AAEE 2012 CONFERENCE
Melbourne, Australia
www.aaee.com.au/conferences/2012/

Assessment Methodology to Incorporate Internal and External Constituents into Engineering Curricula

A. Samer Ezeldin
Professor, Department of Construction and Architectural Engineering, American University in Cairo, Egypt
Corresponding Author Email:aezeldin@aucegypt.edu

BACKGROUND
International accreditation for engineering programs are becoming more challenging yet increasingly demanded to compete with strong and reputed undergraduate engineering programs. It is the responsibility of the institution seeking accreditation of an engineering program to demonstrate clearly that the program has established a specific assessment and enhancement process that includes the input from external and internal constituents. Major Internal constituents include students and faculty. External constituents are employers of graduating engineers, industrial training companies, and the alumni.

PURPOSE
This paper addresses the assessment procedures followed in the Construction Engineering program at the American University in Cairo to successfully gain a no-comment accreditation from ABET.

DESIGN/METHOD
The procedures are based on seeking the continuous input of internal and external constituents to first formulate educational objectives and outcomes for the program that are inter-related to each other and conform to the University mission and objectives and later to update and improve the program content. The procedures include three-inter-related cycles as an assessment scheme that ensures a continuous review and feedback from the academia and the industry. This scheme allows the input of the constituents to be received and statistically assessed within the three cycles in a coordinated and effective methodology. Each assessment tool has a tool metric and action procedures that is compatible with the overall assessment scheme of the program.

RESULTS
The short cycle is completed every academic year and covers the courses content. The medium cycle is conducted every two years and focuses with the courses outcomes. Finally, the long cycle, performed every five years, seeks the cumulative input of all accumulated data to initiate a process of program assessment that evolves to overall program evaluation and review of educational objectives, outcomes, and mission. This inter-related and continuous approach worked effectively to achieve the intended goal but required intensive monitoring.

CONCLUSIONS
The adopted assessment program was found to be flexible, effective, and useful. With its implementation, the construction engineering program was able to secure a no-comment six-year accreditation from ABET.

KEYWORDS
Engineering programs, Assessment, Accreditation.

Introduction

The American University in Cairo is a private institution of higher education engaged in teaching, research, and service. The academic area is divided into the School of Humanities and Social Sciences, the School of Sciences and Engineering, and the School of Business, Economics and Communication. The Schools are each headed by a Dean and each includes a number of related academic departments. Starting from 2000/2001 the School of Sciences and Engineering has been operating under a new administrative structure. The School of Sciences and Engineering includes eight departments in addition to the Construction Engineering Department.

The Department of Construction and Architectural Engineering (CANG) was established in 1987, as the Department of Construction Engineering, to fill a gap which emerged in the construction industry in Egypt and the region. This was faced with many difficulties when considering it was the first program in the region with challenges to differentiate itself from other programs like civil engineering programs. Being an institute based in Egypt and outside the USA, gaining this international accreditation under the ABET 2000 was a challenge and a goal. Careful distinction was carved by establishing a comprehensive set of courses along with a broader engineering group of courses. This was offered within a curriculum that promotes cultural aspects and humanities.

The Engineering Accreditation Commission (EAC) of the Accreditation Board for Engineering and Technology (ABET) evaluated the Construction Engineering Program at the American University in Cairo for the first time according to ABET 2000 criteria during a site visit in 2003. The program was accredited for 6 years to September 30, 2009. The program seeked re-accreditation effective fall 2009 and was successfully granted another 6 years with no deficiencies.

This paper focuses on the procedures followed in the Construction Engineering program at the American University in Cairo to establish links with the internal and external constituents of the program that feed into the curriculum development. These procedures were part of an overall major effort to successfully gain accreditation from ABET in accordance with EC-2000 criteria.

The procedures are based on seeking the input of internal and external constituents to first formulate educational objectives and outcomes for the program that are inter-related to each other and that conform to the University mission and objectives. The procedures, also, include an assessment scheme that ensures a continuous review and feedback from the industry. This scheme allows the input of the industry constituencies to be received and assessed within three inter-related cycles.

