AC 2008-1053: ASSESSMENT AND EVALUATION OF ENGINEERING TECHNOLOGY PROGRAM OUTCOMES USING DIRECT MEASURES

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Assessment and Evaluation of Engineering Technology Program Outcomes Using Direct Measures

Abstract

In order to ensure the quality of a program on an ongoing basis, it is essential that a program has a sound and viable Continuous Improvement Plan. The two key elements of the plan are assessment and evaluation. The term "assessment" means one or more processes that identify, collect, use and prepare data that can be used to evaluate achievement of program outcomes and educational objectives. The term "evaluation" characterizes one or more processes for interpretation of the data and evidence accumulated through assessment practices that (a) determine the extent to which program outcomes or educational objectives are being achieved; or (b) result in decisions and actions taken to improve the program.

Multiple constituencies are to be involved in the process, as the TAC/ABET Technology Criteria 2000 (TC2K) stipulate use of multiple assessment tools and measures for (a) the program outcomes, i.e., knowledge and capabilities of students at the time of graduation and (b) the program objectives, i.e., the expected accomplishments of graduates during the first few years after graduation. Effective assessment tools provide the information needed to measure outcomes and objectives, so necessary improvements can be implemented.

The focus of this paper is on assessment of program outcomes. The primary assessment of program outcomes is based on direct measures, i.e., student work, such as assignments, exams and student portfolios related to coursework. Some such measures, which have been used by the civil engineering technology program at this institution for two specific courses, are discussed in this paper. Various templates (rubrics) used in the process are also included. An evaluation of assessment data through comparison with established benchmarks is presented to determine the extent to which program outcomes pertaining to the two courses are being achieved. Follow-up actions warranted to implement the results of program evaluation, and thus "to close the loop," are also discussed.

I. Introduction

The basic premise of the accreditation process for engineering technology programs, in accordance with the technology criteria 2000 (TC2K)[1] adopted by the TAC/ABET, is that every program must demonstrate, through documentary evidence, that *program educational objectives* and *program outcomes* are achieved. The program educational objectives are defined as broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve *during the first few years following graduation*. The program outcomes are defined as statements that describe what units of knowledge or skill students are expected to acquire from the program to prepare them to achieve the program educational objectives. These are typically demonstrated by the student and measured by the program *at the time of graduation*. The TAC/ABET designated (a – k) requirements must be included in some way in the program outcomes.

In order to ensure the quality of a program on an ongoing basis, it is essential that a program has a sound and viable Continuous Improvement Plan. The two key elements of the plan are assessment and evaluation. The term "assessment" means one or more processes that identify, collect, and analyze data that can be used to evaluate achievement of program outcomes and educational objectives[2]. The term "evaluation" characterizes one or more processes for interpretation of the data and evidence accumulated through assessment practices that a) determine the extent to which program outcomes or educational objectives are being achieved; or b) result in decisions and actions taken to improve the program.

A few years ago, the Civil Engineering Technology program at this institution went through TAC/ABET evaluation under the TC2K criteria for the first time. Based on the feedback from the visiting team with respect to assessment and evaluation of the program, or lack thereof, a major effort was launched to augment the existing process. Starting with an updated Continuous Improvement Plan, the faculty developed more detailed plans for assessment and evaluation of the program. As part of the process, numerous rubric-based assessment tools have been developed, and additional ones may be incorporated in future. The issue of assessment and evaluation of the program appears to have been satisfactorily resolved upon submittal of a progress report (that included extensive use of various assessment tools developed) to TAC/ABET.

The focus of this paper is on assessment and evaluation of program outcomes. A detailed discussion of this aspect is contained in the following sections using a case study of the Civil Engineering Technology (CET) Program at Georgia Southern University.

II. Continuous Improvement Plan

A schematic diagram of the Continuous Improvement Plan adopted by the Civil Engineering Technology Program at Georgia Southern University is shown in Figure 1. The elements of the plan are listed below.

1. Program Mission
2. Program Educational Objectives
3. Program Outcomes
4. Constituencies
5. Assessment of Program Outcomes and Objectives
6. Evaluation of Program Outcomes and Objectives
7. Use of Evaluation Results for Curriculum Improvement

The details of assessment and evaluation (items 5 and 6) of program outcomes are as follows. .

III. Assessment Details

Identification of data
Multiple[2] assessment methods are recommended for each objective and outcome, as appropriate to institution/program resources. They must follow timely and regular cycles – short (for

