

Continuous Improvement Educational Initiative: A Campus-Wide Assessment Effort – Looking Beyond Accreditation

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ABSTRACT: *Ever since the approval of the new Accreditation Board for Engineering and Technology (ABET) Engineering Criteria (EC 2000) on November 2, 1996, educational institutions across the United States have had to assess and evaluate their undergraduate engineering programs from a different perspective. The University of Puerto Rico at Mayaguez undertook steps fully four years prior to the actual site visit. All six undergraduate engineering programs were evaluated during November 2002 and have been successfully reaccredited. The experience gained was subsequently utilized as a springboard to establish a new campus-wide Continuous Improvement Educational Initiative (CIEI) lead by a multi-disciplinary team. The long-term objective of this initiative is to assess not only the student learning outcomes across campus, which also includes the non-engineering disciplines, but to even develop a process by which the various support services could be assessed. This required the design and administration of customized questionnaires as instruments of assessment, including the development of an overall institutional assessment plan, and an institutional plan for student learning outcomes, for the very first time.*

1 OBJECTIVE

The objective of this paper is to demonstrate how the experience gained in the process of preparing for reaccreditation of engineering programs has helped in extending the ideas of continuous improvement beyond the College of Engineering to the rest of the campus. Furthermore, the intent of this paper is to share the experience with other institutions who may also be in the early stages of preparation. Various other independent accounts of such experiences can also be found in literature, such as the Ohio State University¹ and Drexel University².

2 INTRODUCTION

The University of Puerto Rico at Mayaguez (UPRM) is one of the 11 campuses of the University of Puerto Rico System. The UPR System is a public institution, which was created by the Puerto Rico Legislative Assembly on March 12, 1903. It collectively enrolls about 67,000 students. The Mayaguez Campus (UPRM) is a land grant institution that began in 1911 with the College of Agricultural Sciences. Subsequently, other colleges were added as follows: College of Engineering (1913), College of Arts & Sciences (1943), and the College of Business (1970). The student body consists of about 11,000 undergraduate and 970 graduate students. The College of Engineering counts on an undergraduate enrollment of 4458 students, of which, 36 percent are females, which is one of the highest in engineering among U.S. institutions. This enrollment results in UPRM as ranking 15th nationally in terms of the number of bachelors degrees awarded (695) during 2000-2001³. The strategic plan of the College of Engineering was approved by its faculty on October 13, 1998, and subsequently revised on September 25, 2003. The vision and mission statements, which are an integral part of the strategic plan, are well in consonance and they subscribe to preparing “best professionals in engineering” and “strong education in engineering.” This commitment to excellence is reflected in our college’s philosophy “to provide a firm educational foundation⁴.” Undergraduate education is our strength. While emphasis on research and graduate education with newer doctoral programs has gained increased attention, the fact remains that graduate degrees have consistently accounted for less than ten percent of the total bachelor’s degrees conferred. The College of Engineering comprises six academic units or departments, which are: Electrical &

Computer Engineering, Mechanical Engineering, Industrial Engineering, Chemical Engineering, Civil Engineering & Surveying, and General Engineering. These collectively offer seven bachelor's degree programs, of which, six are in engineering with a separate program in surveying. All of the six bachelor's degree programs in Electrical, Computer, Mechanical, Industrial, Civil, and Chemical Engineering are accredited by the Accreditation Board for Engineering and Technology (ABET). The bachelor's degree programs at UPRM are of five-year duration as opposed to four years at most U.S. institutions. This provides both breadth and depth, along with ample opportunities for summer internships, undergraduate research, exchange programs, and a strong cooperative education program in partnership with industry. Approximately 27 percent of all undergraduate engineering students avail themselves of this cooperative education industry experience, with bulk of the students, about 45 percent, coming from Mechanical and Chemical Engineering programs. The programs underwent a reaccreditation site visit during November 2002 as per ABET's new Engineering Criteria 2000.