Program Constituencies

The designation of constituents was established based on extensive discussion among the faculty members themselves and among the faculty with representatives from the student body, the Industrial Advisory Board, and practicing engineers. A particular challenge was the need for different stakeholders while still integrating their input in the feed-back and assessment framework. The designated Construction Engineering Program's constituents are:

- Students (internal),

- Alumni (external),
- Employers of our graduates (external),
- Industrial Advisory Board (external), and
- Faculty members (internal)

The Construction Engineering Program at AUC has an Industrial Advisory Board (IAB) comprised of seventeen (17) prominent, well-reputed, professional engineers to provide feedback on the quality of the Programs and graduates. Thirteen of the seventeen members come from the construction industry. Annual meetings are attended by the Industrial Advisory Board and the faculty to maintain close contact and to obtain continuous input. Through this interaction, the Industrial Advisory Board plays an important role in strengthening the link between the Construction Engineering Program at AUC and the professional engineering community in Egypt and the region. This helps in identifying industry expectations for the skills and the knowledge of entry-level engineers, and in developing ways to enhance the knowledge and skills of practicing engineers through appropriate focused professional development courses.

Process to Establish Program Objectives and Outcomes

The Department of Construction Engineering began to assess the compliance of its program educational objectives with ABET- EC 2000 in spring 2001. The process was initiated by forming a ABET departmental committee. The charge of this standing committee is to develop drafts for program mission, objectives, and outcomes, and to continuously co-ordinate relevant external and internal processes. The ABET committee analysed the previously adopted program educational objectives along with the University mission and educational objectives. Moreover, The ABET committee reviewed the results of the AUC Graduate Opinion Survey that was conducted by AUC's Career Advising and Placement Services (CAPS) in 1999. After this initial analysis and review, several external and internal activities were performed. The External Activities consisted of having selected faculty members attending two ABET related workshops and of conducting an Industrial Advisory meeting of construction engineering members of the Board. The Internal Activities consisted of organizing faculty seminars to present to all Faculty members detailed information about the attended ABET workshops and of holding bi-weekly and sometimes weekly meetings devoted to ABET related topics. In these meetings, drafts submitted by the ABET departmental Committee were presented, discussed, modified and later approved by the Faculty.

Figure 1 presents the adopted process to establish the educational objectives for the Construction Engineering Program.