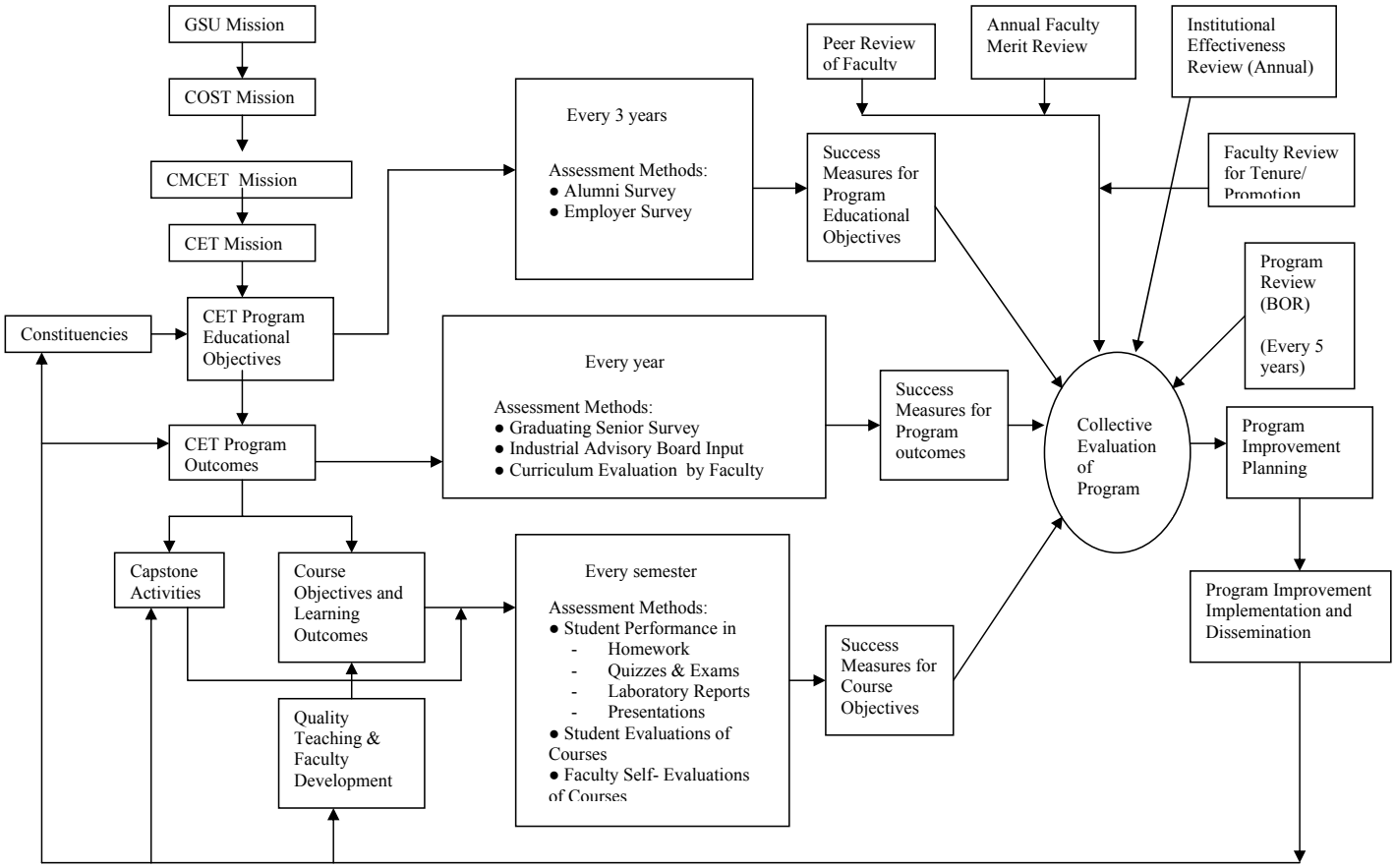

Figure 1: Civil Engineering Technology Program Continuous improvement Plan

outcomes) and long (for objectives). The following assessment methods have been adopted by the Civil Engineering Technology Program at Georgia Southern University:

A. Assessment of Program Outcomes
    1. Course assignments (Homework/ Quizzes)
    2. Exams
    3. Comprehensive final exams
    4. Laboratory reports
    5. Oral presentations
    6. Field-work
    7. Capstone projects
    8. Course exit survey
    9. Teaching portfolios
    10. Exit Survey of graduating seniors
    11. Industrial Advisory Board Review

B. Assessment of Program Educational Objectives
    1. Survey of alumni
    2. Survey of employers
    3. Industrial Advisory Board reviews

In the list of assessment methods pertaining to program outcomes (list A), the focus of this paper, the first seven methods constitute *direct* measures, while the remaining four belong to the category of *indirect* measures. Since the primary assessment of program outcomes is based on direct measures, i.e., student work related to coursework, those measures in particular are discussed at length. Other measures (indirect) have been discussed in another paper by the author[3].

While multiple courses within the CET curriculum contribute with varying degrees to each of the outcomes, only specific measures that are considered to be the strongest measure of the outcome are tracked, analyzed, and capable of triggering a continuous improvement action. These measures are agreed upon by the entire CET faculty at the end of each academic year. While all measures are not necessarily applied to every given outcome, at least two measures for each outcome are attempted. The courses that contribute to the outcomes to varying degrees are summarized in Table 1, the Curriculum Mapping Worksheet.

Collection of data

During the data Collection phase, assessment tools are administered to and collected from program constituencies. Table 2 summarizes the general types of assessment tools defined for evaluating program outcomes and program objectives. Data is collected every semester for CET courses, and once every three years for alumni and employer surveys. Typically, alumni are surveyed after one year of graduating, at three years, and at five years.

TABLE 1 - CURRICULUM-MAPPING WORKSHEET
An indication of the degree to which course-level outcomes contribute to the indicated program-level outcome.

Course Prefix	Course Number	Course Title	An appropriate mastery of the knowledge, techniques, skills and modern tools of civil engineering technology	An ability to apply current knowledge and adapt to emerging applications of mathematics, science, engineering, and technology	An ability to conduct, analyze, and interpret, experiments and apply experimental results to improve processes	An ability to apply creativity in the design of systems, components or processes appropriate to CET program objectives	An ability to function effectively on teams	An ability to identify, analyze, and solve technical problems	An ability to communicate effectively	A recognition of the need for, and an ability to engage in lifelong learning	An ability to understand professional, ethical, and social responsibilities	A respect for diversity and knowledge of contemporary professional, societal, and global issues	A commitment to quality, timeliness, and continuous improvement
			(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
ENGR	1133	Engineering Graphics	2	4		3							3
ENGR	1731	Computing for Engineers	2	4		3							3
TENS	2141	Statics	4	4				4					1
TENS	2142	Dynamics	3	3				3					1
TENS	2143	Strength of Materials	4	4	3	2	3	4	4		2		1
TENS	2144	Fluid Mechanics	4	4	4		3	4	4				1
TCET	2241	Surveying	4				3	4	3				2
TCET	3141	Environmental Pollution	4	3	4		3	3			4		4
TCET	3142	Structural Analysis	4	4			2						2
TCET	3233	Transportation Systems	4		2			3	2				
TCET	3234	Construction Materials	4		4		4	3	4				3
TCET	3236	Project Cost Analysis, Planning and Management	4					4			4	3	
TCET	4141	Water Supply Systems	4	3				4					4
TCET	4142	Reinforced Concrete Design	4	4		3		4	2	4			3
TCET	4146	Structural Steel Design	4	4		3		4	2	4			3
TCET	4243	Highway Design	4	4		4	4	4					
TCET	4244	Soil Mechanics and Foundations	4	3	4		4	4	4				
TCET	4245	Water-Wastewater Treatment	4	3	3	1		4			3		
TCET	4536	Senior Project	4	4		4	4	4	4	4	4	4	4
			Level of Contribution to outcome: 4 – Strong, 3 – Moderate, 2 – Some, 1 – Slight										

