Implementation of an Assessment Management System to Meet EC 2000 Engineering Criteria

A.S. McAnally¹, M.E. Meadows¹, R.P. Ray¹ and J.H. Bradburn¹

Abstract

Engineering Criteria (EC 2000) is changing the way engineering programs assess their curricula to a process of continuous quality improvement based on outcome assessment. This paper describes some of the experiences with the formulation and first implementation of an assessment system in the Department of Civil and Environmental Engineering at the University of South Carolina. Topics discussed include the structure of the assessment system, assessment processes, and initial results.

Introduction

During recent years, many papers have been written about engineering education reform that consistently identified common attributes engineering graduates should possess in the 21st century.¹,²,³ As a consequence, the engineering culture has begun to shift from one that emphasizes individual specialization, compartmentalization of knowledge, and a research-based faculty reward structure, to one that values integration as well as specialization, teamwork, educational research, and innovation.²,⁴ Drivers for this culture change include the engineering professional societies (especially ASEE), the National Science Foundation (NSF), and the Accreditation Board for Engineering and Technology (ABET).

The paradigm shift is clearly evident in the new accreditation criteria (EC 2000) adopted by ABET that promotes continuous quality improvement (CQI) through the use of outcomes assessment. Although much excitement has been generated concerning EC 2000 flexibility to accommodate a variety of institutional missions and program goals, no one involved with the EC 2000 implementation expects it to be a simple matter. Having completed the initial stages, the authors can safely say those expectations are valid.

The engineering programs at the University of South Carolina were reviewed under the EC 2000 during fall semester 1999. This paper describes our experience in the Department of Civil and Environmental Engineering with preparation and implementation of an assessment system to meet the EC 2000 requirements.

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**Background**

The University of South Carolina College of Engineering and Information Technology (USC COE&IT) consists of five academic degree programs: Chemical Engineering, Civil and Environmental Engineering, Electrical and Computer Engineering (separate academic programs), and Mechanical Engineering. In addition, the College houses research centers for Electrochemical Engineering, Information Technology, and Mechanics, Materials and Non-Destructive Evaluation. The college offers Bachelor of Science, Master of Science, Master of Engineering, and Doctor of Philosophy degrees in Chemical Engineering, Civil Engineering, Computer Engineering, Electrical Engineering, and Mechanical Engineering. Enrollment in the College was 1,022 undergraduate and 253 graduate students during the 1998-99 academic year. The College has 62 tenure-track faculty.

The Department of Civil and Environmental Engineering (CEE) has 15 tenure-track faculty and an approximate enrollment of 130 undergraduate and 30 graduate students. The Civil Engineering program offers the students four areas of specialization: geotechnical, environmental, structures, and water resources.

The ABET EC 2000 requires individual programs to publish educational objectives consistent with the mission of their institution, document progress toward achieving these objectives, and use information learned from evaluations and feedback to improve the program. Individual programs also must devise and implement appropriate assessment methodologies to evaluate the success of students in meeting published objectives. USC COE&IT faculty found that participation in the Gateway Coalition was a great asset as we began preparation to implement and institutionalize systematic engineering education reform. The Gateway Engineering Education Coalition is a collaborative program sponsored by the National Science Foundation that involves seven universities working to open new "gateways" to learning by shifting the program emphasis to one that is process driven and student oriented.

As CEE began implementing the requirements of EC 2000, our initial efforts were concentrated on curriculum innovation and development, educational technology and methodology, human potential development, student development and evaluation, and quality assurance. An engineering education excellence project initiated in 1992 was the earliest effort to formalize a CQI process for evaluation of the curricula in the College. The CEE department was assisted by the Partnership Board (the college’s industry advisory group) in developing a plan similar to the Flour Daniel Continuous Improvement Plan. Faculty and staff participated through a series of workshops that attracted about half the faculty and most of the staff. Unfortunately this project was ahead of its time at USC. This effort faltered because of lack of support from the university administration and a demoralizing letter from the University President expressing his opinion that Total Quality Management (TQM) or other quality programs used in industry have no place in an academic institution. A couple of events, hiring a forward-thinking Dean in 1996 and the
impending ABET visit during fall semester 1999, provided the boost the CEE department needed to move forward with a CQI program. CEE has put into place an assessment process that will serve as the basis for continuous quality improvement of the program as well as satisfy the needs of ABET EC 2000, SACS, and the requirements of the South Carolina Commission on Higher Education.5