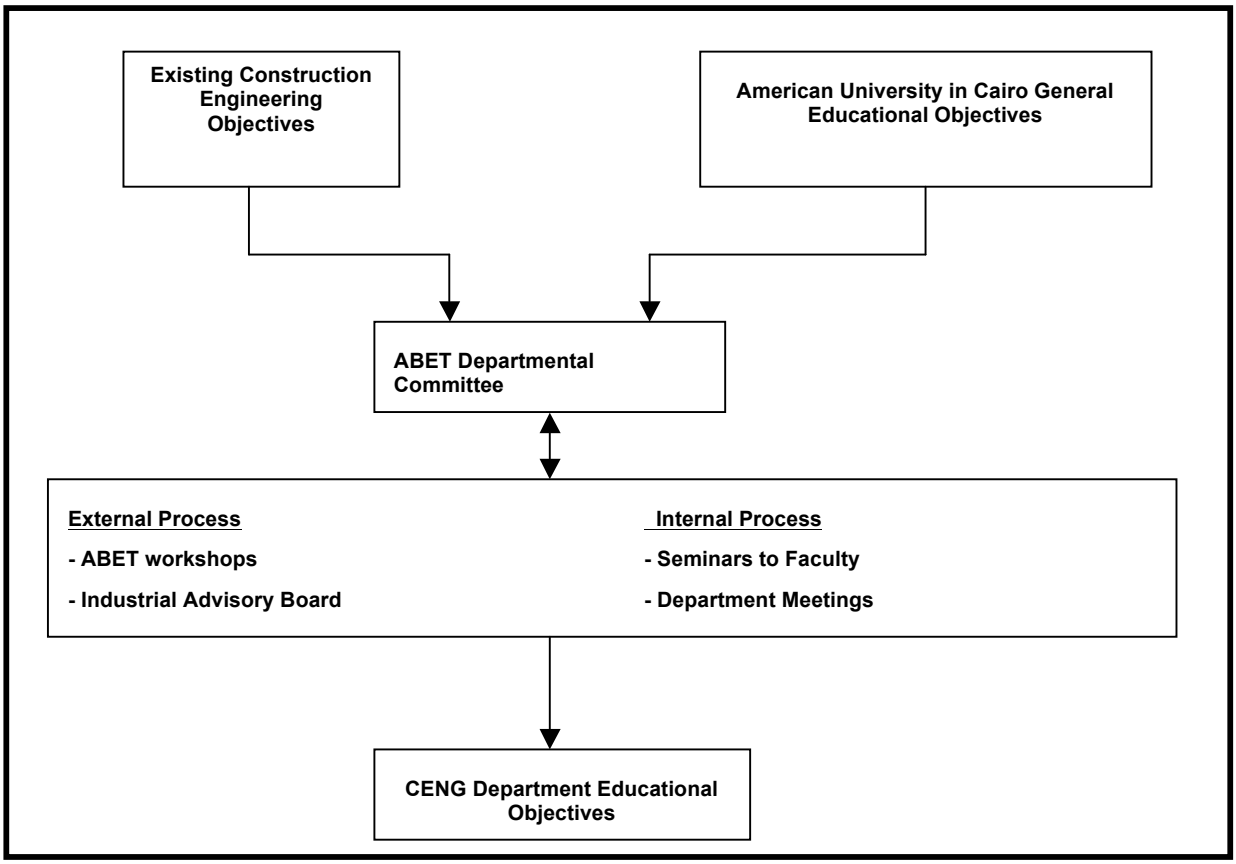

Figure 1: Process to establish the educational objectives of Construction Engineering (CENG) Program

The established Objectives of the Program of Construction Engineering are to:

1. Educate students in fundamentals of science and engineering needed to pursue their career in Construction Engineering Profession.
2. Introduce students to a broad spectrum of Construction Engineering topics, with concentration in an area of their choice, to plan for construction operations and to fit in construction organisations.
3. Prepare students to cope with and improve on the ever-evolving technologies in production, products, and components of the construction industry.
4. Enable students to communicate effectively, work independently and in teams, and fit in a multi-disciplinary environment.
5. Inspire students to recognize and consider the impact of engineering solutions in a global and societal context with ability to understand and be sensitive to other cultures.
6. Motivate students to engage in life-long learning and develop their ability to pursue graduate studies.
7. Develop students who are creative, possess qualities of leadership, and committed to professional and ethical conduct.

Later, The Construction Engineering Program has identified a set of twenty-two (22) program outcomes that are compatible with ABET Criterion 3 A-K set of outcomes, Table 1. The interrelationships among the outcomes and the objectives were verified. This verification

indicates that each of the seven program objectives is accomplished through two or more of the program outcomes.

Table1: Outcomes of the Construction Engineering Program

1. Apply knowledge of basic mathematics, general chemistry, and calculus-based physics to solving engineering problems.
2. Implement their acquired knowledge of engineering science to provide meaningful solutions to engineering problems.
3. Design and conduct experiments in the areas of fluid mechanics, materials engineering, soil mechanics, and hydraulics.
4. Analyse and interpret data using methodologies for validation of experimental results.
5. Design concrete structures, steel structures, foundations, highways, hydraulic, and environmental systems.
6. Select appropriate construction materials, methods, and equipment for projects.
7. Utilize design principles to interconnect components and synthesize assemblies and systems.
8. Perform cost estimates for projects, planning, scheduling, and project control for construction applications.
9. Assess legal and contractual situations as well as analyse financial strengths and weaknesses of construction organisations.
10. Define overall needs and constraints in a system or a component including cost, and safety aspects.
11. Organize, administer, and assure quality of construction activities.
12. Function effectively in a teamwork environment.
13. Think critically, identify, formulate and solve construction engineering problems.
14. Realize the meaning and importance of professional ethics and values and how this relates to the construction practice. Recognize their responsibilities toward society and engage in community services.
15. Strive for quality and thoroughness in undertaken tasks.
16. Communicate effectively in English.
17. Interact successfully with their constituents.
18. Consider the impact of engineering solutions in a societal and global context
19. Engage in post-graduate studies and professional activities.
20. Use their liberal education to follow up on and engage in contemporary issues.
21. Use computers and information technology necessary for engineering practice.
22. Use modern techniques, skills, and engineering tools in construction applications.

Process to Review Program Objectives and Outcomes

The process used to ensure a continuous review of the program educational objectives is presented below. The program assessment and enhancement consists essentially of three inter-related cycles. This assessment process ensures contributions from both internal and

external constituents at all stages. Such contributions will impacts program objectives and outcomes as well courses outcomes.

A short-term cycle focuses on individual courses assessment and enhancement. This cycle is completed each year. It concentrates on enhancing the outcomes of individual courses. It utilizes input from the course instructor, students attending the course, and senior exit surveys.

The medium-term cycle is conducted every two years. It focuses on evaluating and updating the program outcomes. It uses the accumulated results of the short-term cycles along with the feedback received from industrial training employers surveys and the Advisory industry board.

The long-term cycle is performed every five years. It utilizes the cumulative input of the medium-term cycle along with inputs from graduate employers surveys, alumni surveys and placement data of graduates.It targets an overall program evaluation and review of educational mission, objectives, and outcomes.