TABLE 2 - ASSESSMENT TOOLS		
Assessment Tool	Frequency of Assessment	Responsibility of Assessment
Assessment of Program Outcomes (Measurement Instrument):		
1. Rubric Analysis of Student Performance on a Key Homework Assignment (rubric summary)	Fall and Spring	Course Instructor
2. Rubric Analysis of Student Performance on a Final Exam (rubric summary)	Fall and Spring	Course Instructor
3. Rubric Analysis of a Laboratory Report Activity (rubric summary)	Fall and Spring	Course Instructor
4. Rubric Analysis of an Oral presentation (rubric summary)	Fall and Spring	Course Instructor
5. Rubric Analysis for Assessment of a specific Skill or Knowledge (rubric summary)	Fall and Spring	Course Instructor
6. Rubric Analysis of Senior Project (rubric summary)	Spring	Course Instructor
7. Rubric Analysis of Term Project Written Report(rubric summary)	Fall and/or Spring	Course Instructor
8. Course Exit Survey (survey summary)	Fall and Spring	Course Instructor
9. Senior Exit Survey (survey summary)	Fall and Spring	Course Instructor
Assessment of Program Educational Objectives (Measurement Instrument):		
1. Survey of Alumni (Summary Report)	Once every 3 years (spring)	Coordinator
2. Survey of Employers/Supervisors (Summary Report)	Once every 3 years (spring)	Coordinator
3. Industrial Advisory Board Reviews (Summary Report)	Every year (fall)	Coordinator

Several of current tools that are being used to assess outcomes and objectives require a rubric-based analysis of an activity (final exam, homework, report, presentation, term project etc.). For the purpose of this document, a rubric is defined as a scoring guide that specifies the skill or category being assessed with an associated numerical rating scale indicating the level of student performance. For example, Table 3 is an illustration of a rubric developed to evaluate specific outcomes on a comprehensive final exam in TCET 3142 Structural Analysis course. The first column in this rubric identifies the performance categories or skills that are being addressed by this assignment. The next four columns indicate the ratings (from 1 to 4) a student can receive for this category based on their demonstration of this skill.

Each program outcome that is assessed using a rubric analysis will be rated on a rubric scale, typically a 4-point scale with 4.0 being the best rating or a 5-point scale with 5 being the highest rating. Each program outcome or objective that is assessed using a survey (indirect measure) will be rated on a five-point scale, with 5.0 being the best rating.

Using a generic template, individual program faculty developed appropriate rubrics for the course level outcomes in their respective courses. These course-specific rubrics were then collected as an appendix of the Continuous Improvement Plan (CIP), so future faculty can re-use the same measurement tools and definitions/standards.

Significant headway has been made in establishing uniform rubric-based assessment standards and measuring/reporting tools that all CET faculty use. Sample templates of the measurement and analysis forms are given in Appendix. Some such measures, which have been used by the

Table 3
Rubric for Final Exam – TCET 3142 Structural Analysis (Form M-2)

CATEGORY	4 – Exceeds Criteria	3 – Meets Criteria	2 – Progressing to Criteria	1 – Below Expectations	Points
Identify structure types and load types, and calculate various types of loads on structures.	Provides ample evidence of ability to recognize statically determinate vs. statically indeterminate structures, and to determine various loads on a structure with correct answers, including proper signs and symbols.	Provides adequate evidence of ability to recognize statically determinate vs. statically indeterminate structures, and to determine various loads on a structure with mostly correct answers, including proper signs and symbols.	Provides some evidence of ability to recognize statically determinate vs. statically indeterminate structures, and to determine various loads on a structure with only a few correct answers, including proper signs and symbols.	Provides little or no evidence of ability to recognize statically determinate vs. statically indeterminate structures, or to determine various loads on a structure with any correct answers, including proper signs and symbols.	
Solve for support reactions, and internal reactions in trusses, beams, and frames.	Provides ample evidence of ability to determine the external support reactions, and internal reactions (axial, shear and moment) in a structure using the correct procedure.	Provides adequate evidence of ability to determine the external support reactions, and internal reactions (axial, shear and moment) in a structure using the correct procedure, but not without some minor errors.	Provides some evidence of ability to determine the external support reactions, and internal reactions (axial, shear and moment) in a structure using flawed procedure.	Provides little or no evidence of ability to determine the external support reactions, or internal reactions (axial, shear and moment) in a structure using totally wrong procedure.	
Solve for deflections of statically determinate beams, trusses, and frames	Provides ample evidence of ability to determine the deflection (and slope) at a point in a structure using the correct procedure.	Provides adequate evidence of ability to determine the deflection (and slope) at a point in a structure using the correct procedure, but not without some minor errors.	Provides some evidence of ability to determine the deflection (and slope) at a point in a structure using flawed procedure.	Provides little or no evidence of ability to determine the deflection (and slope) at a point in a structure using totally wrong procedure.	
Solve for statically indeterminate beams, trusses and frames by approximate methods	Provides ample evidence of ability to solve statically indeterminate structures by approximate methods. Use of right procedure with flawless computations leads to correct answers.	Provides adequate evidence of ability to solve statically indeterminate structures by approximate methods. Use of right procedure with small computational errors leads to partially correct answers.	Provides some evidence of ability to solve statically indeterminate structures by approximate methods. Use of flawed procedure with or without computational errors leads to mostly incorrect answers.	Provides little or no evidence of ability to solve statically indeterminate structures by approximate methods. Use of wrong procedure with or without computational errors leads to all incorrect answers.	
Solve for statically indeterminate beams and frames by classical Slope-Deflection Method	Provides ample evidence of ability to solve statically indeterminate structures by Slope-Deflection method. Use of right procedure with flawless computations leads to correct answers.	Provides adequate evidence of ability to solve statically indeterminate structures by Slope-Deflection method. Use of right procedure with small computational errors leads to partially correct answers	Provides some evidence of ability to solve statically indeterminate structures by Slope-Deflection method. Use of flawed procedure with or without computational errors leads to mostly incorrect answers.	Provides little or no evidence of ability to solve statically indeterminate structures by Slope-Deflection method. Use of wrong procedure with or without computational errors leads to all incorrect answers.	
Solve for statically indeterminate beams and frames by classical Moment-Distribution Method	Provides ample evidence of ability to solve statically indeterminate structures by Moment Distribution method. Use of right procedure with flawless computations leads to correct answers.	Provides adequate evidence of ability to solve statically indeterminate structures by Moment Distribution method. Use of right procedure with small computational errors leads to partially correct answers	Provides some evidence of ability to solve statically indeterminate structures by Moment-Distribution method. Use of flawed procedure with or without computational errors leads to mostly incorrect answers.	Provides little or no evidence of ability to solve statically indeterminate structures by Moment-Distribution method. Use of wrong procedure with or without computational errors leads to all incorrect answers.	
Demonstrate mathematical skills including use of appropriate formulas, units, and symbols	Correct formula used to solve problems with correct answers given with proper units and symbols.	Correct formula used to solve problems with mostly correct answers given with proper units and symbols	Correct formula used to solve problems but with mostly wrong answers given with incorrect units and symbols	Wrong formula used to solve problems with answers that do not make sense with or without correct units and symbols	

