visit during the fall of 2002, using the EC 2000 Criteria. The assessment efforts are reviewed, including the formation and working of the Cal Poly Engineering Assessment Committee and the initiation of the Cal Poly Engineering Assessment Center. The Engineering Assessment Center (EAC), consisting of a full-time coordinator and student employees, works with faculty program representatives to coordinate and support their assessment efforts. The EAC is committed to excellence in all aspects of assessment practices and processes, paying particular attention to accuracy and timeliness. The EAC initiates and records quarterly forms for faculty and chairs and thus minimizes the impact upon program faculty and the staff in eight departmental offices. A primary purpose of the Engineering Assessment Office is to provide sustainability to the assessment process. The formation, funding, and daily activities of the Cal Poly Engineering Assessment Office are discussed.

Introduction

In 1996, the Accreditation Board for Engineering and Technology (ABET) adopted an accreditation method that emphasizes individual engineering program outcomes assessment. The most significant change of the new engineering criteria, EC 2000,[1] is the accountability and responsibility placed upon faculty for measuring the success of their own program. Initially, EC 2000 impressed the already taxed engineering program faculty as a burdensome process. Knowing that being accredited was directly related to faculty involvement in this self-assessing, continuous improvement process added even more stress to a process that had not yet been fully established. This unknown process was facilitated at the local level with minimum disruption and reached its culmination during the fall 2002 ABET visit.

Beginning in the spring of 1998, orientation workshops and organizational meetings were held to present the new process to faculties and department chairs. To help establish the new process, in the fall of 1998 the Engineering Assessment Committee was formed, which consisted of faculty representatives from Computer Science, each of the nine accredited engineering programs in the College of Engineering, and BioResource and Agricultural Engineering from the College of Agriculture. The Architectural Engineering program in the College of Architecture and Environmental Design decided not to participate in this committee.

Because of the iterative nature of the assessment process it was imperative that the process begin, even though some of the parameters were not fully defined. Therefore, the Associate Dean of Engineering established the Engineering Assessment and Accreditation Center in November

1999, and the title was later shortened to the Engineering Assessment Center (EAC). The EAC works with faculty representatives from ten engineering programs on the Engineering Assessment Committee to coordinate and support their accreditation efforts. The EAC is committed to excellence in all aspects of assessment practices and processes, paying particular attention to accuracy and timeliness. Thus, the purpose of the EAC is to relieve some of the extra workload from the faculty and the staff of eight departmental offices, as well as help organize the faculty assessment efforts. The Engineering Assessment Center consists of a full-time coordinator and student employees. The cost of the EAC includes staff salaries for a full-time coordinator and student employees, operating expenses (telephones, copier maintenance, etc.), supplies, and equipment. Funding for the EAC is assigned to the engineering programs as a percentage depending upon the number of students and the number of courses taught. The 2001-02 EAC cost was about $56,000. See the *Center's 2001-02 budget* at http://assessment.calpoly.edu/over/aco/newfrontpage.htm.

Meeting weekly, the Engineering Assessment Committee, the Coordinator of the Engineering Assessment Center, and the Associate Dean of Engineering, who chaired the Committee, began the arduous task of deciphering the locally untried EC 2000 Criteria. The accreditation expectations ABET created through EC 2000 were well-defined: Each program's faculty, as one of the main constituent groups, had to define their own program's Educational Objectives (PEOs) under advisement and evaluation of their program's newly-defined constituent groups. Once having determined their program's PEOs, faculty then had to agree on which local program outcomes a student should be able to demonstrate at graduation, in addition to all of the national general outcomes (ABET Criterion 3(a-k)) and program-specific outcomes (ABET Criterion 8). Therefore, if students achieved the program's PEOs, that would indicate that the Program Educational Objectives also would be achieved. Once the parameters were established, the Continuous Improvement Process began to take shape, that is, asking identified constituent groups if pre-determined levels of success for outcomes/objectives had been achieved. This process for developing the PEOs was demonstrated in a Flash Movie and posted on the assessment web site. It can be accessed at *http://assessment.calpoly.edu/over/lsp/movie01.11.01/movie_page.htm*

Continuous Improvement Process Model

The ABET 2-Loop Model, originally distributed by ABET at conferences and workshops, provided the basis for the modeling of the Continuous Improvement Process, although minor modifications were incorporated. The evaluative cycle (1st ABET Loop) was externally focused, while the assessment cycle (2nd ABET Loop) was internally focused. Initially, the evaluation loop was a two- or three-year cycle, and the initial assessment loop as an annual cycle. Later, the intent would be to extend the evaluation and assessment loops for longer cycles.

