TENNESSEE TECHNOLOGICAL UNIVERSITY
Department of Civil and Environmental Engineering
Outcomes, Assessments and Actions

The Department of Civil and Environmental Engineering offers one undergraduate degree program, BSCE; and one graduate program, MSCE. This document presents the program and learning outcomes for each program and assessments for each.

Program: Bachelor of Science in Civil Engineering

Mission:

The principal mission of the Civil Engineering program is to offer the strong academic program needed to produce well-educated students who can become productive members of the civil engineering profession. This mission is consistent with the academic component of the University's mission, which is in part to provide a strong academic program in engineering.

Civil Engineering Undergraduate Program Outcomes and Assessments

The civil engineering program educational objectives have been formulated to produce eleven core outcomes, each comprised of multiple components. The desired outcomes are as follows:

Objective 1:

The educational program will provide and deliver a broad understanding of relevant principles of mathematics, science, and engineering.

Outcome 1:

1.1. The graduates will have an understanding of the role of mathematics as a tool in modeling systems and will be able to make appropriate mathematics-related assumptions to produce engineering models with the required accuracy.

1.2. The graduates will have an understanding of conservation principles of mass, momentum, and energy.

1.3. The graduates will have an understanding of the fundamental laws of physics and chemistry.

1.4. The graduates will understand the basic concept of statistics and probability as applied to engineering systems.

1.5. The graduates will have an understanding of comparing various alternatives through skills of engineering economy.
1.6. The graduates will have an understanding of engineering geology and material properties.

**Objective 2:**

The educational program will offer a general comprehension of the breadth of civil engineering and in-depth knowledge of at least one major civil engineering area.

**Outcome 2:**

2.1. The graduates will be exposed to various civil engineering disciplines, including structural, environmental, transportation, and engineering mechanics.

2.2. The graduates will take one or more courses in structures, environmental, hydraulics, transportation, engineering mechanics, geotechnical, materials, and surveying.

2.3. The graduates will have a coherent group of technical electives concentrating on a single area of civil engineering (structures, engineering mechanics, environmental, and transportation).

**Objective 3:**

The educational program will prepare students to begin the professional registration process prior to graduation.

**Outcome 3:**

3.1. The graduates will understand the process involved in obtaining a professional license.

3.2. The graduates will take the FE exam prior to graduation.

3.3. The graduates will be aware of the need for additional training and professional short courses to remain current in their field.

**Objective 4:**

The educational program will require that students are taught design activities throughout the professional component of the civil engineering curriculum and have the ability to identify, formulate, and solve civil engineering problems.

**Outcome 4:**

4.1. The graduates will construct problem statements and offer solution criteria.

4.2. The graduates will select appropriate solutions based on the given criteria.

4.3. The graduates will select and document a recommended solution.
4.4. The graduates will acquire problem-solving experiences through independent and group study.

4.5. The graduates will incorporate multi-disciplinary knowledge into solutions.

4.6. The graduates will recognize the broad and diverse fields of civil engineering knowledge that are involved in problem solving.

**Objective 5:**

The educational program will promote effective communication skills.

**Outcome 5:**

5.1. The graduates will be able to organize and present ideas clearly and logically.

5.2. The graduates will use proper grammar.

5.3. The graduates will be able to collaborate with their peers in preparing proposals and reports.

5.4. The graduates will choose appropriate audiovisual tools to support their presentation.

5.5. The graduates will be encouraged to speak clearly and understandably, and provide professional presentations appropriate to the situation and audience.

**Objective 6:**

The educational program will develop the students’ ability to function on multi-disciplinary teams.

**Outcome 6:**

6.1. The graduates will communicate and interact with their peers in a team environment.

6.2. The graduates will understand the importance of project deadlines and attending team meetings regularly.

6.3. The graduates will participate in the development of ideas and the needed methodologies to implement the ideas.

6.4. The graduates will understand the importance of obtaining meaningful group consensus and working with team members to resolve conflicts constructively.
Objective 7:

The educational program will enhance the understanding of the experimental process through effective laboratory experiences.

Outcome 7:

7.1. The graduates will use the knowledge of mathematics, chemistry, statistics, and engineering science in laboratory courses.

7.2. The graduates will use generic software, i.e., word processors, spreadsheets, engineering solvers, etc., to complete laboratory assignments.

7.3. The graduates will relate theoretical concepts to relevant laboratory experiments.

7.4. The graduates will recognize the importance of the laboratory courses in preparation for conducting experimental research.

Objective 8:

The educational program will develop the students’ ability to use techniques, skills, and modern engineering tools needed for engineering practice.

Outcome 8:

8.1. The graduates will use e-mail and World Wide Web for communicating and obtaining needed information.

8.2. The graduates will utilize word-processors, spreadsheets, and other presentation software.

8.3. The graduates will write programs using a programming language.

8.4. The graduates will produce basic engineering drawings using computer aided drafting (CAD) software.

8.5. The graduates will use typical civil engineering software.

Objective 9:

The educational program will promote the students’ social development and ethical responsibilities.