Table 3
Rubric for Final Exam – TCET 3142 Structural Analysis (Form M-2)

CATEGORY	4 – Exceeds Criteria	3 – Meets Criteria	2 – Progressing to Criteria	1 – Below Expectations	Points
Faculty perception of student's ability to use knowledge and skills gained from pre-requisite courses	Demonstrates ample evidence of a thorough understanding of all key concepts and pertinent skills gained from the prerequisite courses.	Demonstrates adequate evidence of understanding most of the key concepts and pertinent skills gained from the prerequisite courses.	Demonstrates some evidence of understanding only a few of the key concepts and pertinent skills gained from the prerequisite courses.	Demonstrates little or no evidence of understanding any key concepts and pertinent skills gained from the prerequisite courses.	
				TOTAL:	

CET program at this institution for two specific courses (Structural Analysis and Reinforced Concrete Design), are discussed in detail.

Analysis of data
Following data collection, an assessment summary based upon the rubric is compiled—as shown in Table 4 for TCET 3142 Structural Analysis course. The summary contains rubric scores for each student for each skill category that is assessed. An average rubric score for each student is calculated, and used to determine if a particular student is performing significantly below expectation. An average rubric score for each outcome measure is also calculated and compared to a benchmark (see next section) adopted by the CET program faculty. Another example of rubric analysis (summary) is provided for a different course (TCET 4142 Reinforced Concrete Design) is provided in Table 5.

IV. Evaluation of Program Outcomes

As stated before, evaluation is interpretation of the data collected through a systematic assessment process, to determine the quality of the program and also to what extent improvements are needed. Evaluation is necessary for every program outcome and educational objective. For the purpose of interpretation of data, benchmarks (i.e. performance expectations or standards) need to be established. A benchmark is typically a numerical value, and a consensus among the Civil Engineering Technology program faculty is reached as to every such value used in the evaluation process. A benchmark of 2.5 has been adopted by the CET faculty.

In a rubric analysis, if an average score falls below 2.5, the corresponding measure is flagged, an instructor review is triggered, the continuous improvement effort (CIE) report is completed by the instructor and submitted to the program coordinator, improvements are implemented the next course offering, and the outcome is again measured. The CIE report identifies the triggered benchmark, the related program-level outcome, and the proposed plan of action to raise future ratings If the measure falls below the benchmark for three successive course offerings, a CET faculty-wide review is initiated leading to a documented improvement strategy. In the example of TCET 3142 (Table 4), four rubric score averages fell below the benchmark. The course instructor completed a Continuous Improvement Efforts (CIE) report which documented a strategy for instructional improvement and submitted it to the program coordinator. A copy of the actual CIE report is shown in Table 6 as a sample.

Successful completion of course work (through demonstration of learning outcomes associated with course objectives) contributes toward achievement of program outcomes which in turn contribute toward accomplishment of program educational objectives. Thus, assessment and evaluation of all major courses constitute a key part of the evaluation of the program itself. At the conclusion of each course, students provide input as to their perceived gain in knowledge, skills etc. on a scale of 1 to 5 as a result of taking the course (rubric not included). Then the faculty member in-charge of the course does his/her assessment and evaluation of the course, using multiple assessment methods including the feedback from the students. These documents of course assessment and evaluation by individual faculty members become part of the teaching portfolio for each course.

Table 4
Rubric Summary of Final Exam

Course: TCET 3142 Structural Analysis **Term: Fall 2006** **Date: 12-15-06** **Evaluator: XXXX**

Last Name of Student	**Description of Outcome Measures:**								Average rubric score for each student on a scale of 1 to 4
	Identify structure types and load types, and calculate various types of loads on structures.	Solve for support reactions, and internal forces in trusses, beams, and frames.	Solve for deflections of statically determinate beams, trusses, and frames	Solve for statically indeterminate beams, trusses and frames by approximate methods	Solve for statically indeterminate beams and frames by classical Slope-Deflection Method	Solve for statically indeterminate beams and frames by classical Moment-Distribution Method	Demonstrate mathematical skills including use of appropriate formulas, units, and symbols.	Faculty perception of student's ability to use knowledge and skills gained from pre-requisite courses	
Student 1	1	1	2	1	2	2	2	2	1.625
Student 2	3	2	2	4	4	3	3	3	3.0
Student 3	2	1	2	2	1	1	2	2	1.625
Student 4	1	2	2	2	2	2	3	2	2.0
Student 5	3	2	2	2	2	1	2	2	2.0
Student 6	4	1	2	4	2	2	3	3	2.625
Student 7	4	4	3	3	4	3	3	3	3.375
Student 8	3	3	3	4	4	3	3	4	3.375
Student 9	3	3	4	4	4	3	3	4	3.5
Student 10	3	2	2	2	3	2	3	3	2.5
Student 11	2	2	1	1	4	1	2	2	1.875
Student 12	3	2	2	3	2	3	2	2	2.375
Student 13	1	2	2	3	2	2	3	3	2.25
Student 14	1	3	2	3	3	2	4	3	2.625
Student 15	2	2	3	4	3	4	3	3	3.0
Student 16	3	4	2	3	4	4	3	3	3.25
Student 17	1	1	2	1	1	1	1	1	1.125
Student 18	2	2	1	4	2	2	2	2	2.125
Student 19	1	3	4	4	3	2	4	4	3.125
Student 20	4	3	1	4	3	4	3	3	3.125
Student 21	1	2	2	4	2	2	2	2	2.125
Student 22	3	3	2	3	4	3	3	3	3.0
Student 23	1	1	1	1	1	1	1	1	1.0
Rubric Score Average	2.26	2.25	2.13	2.87	2.70	2.30	2.61	2.61	**2..47 (overall)**
Benchmark			If Rubric Score average falls below 2.5, an instructor review is initiated. If that trend is observed for 3 successive measuring periods, then a faculty wide review leading to an improvement strategy is initiated.						