3 FOCUS OF ABET's EC 2000

ABET's periodic review of engineering programs is well accepted as a form of program assessment and quality assurance. Since its enactment, Engineering Criteria 2000 have been well publicized in various sources, and effective Fall 2001, all programs coming up for accreditation review, are being evaluated for compliance against these criteria. These essentially consist of eight criteria with a goal of continuous program improvement as opposed to the earlier focus on rigid quantitative inputs⁵. These criteria encompass: (1) Students, (2) Program Educational Objectives, (3) Program Outcomes and Assessment, (4) Professional Component, (5) Faculty, (6) Facilities, (7) Institutional Support and Financial Resources, and (8) Specific Program criteria. Peterson⁶, ABET's Executive Director, states that at the core of these criteria "is an outcomes assessment component that requires each engineering program seeking accreditation or reaccreditation to establish its own internal assessment process, which in turn, will be assessed by ABET." Aldridge and Benefield⁷ point out that it is not sufficient to merely demonstrate the achievement of educational objectives (Criterion 2) and program outcomes (Criterion 3), but additionally, "a commitment to continuous improvement and the stability to continue its achievement record over the next six years." Splitt⁸ succinctly remarked, "engineering education reform presents a formidable challenge, given academe's interest in preservation of the status quo." The entire process can be summarized into the following key steps⁹:

- (a) The Institution requests an evaluation visit
- (b) The Engineering Accreditation Commission selects the Team Chair
- (c) The Team Chair contacts the Dean of Engineering to select dates for the campus visit, and to determine the status of self-study materials.
- (d) The Institution provides all applicable Program Self-Study reports to ABET Headquarters.
- (e) The Team Chair assembles a team by selecting Program Evaluators
- (f) The Institution provides all applicable Program Self-Study reports and other applicable materials to the Team Chair, the Program Evaluators, and the Headquarters.
- (g) The Team visits the campus.
- (h) The Team conducts an exit interview with university officials and issues a draft statement at the time of departure.
- (i) The Engineering Accreditation Commission revises the draft statement, if necessary, and takes final action.

4 OUR EARLY EFFORTS AND CHALLENGES

Unlike the earlier traditional accreditation-related efforts, where the crux of the effort was put into producing a self-study document and demonstrating that the minimum curricular requirements were met or exceeded, the leadership of the College of Engineering recognized the importance of EC 2000 as far back as November 1998, fully four years ahead of ABET's next review visit. This wasn't something that could be relegated to the last minute. It was a whole new approach that required early action and planning, and with which, not many of us were well conversant. It was a bold move on the part of the

administrative leadership to encourage a team consisting of department heads to participate in the 2nd Working Symposium on Best Assessment Processes in Engineering Education at the Rose Hulman Institute of Technology in Terre Haute, Indiana. This was the start of our efforts, which was soon followed by the formal establishment of a Faculty ABET Committee with a lead coordinator within the College of Engineering. As Meredith¹⁰ corroborated later that, “The most important element in conducting a successful EC 2000 implementation is commitment at the highest level.”

Some of the early challenges faced were: simply getting to understand and digest the implications of EC 2000, team composition and its stability, the holding of regular meetings to identify constituents, and discussion on possible assessment methods and tools. It was quite evident early on that Criterion 2 and Criterion 3 in particular would be the most demanding. Criterion 2 calls for a clear establishment of Program Educational Objectives, with input from the key stakeholders or constituents. And these program educational objectives would need to have an embedded self-improvement process in place (the first loop) by establishing an assessment mechanism. Criterion 3 calls for the definition of Program Outcomes that should as a minimum, embrace the eleven (a-k) outcomes listed under the criterion; along with proper assessment methods, which would constitute the second loop of the self-improvement process. Criterion 3 could be viewed as a subset that had to map on to Criterion 2, which, up the ladder, was also required to satisfy the mission and vision of the College of Engineering, and eventually, that of the institution as a whole. Course syllabi were restructured to incorporate applicable (a-k) outcomes. All six programs were required to develop not only their own strategic plans, but also within these, their specific program educational objectives with input from their constituents and identify program outcomes. Consequently, this led to the establishment of each program’s ABET sub-committee and the scheduling of numerous working retreats by each department. Each department chose its coordinator, who in turn, became a member of the Faculty ABET Team at the college level. Some of the team members also participated at different stages in the ABET Program Evaluator Training workshops.

5 ASSESSMENT METHODS & TOOLS

Given the new accreditation paradigm that every engineering program establish an assessment process and document results, Peterson⁶ was quite correct in his statement “No one expects that the outcomes assessment component of Engineering Criteria 2000 will be easy to implement. Establishing measurable objectives and evaluating their outcomes are sophisticated activities with which most engineering educators have had little or no experience.” The Faculty ABET Team organized a series of one-day workshops in mid-year 2001 that led to the development of assessment tools and strategies package. These were adopted for common use by all programs with each one at liberty to modify or be selective about the recommended methods or tools. The package contained an outcomes assessment matrix, an assessment strategies matrix, and various custom-designed assessment forms for integrating ethics, oral and written reports, teamwork, peer evaluation, course/project evaluations, exit survey, alumni survey, employer survey, and internships. Felder and Brent¹¹ have also reported on a strategy for integrating program-level and course-level activities to fulfill the ABET criteria.