Using this Continuous Improvement Process model was logical, even as the understanding of the committee grew, but the establishment of a working glossary proved much more difficult. ABET's expectations were well-defined, but the terms were not. The accreditation body chose not to define any of the specific terms of accreditation, leaving that task to program faculty at individual campuses. The Cal Poly Engineering Assessment Committee began to assimilate assessment terminology and concepts: Program educational objectives, program outcomes, constituent groups, measurement tools to assess outcome achievement and evaluate program

educational objectives, and levels of acceptance. The committee, presented with various interpretations of these terms from around the country, including ABET workshops, began reviewing lists. They rejected some terms, finding them inappropriate or self-explanatory, and identified terms they felt needed clarification for the new engineering criteria. Once the definitions of program educational objectives and program outcomes were agreed upon by the committee, the process of taking the definitions to program faculty to ascertain each individual program's education objectives became more challenging. The process of defining oneself in terms of the mission statement and the institutional direction were difficult at first. See *Glossary of Terms* at http://assessment.calpoly.edu/over/presntns/ThisMenuPosted.htm.

Outcomes Mapping Logic

The Outcomes Mapping Logic model, Figure 1, was recommended by the Committee to help program faculty understand the overall concept of mapping outcomes to objectives and how the use of measurement tools helps prove the achievement of educational objectives. Using three measurement tools for each outcome, with thresholds pre-determined to indicate the level of achievement, a program could then assess whether their students at graduation demonstrated the desired level of the program outcomes. If the desired level of outcome assessment was achieved, then the intent is that the program education objectives would be achieved at sufficient levels three-to-five years later.

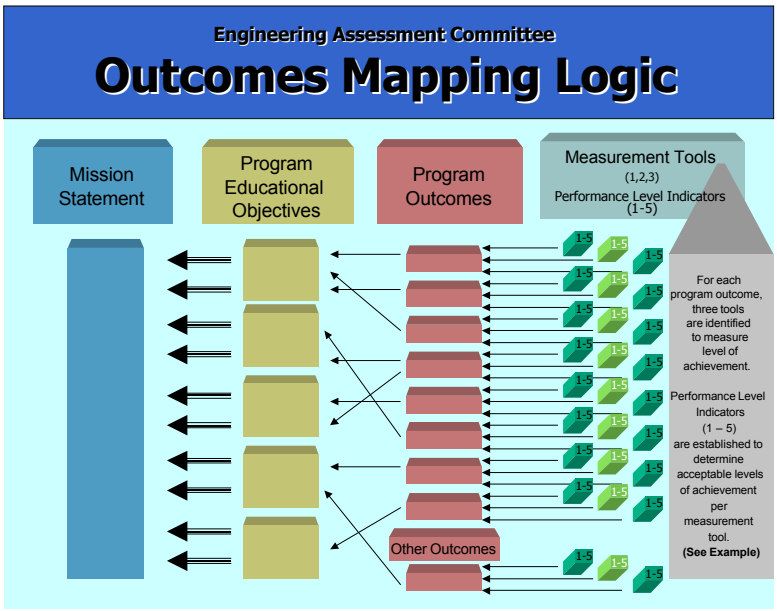


Figure 1: Outcomes Mapping Logic *(Later developed as a Flash Movie and posted to the assessment web site. It can be accessed at* http://assessment.calpoly.edu/over/ologic/Movie1(alex).swf

Initially, many programs formulated their own program outcomes based upon ABET Criterion 3(a-k) and added their own campus program-specific outcomes in more generic terms. Although committee representatives produced program outcomes based on what they felt was required by ABET, not many have used them in their actual assessment process. Most programs used Criteria 3(a-k) and Criterion 8, which are Program Criteria that survey identified constituent groups. The rationale was two-fold: To develop outcomes for most programs using combinations of 3(a-k) (which were too broad to accurately measure each subject matter), and to

keep a common language which would help the understanding of students and faculty college-wide.

ASSESSMENT MEASUREMENT TOOLS

The assessment committee struggled with identifying valid and reliable tools to measure program outcomes. For the most part, the Graduating Senior Surveys were identified as the primary measurement tool. The secondary tool tended to be faculty analysis of the student course evaluation results to determine if the course had achieved the outcomes at the levels the course coordinator pre-determined. For the third tool, program faculty widely varied the measurement tool. Some used grades or an average of grades from a series of courses to determine if students met certain pre-determined goals. One effective measurement tool was the use of focus groups, which consisted of interviewing on-campus recruiters. They helped to identify trends for educational objectives, confirmed the demonstrable abilities for which they were recruiting, and then, they stated their opinion of the preparedness of our graduates.