**Formulation of Assessment Infrastructure**

**College Assessment System**

In order to build a viable CQI program all participants need a clear roadmap.6 The members of the college ABET/Gateway Committee have been the primary personnel involved with the initial organization and maintenance of the College-wide assessment infrastructure. The college-wide structure consists of the following components and processes: (1) input from multiple constituencies including the industrial advisory board (IAB), faculty and staff, students, parents, employers and alumnae/alumni; (2) oversight and decision-making by the Executive Council that includes the Dean, Associate Deans, Department Chairpersons, and the ABET/Gateway Committee Chair; (3) collaboration, coordination and implementation through the ABET/Gateway Committee consisting of the Committee Chair, Assessment Coordinator, Special projects Coordinator, Associate Dean for Academic Affairs, and one faculty representative from each department; and (4) problem-solving and innovation through the Departmental Assessment Committees that include 3-5 faculty members.

In 1997, the Coordinator of Assessment position was created to provide professional support to the Departments in structuring a CQI program. To this end, the Coordinator of Assessment prepared a document outlining the recommended procedures for articulating and documenting assessment processes. Key issues to be addressed by the departmental plan were to: (1) create a management structure within the department to conduct program assessment, (2) define a process by which the management structure collects and analyzes data, makes recommendations and reports findings, (3) identify the assessment techniques, tools and strategies that will be used to collect the information for the evaluation, (4) articulate and document the assessment outcomes, (5) provide conclusions and recommendations, and (6) articulate the process for feeding back information to the college and into the next evaluation loop.7 Figure 1 outlines the college assessment system and shows the linkage of the CEE department process to the college-wide process.
The CEE Department Assessment System was adopted during the 1998-99 academic year. It comprises the following steps: (1) develop objectives with constituents, (2) publish objectives, (3) acquire data, (4) interpret data, (5) improve program and curriculum, (6) improve measurement tools, (7) modify program objectives and/or outcomes, (8) report to constituents, (9) review input from constituents.

The assessment process captures the Two-Loop Model of ABET (EC 2000) by applying continuous quality improvement to the development and assessment of program objectives and outcomes. A schematic of the annual assessment process within the CEE Department is presented in Figure 2. The process to review program objectives and outcomes includes soliciting input from the IAB, students, alumni, and employers. Mechanisms for obtaining and analyzing this input are being phased-in.
The Department Chair and an Undergraduate Program Committee (UGPC) consisting of four sub-disciplinary Program Coordinators facilitate management of the Department. The Undergraduate Program Director is responsible for student advising, student enrollment, and awards and scholarships. The UGPC is responsible for the undergraduate program, courses, and curriculum assessment and improvement.

The UGPC meets semi-annually to review the assessment results and recommendations and provide an executive summary of the impact of the assessment judgements to the College-University ABET, etc.

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**Table: Schematic of Assessment Process**

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>INPUT</th>
<th>RESPONSE</th>
<th>FEEDBACK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department Chair</td>
<td>Constituent Formal Assessment Input</td>
<td>Evaluate in Context</td>
<td>College-University ABET, etc.</td>
</tr>
<tr>
<td>Qualitative Review</td>
<td>Action as Required</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undergraduate Program Committee</td>
<td>Qualitative Review, Evaluation of Assessment</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>of Data, Dissemination of Data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-disciplinary Programs</td>
<td>Evaluation of Assessment Data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual Faculty</td>
<td>Evaluation of Assessment Data</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Informal Anecdotal Student Input</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 2. Schematic of CEE Department Assessment Process**
Department Chair. The UGPC also may recommend changes to the department educational objectives, which go to the Department Chair for consideration by the Department Faculty. Recommendations, such as course or curriculum changes, requiring coordination or approval at the college or university level, are reported through the Department Chair to the appropriate committee according to University policies and procedures.