6 PRINCIPAL DRIVERS FOR CHANGE

Maki¹², Director of Assessment, AAHE, stated, “All too frequently higher education institutions view the commitment to assessing their students’ learning and development as a periodic activity – most often driven by an impending accreditation visit.” While this would generally be the case with external drivers such as industry, or ABET, or other institutional accreditors such as the Middle States Commission on Higher Education, we, at the University of Puerto Rico at Mayaguez, had had some experience related with assessment in earlier educational projects, such as MEEP (Manufacturing Engineering Education Partnership) Learning Factory, and PaSCoR (Partnership for Spatial and Computational Research)¹³. And ideally, such should really be the case; institutional curiosity – an internal motivator, versus attempting to comply – an external motivator¹². In order to institutionalize this assessment process as part of the various courses, the College of Engineering established a physical office called System for the Evaluation of Education (SEED) in mid-year 2001.

7 THE SEED OFFICE

With the goal of developing assessing strategies for the undergraduate engineering programs, the principal goals of this office (Figure 1) were to:

- Establish and facilitate a strategy for continuous evaluation of engineering programs and student learning outcomes assessment.
- Coordinate with engineering departments and accreditation committees (ABET EC 2000 and the Middle States Association) the College of Engineering's activities regarding accreditation processes, including their implementation strategies.
- Assess outcomes of the College of Engineering's Strategic Plan.
- Become the College of Engineering's repository of assessment strategies, assessment instruments, and assessment results and reports.
- Coordinate professional development activities concerning evaluation and assessment.
- Disseminate assessment results to stakeholders and decision-makers for their information and decision-making.

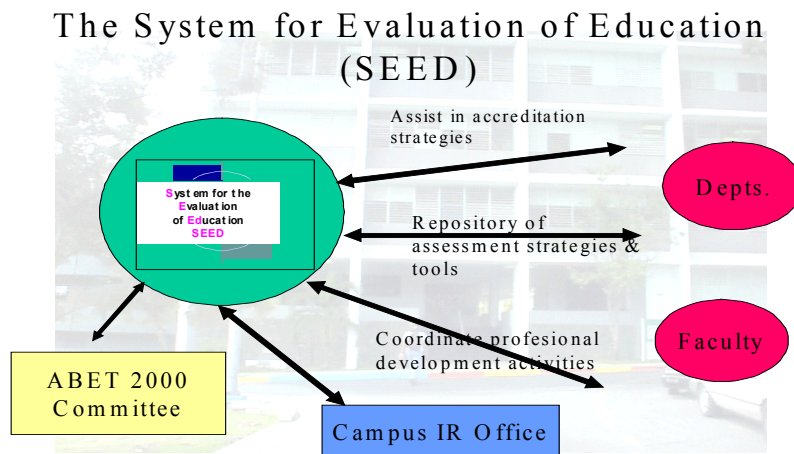


FIGURE 1.

The SEED Office counts on the services of a coordinator on a half-time basis, a person in-charge of database management and web page maintenance, and a full-time secretary. As an extension to this concept, similar offices were created in each of the six departments with names such as Continuous Improvement Center, The Curriculum Renewal Plan, and Center for Academic Research.

8 AWARENESS CAMPAIGN

A series of workshops and retreats were organized with guidance and support from industry and other U.S. universities, on the definition of outcomes and the development of outcomes based course syllabi, the development and redefinition of mission statements at individual program as well as faculty level, the mapping of outcomes to program educational objectives, the implications of ABET's EC 2000 criteria – not only to the faculty and staff in the College of Engineering, but also much later to the faculty and staff of the entire campus as part of a much wider awareness outreach. A number of one-day workshops were also organized on the integration of ethics across the curricula, which were well spread out throughout the period. There were also workshops on assessment and student mentoring which were given by invited faculty members representing the NSF's SUCCEED and Foundation coalitions.