Course Classification Form

As definitions, improvement cycles, and mapping logic were debated and recommended, survey instruments and documentation methods were being developed. The Course Classification Form (CCF) was the first instrument designed to document the course coordinator's level of anticipated achievement of the program outcomes. Since all graduates were expected to have the ABET Criterion 3(a-k) abilities, and since most program-created outcomes were too broad, Course Classification Forms were designed, using the ABET Criterion 3(a-k) and Criterion 8 (national program-specific criteria) outcomes verbatim, as well as the campus program-specific outcomes. Thus, the Engineering Assessment Committee members approved the use of ABET outcomes criteria, even though some members felt that the ABET Criterion 3(a-k) was ambiguous and difficult to understand by their faculty and students. Therefore, course coordinators were asked to define their interpretation of the outcomes by listing the "relevant activities" that would demonstrate student achievement. Figure 2 below is an example for ENVE 442 – Advanced Systems Design:

ABET 3(a-k) Criterion	Levels (L, M, H)	Relevant Activities
(a) Ability to apply knowledge of math, science, & engineering	H	Design project with multiple aspects of design engineering
(b) Ability to design & conduct experiments; analyze, interpret data	L	
(c) Ability to design system, component, or process to meet needs	H	Design project with multiple aspects of design engineering - including design of large scale system (e.g., landfill, wastewater treatment plant - project varies each year)
(d) Ability to function on multi-disciplinary teams	H	Heart of class - simulate engineering company
(e) Ability to identify, formulate, & solve engineering problems	H	Identify and develop theory based on specific design assignments
(f) Understanding of professional & ethical responsibility	M	Lecture and discussion. (Running theme throughout class.)
(g) Ability to communicate effectively	H	Weekly oral progress reports to update other teams on relevant progress. Presentation at end of quarter

(h) Broad education necessary to understand impact of engineering solutions in a global & societal context	H	Projects selected by instructors have large environmental impacts - evaluations of impact and how to mitigate problems
(i) Recognize need for & ability to engage in life-long learning	L	
(j) Knowledge of contemporary issues	H	Overall regulatory and economic issues in project
(k) Ability to use techniques, skills, & modern engineering tools necessary for engineering practice	H	Computer applications - spreadsheets, etc., CAD to complete project/Extensive research on WWW

Figure 2: A*n excerpt from the course classification form:* ENVE 442 – Advanced Systems Design

This addition of "Relevant Activities" helped both the faculty and students better understand the outcomes. See an example of a C*ourse Classification Form* at http://assessment.calpoly.edu/over/presntns/ThisMenuPosted.htm

The Course Classification Form became the basis for the Continuous Improvement Process, by which information from the individual courses was summarized into a more comprehensive document, the Courses by Outcomes Matrix. This gave faculty an opportunity to view the overall curriculum in light of the importance they themselves placed upon each outcome for individual courses.

Student Course Evaluation Forms

Once the Course Classification Form was collected, the EAC staff generated the Student Course Evaluation Form (SCEF) which is a survey used to measure student-perceived levels of outcome achievement. Each academic year, a quarter is designated for the SCEFs to be distributed by instructors to students in each section of each program's courses. Questions specific to the course are also asked, alongside the outcomes designated for that course, and include questions about textbook(s), prerequisites, and course technical objectives and topics, if available. See an example of a *Student Course Evaluation Form* at http://assessment.calpoly.edu/over/presntns/ThisMenuPosted.htm.

In 2001-2002 the EAC staff changed the reporting of the data on the SCEF to include the weighted mean of student responses, the standard error of the estimate, and the difference between the means of the students and the instructors. See an example of the *Reporting Template* at http://assessment.calpoly.edu/over/presntns/ThisMenuPosted.htm.

Although there is still faculty unease with the survey tools, most results are normalizing over the quarters as faculty and students become more familiar with the meaning of the outcomes. A noticeable trend in student self-reporting occurred in that their outcome achievement was consistently higher than anticipated by the faculty. As an ongoing part of the continuous improvement assessment process cycle, the outcome achievement measuring tools are being reviewed to ascertain if the measurements of the students' perception of their courses are reliable and valid.