Outcome 9:

9.1. The graduates will be required to complete courses in social sciences and humanities.
9.2. The graduates will be aware of the basic principle of ethical conduct in providing safety and health in performance of their professional activities.

9.3. The graduates will understand social and ethical impacts of design decisions made in civil engineering applications.

**Objective 10:**

The educational program will emphasize the need for life-long learning.

**Outcome 10:**

10.1. The graduates will have opportunities to gain practical experiences and exposure to real-life problems through the Cooperative Education Program.

10.2. The graduates will be aware of the need to obtain new intellectual experiences for professional growth.

10.3. The graduates will be aware of the need for additional training and professional short courses to remain current in their field.

10.4. The graduates will recognize the role of advanced degrees in the practice of the civil engineering profession.

**Objective 11:**

The educational program will maintain an environment to carry out fundamental and applied research and advance engineering knowledge through research.

**Outcome 11:**

1.1. The graduates will be aware of the significance of fundamental and applied research throughout their experiences in basic and engineering science, engineering design, and laboratory classes.

1.2. The graduates have an opportunity to interact with graduate students, and participate in research and scholarly activities through independent courses or project work.
TABLE 3.3. Relationship Among Program Outcome Components, Course Delivery of the Curriculum, and Assessment Methods

**Objective 1:** The educational program will provide and deliver a broad understanding of relevant principles of mathematics, science, and engineering.

<table>
<thead>
<tr>
<th>Outcome 1</th>
<th>Delivery</th>
<th>Assessment Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Engineering Science and Laboratory Courses</td>
<td>Senior Exit Survey and Interviews, and Alumni Survey</td>
</tr>
<tr>
<td>1.2</td>
<td>Engineering Science and Laboratory Courses</td>
<td>Senior Exit Survey and Interviews, and Alumni Survey</td>
</tr>
<tr>
<td>1.3</td>
<td>Basic Science Courses</td>
<td>Student Transcripts</td>
</tr>
<tr>
<td>1.4</td>
<td>ISE 3200, Laboratory Courses, CEE 3610, CEE 4420 and CEE 4440</td>
<td>Course Portfolios, Laboratory Reports, Senior Exit Survey and Interviews, and Alumni Survey</td>
</tr>
<tr>
<td>1.5</td>
<td>ISE 3110</td>
<td>Course Portfolios, Senior Exit Survey and Interviews</td>
</tr>
<tr>
<td>1.6</td>
<td>GEOL 3210</td>
<td>Student Transcripts</td>
</tr>
</tbody>
</table>

**Objective 2:** The educational program will offer a general comprehension of the breadth of civil engineering and in-depth knowledge of at least one major civil engineering area.

<table>
<thead>
<tr>
<th>Outcome 2</th>
<th>Delivery</th>
<th>Assessment Methods</th>
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</thead>
<tbody>
<tr>
<td>2.1</td>
<td>The CEE curriculum</td>
<td>Student Transcript</td>
</tr>
<tr>
<td>2.2</td>
<td>The CEE curriculum</td>
<td>Student Transcripts</td>
</tr>
<tr>
<td>2.3</td>
<td>Advisement and the CEE curriculum</td>
<td>Student Transcripts</td>
</tr>
</tbody>
</table>
**Objective 3:** The educational program will prepare students to begin the professional registration process prior to graduation.

<table>
<thead>
<tr>
<th>Outcome 3</th>
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<th>Assessment Methods</th>
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<tbody>
<tr>
<td>3.1</td>
<td>CEE 4910, 4920, and 4940</td>
<td>Course Portfolio, Senior Exit Survey and Interviews, and Alumni Survey</td>
</tr>
<tr>
<td>3.2</td>
<td>CEE 4940</td>
<td>FE Data, Senior Exit Survey and Interviews</td>
</tr>
<tr>
<td>3.3</td>
<td>CEE 4910, 4920, and 4950</td>
<td>Course Portfolios, Senior Exit Survey and Interviews, and Alumni Survey</td>
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</tbody>
</table>

**Objective 4:** The educational program will require that students are taught design activities throughout the professional component of the civil engineering curriculum and have the ability to identify, formulate, and solve civil engineering problems.

<table>
<thead>
<tr>
<th>Outcome 4</th>
<th>Delivery</th>
<th>Assessment Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>Engineering Design, Senior Design Projects, and Laboratory Courses</td>
<td>Course Portfolios, Senior Exit Survey and Interviews, Alumni Survey, and Employer Survey</td>
</tr>
<tr>
<td>4.2</td>
<td>Engineering Design Courses, and Senior Design Projects</td>
<td>Course Portfolios, Senior Exit Survey and Interviews, Alumni Survey, and Employer Survey</td>
</tr>
<tr>
<td>4.3</td>
<td>Engineering Design Courses, and Senior Design Projects</td>
<td>Course Portfolios, Senior Exit Survey and Interviews, Alumni Survey, and Employer Survey</td>
</tr>
<tr>
<td>4.4</td>
<td>Engineering Design, CEE 4950, and Laboratory Courses</td>
<td>Course Portfolios, Senior Exit Survey and Interviews, Alumni Survey, and Employer Survey</td>
</tr>
<tr>
<td>4.5</td>
<td>Senior Design Projects</td>
<td>Course Portfolios, Senior Exit Survey and Interviews, Alumni Survey, and Employer Survey</td>
</tr>
<tr>
<td>4.6</td>
<td>Engineering Design Courses, and Senior Design Projects</td>
<td>Senior Exit Survey and Interviews, Alumni Survey, and Employer Survey</td>
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**Objective 5:** The educational program will promote effective communication skills.

