

Assessment Plan for the BS Civil Engineering Program

Updated September 26, 2002

Department of Civil, Structural, and Environmental Engineering University at Buffalo

1 INTRODUCTION

As part of the ongoing effort to evaluate and improve the quality of undergraduate programs, and in conjunction with the ongoing accreditation review by the Accreditation Board for Engineering and Technology (ABET), the Department of Civil Structural and Environmental Engineering (CSEE) has developed a program of activities to evaluate the BS Civil Engineering program. This report provides a description and schedule for these activities.

In March 2001, the CSEE department formalized the Educational Objectives for the Civil Engineering program (summarized in Appendix) and identified the constituencies served by this program. These constituencies include:

- Current students in the civil engineering program and their families
- Department faculty
- Other faculty in the School of Engineering and Applied Science
- Other faculty of the University at Buffalo
- Graduate and professional schools
- Employers of our graduates, including engineering consulting firms, government agencies, manufacturing/construction companies, and educational/research institutions
- Employers who participate the Engineering Career Institute and Internship programs
- Alumni of the Department

The responsibility for implementing the Assessment Program rests with the CSEE Undergraduate Studies Committee, chaired by the Director of Undergraduate Studies. The CSEE undergraduate studies secretary and various student assistants also participate in data collection and analysis.

Since the accreditation of UB's Civil Engineering program in 1996, the approach implemented by ABET has undergone extensive revision, as reflected in the published ABET2000 criteria. Of the many changes implemented in this document, one of the most significant is the transition from a criteria-driven process to a more flexible assessment-driven process. Under this new paradigm, academic programs are directed to define educational objectives particular to their constituencies and perform a detailed self-assessment.

The primary objective of the activities described here are to assess the overall quality of the BS Civil Engineering program and the achievement of results consistent with: 1) the Civil Engineering Educational Objectives and Outcomes, 2) the ABET general criteria,

particularly “a through k”, and 3) the ABET Civil Engineering program criteria. These criteria are summarized in the Appendix.

2 ASSESSMENT INSTRUMENTS

2.1 Overview

The primary constituencies considered in this report include students, alumni, and employers. Dialogue among UB faculty is normally accomplished through frequent meetings of the Undergraduate Studies Committee (typically, 2-4 week intervals), monthly departmental faculty meetings, and monthly meetings of the Academic Programs Committee of the School of Engineering and Applied Science (SEAS).

The Civil Engineering Assessment program includes a number of instruments that are categorized as primary and secondary activities. *Primary* activities were designed primarily for accreditation purposes and are performed by the CSEE Department at regular intervals, while *secondary* activities are performed by outside parties and/or for other purposes. The primary activities include the following:

- Annual exit surveys of graduating seniors, first initiated in 1998. When deemed useful and feasible, these surveys are supplemented by in-person follow-up interviews.
- Alumni surveys. In June 2001, questionnaires were distributed to Civil Engineering alumni who graduated between June 1995 and December 2000. These surveys will be repeated at 3-year intervals.
- Employer surveys. Also in June 2001, questionnaires were distributed to employers of UB Civil Engineering graduates, to be repeated at 3-year intervals.
- Focus group meetings. Periodically, focus group meetings will be held with alumni and/or employers. These meetings will involve 5-10 invited participants from the target constituency participating in a focused discussion, usually over breakfast or lunch. The first meeting with an employer group was held in December 2001.

In addition to the above instruments, the following “secondary” information will be reviewed upon availability:

- Records of student performance on the Fundamentals of Engineering exam, which are normally transmitted in August following the April exam. Records are currently on file dating back to 1995.
- Course evaluations performed by the School of Engineering and Applied Science (SEAS).
- Surveys completed by employers associated with the SEAS internship and summer *Engineering Career Institute* work experience courses. Typically, approximately 10-15 students participate in each of these programs.
- Surveys conducted by other UB groups. At the time of this writing, two relevant surveys are available: 1) A survey of engineering employers conducted by staff associated with the SEAS Technical Communications program in 2000, and 2) A

- placement survey conducted by the UB Office of Career Planning and Placement of students who graduated in 2000, including 24 civil engineering majors.
- Published survey data and reports distributed by outside engineering organizations and contained in the engineering education literature.