Instructor Course Evaluation Form (ICEF)

At the same time the SCEF is distributed, the instructor for each section is given the opportunity to evaluate the level of outcome achievement s/he thinks students have attained. This document

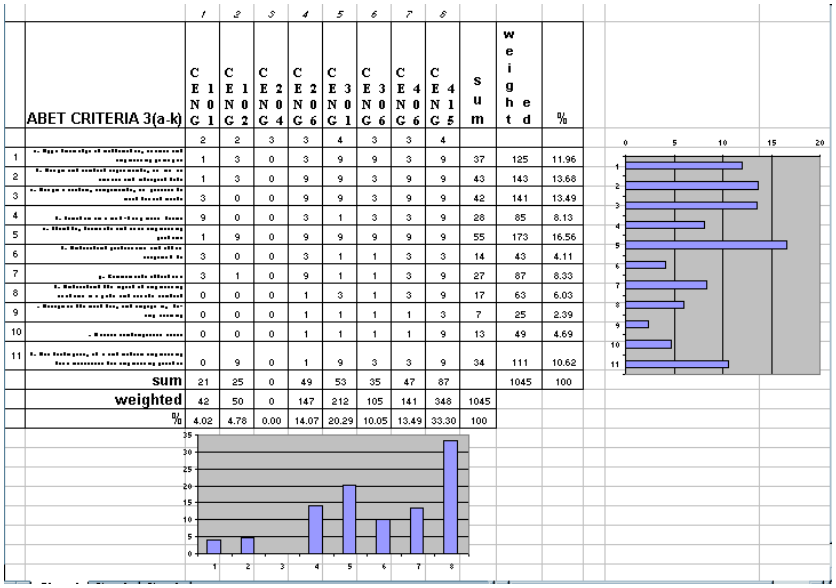
is referred to as the Instructor Course Evaluation Form (ICEF), more commonly known as the Instructor Feedback Form. The ICEF gives instructors the opportunity to respond to individual course accomplishments; simultaneously, course coordinators can examine individual instructor's perception of level of outcome achievement and review a feedback summary from all sections of a given course. See an example of the *Instructor Course Evaluation Form* at http://assessment.calpoly.edu/over/presntns/ThisMenuPosted.htm.

Results are distributed to each of the Engineering Assessment Committee representatives, for their specific programs, to be used as part of their program review and improvement process. The intent of surveying the students is to gather course statistics until the levels of achievement reach agreement among the course coordinator, instructors, and students. Once this is attained, the faculty representative to the assessment committee will notify the EAC staff, and this course will be evaluated only every two years, or sooner, if requested by the faculty.

Occasionally, the EAC staff has been requested to take specific data to create different formulas and formats to help programs in their analysis of the assessment information. The faculty analyzed the information provided by the different course evaluation surveys and made overall program outcome inferences in their self-studies, based upon the student and faculty perception of course-level outcome achievement.

Courses by Outcomes Matrix

When course coordinators complete the Course Classification Form, they also provide data used collectively for the Courses by Outcomes Matrix, Figure 3, that indicates which outcomes faculty emphasize in their program's curriculum. Also, this Matrix is reviewed by the faculty to make sure that the outcomes accurately reflect their own intentions for their own program curriculum. The Courses by Outcomes Matrix also identifies any courses that need attention in achieving the desired level of each program's outcome, as indicated by the appropriate assessment tool. Using the data from the Matrix, the program's curriculum committee considers how to resolve any curricular issue. The Courses by Outcomes Matrix is also helpful for guiding faculty in prioritizing their assessment efforts. This is accomplished by reviewing the outcomes that have been emphasized by the faculty but have been rated low by one or more measurement tools. See *Curriculum-Outcomes Analysis* at http://assessment.calpoly.edu/over/overfram.htm.)



	ABET CRITERIA 3(a-k)	CE1NG1	CE1NG2	CE2NG4	CE2NG6	CE3NG1	CE3NG6	CE4NG6	CE4NG5	sum	weighted	%
		2	2	3	3	4	3	3	4			
1		1	3	0	3	9	9	3	9	37	125	11.96
2		1	3	0	9	9	3	9	9	43	143	13.68
3		3	0	0	9	9	3	9	9	42	141	13.49
4		9	0	0	3	1	3	3	9	28	85	8.13
5		1	9	0	9	9	9	9	9	55	173	16.56
6		3	0	0	3	1	1	3	3	14	43	4.11
7		3	1	0	9	1	1	3	9	27	87	8.33
8		0	0	0	1	3	1	3	9	17	63	6.03
9		0	0	0	1	1	1	1	3	7	25	2.39
10		0	0	0	1	1	1	1	9	13	49	4.69
11		0	9	0	1	9	3	3	9	34	111	10.62
	sum	21	25	0	49	53	35	47	87		1045	100
	weighted	42	50	0	147	212	105	141	348	1045		
	%	4.02	4.78	0.00	14.07	20.29	10.05	13.49	33.30	100		