9 INDUSTRY SUPPORT

Criterion 4 (Professional Component) and Criterion 5 (Faculty) allude to interactions with industrial and professional practitioners as well as employers of students. Laurenson¹⁴ from ASME stated, "A positive result of EC 2000 was the involvement of the program Advisory Boards. These groups have provided a very useful resource to the programs in establishing educational objectives and defining

associated measurements of student outcomes.” We, at the University of Puerto Rico at Mayaguez, sought out industry partnership very early on in the process of preparing for the re-accreditation site visit in November 2002. For example, early in the process Hewlett Packard donated the server used to collect all data regarding the college’s outcomes assessment and strategic plans. A college-wide ABET EC 2000 Retreat led by Raytheon engineers and quality improvement personnel, and co-sponsored by Microsoft, was organized in November 2000 to assist each program to define their Program Educational Objectives (Criterion 2) and Program Outcomes (Criterion 3). This retreat workshop enabled each program to develop or re-define their mission statement, to develop outcomes based course syllabi, and to map the outcomes to program educational objectives. This retreat led to an ABET EC 2000 mock visit sponsored by Raytheon Missile Systems, Microsoft, Hewlett Packard and Boeing in January 2002 with team members representing both academia and industry. The objectives of the mock visit were to visit the laboratory facilities, conduct interviews with faculty and students, evaluate the first drafts of the individual self-study reports, and to offer candid comments and recommendations to incorporate assessment and continuous quality improvements within the programs.

10 EARLY LESSONS LEARNED

The results from the mock visit were an eye-opener for many of us, both the faculty and the administration, and provided a vital external feedback on our status. It, in essence, provided the impetus towards redesigning the course syllabi, incorporating the applicable outcomes of Criterion (3), and in general in becoming more sensitive towards the new criteria. There were severe flaws in the self-study report drafts. The visit was soon followed by the formation of the first Industrial Advisory Board (IAB) of the College of Engineering in June 2002, although each of the departments had individually been interacting formally or informally with industry representatives. The college saw the need to form the IAB to receive direct feedback from their senior-level industry constituents. Holly¹⁵ correctly pointed out that “EC 2000 has made us much more attentive to the advice and observations of industrial advisory boards.” As an outcome of this IAB meeting, it was recommended to organize a second ABET mock visit in September 2002, fully two months prior to the actual ABET site visit. The second mock visit team was similarly composed of members representing both academia and industry like the team in January 2002, and had with them, prior to their arrival on campus, copies of the final self-study reports for all six programs that had been submitted to ABET by the end of June 2002. This mock visit was sponsored by a much wider group of industries as Raytheon Missile Systems, Hamilton Sundstrand, Abbott, Microsoft, Boeing, Merck Sharp & Dohme, and Eli Lilly. During this time, we fared significantly better in all aspects of our preparation and served to provide the confidence for the evaluation visit in November 2002.

11 THE SUCCESS OF THE PROCESS AND BEYOND

Though the detailed comments with regard to each of the programs are not meant to be publicly listed, all six programs, which were evaluated according to the new criteria EC 2000 for the first time, were re-accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology. However, the comment that “the institution’s systematic and innovative effort to introduce the culture of outcomes-based assessment to the College of Engineering community is especially noteworthy” is an indicator of the successful process.

Throughout the course of the preparatory efforts during the span of last four years, and leading up to the ABET site visit, proper documentation was maintained. This included all reports as well as the minutes of all meetings conducted by the Faculty ABET Team which can be found in the website <http://www.abet.uprm.edu>. The website can also be accessed from the College of Engineering website <http://ing.uprm.edu>. The SEED Office under the College of Engineering is expected to continue providing support to ensure the smooth functioning of such offices in each department. This would require conducting assessments on a regular basis, and by combining common assessment practices and methods. Mulrine¹⁶ similarly summarizes the various accreditation visit experiences, and at the same time stresses on the need for the post-visit continuous quality improvement phase. In our own particular case, the experience gained from this effort is already being applied towards UPRM’s institutional re-

accreditation efforts for a decennial visit from the Middle States Commission on Higher Education (MSCHE) in 2005. The new team, using its gathered experience with ABET's EC 2000, has not only formalized some institutional student learning outcomes from the newly-developed plan for the assessment of student learning, but also developed questionnaires for campus-wide surveys with the hope of institutionalizing a continuous improvement process.

12 CONTINUOUS IMPROVEMENT EDUCATIONAL INITIATIVE (CIED)

The role of this initiative is to not only prepare for the impending institutional joint re-accreditation visit in 2005 from the MSCHE and the Puerto Rico Council on Higher Education (PRCHE), but also to sustain the institutional assessment process in the long run. Assessment has become a key methodology for measuring outcomes for an institution, program, course, or any service, which is offered by an academic institution of higher education. The intent of assessment is continuous improvement, which drives quality. Continuous improvement is at the core of ISO 9001 Standards used by the private sector. Universities depend on external accreditations for assuring quality. The new outcomes-based criteria, whether ABET's EC 2000, or MSCHE's Standards of Excellence, require that these processes be eventually internalized by an institution. Our ongoing efforts are well documented under <http://www.uprm.edu/msa>.