Details of the various assessment instruments are presented below.

2.2 Student exit surveys

Beginning in May 1998, written questionnaires have been distributed to students enrolled in a required senior course CIE415 (Professional Practice Issues). Students are typically informed that completion of the survey is required for the course; the completion rate normally exceeds 90 percent in each year. The survey typically consists of 5-7 pages of questions that assess achievement of the program objectives and outcomes, as well as “quality of life” issues.

As a follow-up to the surveys, exit interviews are sometimes conducted with selected students. For example, in 1998, 2000, and 2002, informal interviews were conducted by several faculty members of the Undergraduate Studies Committee and discussed during committee meetings. In 2001, a more formal procedure was used: 10 students were selected randomly from the CIE415 class list and contacted individually. Interviews conducted by the Director of Undergraduate Studies normally last 20-30 minutes. A significant portion of each interview is devoted to clarification of comments and trends noted from the written surveys. The need for and scope of follow-up interviews will be determined on a year-to-year basis.

2.3 Alumni surveys

The first survey of Civil Engineering alumni was conducted during the summer of 2001. A 6-page questionnaire was developed by the Undergraduate Studies Committee, based on the CSEE Educational Objectives, ABET criteria, previously administered student surveys, and other factors. In June 2001, approximately 325 surveys were mailed to alumni who received their degree during the 1995-2001 period; approximately 75 surveys were returned. The alumni surveys will be repeated at 3-year intervals. Thus, for future ABET accreditation studies, two rounds of survey data will be available for assessment.

2.4 Employer surveys

The first survey of Civil Engineering alumni was conducted during the summer of 2001. A 5-page questionnaire was developed by the Undergraduate Studies Committee, based on the Educational Objectives, ABET criteria, consistency with the student and alumni surveys, and other factors. In summer 2001, approximately 100 surveys were mailed to 25 employers. In addition, personal contacts were initiated with institutions that typically employ a large number of UB Civil Engineering graduates, including the US Army Corps of Engineers, New York State Department of Transportation, New York State Department of Environmental Conservation, and several large consulting/construction

firms. Approximately 25 surveys were returned, representing managers who supervised over 600 employees. The alumni surveys will be repeated at 3-year intervals. Thus, for future ABET accreditation studies, two rounds of survey data will be available for assessment.

2.5 FE Exam

The New York State Department of Education typically provides detailed information regarding the performance of students on the Fundamentals of Engineering Exam, including number taking the exam, number passing, and percentage of correct answers in each of the subject areas. In addition to the institution-specific information, statistics are also provided for all national and New York State students. Normally, graduating seniors take the exam in April of their senior year, and New York State provides a written report in the following August. As part of the assessment process, exam results have been compiled beginning in 1995.

2.6 Work Experiences

Students who participate in one of the work experience courses (internship, co-op, or summer *Engineering Career Institute*) normally are evaluated by the employer sponsor. These evaluations are collected by the supervising faculty member (normally a member of the Undergraduate Studies Committee) and reviewed by the committee on an annual basis. Comments from students are also solicited and considered in the process of approving specific internship/co-op relationships.

2.7 Undergraduate Studies Committee

The activities listed in the previous Sections are supervised by the Undergraduate Studies Committee (USC), as summarized in Table 1. In addition to these general activities, an in-depth course-by-course review of the curriculum was initiated in 2001. During these reviews faculty members who have recently taught a particular course will meet with the committee to review the philosophy of the class and present course materials. The purpose of these reviews is multifold, but does not usually result in immediate recommendations. For example, the reviews conducted in 2001-02 were primarily focused on the senior-year design electives, with the goal of establishing important prerequisites that can be conveyed to the instructors of the junior-year “core” courses. A tentative schedule for the course reviews is summarized in Table 2a. The courses listed in Table 2b are also reviewed by the Undergraduate Studies Committee, but on an less formal basis.