Figure 3: Generic Example of Courses by Outcomes Matrix

ABET Faculty Vita and Course Syllabi

In an effort to maintain a visual similarity among the ABET Self-Study Reports, the EAC forwarded two recommendations to program faculty. One recommendation was an ABET Course Syllabus template. At the same time, a two-page ABET Faculty Vita format was approved. Both documents have been posted on the assessment website as Word documents. Faculty need only access their program's web pages to download a uniform format for course syllabi and vitas.

Some faculty members have expressed unease about posting vitas to the worldwide web. To alleviate their concerns, those faculty are asked to notify the EAC to not post their vita when they hand in their final draft. An asterisk is placed next to that faculty member's name on the web and the link to their vita is disengaged. The asterisk references a note at the bottom of the web page stating, "Not Posted." This allows committee representatives to delineate between those who have not posted or changed anything from those who have updated and yet do not want their vitas posted.

Graduating Senior Surveys

Prior to 1999, the College of Engineering conducted an overall Graduating Senior Survey to gather feedback from graduates (or soon-to-be graduates) on their overall engineering experience at Cal Poly. In 1999, the Engineering Assessment Committee started reviewing the Graduating Senior Survey, which had posed questions directly related to the outcomes defined by ABET Criterion 3(a-k). Each annual iteration of the survey incorporated changes recommended by the Engineering Assessment Committee. The latest survey was taken during the 2002 Spring Quarter. Results from all surveys have been posted on the web site, but are password protected for review by Cal Poly faculty only. Examples of past *Graduating Senior Surveys* can be found at http://assessment.calpoly.edu/over/presntns/ThisMenuPosted.htm.

Ease of Use: Web-based Graduating Senior Surveys
Upon the request of the BioResource and Agricultural Engineering (BRAE) program, the assessment office has created a web-based Graduating Senior Survey, using a computer-graphic interface (CGI.bin). Responses are generated and submitted to a designated email account and then reformatted for inclusion in a database. Presently, a return rate of 100% for the BRAE graduating seniors is attributed to the mandatory survey completion requirement needed for graduation. The accessibility of the web-based survey allows students the opportunity to complete the survey at their convenience, and, hopefully, allowing for more thoughtful responses.

Alumni Surveys
Having identified alumni as a key constituent group, the committee prepared the first Alumni Survey and the Employer Survey during the winter and spring of 2000. The goals were to solicit information regarding achievement of the respective program's educational objectives and to confirm outcomes achievement.

Most programs targeted alumni three years out of school. However, some programs targeted alumni three and five years out, to ask about professional licensure issues which were included in their educational objectives. The intent was to gather information regarding alumni perspective on two aspects of the educational objectives: Achievement and appropriateness of objectives for each specific engineering program. Also, more emphasis was placed on feedback regarding professional development, life-long learning and career choices. A place for comments regarding program improvement, messages to faculty and staff, and other items, as determined by each program, was included on the back page. Compared to previous surveys, the 2001 June questionnaire was more concise, the lay-out was not as crowded, a green shade of paper was used with the university seal for visibility, and the questionnaire was accompanied by a letter from the college dean. The survey was administered through a mass mailing to alumni identified by Cal Poly's Advancement Services. Alumni were given a unique identifier known only to the EAC, and this number was used simply for tracking purposes. As a follow-up to the mailing, a web-based survey was used in an effort to contact those alumni who had not responded to the mailing. The final rate of return was approximately 21%. Although statistically-speaking the sample size still was not of an appropriate size, faculty were beginning to use the "triangulation method" of assessment, consisting of three soft measurements tools. This survey information from alumni, combined with other data from two other measurement tools, presented a picture that could be reported to faculty and industrial advisory boards for review, analysis and recommendation for improvement, if deemed necessary. Examples of past *Alumni Surveys* can be found at http://assessment.calpoly.edu/over/presntns/ThisMenuPosted.htm

Assessment Process Sustainability
The EAC has taken many burdensome procedures off the faculty and departmental staff. One technique used was the development and then the dissemination of information and assessment forms on the assessment web site. This web site not only improved the morale but also helped in the timeliness of preparing and processing the assessment tools and analysis. Thus, the efficiency of the process was high.