13 INSTITUTIONAL ASSESSMENT PLANS

The UPRM/MSCHE Institutional Steering Team developed two institutional assessment plans, namely: the Overall Institutional Assessment Plan¹⁷, and the Institutional Student Learning Assessment Plan¹⁸. The two plans are conceptually represented below (Figure 2), with the Student Learning Assessment Plan at the core, and both being subsets of the Institutional Strategic Plan.

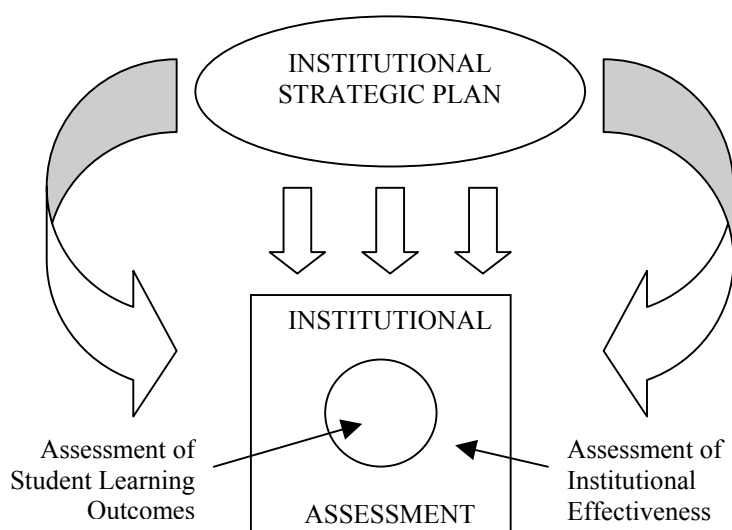


FIGURE 2. Conceptual Diagram of Strategic Planning and Assessment at UPRM¹⁷

Overall institutional assessment was carried out via the following customized questionnaires, which served as assessment instruments, to provide an institutional snapshot:

- Chancellor, Administrative Board, Deans of Academic Colleges, Administration, Students, and Academic Affairs, Elected Senators, Department Directors, Office of Institutional Research & Planning, Budget Office, Finance Office, Purchasing Office, Alumni Office, Human Resources Office, Physical Plant, Admissions Office, Registrar's Office, Computing Center, Research & Development Center, Agricultural Experiment Station, Agricultural Extension Service, Student Ombudsman, Guidance & Academic Counselors, Presidents of Unions, Graduate Studies, Library, Professional Enhancement Center, Faculty, Students, Non-Teaching Personnel, and Continuing Education Division.

These questionnaires were designed from the charge questions, which were identified first to address the following MSCHE's Standards of Excellence¹⁹:

- Missions, Goals, and Objectives
- Planning, Resource Allocation, and Institutional Renewal
- Institutional Resources
- Leadership and Governance
- Administration
- Integrity
- Institutional Assessment
- Student Admissions
- Student Support Services
- Faculty
- Educational Offerings
- General Education
- Related Educational Activities
- Assessment of Student Learning

The Student Learning Assessment Plan¹⁸ identified the following institutional student learning outcomes, which, the UPRM students will be able to do by the time of their graduation:

- Communicate effectively.
- Identify and solve problems, think critically, and synthesize knowledge appropriate to their discipline.
- Apply mathematical reasoning skills, scientific inquiry methods, and tools of information technology.
- Apply ethical standards.
- Recognize the Puerto Rican heritage and interpret contemporary issues.
- Appraise the essential values of a democratic society.
- Operate in a global context, relate to a societal context, and demonstrate respect for other cultures.
- Develop an appreciation for the arts and humanities.
- Recognize the need to engage in life-long learning.

The purpose of this plan is to guide UPRM academic departments/programs in the development of student learning outcomes assessment processes and continuous quality improvement programs. This plan could not reasonably include in full detail all activities for the assessment of all levels of student learning goals. Rather, the focus in the plan is to set the frame for the development and implementation of assessment processes at the department/program level. It is intended to be a source of guidance without constraining experimentation or alternate approaches that may be developed by departments or programs within the institution. Every department, or program, at UPRM would be expected to develop and include in their student learning assessment plan a matrix depicting the relationship of their program outcomes with these institutional student learning outcomes, and a matrix or table outlining how each of the program outcomes will be assessed, and in what courses. The completed returned survey forms will assist in developing an institutional snapshot with the objective of refining the questions in redesigning the future questionnaires, so eventually in the long run, institutional decisions on academic programs, courses, personnel, services, and resource allocations could be more objectively based. In the short term however, the gathered information would assist in writing a comprehensive self-study report to address MSCHE's Standards of Excellence.

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