Table 1. Schedule of Civil Engineering assessment activities

Assessment Vehicle	Interval	Initiated	Scheduled
Undergrad Studies Committee meetings	4-8 times each semester	pre-1996	Ongoing
Senior exit surveys	Annual	May 1998	May, annually
Alumni surveys	3-years	June 2001	June 2004

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Employer surveys	3-years	June 2001	June 2004
Review of student course evaluations	Semester	pre-1996	Under discussion
Review of FE data	Annual	June 2001 review of data for 1995-2001	September
Review of work experience evaluations	Annual	June 2002 review of data for 1998-2001	September
Focus group meetings	1-2 times annually	December 2001	December 2002 (tent.)

Table 2a. Schedule for review of Civil Engineering courses (updated 9/25/02)

Course	Recent Instructor	Date of review	Comment
<i>Required Fall courses</i>			
EAS451 Mod. Meth. Eng. Comput.	Aref	Spring 2003	Applied math elective
CIE323 Structures I	Chen	October 9, 2002	Review with CIE324
CIE354 Fluid Mechanics	Jankovic	September 25, 2002	Review with CIE343
CIE327 Civil Eng Materials	Aref	Spring 2003	
CIE303 Geodesy, GIS, GPS	Green	November 13, 2002	Taught by adjuncts in 2001 & 2002
CIE361 Civil Eng Lab I	Whittaker	Ongoing	First offered in Fall 02
CIE435 Foundation Eng	Richards	October 23, 2002	Review with CIE334
CIE439 Transportation Eng	Mohan/Zech	Spring 2003	Taught by adjuncts in 2001 & 2002
<i>Required Spring courses</i>			
EAS308 Eng. Statistics (S)	Tsai	Spring 2003	
CIE101 Civil Engineering Creations	Richards	NS	1-credit freshman course
CIE324 Structures II	Constantinou	October 9, 2002	Review with CIE323
CIE334 Soil Mechanics	Theva	October 23, 2002	Review with CIE435
CIE340 Environmental Eng	Weber	Spring 2003	
CIE343 Hydraulic Eng	Van Benschoten	September 25, 2002	Review with CIE354
CIE362 Civil Eng Lab II	Theva	Ongoing	First offering: Spring 2003
CIE415 Prof Practice Issues	Chen	January 30, 2002; November 13, 2002	Reviewed frequently
<i>Fall Technical Electives</i>			
CIE428 Steel Design	Chen	October 10, 2001	Design elective
CIE429 Concrete Design	Reinhorn	May 10, 2002	Design elective
CIE437 Pavement Mat/Des *	Springer	2003-04 (tent.)	
CIE441 Ecologic Engineering	Jensen	2003-04 (tent.)	Also reviewed by ENV subgroup
CIE444 Hydrologic Eng	Atkinson	NS	Also reviewed by ENV subgroup
CIE447 Env Eng Practicum	Weber	NS	Also reviewed by ENV subgroup
CIE448 Water Quality Principles	Van Benschoten	NS	Also reviewed by ENV subgroup
CIE458 Geoenvironmental Eng	Theva	NS	Offered in alternate years
CIE491 Construction Estimating	Mannarino	NS	
<i>Spring Technical Electives</i>			
CIE404 Internship *	Ahmad	NS	
CIE407 Co-op *	Ahmad	NS	
CIE423 Structures III	Aref	NS	
CIE424 CAD	Chen	NS	
CIE442 Treatment Process Eng	Jensen	Spring 02	Design elective
CIE438 Struc Des/Cons Found	Basaran	February 26, 2002	Design elective
CIE445 Groundwater Eng	Jankovic	NS	
CIE449 Env Eng Design	Rabideau	Fall 02	Design elective
CIE493 Project Management	Mannarino	NS	