<table>
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<tr>
<th>Outcome 5</th>
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<tbody>
<tr>
<td>5.1</td>
<td>English Courses, Engineering Science, Engineering Design, Laboratory Courses, and CEE 4950</td>
<td>Course Portfolios, Senior Exit Survey and Interviews, Alumni Survey, and Employer Survey</td>
</tr>
<tr>
<td>5.2</td>
<td>English Courses, Laboratory Courses, and CEE 4950</td>
<td>Course Portfolios, Senior Exit Survey and Interviews, Alumni Survey, and Employer Survey</td>
</tr>
<tr>
<td>5.3</td>
<td>Selected Engineering Design, Laboratory Courses, and CEE 4950</td>
<td>Course Portfolios, Senior Exit Survey and Interviews, Alumni Survey, and Employer Survey</td>
</tr>
<tr>
<td>5.4</td>
<td>Selected Engineering Design, Laboratory Courses, and CEE 4950</td>
<td>Course Portfolios, Senior Exit Survey and Interviews, Alumni Survey, and Employer Survey</td>
</tr>
<tr>
<td>5.5</td>
<td>Selected Engineering Design, Laboratory Courses, and CEE 4950</td>
<td>Course Portfolios, Senior Exit Survey and Interviews, Alumni Survey, and Employer Survey</td>
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</table>

**Objective 6:** The educational program will develop the students’ ability to function on multidisciplinary teams.

<table>
<thead>
<tr>
<th>Outcome 6</th>
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<tbody>
<tr>
<td>6.1</td>
<td>CEE 4500, 4630, 4640, and 4950</td>
<td>Course Portfolios, Senior Exit Survey and Interviews, Alumni Survey, and Employer Survey</td>
</tr>
<tr>
<td>6.2</td>
<td>CEE 4500, 4630, 4640, and 4950</td>
<td>Course Portfolios, Senior Exit Survey and Interviews, Alumni Survey, and Employer Survey</td>
</tr>
<tr>
<td>6.3</td>
<td>CEE 4500, 4630, 4640, and 4950</td>
<td>Course Portfolios, Senior Exit Survey and Interviews, Alumni Survey, and Employer Survey</td>
</tr>
<tr>
<td>6.4</td>
<td>CEE 4500, 4630, 4640, and 4950</td>
<td>Course Portfolios, Senior Exit Survey and Interviews, Alumni Survey, and Employer Survey</td>
</tr>
</tbody>
</table>
**Objective 7:** The educational program will enhance students’ understanding of the experimental process through effective laboratory experiences.

<table>
<thead>
<tr>
<th>Outcome 7</th>
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<tbody>
<tr>
<td>7.1</td>
<td>Laboratory Courses</td>
<td>Course Portfolios, Senior Exit Survey and Interviews, Alumni Survey, and Employer Survey</td>
</tr>
<tr>
<td>7.2</td>
<td>Laboratory Courses</td>
<td>Course Portfolios, Senior Exit Survey and Interviews, Alumni Survey, and Employer Survey</td>
</tr>
<tr>
<td>7.3</td>
<td>Laboratory Courses</td>
<td>Course Portfolios, Senior Exit Survey and Interviews, Alumni Survey, and Employer Survey</td>
</tr>
<tr>
<td>7.4</td>
<td>Laboratory Courses</td>
<td>Course Portfolios, Senior Exit Survey and Interviews, Alumni Survey, and Employer Survey</td>
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</table>

**Objective 8:** The educational program will develop the students’ ability to use techniques, skills, and modern engineering tools needed for engineering practice.

<table>
<thead>
<tr>
<th>Outcome 8</th>
<th>Delivery</th>
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<tbody>
<tr>
<td>8.1</td>
<td>BE 1210</td>
<td>Senior Exit Survey and Interviews, Employer Survey, and Alumni Survey</td>
</tr>
<tr>
<td>8.2</td>
<td>BE 1210, CEE 3100, and Selected CEE Courses</td>
<td>Senior Exit Survey and Interviews, Employer Survey, and Alumni Survey</td>
</tr>
<tr>
<td>8.3</td>
<td>BE 1120</td>
<td>Senior Exit Survey and Interviews, Employer Survey, and Alumni Survey</td>
</tr>
<tr>
<td>8.4</td>
<td>BE 1110 and CEE 4950</td>
<td>Senior Exit Survey and Interviews, Employer Survey, and Alumni Survey</td>
</tr>
<tr>
<td>8.5</td>
<td>Design Courses and CEE 3100, 3420, and 4950</td>
<td>Senior Exit Survey and Interviews, Employer Survey, and Alumni Survey</td>
</tr>
</tbody>
</table>
**Objective 9:** The educational program will promote the students’ social development and ethical responsibilities.