Table 5
Rubric Summary of Final Exam

Course: TCET 4142 Reinforced Concrete Design Term: Fall 2006 Evaluator: XXXX Date: 12-15-06

Last Name of Student	Description of Outcome Measures							
	Comprehend the basic concept of ACI Strength Design (Required Strength, Design Strength, and the relationship between the two).	Demonstrate mathematical skills including use of appropriate formulas, units, and symbols.	Perform design/analysis of one-way slabs.	Perform design/analysis of beams for moment.	Perform design/analysis of beams for shear.	Perform design/analysis of columns.	Faculty perception of student's ability to use knowledge and skills gained from pre-requisite courses	Composite Rubric Score for each student on a scale of 1 to 4
Student 1	4	3	4	2	3	2	4	3.143
Student 2	3	2	2	2	1	1	2	1.857
Student 3	3	2	3	2	2	1	2	2.143
Student 4	2	2	3	2	1	1	2	1.857
Student 5	3	2	2	2	3	3	2	2.429
Student 6	3	3	3	2	3	2	3	2.714
Student 7	3	3	3	2	2	3	3	2.714
Student 8	4	3	3	3	3	3	3	3.143
Student 9	3	2	2	2	2	3	3	2.429
Student 10	3	3	3	2	3	3	2	2.714
Student 11	4	3	3	3	4	4	4	3.571
Student 12	4	3	4	3	4	3	4	3.571
Student 13	3	3	3	2	3	4	3	3.0
Student 14	3	2	3	2	2	4	3	2.714
Student 15	3	2	2	2	3	3	3	2.571
Student 16	3	3	4	3	2	3	3	3.0
Student 17	4	3	3	2	3	4	4	3.286
Student 18	3	2	2	1	2	3	3	2.286
Student 19	4	3	3	3	2	4	4	3.286
Rubric Score Average	3.31	2.58	2.89	**2.21**	2.53	2.84	3.0	2.77

Benchmark: If Rubric Score average falls below 2.5, an instructor review is initiated. If that trend is observed for 3 successive measuring periods, then a faculty wide review leading to an improvement strategy is initiated.

V. Corrective Actions for Curriculum Improvement

As an example, TCET 3142 Structural Analysis is considered again. Implementation of the suggested improvement measures in the CIE form (Table 6) constitute the corrective actions warranted. A similar rubric analysis based on the student performance in the next offering would reveal the extent of improvements.

VI. Links between Course Assessment and Program Outcomes Assessment

With reference to Table 1 Curriculum mapping worksheet, for each of the 11 program outcomes (a – k) listed therein, the assessment results for all related courses are linked to that specific program outcome in a tabular form. Table 7 is an example of one such instrument (for outcome *b. An ability to apply current knowledge and adapt to emerging applications of mathematics, science, engineering and technology*). As can be seen, the TCET 3142 Structural Analysis course (the assessment and evaluation of which is discussed in details in this paper), among others, contributes to the achievement of this particular outcome when all the course-related outcomes are accomplished as evidenced by rubric summary scores meeting the prescribed benchmarks.

VII. Summary

Effective implementation of a viable continuous improvement plan is crucial to maintain and improve the quality of a program in compliance with the TAC/ABET TC 2K criteria. Assessment and evaluation of program outcomes and program educational objectives constitute two key elements of the plan. Both short-term and long-term well-defined assessment activities at specified frequencies involving multiple constituencies are essential. The continuous improvement plan adopted by the Civil Engineering Technology program at Georgia Southern University is discussed in this paper with particular emphasis on the use of direct measures for assessment and evaluation of program outcomes. These primarily include quantitative evaluation of student learning which in turn indicates the extent to which program outcomes are achieved.

Bibliography:

1. TAC/ABET *Criteria for Accrediting Engineering Technology Programs* (Effective for Evaluations During the 2006-2007 Accreditation Cycle)
2. *ABET Program Evaluator Training* (TC2K Training), sponsored by ABET Education and Information Services during the 2002 American Society for Engineering Education Annual Conference and Exposition in Montreal, Canada.
3. Das, Nirmal K., "Assessment and Evaluation of Engineering Technology Programs," *Proceedings of the ASEE Annual Conference*, Chicago, Illinois, 2006

Table 6 Continuous Improvement Efforts (CIE) Report	
Course/Activity Measured: TCET 3142 Final Exam	**Semester: Fall 2006**
Prepared by: XXXX	**Date: 12-15-2006**
What *issue* was triggered that prompted change?	Course Learning Outcome #7: Ability to solve for deflections of statically determinate beams, trusses, and frames
What *tool* was used that prompted the change? (For example, student feedback, faculty observations, IAB suggestions, rubric analysis of Student performance, etc)	Rubric analysis of student performance on TCET 3142 Final Exam.
What was the *change* or improvement?	The instructor has devised the following plan: - Focus on the application of Virtual work method. - Increase the time dedicated to this topic. - Administer a quiz to test students' performance in this area.
What was the *result of implementing* the change? (i.e. did the change correct the issue?)	The instructor has recommended the above measures be taken next time the course is offered. The grading on the assignment or quiz should indicate improvement before final exam.