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* = offered both semesters, NS = not yet scheduled, ENV = environmental faculty

Table 2b. Civil Engineering courses that are reviewed informally

Course	2001-02 Instructor	Comment
EAS140 Eng. Solutions (F)	Jensen	Reviewed by SEAS Dean's Office
EAS150 Engineering Drawing (S)	Staff	Not currently scheduled
EAS207 Statics (F,S)	Ahmad	Reviewed by SEAS Dean's Office
EAS208 Dynamics (F,S)	Dargush	Reviewed by SEAS Dean's Office
EAS209 Solid Mech. (F,S)	Richards	Reviewed by SEAS Dean's Office
CIE426 Finite Elem Struct	Banarjee	Primarily grad course
CIE476 Design of Earth Struct	Theva	Primarily grad course

F = Fall semester, S = Spring semester

3 REPORTING OF RESULTS

The information gathered during the assessment process will be maintained in several formats. A written "Assessment Report" will be published on the department web site and updated annually (typically, during the summer following a graduating class); hard copy reports will be generated annually and/or as needed. The Assessment Report will be "cumulative" in nature, summarizing all activity completed to date, with an emphasis on the most recent instrument(s). Summaries of the raw data for each survey or other instrument will be maintained as stand-alone documents.

Although quantitative in nature, most of the survey measures do not lend themselves to statistical hypothesis testing. Many of the survey questions are based on a "Likert" scale in which respondents indicate their relative agreement with a proposition using a numerical scale (1-5). Although it is more common to report the percentage of answers associated with each of the 5 responses, there is also value in reporting the numerical averages for each question as a simple indicator of the relative success of the particular measure. Recognizing that the development of detailed quantitative targets for individual questions may be a difficult and ongoing enterprise, the following interim approach has been adopted:

For statements posed in the affirmative (e.g., the CSEE faculty are excellent teachers) average responses of 3.5 or higher will be interpreted as indicative of success, while average scores below 3.0 will be regarded as problematic. Scores within the range of 3.0 – 3.5 should be interpreted in the context of other information (additional survey questions or interviews).

Further development of assessment metrics and goals will be an ongoing task of the Undergraduate Studies Committee.

4 FUTURE WORK

The development of the Civil Engineering Assessment program is an ongoing process. The maintenance of a flexible program will facilitate incorporation of emerging ideas and assessment vehicles, as well as cost-effective utilization of faculty and staff resources. Priorities for future work include the following:

- The development of a comprehensive relational database (*MS Access*) for BS students and alumni is ongoing. Completion of this database will facilitate the preparation of several of the assessment instruments (e.g., alumni surveys) and support more precise quantification of placement data. Transition from the current *ad hoc* system of data management to the use of the new database is anticipated to take place during the 2002-03 academic year.
- Currently, no formal vehicle is in place to track the performance of civil engineering graduates in graduate school. Following the implementation of the new undergraduate database, a suitable monitoring instrument will be developed (e.g., a targeted survey of graduate advisors).
- Student course evaluations are administered by SEAS at the end of each semester. At the time of this writing, the questions used in these surveys are standardized and not tailored to the program objectives or outcomes. Summaries of the evaluations are provided to the department chairs and used primarily in faculty evaluations for promotion and tenure. However, the form of the evaluations will support some degree of customization to include questions designed to complement the civil engineering program. Discussion are ongoing with the SEAS Dean's Office, and development of this assessment vehicle is anticipated to during the 2002-03 academic year.
- Alternative techniques for quantitatively interpreting the 5-point "Likert" surveys are being pursued in consultation with colleagues in UB's Graduate School of Education.
- The development of a civil engineering advisory panel is under discussion by the Undergraduate Studies Committee.