<table>
<thead>
<tr>
<th>Outcome 9</th>
<th>Delivery</th>
<th>Assessment Methods</th>
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</thead>
<tbody>
<tr>
<td>9.1</td>
<td>ENGL 2210 (or 2220 or 2330), 2130, 4910 (or 4920 or 4930); and Approved Social Science and Humanities Courses</td>
<td>Student Transcript, Senior Exit Survey and Interviews, and Alumni Survey</td>
</tr>
<tr>
<td>9.2</td>
<td>BE 1210; CEE 4920 and Design Courses</td>
<td>Senior Exit Survey and Interviews, and Alumni Survey</td>
</tr>
<tr>
<td>9.3</td>
<td>CEE 4920 and 4950</td>
<td>Senior Exit Survey and Interviews, and Alumni Survey</td>
</tr>
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</table>

**Objective 10:** The educational program will emphasize the need for life-long learning.

<table>
<thead>
<tr>
<th>Outcome 10</th>
<th>Delivery</th>
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<tbody>
<tr>
<td>10.1</td>
<td>Co-Op Program</td>
<td>Senior Exit Survey and Interviews, Alumni Survey, and Co-Op Participant Survey</td>
</tr>
<tr>
<td>10.2</td>
<td>CEE 4910, 4920, and 4950</td>
<td>Senior Exit Survey and Interviews, and Alumni Survey</td>
</tr>
<tr>
<td>10.3</td>
<td>CEE 4910, 4920, and 4950</td>
<td>Senior Exit Survey and Interviews, and Alumni Survey</td>
</tr>
<tr>
<td>10.4</td>
<td>CEE 3100, 4910, 4920, and 4950</td>
<td>Senior Exit Survey and Interviews, and Alumni Survey</td>
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</table>

**Objective 11:** The educational program will maintain an environment to carry-out fundamental and applied research and advance engineering knowledge through research.

<table>
<thead>
<tr>
<th>Outcome 11</th>
<th>Delivery</th>
<th>Assessment Methods</th>
</tr>
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<tbody>
<tr>
<td>11.1</td>
<td>Laboratory Courses and CEE 3100</td>
<td>Course Portfolios and Senior Exit Survey and Interviews</td>
</tr>
<tr>
<td>11.2</td>
<td>CEE 4990</td>
<td>Student Transcripts and Senior Exit Survey and Interviews</td>
</tr>
</tbody>
</table>
Processes to Assure that Program Outcomes are Achieved

A system is in place to achieve continual evaluation, assessment, and improvement. The system employs various assessment tools to evaluate objective achievement. Results of assessment tools are used by four advisory committees (ABET, curriculum, computer, and equipment) in joint or respective consideration to arrive at recommendations that are acted upon by the CEE faculty.

Changes and/or improvements in educational objectives/outcomes are referred to the ABET advisory committees. Assessment tools that are used to address issues primarily related to curriculum are referred to the curriculum advisory committee. Improvement in instruction through technology is addressed through the computer advisory committee. The equipment advisory committee provides short- and long-term plans for equipment acquisitions and examines the state of various departmental laboratories. Table 3.4 highlights charges and responsibilities of the CEE Department advisory committees.

Table 3.4. CEE Department Advisory Committees: Charges and Responsibilities

<table>
<thead>
<tr>
<th>ABET Advisory Committee</th>
<th>Curriculum Advisory Committee</th>
<th>Computer Advisory Committee</th>
<th>Equipment Advisory Committee</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Provides periodical examination of the department’s educational objectives</td>
<td>• Ensures that the curriculum addresses educational objectives and outcomes</td>
<td>• Addresses adequacy of technological resource support for instruction and research</td>
<td>• Identifies short- and long-range plan for departmental laboratory equipment needs</td>
</tr>
<tr>
<td>• Monitors the continuous assessment and improvement process</td>
<td>• Examines course content to insure that the curriculum meets departmental educational objectives and outcomes</td>
<td>• Assesses the condition of the existing laboratory equipment for replacement or upgrade.</td>
<td></td>
</tr>
<tr>
<td>• Assembles the necessary materials to support the fulfillment of educational outcomes</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>• Develops action procedures to maintain the established metrics</td>
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</tbody>
</table>

Assessment Processes, Results, and Program Improvement

The CEE Department uses multiple assessment tools to ascertain the extent to which the graduates and the programs have achieved desired outcomes. These assessment tools are:
1. **Fundamentals of Engineering Exam**: The CEE faculty feels very strongly about this assessment and requires all students to take the FE Exam during the last semester of their senior year. The FE Examination also serves as the first step toward professional registration and is used to evaluate the performance of the graduates in comparison to their peers at state and national levels. The performance criterion is that at least eighty percent of CEE students taking the FE Exam pass on the first attempt. A lesser pass percentage would generate a concern, which would require an action by the department ABET advisory committee.