Table 7
Links between Course Assessment and Program Outcomes

Program Outcome: b. An ability to apply current knowledge and adapt to emerging applications of mathematics, science, engineering and technology.				**Related TAC of ABET Criterion:** 2b	
	Measurements Contributing to Indicated Outcome				
	Assessment Tool(s)		**Benchmark**	**Assessment Frequency**	**Responsible Assessor**
1	Rubric Analysis of Student Performance on Final Exam in TCET 3141 (Environmental Pollution)	Rubric Summary C3141-Final-Rubric-FXX	2.5 out of 4	Every Course Offering—once per year	Instructor reports CIE results to Program Coordinator
2	Rubric Analysis of Student Performance on Final Exam in TCET 3142 (Structural Analysis)	Rubric Summary C3142-Final-Rubric-FXX	2.5 out of 4	Every Course Offering—once per year	Instructor reports CIE results to Program Coordinator
3	Rubric Analysis of Student Performance on Final Exam in TCET 4141 (Water Supply and Distribution Systems)	Rubric Summary C4141-Final-Rubric-FXX	2.5 out of 4	Every Course Offering—once per year	Instructor reports CIE results to Program Coordinator
4	Rubric Analysis of Student Performance on Final Exam in TCET 4142 (Reinforced Concrete Design)	Rubric Summary C4142-Final-Rubric-FXX	2.5 out of 4	Every Course Offering—once per year	Instructor reports CIE results to Program Coordinator
5	Rubric Analysis of Student Performance on Final Exam in TCET 4146 (Structural steel Design)	Rubric Summary C4146-Final-Rubric-SXX	2.5 out of 4	Every Course Offering—once per year	Instructor reports CIE results to Program Coordinator
6	Rubric Analysis of Student Performance on Final Exam in TCET 4243 (Highway Design)	Rubric Summary C4243-Final-Rubric-FXX	2.5 out of 4	Every Course Offering—once per year	Instructor reports CIE results to Program Coordinator
7	Rubric Analysis of Student Performance on Final Exam in TCET 4244 (Soil Mechanics and Foundations)	Rubric Summary C4244-Final-Rubric-FXX	2.5 out of 4	Every Course Offering—once per year	Instructor reports CIE results to Program Coordinator
8	Rubric Analysis of Student Performance on Final Exam in TCET 4245 (Water and Wastewater Treatment)	Rubric Summary C4245-Final-Rubric-SXX	2.5 out of 4	Every Course Offering—once per year	Instructor reports CIE results to Program Coordinator
9	Rubric Analysis of the Senior Design Project in TCET 4536	Rubric Summary C4536-Project-Rubric-SXX	2.5 out of 4	Every Course Offering—once per year	Instructor reports CIE results to Program Coordinator
10	Course Exit Survey: TCET 3141 (Environmental Pollution)	Survey Summary TCET-3141-Survey-FXX	2.5 out of 5	Every Course Offering—once per year	Instructor reports CIE results to Program Coordinator
11	Course Exit Survey: TCET 3142 (Structural Analysis)	Survey Summary TCET-3142-Survey-FXX	2.5 out of 5	Every Course Offering—once per year	Instructor reports CIE results to Program Coordinator
12	Course Exit Survey: TCET 4141 (Water Supply and Distribution Systems	Survey Summary TCET-4141-Survey- FXX	2.5 out of 5	Every Course Offering—once per year	Instructor reports CIE results to Program Coordinator
13	Course Exit Survey: TCET 4142 (Reinforced Concrete Design)	Survey Summary TCET-4142-Survey- FXX	2.5 out of 5	Every Course Offering—once per year	Instructor reports CIE results to Program Coordinator
14	Course Exit Survey: TCET 4146	Survey Summary	2.5 out of 5	Every Course	Instructor reports CIE

	(Structural Steel Design)	TCET-4146-Survey- SXX		Offering—once per year	results to Program Coordinator
15	Course Exit Survey: TCET 4243 (Highway Design)	Survey Summary TCET-4243-Survey- SXX	2.5 out of 5	Every Course Offering—once per year	Instructor reports CIE results to Program Coordinator
16	Course Exit Survey: TCET 4244 (Soil Mechanics and Foundations)	Survey Summary TCET-4244-Survey- FXX	2.5 out of 5	Every Course Offering—once per year	Instructor reports CIE results to Program Coordinator
17	Course Exit Survey: TCET 4245 (Water and Wastewater Treatment)	Survey Summary TCET-4245-Survey- S06	2.5 out of 5	Every Course Offering—once per year	Instructor reports CIE results to Program Coordinator
18	Course Exit Survey: TCET 4536 (Senior Project)	Survey Summary TCET-4536-Survey- SXX	2.5 out of 5	Every Course Offering—once per year	Instructor reports CIE results to Program Coordinator
19	CET Senior Exit Survey Question IB	Survey Summary CET-Senior Survey-FXX/ SXX	2.5 out of 5	Every Senior Course Offering—students complete only once	Instructor reports summary results to Program Coordinator

Appendix:

Outcome Measures and Their Corresponding Codes

M-1 Assessment of Key Homework Assignments

M-2 Assessment of Course Final Exam

M-3 Assessment of Laboratory Reports

M-4 Assessment of Oral Presentations

M-5 Assessment of Specific Skills or Knowledge

M-6 Assessment of Senior Project

CIE Continuous Improvement Efforts form

Form M-1

Assessment Rubric for Key Homework Assignments

Course Number and Title: TCET XXXX

Evaluating Faculty:

Semester and Year: Date:

Description of Outcome Measure: **Identification and application of key concept relevant to homework**	1 Poor	2 Marginal	3 Satisfactory	4 Good	5 Excellent	Rubric Score
Brief description of measured activity a. Mastery of the knowledge, techniques, skills, and modern tools of civil engineering technology.	The student demonstrates no ability to solve the problem.	Student demonstrates a vague notion of the key concept, but very little ability to solve the problem.	Student correctly identifies the need to use the key concept, and follows through correct procedure for solution. Two necessary parameters are used incorrectly to solve the problem. The problem is thus incorrectly or incompletely solved.	Student correctly identifies the need to use the key concept, and follows through correct procedure for solution. Two necessary parameters are used correctly to solve the problem. Minor errors result in an incorrect solution, but a significant demonstration of understanding is reflected.	Student correctly identifies the need to use the key concept, and follows through correct procedure for solution. Two necessary parameters are used correctly to solve the problem. The problem is correctly solved.	
Student 1						
Student 2						
Student 3						
Student 4						
…						
…						
…						
Student Last						
Average						
Benchmark	If Rubric Score average falls below 2.5, an instructor review is initiated. If that trend is observed for 3 successive measuring periods, then a faculty wide review leading to an improvement strategy is initiated.					