APPENDIX I UB EDUCATIONAL OBJECTIVES AND OUTCOMES

Civil Engineering Educational Objectives

Consistent with the mission and vision of the Department, the objectives of the Civil Engineering program are to:

- Provide students with engineering knowledge and skills that allow them to work effectively as Civil Engineers and related job functions in consulting, industry, government, and academia
- Prepare students for graduate study in one of the Civil Engineering specialty areas
- Provide students with a broad general education that fosters an understanding of the impact of civil engineering solutions in a global and societal context
- Monitor and ensure student progress by providing timely advisement
- Evaluate and update the undergraduate curriculum and teaching facilities on a continuous basis to satisfy the program needs and to ensure a high quality of instruction
- Monitor faculty development to ensure a high quality of teaching and maintain the currency of course content by drawing on active faculty research
- Support students in their professional and postgraduate educational development by offering faculty advice and departmental support, including support for student societies and professional groups

Civil Engineering Educational Outcomes

Consistent with the CSEE educational objectives, graduates of the Civil Engineering program should demonstrate:

1. An ability to apply basic knowledge of mathematics, science, and engineering
2. An ability to identify, formulate, and solve technical problems using modern tools of engineering and applied mathematics
3. An ability to design civil engineering systems, components, or processes
4. An ability to design and conduct physical and numerical experiments, as well as to analyze and interpret data, in at least two of the following areas: environmental engineering, geotechnical engineering, fluids/hydraulic engineering, and structural engineering
5. Proficiency in at least 4 of the following civil engineering sub-disciplines: construction management, environmental engineering, geotechnical engineering, structural engineering, transportation engineering, water resources engineering
6. An ability to communicate effectively and function on multi-disciplinary teams
7. An understanding of professional practice issues, including the interaction of professionals in the construction process, the importance of professional licensure, and ethical responsibility
8. A knowledge of contemporary issues and a recognition of the need for, and an ability to engage in, life-long learning

APPENDIX II ABET CRITERIA

from *Criteria for Accrediting Engineering Programs* (2002-2003 Accreditation Cycle)

Criterion 3. Program Outcomes and Assessment

Engineering programs must demonstrate that their graduates have:

- a) an ability to apply knowledge of mathematics, science, and engineering
- b) an ability to design and conduct experiments, as well as to analyze and interpret data
- c) an ability to design a system, component, or process to meet desired needs
- d) an ability to function on multi-disciplinary teams
- e) an ability to identify, formulate, and solve engineering problems
- f) an understanding of professional and ethical responsibility
- g) an ability to communicate effectively
- h) the broad education necessary to understand the impact of engineering solutions in a global and societal context
- i) a recognition of the need for, and an ability to engage in life-long learning
- j) a knowledge of contemporary issues
- k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

PROGRAM CRITERIA FOR CIVIL AND SIMILARLY NAMED ENGINEERING PROGRAMS

Lead Society: American Society of Civil Engineers

These program criteria apply to engineering programs including "civil" and similar modifiers in their titles.

1. Curriculum

The program must demonstrate that graduates have: proficiency in mathematics through differential equations; probability and statistics; calculus-based physics; and general chemistry; proficiency in a minimum of four (4) recognized major civil engineering areas; the ability to conduct laboratory experiments and to critically analyze and interpret data in more than one of the recognized major civil engineering areas; the ability to perform civil engineering design by means of design experiences integrated throughout the professional component of the curriculum; an understanding of professional practice issues such as: procurement of work; bidding versus quality based selection processes; how the design professionals and the construction professions interact to construct a project; the importance of professional licensure and continuing education; and/or other professional practice issues.

2. Faculty

The program must demonstrate that faculty teaching courses that are primarily design in content are qualified to teach the subject matter by virtue of professional licensure, or by education and design experience. The program must demonstrate that it is not critically dependent on one individual.