2. **College Base Exam**: Based on the requirements of the Tennessee Board of Regents (TBR), graduating seniors are required to take the College Based Exams in four categories, namely, English, mathematics, science and social studies. The metric established for College Based Exam results is that the composite score for civil engineering students should be above that attained for the university-wide students. A failure to meet the established metric would cause a concern, which would require an action by the department ABET advisory committee. *Note – This exam is no longer administered at TTU.*

3. **Graduating Senior Surveys**: Confidential surveys of graduating seniors are conducted every semester to ascertain educational experience, appropriateness and relevance of the curriculum, and the extent to which educational objectives and outcomes are met. The established metric calls for at least eighty percent of graduating senior respondents to “agree” or “strongly agree” that the program provided them with adequate preparation. Failure to meet this percentage, and when the response on individual questions constitutes less than fifty percent combined “agree or strongly agree,” would register a concern. The department ABET advisory committee would then initiate a review and recommend actions for faculty considerations.

4. **Alumni Questionnaires**: One year after graduation and every five years thereafter, alumni are given a set of questionnaires to examine (1) the appropriateness and relevance of the curriculum structure to their activities after graduation, (2) the extent to which they acquire needed skills for job performance and the degree of engagement in professionally-related learning experience, and (3) whether the curriculum objectives and outcomes are met. The metric that has been established is that at least eighty percent of alumni respondents “agree” or “strongly agree” that the program provided them with adequate preparation. A lesser percentage and response on individual questions that constitute less than fifty percent combined “agree or strongly agree” would generate a concern, which would require a review and actions by department ABET advisory committee.

5. **Employer Surveys**: Employers are surveyed to ascertain the level of preparation of the graduates for the position held currently. The recommended metric is that at least seventy-five percent of employers responding to the survey “agree” or “strongly agree” that the overall curriculum provided their TTU alumni employees with adequate preparation. A lesser rating on each response would trigger a concern, which would call for a review and actions by the department ABET advisory committee.

6. **Advisory Board Questionnaires**: From time to time, the CEE Department advisory board is surveyed on matters related to curriculum, assessment tools, and performance of graduates. No metric is assigned.
7. **Course Questionnaires**: Each semester, CEE courses are surveyed to examine the extent to which the course learning objectives are attained. Once results are tallied, the course instructor prepares a written response to outline the specific actions to improve course performance. This approach is intended to close the gap between the desired outcomes and actual outcomes.

**Results of Assessment Tools**

**FE Exam**

An examination of the results of the FE Exam from October 2008 through April 2011 shows that the performance criterion for this assessment tool is being successfully met by the Civil and Environmental Department. Similar results are available by curricular topic.

![FE Passing Rate](image)

**Course Questionnaires**

A representative sample of this assessment tool is given below. This class, CEE 3430, is taught every semester, and therefore the continuity of student response and instructor modification is easily seen. Similar results are available for each course taught in the department. In addition, the IDEA Evaluation is used to evaluate and improve teaching methods.
Overall, I was relatively pleased with the outcome of the evaluation as general improvements in student knowledge were seen. Similar to prior semesters, primary considerations will be to review prior knowledge (e.g., chemistry) and to ensure basic concepts are well understood prior to introducing more advanced concepts. It is believed that the larger class size for the Spring semester (31 registered students) had a slight negative impact on the performance of the students compared to previous semesters when enrollment was approximately 20-23 students.

The nature of this course is very different than most civil engineering courses as computational work is not a primary mechanism of learning. This course is taught on a materials science basis, as applied to practical considerations, similar to a general chemistry and/or physics class, which some students took longer to adapt to than others. The pace of the course was slower than previously taught, which seemed to help the students grasp the information presented.

In addition, Power Point slides were distributed but were missing some information except for pictures and figures. Furthermore, the lectures were not posted on the course website, thus encouraging constant course attendance. Previously, students tended to not take notes despite material taught that was not included on the slides. The new approach led to more interaction and a subsequent slower pace, thus allowing for a more thorough understanding of concepts.

Continued emphasis will be placed on technical writing in the lab reports as it was determined that some students could not communicate effectively through writing. Examples of the “good, bad, and ugly” will continue to be given.

It should be noted that certain ABET questions were rewritten to correspond to other instructor’s course content for this course. The vast majority of covered material is the same for both instructors. However, certain questions need to be reformatted in the future as certain information differed.

1. *I can perform aggregate calculations such as gradation analysis, specific gravity and moisture content, and aggregate weight-volume relations.*
   Spring 2011 – 3.28
   Spring 2009 – 3.36
   Fall 2007 – 3.42
   Fall 2006 – 3.38
   Spring 2006 – 3.29

   The students performed three labs on these concepts concerning both fine and coarse aggregates. One individual lab report was submitted by each student. In addition, the students were evaluated on these concepts on homework, the first exam, and on the final exam. Students seemed to have difficulty understanding gradation analyses, specifically fineness modulus calculations, which will continue to be emphasized in the future.