Form M-2 Rubric for Final Exam- TCET 4244 Soil Mechanics and Foundations					
CATEGORY	**4-Exceeds Criteria**	**3-Meets Criteria**	**2-Progressing to Criteria**	**1-Below Expectations**	Points
To define, describe, and classify soils	Provide ample evidence of the ability	Provide adequate evidence of the ability	Provide some evidence of the ability	Provide little or no evidence of the ability	
To determine weight-volume characteristics	Provide ample evidence of the ability	Provide adequate evidence of the ability	Provide some evidence of the ability	Provide little or no evidence of the ability	
To solve various soil mechanics problems	Provide ample evidence of the ability	Provide adequate evidence of the ability	Provide some evidence of the ability	Provide little or no evidence of the ability	
To determine angle of internal friction and cohesion	Provide ample evidence of the ability	Provide adequate evidence of the ability	Provide some evidence of the ability	Provide little or no evidence of the ability	
To do Lab works	Provided ample evidence of the ability	Provided adequate evidence of the ability	Provided some evidence of the ability	Provided little or no evidence of the ability	
Determine ultimate and allowable soil bearing capacity	Provide ample evidence of the ability	Provide adequate evidence of the ability	Provide some evidence of the ability	Provide little or no evidence of the ability	
Determine required minimum dimensions of footings	Provide ample evidence of the ability	Provide adequate evidence of the ability	Provide some evidence of the ability	Provide little or no evidence of the ability	
Faculty perception of student's ability to use knowledge and skills gained from pre-requisite course	Demonstrates ample evidence of a thorough understanding	Demonstrates adequate evidence of a thorough understanding	Demonstrates some evidence of a thorough understanding	Demonstrates little or no evidence of a thorough understanding	

Form M-3
RUBRIC For the Evaluation of a TCET Laboratory Report

Course:
Date:
Activity Evaluated:
Student Evaluated:
Evaluator:

Outcome Measure:	1 Poor	2	3	4	5 Excellent	Score
The student is capable of summarizing experimental findings in a concise abstract. g. An ability to communicate effectively.	There is no abstract included with the report.	The abstract has absolutely no content related to results. It almost seems as if the abstract was written before the data was analyzed and the body of the report was written.	The abstract has vague content related to results—usually descriptive. Elements inappropriate to the abstract- equations, tables, figures, reference to tables or figures, are included .	The student makes concessions to include numerical summary content in the abstract but it is too little or inappropriate.	The abstract is an appropriate balance between overview content and specific technical summary. It is an insightful summary of the report.	
The student demonstrates an ability to write a technical introduction g. An ability to communicate effectively.	No introduction included or a token attempt	Very little background information provided or information is incorrect	Some introductory information, but still missing some major points	Introduction is nearly complete, missing some minor points. No attempt to incorporate material beyond basic laboratory handout or text coverage.	Introduction complete and well-written; provides all necessary background principles for the experiment; demonstrates some effort to research the topic.	
The student is capable of reporting the procedure that was executed in the experiment g. An ability to communicate effectively.	There is no procedure included in the report.	The student prepares a list of instructions rather than reporting what was done.	The student reports what was done, but with insufficient detail.	The student reports what was done but neglects to include a diagram in the presentation or stops the procedure with data collection.	The student reports what was done with reasonable completeness and clarity. A diagram is included in the presentation. A summary of the analysis approach is included in the presentation.	

Outcome Measure:	1	2	3	4	5	Score
The ability to write a technical discussion that incorporates theory and an interpretation of data and results. g. An ability to communicate effectively. c. An ability to conduct, analyze and interpret experiments	No discussion included or a token effort.	Very incomplete. A lack of basic understanding reflected.	Incomplete or incorrect interpretation of trends and comparison of data indicating a lack of understanding of results. No direct citation of results and/or data in the text.	Some of the results have been correctly interpreted and discussed; partial but incomplete understanding of results is still evident Token citation of results and/or data in the text	All important trends and data comparisons have been interpreted correctly and discussed, good understanding of results is conveyed	
Spelling, grammar, sentence structure g. An ability to communicate effectively.	Frequent grammar and/or spelling errors, writing style is rough and immature. Seems that no one proof read the document.	Significant grammar and/or spelling errors, writing style is rough. Frequent verb tense changes. Frequent use of DOAs.	Occasional grammar/spelling errors, generally readable with some rough spots in writing style	Reasonable grammar/spelling errors that do not distract from the reading of the text.	Grammar/spelling correct and very well-written. Enjoyable document to read	
The student is capable of preparing figures and tables to professional standards g. An ability to communicate effectively.	No tables or figures were included in the report, when it was necessary to do so.	Tables and Figures are included, but the format is poorly thought out. Tables and Figures have no titles and/or no indicating numbers. Units are left off column headings.	Tables and Figures are included. Some attempt is made at format but frequent errors are observed.. Titles are provided but they are not detailed enough to stand alone. Tables are split across pages without properly repeating title and column headings.	Tables and Figures are included. A reasonable attempt is made at format. Some occasional mistakes are made.	Tables and Figures are logically formatted and polished in appearance. Information is readily conveyed. Titles are detailed and capable of standing alone.	
The concept of measurement repeatability is adequately demonstrated in laboratory findings. c. An ability to conduct, analyze and interpret experiments	The student demonstrates no understanding of measurement theory. There is no demonstration of repeatability. The student uses an inappropriate number of significant figures.	The student recognizes a need for repeatability, but considers doing the experiment multiple times to satisfy the requirement.	The student demonstrates a proper understanding of repeatability by the data and results preparation, but does not incorporate the concept adequately into the discussion	The student demonstrates an application of reporting statistical analysis of results. The student includes the concept of repeatability in the discussion but does not tie the concept to a trend in the results	The student demonstrates an application of reporting statistical analysis of results and uses a trend in these results to support or detract from a theory.	