Faculty members and department chairs have a greater appreciation for the continuity of the

assessment process and encourage its continuation through the efforts of the EAC. For those not quite burned out from the visit, their energy has been re-directed to researching new methods of ascertaining linkage in the curriculum to the educational objectives. Working with Bloom's *Taxonomy*[2] as developed by Besterfield-Sacre, et al, for application to EC 2000[3], the goal is to create a better-defined system to measure outcomes achievement. A very good web site for studying this development is http://www.engr.pitt.edu/~ec2000/ec2000_attributes.html .

ABET Visit Organization

The EAC organized the printing and mailing of the ABET Self-Study Report for the various programs and handled initial correspondence with program evaluators regarding transcripts. Additionally, all pre-visit details were organized through the Center. These details included information on airlines, lodging, off-campus meeting rooms with set-up requirements, and local transportation. On-campus details included scheduling between the ABET team (which consisted of 18 members) and Cal Poly administrators, organizing and arranging the Cal Poly course material and outcomes displays for the ABET teams, on-campus lunches, and information on various off-campus restaurants.

The organization of the visit was greatly benefited by the appointment of the Coordinator of the Engineering Assessment Center as facilitator for the two team chairs, thirteen program evaluators and three ABET visitors. Having a direct contact on both sides, the accreditation side and the university side, helped ensure that all needs and issues were resolved prior to the arrival of the team.

Assessing our Assessment Processes

The paper system established to support the assessment efforts of Cal Poly's engineering programs has worked well throughout the transition/learning phase of ABET's EC 2000. But common threads have begun to emerge that could help consolidate engineering assessment efforts for a more productive process.

EAC staff has identified the key documents faculty are responsible to fill out for the ABET accreditation: ABET Course Syllabi, Faculty Vita, and the Course Classification Form (CCF). The EAC is proposing to convert the paper system to a form-based web site where faculty members can enter/edit information regarding their specific course (CCF or Syllabus) or their vita. By having faculty update their course data in a web-interfaced database and having that information roll into the needed survey tools and assessment documents (Student Course Evaluation Form (SCEF), Instructor Course Evaluation Form (ICEF), Course by Outcomes Matrix, etc.), faculty will have real-time input into how their data affects the curriculum. Plus, the automatic generation of student course evaluation forms and instructor course evaluation forms saves time and is less likely to have errors.

The overall benefits of converting to a web-based input process include, but are not limited to: Demonstrated sustainability of the assessment process, archival documentation, furthering the education of faculty regarding the assessment processes, providing real-time updating of pertinent course information, ease-of-use by faculty members, ability to update and manipulate a system based upon specific program needs, and better coordination of assessment results for a more coordinated approach to the Continuous Improvement Process.

Conclusion

Having the Engineering Assessment Center has been an effective method to improve the efficiency of the assessment process and has ensured that the process continues. It has identified, prepared, processed, and stored the key assessment documents for the faculty while developing and maintaining an assessment web site. One of the unspoken benefits of the EAC is its neutrality in reporting results, creating a non-political environment for discussion about curriculum. As one of the Center's goals, the process of assessment is about curriculum and not individual faculty members.

References

1. ABET Engineering Criteria 2000. http://www.abet.org/images/Criteria/eac_criteria_b.pdf. Accessed 1999.

2. Bloom, BS, et al. 1956. Taxonomy of Educational Objectives: The Classification of Educational Goals, Handbook I: Cognitive Domain. New York: David McKay Company, Inc.

3. Besterfield-Sacre, M, et al. 2000. Defining the Outcomes: A Framework for EC 2000. IEEE Transactions on Education 43 (2): 100-110.

KENA BURKE is the Coordinator of the Engineering Assessment Center at California Polytechnic State University, San Luis Obispo. She is currently working on a masters degree at California Polytechnic State University, San Luis Obispo. She received a B.A. degree in English at Texas Tech University in 1989.

PAUL E. RAINEY is a Professor of Materials Engineering and Industrial and Manufacturing Engineering and is Associate Dean for the College of Engineering at California Polytechnic State University, San Luis Obispo. He also serves as coordinator of engineering facilities and assessment. He received B.S. degrees in Mechanical Engineering and Metallurgical Engineering from Purdue University in 1967, M.S. Degree in Metallurgy from M.I.T. in 1968, and a Ph.D. in Industrial Education from Texas A&M University in 1981.