2. *I have a basic understanding of portland cement ASTM types and their applications*
   Spring 2011 – 3.40

   This was a new evaluation criteria for this instructor, though the subject matter has been taught previously. Students seemed to grasp the concept. Continued emphasis will be placed on illustrating various applications.

3. *I have a basic understanding of portland cement hydration and microstructural development*
   Spring 2011 – 3.20

   This was a new evaluation criteria for this instructor, though the subject matter has been taught previously. Students seemed to grasp the concept, despite an emphasis on cement chemistry and physical concepts at the micro-scale level that are difficult to visualize. Physical demonstrations, such as crumbled Al foil for C-S-H, koosh balls for ettringite, and plastic flowers for monosulfate, will be emphasized further.
4. I can calculate PCC air content, unit weight, and gravimetric air content.
   Spring 2011 – 3.16
   Spring 2009 – 3.16
   Fall 2007 – 3.42

   One laboratory session concerned PCC fresh properties. Students had difficulty differentiating between volumetric and gravimetric air content so these concepts will be emphasized more during class lectures. More in class time needs to be devoted to these concepts as the larger lab section sizes may have contributed to lower understanding.

5. I can perform calculations to determine PCC compressive strength, flexural strength, tensile strength, and modulus of elasticity
   Spring 2011 – 3.24
   Spring 2009 – 3.28
   Fall 2007 – 3.32
   Fall 2006 – 3.33
   Spring 2006 – 3.17

   The students performed a laboratory devoted to testing concrete cylinders for determination of the compressive and tensile strength according to the ASTM standards. Each student tested at least one cylinder. Due to time limitations, more cylinders cannot be tested. However, the concept of converting from the load determined to actual strength will be emphasized in class.

6. I can design basic PCC mixtures via the ACI method.
   Spring 2011 – 3.16
   Spring 2009 – 3.16
   Fall 2007 – 3.26
   Fall 2006 – 3.21
   Spring 2006 – 3.08

   A full lecture was devoted to this practical concept including in class work. Compared to previous semesters, this information was presented at a slower pace and more basic examples were given. In addition, a “laboratory” is devoted to the ACI mix design procedure instead of class time, thus allowing more time for explanation and in class work. Students still continue to have difficulties will understanding the calculations. Instead of group work assignments, individual mix design assignments will be given, as it was felt that only a limited number of students actually did the group work.

7. I have a basic understanding of HMA materials.
   Spring 2011 – 2.92
   Spring 2009 – 3.12
   Fall 2007 – 3.33
   Fall 2006 – 3.13
   Spring 2006 – 2.87

   This concept was presented in several lectures and homework. Previously, the students often confused terminology; thus, more introductory material was given regarding definitions, leading to the observation of improved student attitudes and learning. Due to traveling, a Ph.D. student presented some of this information, which apparently led to decreased understanding.

8. I can perform HMA volumetric calculations such as Gmb, Gmm, and percent air voids.
   Spring 2011 – 3.28
   Spring 2009 – 3.00
   Fall 2007 – 3.11
   Fall 2006 – 3.25
   Spring 2006 – 3.54
The slow progression of decreased understanding regarding this topic is a cause of concern for the instructor. These concepts were heavily emphasized and will continue to be in the future. Example problems were detailed in the lecture and homework was given. More emphasis will be placed on specific gravity differences and anticipated values.

9. I have a basic understanding of HMA mixture design and related calculations.
   Spring 2011 – 3.04  
   Spring 2009 – 3.00  
   Fall 2007 – 3.11

HMA mix design calculations were presented in class lectures. However, it appears that more emphasis needs to be placed on mix design, such as that done with PCC materials. The Marshall mix design was presented and mix design problems were assigned as homework. An exam question was also given on Marshall mix design. Superpave mix design has been introduced and led to significant difficulties. More time will be spend to explain this concept and subsequent problems.

Alumni and Alumni Employer Survey

Response rates remain high for all surveys. Response results remain consistently positive. This information is evaluated periodically and actions are taken to remedy slight deficiencies. Some of these are detailed in the section titled “Summary of Continuous Improvements.”


Summary of Continuous Improvements

Comparisons of the assessment results with the established benchmark show that the Outcomes have been achieved with no major concerns identified. However, the regular reviews of various assessments results by the Department ABET advisory committee and an in-depth review by the CEE faculty resulted in several acts to improve upon the program. Representative improvements are described below.

Actions Taken to Improve on Communication Skills

The results of Graduating Senior Surveys, One-Year alumni Surveys, and Six-Year Alumni Surveys revealed a concern with communication skills. The CEE Department therefore took action to improve upon the program in this area. The remedial actions were drawn recognizing that the curriculum, through required courses, already provides for development of written and oral communication skills. More specifically, all Civil Engineering students are required to take two semesters of English composition, one semester of literature, and an additional semester of speaking/communication. Opportunities to improve written and oral communication skills are also available in various CEE courses requiring laboratory, project, or term paper reports. Additionally,
Senior Design Project, CEE 4950, extensively emphasizes personal (teamwork), as well as written and oral communication skills.