The process involves continuous quality improvement towards achieving a student graduating body that meets the specific outcomes. The process is designed to incorporate the input of external and internal constituents.

Input of External Constituents

The external constituents help in reviewing and shaping the Program educational objectives through the following mechanisms:

- Industrial Advisory Board (IAB) meetings and input.
- Employer questionnaires
- Industrial training employer questionnaires.
- Alumni questionnaires.

The purpose of the IAB meetings is to solicit the members' input and obtain their evaluation of the Construction Engineering Program. This meeting is held once every year. The comments of the IAB members are recorded and evaluated for implementation. The employers of senior-level trainees of the Construction Engineering Program are surveyed every year for their assessment of the Program objectives and/or outcomes. Employers are asked to give their opinion on the performance of our students during their industrial training at their companies. The results of the survey of training employers of senior Construction Engineering student trainees are analysed. The results are tabulated for monitoring and possible remedial actions. The employers of our graduates are asked to give their evaluations for recent AUC graduates as well as more senior employees. This survey is conducted every 2-3 years. During the last survey, a total of 60 professional companies were contacted. 17 companies responded by returning a completed survey form. The results were summarized and evaluated. Alumni are surveyed to solicit their input once every 3-4 years. During the last survey, a total of one hundred and twelve (112) graduates from the period of 1992 to 2007 responded by returning completed survey forms. The results were also summarized and evaluated. The feedback obtained from these surveys are incorporated in the Program assessment and enhancement process to update and review course outcomes, Program outcomes, and/or Program objectives and mission.

Input of Internal Constituents

The contributions of the internal constituents towards the development and the assessment of achieving the Program objectives are obtained by the following instruments:

- Students' evaluation of the course outcomes.
- Senior exit survey/exit interview.
- Industrial training student questionnaire.
- Meetings of faculty members.

The students' input on the benefits and the coverage of specific courses is obtained at the end of each semester by completing a form on course outcomes and self-evaluation of performance. This input is included in the course report generated by the instructor at the end of the semester. Input from graduating seniors is directly obtained from the senior exit survey and exit interviews. This survey is conducted every semester one week before commencement. Students' input is also obtained by analysing their answers on questionnaires that seek the evaluation of their industrial training experience with an industry employer. It is conducted at the end of the semester. Feedback from faculty members relative to program objectives and outcomes is obtained from their course reports and during specific departmental meetings for evaluation of the Construction Engineering Program and its objectives. Comments, observations, and remarks are compiled by the ABET departmental committee.

ASSESSMENT TOOLS

The construction engineering program utilizes five (5) external evaluation assessment tools and three (3) internal evaluation assessment tools for a total of eight (8) assessment tools to assure that program outcomes and objectives are met.

The external evaluation tools consist of:

1. Alumni survey
2. Industrial training employer questionnaires.
3. Employer survey
4. Industrial Advisory Board meeting minutes and input.
5. Placement of graduates

The internal evaluation tools consist of:

6. Faculty course assessment.
7. Student course outcomes assessment.
8. Senior exit survey

Seven of the eight tools (1, 2, 3, 4, 6, 7, and 8) have an associated metric and a plan that is used to determine if actions are required when metrics are not met. The placement of graduates (#5) is used as an indicative measure to reflect the demand on our graduates in the working market.

External Assessment Tools Metrics

The results of survey received from alumni, employers of the construction engineering trainees and graduates are analysed.

The metric for questionnaire of surveys, conducted during the short and medium assessment cycles is intended to create a two-stage warning system. An average response from any constituent group on individual questions less than three on a five assessment scale would initiate a *concern* and results will be flagged by the ABET departmental committee. An average response of less than three on a five assessment scale in two consecutive questionnaire surveys for the same question(s) would indicate a *warning* and would initiate action procedures as presented later.

The metric for questionnaire of surveys conducted during the long assessment cycle as well as comments in all surveys and meetings is intended to develop a single stage warning system. A statistically meaningful number of specific negative comments would indicate a *warning* and would initiate action procedures as presented later.

Internal Assessment Tools Metrics

The results of exit survey received from graduating seniors are dealt with similar to the metric just presented. That is, the metric for the numeric assessment of the questionnaire of surveys is intended to create a two-stage warning system. An average response from any constituent group on individual questions less than three on a five assessment scale would initiate a *concern* and results will be flagged by the ABET departmental committee. An average response of less than three on a five assessment scale in two consecutive questionnaire surveys for the same question(s) would indicate a *warning* and would initiate action procedures as presented later.

The metric for comments in these surveys is intended to develop a single stage warning system. A statistically meaningful number of specific negative comments would indicate a *warning* and would initiate action procedures as presented later.