Formal assessment input is generated at a number of constituent sources and introduced to the department through the Chair. Initially, the Chair reviews this information qualitatively to ensure a level of continuity throughout the department and to maintain confidentiality when necessary. The Chair then disseminates the filtered assessment data to the Undergraduate Program Committee for qualitative review and dissemination to the appropriate sub-disciplinary Program Coordinators. Each Program Coordinator reviews and disseminates the data to the appropriate faculty members within the program for individual evaluation. The individual faculty may also receive anecdotal assessment information from students.

Evaluation of the assessment data as it passes through each level of the department may result in a record of recommended strategies and actions to be implemented at one of three levels. The department Chair and/or the Undergraduate Program Committee may recommend an action based on how the assessment data relate to the departmental program objectives. At another level the Program Coordinators, program members, and individual faculty may recommend an action based on how the assessment data relate to the sub-disciplinary program goals and objectives. The last level involves actions by the individual faculty based on how the assessment data and/or anecdotal student information relate to the course; an action at this level will result in modification of the course portfolio.

The achievement of the program objectives is assessed as follows. First, each student’s achievement of the course objectives is evaluated by graded performance on examinations, homework, projects, presentations, etc. Course portfolios are maintained by the faculty and are available in the ABET Visitor's room. The portfolios contain information such as the course syllabi, course objectives, other administrative material, and examples of student work. Second, each course is evaluated by the instructor (using feedback from the students) to verify that it meets its requirements within the curriculum and program. These evaluations are also available in the course portfolio. Finally, the curriculum is evaluated by the faculty, through the UGPC, for the degree of implementation of the program outcomes and achievement of the program objectives. The evaluation by the various constituencies provides a measure of program effectiveness in meeting their individual needs.
**Application of Assessment Process**

The department began formalizing its outcomes-based assessment plan for the undergraduate program during fall semester 1997 with the creation of an ad-hoc ABET Committee. This was followed in spring semester 1998 by an ad-hoc Curriculum Committee formed to implement the formal CEE Department assessment activities. During fall semester 1997, ABET Committee members and other faculty familiarized themselves on outcomes-based assessment by reading articles and reports and by participating in a series of workshops at USC that were led by Jack McGourty (Assessment Coordinator for the Gateway Coalition) and sponsored by the Gateway Coalition. The ABET Committee collected and reviewed the existing ABET EC 2000, university mission statement, college long-range plan and departmental long-range plan. The committee drafted a list of four educational objectives and sixteen program (learning) outcomes for the program that were consistent with these documents. Several focus meetings were held to obtain input from the department faculty on the draft objectives and outcomes. The committee made changes and the completed document was unanimously approved at a departmental faculty meeting in September 1998.

Prior to 1998, industry input came through the College’s Partnership Board. During spring semester 1998, the department hosted its first meeting of the CEE Industrial Advisory Board. Members of the Partnership Board were assigned to each department IAB by the Dean’s office for the spring 1998 meeting. The program objectives and outcomes were presented to the industrial participants as part of that meeting.

A Student Advisory Committee (SAC) was organized in December 1998. At its first meeting during spring semester 1999, the Department Chair discussed the importance and philosophy of EC 2000 accreditation and relationship to the development of the current program objectives and outcomes. The students were presented an information packet consisting of the CEE draft program objectives and outcomes along with the EC 2000 Criteria, and the department, college and university mission statements.

The CEE Department adopted assessment measures that include instructor grades, faculty evaluation of course portfolios, course survey, senior exit survey, alumni survey, employer focus groups/ employer survey, and review of FE summary reports. In addition to the assessment instrument feedback, other useful assessment activities include transcript analysis/advising, IAB input, departmental committee feedback- Strategic Planning, Undergraduate Curriculum, Graduate Studies, ABET and Student Advisory, College Level Feedback- Lower Division Committee, and Engineering Career Services. The evaluation schedule is presented in Table 1.
Initial Results of Assessment of Process