The first action taken in order to (1) emphasize the importance of communication skills and (2) strengthen communication skills of the students was the adoption of uniform guidelines for effective written and oral presentations, and for the evaluation of non-technical content of the laboratory or project reports in Fall 2002. The CEE departmental faculty developed the guidelines for effective written and oral presentations (shown in Appendix E.7), which require students to prepare written reports and presentations in a professional manner. The second action was the promotion of utilizing available university resources such as the University Writing Center in Fall 2007. The University Writing Center is hosted by the Department of English Communications and is open to all students at Tennessee Technological University. Students can take a draft of particular assignments and get help with their writing. The center is open four to five hours per day on Monday through Thursday.

Additionally, the university has included a three-hour course in English oral presentational communication PC 2500/SPCH 2410 as a required general education course effective Fall Semester 2004. The new addition helps students improve their oral communication skills.

In the meetings with CEE graduating seniors post-implementation of these actions, the students felt that the significance of written and oral communication skills is emphasized throughout the curriculum. Further, the various survey results for Outcome 5 shown in Fig4.2 and 4.3 also demonstrate that there has been improvement in students’ communication skills.

**Actions Taken on the Knowledge of Contemporary Issues**

Although the satisfactory ratings on knowledge of research and contemporary issues are obviously higher than the established benchmark, it was observed that the students and alumni have rated this item relatively lower than the other statements in the survey. Presently, all Civil Engineering students are required to take a minimum of six credit hours in a selected list of social science and fine art. There are many seminars and presentations on campus that are open to all students. Students do have opportunities to learn the impact of various societal, professional, and global concerns and issues. However, it appears that not all students easily make the linkage of the content of these courses and seminars with the terminology “knowledge of contemporary issues in the world”. The general consensus among CEE faculty was that the Department should emphasize the importance of contemporary issues, especially in the engineering profession. The faculty decided to address the problem by requiring student attendance at least 1 or 2 seminars in CEE 1020 – Connections to Civil Engineering, CEE 4920 – Professionals and Ethics, and CEE 4950 – Senior Design. In addition, the faculty suggested changing question #13 on the alumni survey and the senior exit questionnaire to read “contemporary issues in engineering”. Both of these suggestions have been incorporated in the above-mentioned courses starting in the fall 2007 semester as well as the surveys.

**Action Taken on the Concepts of Leadership, Management, and Public Policy**

To address the recent ABET changes, the faculty voted in August 2007 to include a twelfth objective to the CEE departmental Educational Objectives. This objective addressed the issue of ‘broad understanding of fundamental principles and key concepts in engineering management, business, public policy, and leadership’. Implementation of Objective 12 has been accomplished primarily through CEE 4950 (Senior Design Project) and CEE 4920 (Professionalisms and Ethics) by inviting
well-qualified speakers to come to campus and give seminars on those topics. In the spring semester of CEE 4950, the invited speakers were: a former general manager of Texaco's International Offshore Engineering Department who gave the lectures on Leadership; a Senior Vice President of J.R. Wauford & Co. who gave the lectures on Management; and a former Vice Mayor of Nashville who gave the lecture on Public Policy. By implementing this action, CEE students understand and are able to explain basic concepts in leadership, management, and public policy respectively.

**Actions Taken on Improving Laboratory Facilities**

The results of assessment on quality of course work and effectiveness of the training in various areas are very positive. The overall percentage of favorable responses (percent agree or strongly agree) were significantly higher than the negative responses (percent disagree or strongly disagree), and well above the established benchmark. However, there were a few areas that needed to be addressed to improve upon students’ experience. Improving laboratory facilities was one of them.

The upgrade of CEE 3120 (Mechanics of Materials laboratory) began in summer 2006 after necessary funds became available. The improvement included a new tension testing machine, new torsion testing machine, new Instron universal testing machine, new computer software for experiments, a newly manufactured test specimen for stress concentration, and room renovation for lab security. The survey ratings for lab facilities are clearly improved after the renovation.

A new laboratory named “Cement and Concrete Composites Laboratory” was set up in 2007. The centerpiece of this lab is an Instron 100-kN universal testing machine (UTM) with closed loop controls and assorted accessories including tension grips, 3/4-point flexure fixture and extensometers for tensile and flexure testing. This new state of the art laboratory is expected to further enrich and enhance senior level elective classes and help with undergraduate student research experience in the Materials/Transportation area of specialization.

**Actions Taken on Use of CAD and Other Engineering Software**

As noted above, the survey results show that the students were not fully satisfied with use of CAD and engineering software in the curriculum. In response to this concern, the CEE Department has taken steps to increase exposure to AutoCAD in ENGR 1110 (Engineering Graphics) and, to the extent possible, in some CEE design courses. The faculty have continually introduced AutoCAD in selected CEE course homework since the last ABET visit. The measure was reemphasized at the Faculty Retreat in August 2007. Currently, the courses that require homework assignments to be undertaken with AutoCAD are CEE 3110, 3610, 4320, 4350, 44640, and 4950.