Form M-4
RUBRIC For the Evaluation of a TCET Presentation

Course:
Date:
Activity Evaluated:
Student Evaluated:
Evaluator Name:
Evaluator is (circle one) Course Instructor Student Visiting Faculty Visitor

Outcome Measure:	1 Poor	2	3	4	5 Excellent	Score
Organization	Presenters not prepared.	Presentation is very confused and unclear. Listeners cannot follow.	Effort required by listeners to follow the presentation. Organization not well thought out	Presentation is generally clear.	Presentation is clear and logical. Technical points are well made.	
Delivery	Speaker can not be heard or understood. Presentation is too short or long.	Information is read from a script or directly from the screen. Poor posture.	An annoying number of 'Ahs" and Uhms". Pace is too fast or to slow.	Reasonable pace and style. Some rough spots.	Planned conversation with the audience, paced for understanding. Enjoyable to listen to.	
Technical Content	Information is so inaccurate that listener cannot depend on the content	Enough errors made to be distracting. Confidence in the work begins to be questioned.	No significant errors made. Listeners recognize errors as a result of oversight or nervousness.	No significant errors made. Presenter catches errors and corrects them.	No apparent technical errors. Purpose, method, results, and conclusions clearly stated.	
Use of visual aids	No aids are used or they are so poorly prepared that they detract from the presentation.	Aids are difficult to read. Images are poor. Font size inappropriate. Significant use of distracting backgrounds and animations.	Aids are marginal. Font is large enough to read. Some distracting use of backgrounds and animation.	Aids are reasonably good. Font is large enough to read.	Aids presented are professional and polished. Font is large enough to read.	

Outcome Measure:	1	2	3	4	5	Score
Ability to answer questions	Avoids audience interaction.	Not sure of answers, or answers incorrectly.		Unsure of themselves at first, but ultimately answers the question.	Answers questions directly and accurately. Interacts well with students.	
Physical Appearance k. A commitment to quality, timeliness, and continuous improvement.	No attempt made to improve. Typical street clothing worn.				Clear attempt made. Business casual or formal dress worn.	
TEAM WORK e. An ability to function effectively on teams.	Inappropriate distribution of effort. One or more members responsible for most of the presentation or one or more members not participating		All members participate but one or more members dominate.		Balanced Participation	
Evaluation Average from Student Surveys						
Evaluation Average from Visiting Faculty						

Form M-5

Rubric for Assessment of Specific Skills

Skill:
Course:
Activity:
Evaluating Faculty:
Date:

Description of Outcome Measure:	1 Poor	2	3	4	5 Excellent	Rubric Score
a. Mastery of the knowledge, techniques, skills, and modern tools of civil engineer technology.	No measurable use of skill.	There is a token attempt to use the skill in a report or capstone project. Proficiency not clearly reflected in the work, or some errors reflected in the work.	Appropriate average skill levels are reflected in a report or capstone.	.The student demonstrates a solid ability to use the skill based upon the quality of course projects. Results are error free and a reasonable interpretation/usage of the results is demonstrated	The student demonstrates a advanced ability to apply the skill based upon the quality of course projects. The student demonstrates an ability to learn advanced skills—beyond what was taught in class. The student is often sought out by peers for instruction and advice.	
Student 1						
Student 2						
Student 3						
Student 4						
Student Last						
Average						
Benchmark	If Rubric Score average falls below 2.5, an instructor review is initiated. If that trend is observed for 3 successive measuring periods, then a faculty wide review leading to an improvement strategy is initiated..					

Form M-6

Rubric Definitions for TCET 4536 - Final Report

Course: TCET 4536 (Senior Project) Semester and Year:

Date:

Evaluator:

	Category	**Points**			
		4	3	2	1
1	Objectives of the Project	Demonstrated clear objectives by explaining the interest and selection criteria	Objective was mentioned but lacking of explanation in detail.	Objective was not clearly mentioned	Limited understanding of the objectives
2	Introduction of the selected Project	Explained the detail background information and the basis of the project, well written.	Described the fundamental basis of the project briefly	Presented a very short summary of the background topics	Very little explanation of the introductory material
3	Explanation of the designed elements and detailed technical Information	Demonstrated very clear idea about all the designed elements within the scope of the project.	Understood the function of various elements but could not explain the technical details of all elements in a clear fashion.	Explained only a part of the project well;	Only a few scattered technical information about the project elements.
4	Design computations	Performed all design computations accurately following correct procedures and using appropriate design aids/standards, and presented them in a neat, organized manner.	Performed all design computations, but not without some mistakes, following mostly correct procedures and using appropriate design aids/standards, and presented them in a neat, organized manner.	Performed all design computations, but with major flaws in procedure/ standard used and/or with computational errors. Presentation was not very organized.	Did hardly present any significant evidence of design computations.
5	Use of AutoCAD to prepare design drawings.	All drawings were prepared using AutoCAD.	Almost all drawings were prepared using AutoCAD.	Most of the drawings were prepared not using AutoCAD.	No CAD tool was used to produce drawings.
6	Synthesis of knowledge and skills	Demonstrated clearly the comprehension of how various elements of a multi-faceted civil engineering project can be put together to make the project a success.	Demonstrated adequate comprehension (with some wrong notions though) of how various elements of a multi-faceted civil engineering project can be put together to make the project a success.	Marginal comprehension of how various elements of a multi-faceted civil engineering project can be put together to make the project a success.	No clue as to how various elements of a multi-faceted civil engineering project can be put together to make the project a success.
7	Organization and overall quality of the report	Very well organized well written and high quality report.	Well written but not organized properly	Some components like references and conclusions were missing	Very poor quality report

Continuous Improvement Efforts (CIE)

Course/Activity: _____ **Semester:** _____
Evaluated By: _____ **Date:** _____

Category of Continuous Improvement	
What *issue* was flagged that prompted change?	
What *tool* was used that prompted the change? (For example, student feedback, faculty observations, IAB suggestions, rubric analysis of Student performance, etc)	
What was the *change* or improvement?	
What was the *result of implementing* the change? (i.e. did the change correct the issue?)	