Faculty and students course outcomes assessments are included in the course report. An assessment by performance tool is employed by faculty members to ascertain outcome achievement through homework, tests, exams, projects, and reports. Instructors will be using established metrics included in the course assessment matrix form. Actions taken by the course instructor in response to the course outcomes assessment are included in the course report.

Action Procedures for Metrics of Questionnaires and Comments

If the analysis of responses for survey questionnaires or comments indicate a *warning*, the ABET Departmental Committee will take the following actions.

1- The Committee will relay raised concerns to the Department Chair. The Department Chair in consultation with faculty concerned with the raised issues will draft an action plan that is intended to deal with the specific warning(s).

2- The action plan will be presented to the department faculty for discussion and revision if necessary.

3- The action plan, once approved by the department faculty, will be implemented.

Information Used for Program Improvement

The following data is collected on a continuous basis to assure achievement of Program outcomes and objectives and to create an ongoing vehicle for improvement.

Data from the Internal Constituents:

- Instructor's Courses Reports – every semester a course is taught.
- Senior exit surveys and exit interview – every semester.
- Student Evaluation of the Instructor and the Course – Every semester a course is taught
- Faculty discussions in Departmental meetings
- Direct measures of the achievement of the program outcome through course works and exams results.

Data from the External Constituents:

- Industrial training employer surveys – every year.
- Graduates' employer surveys – every 4-5 years.
- Alumni surveys – every 4-5 years.
- Advisory Industry Board (IAB)- every year
- Placement data of graduates

The main challenge in securing this information was the performance of the required surveys, evaluations, surveys, and IAB meetings according to the required plan. The ABET departmental committee was put in charge to coordinate, perform, and analyse efforts for this purpose

Direct Measures for Achieving Program Outcomes

Direct assessment of the extent to which some of the program outcomes are being achieved is implemented through specific questions and requirements in course exams and course works. The following is an example of such direct measures. ***Outcome No. 12 is to Function effectively in a team work, and Outcome No. 16 is to Communicate effectively in English.*** These outcomes are directly measured in the required course CENG 490 – Senior Thesis I. Students are grouped into groups of 3-4 students. Each group selects a project for which they carry out complete design as a group. The project may cover design of one or several aspects in different sub-field such as structures, materials, hydraulics, irrigation, transportation, and/or environment. Each group assigns different tasks to the individual members of the group and coordinates and complements such individual efforts towards successful completion of the project. The groups are required, as part of the total course grade, to present their work in three presentations over the term: initial presentation, in-progress presentation, and final presentation. The presentations are evaluated by a panel of faculty members who evaluate separately, as part of the total evaluation, the effective functioning of each group member in the team work. Also evaluated separately is the ability to communicate effectively in English in terms of clarity of presentation and the use of presentation aids.

CONCLUSIONS

International accreditation for engineering programs are becoming more challenging yet increasingly demanded to compete with strong and reputed undergraduate engineering programs. It is the responsibility of the institution seeking accreditation of an engineering program to demonstrate clearly that the program has established a specific assessment and enhancement process that includes the input from external and internal constituents.

This paper addresses the assessment procedures followed in the Construction Engineering program at the American University in Cairo to successfully gain a no-comment accreditation from ABET.

The procedures are based on seeking the continuous input of internal and external constituents to first formulate educational objectives and outcomes for the program that are inter-related to each other and conform to the University mission and objectives and later to update and improve the program content. The procedures include three-inter-related cycles as an assessment scheme that ensures a continuous review and feedback from the academia and the industry. This scheme allows the input of the constituents to be received and statistically assessed within the three cycles in a coordinated and effective methodology. Each assessment tool has a tool metric and action procedures that is compatible with the overall assessment scheme of the program.

The adopted assessment program was found to be comprehensive, effective, and useful. With its implementation, the construction engineering program was able to secure a no-comment six-year accreditation from ABET.

REFERENCES

1- Self-Study Report: The Construction Engineering Program, The American University in Cairo, Engineering Accreditation Commission, Accreditation Board for Engineering and Technology, June 2008

2- Workshop on Best Assessment Processes IV, Rose-Hulman Institute of Technology, Terre Haute, Indiana, April 2001.

3- ABET/NSF EC2000 Engineering Faculty Workshop, Westborough, MA, September 2009.

4- Ezeldin, A. S., “International Accreditation from Engineering Programs: Mission, Learning Objectives, and Outcomes”, Proceedings of the International Forum on Engineering Education, Kula Lumpur, Malaysia, November 2012.

Copyright statement