The CEE Advisory Board and computer advisory committee were asked to identify the most relevant engineering design software in four areas; namely, structures, structural mechanics, transportation, and environmental engineering. A list was compiled by the Department computer advisory committee and made available to the Department Chairperson to review and purchase as funds become available. To date, the CEE Department, with support from the university and the college of engineering, has purchased AutoCAD, Micro station, GIS, STAAD.Pro, Visual Analysis, RISA 2D, HEC-HMS (Hydrology), HCST, Synchro + SimTMathCAD, MAPLE, MS Excel, and other application programs used in Civil Engineering practice. Faculty have been actively integrating these software packages into various CEE classes since 2003. The classes that currently require students to
use engineering software beyond basic spreadsheet applications are: CEE 3020, 3320, 3610, 4350, 4380, 4440, 4420, 4610, and 4630.

**Actions Taken on Improving Computer Programming**

Another relatively low satisfactory rating was obtained on the quality of the engineering programming course. The Department ABET committee and faculty discussed possible remedial measures in several meetings. During the faculty retreat in August 2007, the faculty decided the departmental Curriculum Committee should examine the programming course taken in Basic Engineering and submit a report. At the same time, CEE faculty suggested a modification to the syllabus of CEE 3100 (Computers in Civil Engineering) to help address some of the concerns with the existing course in programming. Thus, the modified CEE 3100 (Computer in Civil Engineering) was reincarnated in the spring 2008 semester. It is an elective course that is designed to address the need to improve on student's computer programming skills for the Civil Engineering workplace. The new syllabus imparts an independent 'thinking' ability to students to become more rational users of software (rather than blind users). Students learn to develop algorithms as an important step in the development of analytical skills for independent programming. Each problem topic is revisited using two different tools (a spreadsheet tool and a tool in any programming language) to highlight the merits and demerits of using each tool to solve a typical CEE problem. Also, students are required to turn in a complete project report addressing a design or analysis problem assigned to them. The report itself has to be written appropriately with sections on introduction, algorithm formulation, theory, code implementation, results and discussion.

**Actions Taken Based on Suggestions from Students and CEE Advisory Board**

Assessments of the curriculum effectiveness are not limited to the above-mentioned surveys, but also discussed in Department advisory committee meetings, faculty meetings, Department ABET retreats, and meetings and contacts with students. In addition to the analysis of survey results and discussion of remedial actions, concerns brought up by students are discussed in the faculty meetings for action. For example, students expressed concerns about outdated equipment in classrooms and lack of a study space for CEE students only. In consultation with Department Advisory Board and CEE faculty, a fundraising campaign was initiated to generate funds for renovating a new classroom and creating a student study room. As a result of joint efforts of CEE alumni, college of engineering, and the Department, a new 40-seat classroom with state-of-the-art technology was opened for use in the fall 2007 semester. A new student study room with new furnishing also became available to CEE students in the spring 2008 semester.

Additionally, the main auditorium in Prescott Hall, under the jurisdiction of the CEE Department, has been completely renovated with university funds. This room now has state-of-the-art technology and is being used extensively for CEE 4950, Senior Design, and other presentations.
**Program: Master of Science in Civil Engineering**

**Mission:**

The principal mission of the Civil Engineering program is to offer the strong academic program needed to produce well-educated students who can become productive members of the civil engineering profession. This mission is consistent with the academic component of the University's mission, which is in part to provide a strong academic program in engineering.

**CEE Master of Science Program Outcomes**

The CEE faculty strives to provide graduate educational opportunities to prepare students to:

1. Conduct basic and applied research
2. Engage in advanced engineering design and professional practice
3. Continue their education in a doctoral program
4. Be engaged in life-long learning

**Assessment Methods**

Outcome 1. Conduct basic and applied research
   a. Database tracking of student involvement in research activities
   b. Employer feedback

Outcome 2. Engage in advanced engineering design and professional practice
   a. Database tracking of alumni employment and advancement
   b. Alumni surveys
   c. Employer feedback

Outcome 3. Continue their education in a doctoral program
   a. Database tracking of alumni employment and advancement

Outcome 4. Be engaged in life-long learning
   a. Alumni surveys

**Assessment Results and Implementation**

A centralized database will be developed to track our MS graduates. The database will be used to monitor placement, publication records, and academic progress.

**CEE Master of Science Learning Outcomes**

Upon completing the MS program, the graduate will be able to:

1. Conduct basic research and/or design in one of the CEE areas of emphasis
2. Demonstrate depth of knowledge and expertise in his/her area of specialization
Assessment Methods

Outcome 1. Conduct basic research and/or design in one of the CEE areas of emphasis
   a. Database tracking of student publications and presentations
   b. Employer feedback

Outcome 2. Demonstrate depth of knowledge and expertise in one area of specialization
   a. Employer feedback
   b. Database tracking of alumni employment and advancement

Assessment Results and Implementation

   A centralized database will be developed to track our MS graduates. The database will be used to
   monitor placement, publications records, and academic progress.