Initial results are based on: Course Surveys (Fall and Spring 1997, Fall 98), Senior Surveys (Spring and Fall 1998), Alumni Survey (1997), Course Surveys (Spring 1997, Spring and Fall 1998), Faculty assessment of course portfolios (Fall 1998, Spring and Summer 1999), FE Exam summary (Report 5) 1996-1998. Near the end of spring semester 1999, the sub-disciplinary program faculty met and reviewed the courses and curriculum in context of the program area. The results were submitted to the UGPC for review and assessment in context of the overall departmental program and

Table 1 Assessment Schedule

<table>
<thead>
<tr>
<th>Assessment Instrument</th>
<th>Frequency</th>
<th>Source</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior Survey</td>
<td>Semester</td>
<td>College</td>
<td>Summarize, review by UGPC, save</td>
</tr>
<tr>
<td>Alumni Survey</td>
<td>Annual</td>
<td>College</td>
<td>Summarize, review by UGPC, save</td>
</tr>
<tr>
<td>FE Exam Summary</td>
<td>Semi-annual</td>
<td>State and College</td>
<td>Summarize, review by UGPC, save</td>
</tr>
<tr>
<td>Course Survey (Student Evaluation of Instructor and Course)</td>
<td>Semester</td>
<td>College and students</td>
<td>Summarize, review by chairperson</td>
</tr>
<tr>
<td>Course Portfolio (Course evaluation and improvement)</td>
<td>Semester</td>
<td>Department and instructors</td>
<td>Review by UGPC, save</td>
</tr>
<tr>
<td>Instructor Grades (Evaluation of Students)</td>
<td>Semester</td>
<td>Department and instructors</td>
<td>Save</td>
</tr>
</tbody>
</table>

were documented in the UGPC notes and minutes. These were made available in the Supplemental Information File for the ABET visitors.

We are in the early stages of implementing changes and evaluating them for their impact on program improvement. Numerous course and curriculum changes have been
implemented but the period for evaluation has typically been too short to provide
determination of the impact on the program. Weaker areas of the curriculum have been
identified based on evaluation of the assessment information. Some early program
improvements that have been made or are under consideration include increasing student:
(1) level of experience and competence in communications skills, (2) awareness of the global
and societal context of certain courses within the curriculum, and (3) level of experience and
competence in functioning on multidisciplinary teams. We acknowledge that it is necessary
to incorporate global and societal awareness in additional courses to be identified and
implemented in the coming year.

As part of the CEE program assessment and ABET evaluation process, the Chair
established the ad hoc UGPC in January 1998 to review, revise and update the present
curriculum. In preparing the curriculum proposal, the committee had to balance many
conflicting demands, the most important of which is the desire to maximize the student’s
learning experience and achieve the program objectives while making the most efficient use
of the department’s resources. The CEE faculty approved the curriculum proposal in May
1999. The draft of the proposal was initially presented to the IAB for review at their
advisory meeting in September 1998. The curriculum proposal was again reviewed and
discussed at their meeting in April 1999 (IAB meeting notes and minutes). In November
1998 the document was presented to the newly established Student Advisory Committee for
review. Since that time the curriculum proposal has been reviewed by the faculty in the
four sub-disciplinary programs and finally by the UGPC. The student advisory committee
has disseminated the curriculum proposal to the CEE student body for review. The
Undergraduate Program Committee is reviewing the comments from the various
constituencies to consider additional modifications before recommending action by the CEE
faculty.

Key aspects of the curriculum proposal include: (1) a reduction in the total number of hours
from 132 to 127 credits, (2) an increase the elective sequence for specialization, and (3)
modernization of the curriculum by integrating updated technology and tools, non-
engineering subjects, and engineering design into more courses.

CONCLUDING REMARKS

This paper describes the approach of the CEE department to building a viable Continuous
Quality Improvement program. An assessment process had been in place for many years
but the efforts have varied in framework and direction. The advent of EC 2000 has directed
these efforts by encouraging CEE to focus on program needs, and then establish a
systematic program of assessment. EC 2000 has also encouraged the faculty and
administration to "buy-in" to the CQI approach to program management. Our
recommendation to others is to establish the assessment infrastructure as soon as possible
to prepare for the ABET visit. Based on our experience, a minimum three-year period is
required to guarantee any significant feedback on the impact of changes made from the program assessment.

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REFERENCES


