2012-2013 ANNUAL ASSESSMENT REPORT FOR B.S. IN CIVIL ENGINEERING

PREPARED FOR:
Office of Academic Program Assessment
Office of Academic Affairs

SUBMITTED BY:
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To: Office of Academic Program Assessment (OAPA), Office of Academic Affairs

From: Department of Civil Engineering

Subject: Annual Assessment Report for B.S. in Civil Engineering

Date: July 1, 2013

CC: College of Engineering and Computer Science

The 2012-2013 Annual Assessment Report for Department of Civil Engineering is based on the learning outcome assessment template prepared by the Office of Academic Affairs. This memo offers a summary of the assessment strategies used to assess program learning outcomes and feedback from the Office of Academic Affairs for improving the department's assessment practices.

1. *As a result of last year's assessment effort, have you implemented* ***any changes for your assessment including learning outcomes, assessment plan, assessment tools (methods, rubrics, curriculum map, or key assignment etc.), and/or the university baccalaureate learning goals?***
    - *If so, what are those changes? How did you implement those changes?*
    - *How do you know if these changes have achieved the desired results?*
    - *If no, why not?*

The assessment plan for the BS CE program is focused on program quality and improvement during a challenging time with increasing enrollment. The Department assessment plan addresses the requirements of the national external engineering accreditation body, ABET. Assessment includes program and course level outcomes, and both direct and indirect measures are used. Data are collected from students, faculty, alumni, and industry stakeholders.

Using feedback from the University Office of Academic Program Review, the Department initiated plans during the 2012-13 academic year to:

- Collect of longitudinal data from the designated Introductory-, Developmental-, and Graduate-level mastery levels;
- Use standardized rubrics for consistent assessment data across different courses, and
- Provide evidence of the levels of achievement required to meet learning outcomes at both the undergraduate and Master's levels.

The Department has discussed how to better assess the program's learning goals, including exploring rubrics in addition to rubrics it has developed consistent with the ABET guidelines and rubrics to assess University outcomes. The Department has also started to narrow its programmatic discussions to focus on both general education (GE) and major requirements to make sure that a balanced program is maintained and that all overlap between the major and GE are correctly identified.

One specific change made to the assessment program during Spring 2013 was an initial response to the feedback from the University Office of Academic Program Review and Assessment. The faculty will review and amend the BS CE assessment plan to include the University level requirements.

The Department also explored developing standardized rubrics such as the example shown in Table 1 for consistent assessment data across different courses and applying these rubrics to evaluate longitudinal data to assess Introduction-, Development-, and Graduation-stage mastery levels for each course shown in Table 2.

Table 1. Rubric for Evaluating Learning Outcome – Technical Competence for Solving Complex Problems

Exemplary	Very Good	Good	Marginal	Below Expectation
5	4	3	2	1
• Calculations are documented as a professional engineering calculation that supports any engineering decision. • Clearly and consistently documented definition and outline of the engineering problem. • Clearly documented assumptions and requirements of the problem. • Clearly stated approach and solution of the problem at hand. • Clearly labeled schematics and sketches. • Demonstrates command of the theory and application beyond expectation.	• Calculations are documented as a professional engineering calculation that supports any engineering decision with no gaps. • Documented definition and outline the engineering problem with minor gaps. • Documented assumptions and requirements of the problem with minor gaps. • Stated approach and solution for the problem at hand with minor gaps. • Labeled schematics and sketches with minor gaps. • Demonstrates clear understanding of the theory and application.	• Calculations are documented as a professional engineering calculation that supports any engineering decision with some gaps. • Sparsely documented definition and outline the engineering problem with some gaps. • Sparsely documented assumptions and requirements of the problem with some gaps. • Inconsistent documentation of the approach and solution for the problem at hand with minor gaps. • Inconsistent labeling of schematics and sketches. • Demonstrates understanding of the theory and application with minor gaps.	• Calculations are sparsely documented as a professional engineering calculation that supports any engineering decision with some gaps. • Sparsely documented definition and outline the engineering problem with no consistency. • Inconsistent documentation of assumptions and requirements of the problem. • Inconsistent documentation of the approach and solution for the problem at hand with some gaps. • Inconsistent labeling of schematics and sketches. • Demonstrate some understanding of theory and application with some gaps.	• Calculations are not documented as a professional engineering calculation that supports any engineering decision. • No clear documentation of definition and outline the engineering problem. • No clear documentation of assumptions and requirements of the problem. • No clear documentation of the approach and the solution for the problem at hand. • Schematics and sketches are not labeled. • No clear understanding of theory and application.

Table 2. Courses Contributing to Program Learning Outcomes

PLO	Required Courses in the Major																						Overall
	CE1	CE4	CE9	E30	E45	CE100	CE101	E110	E112	E115	E140	E132	E124	CE113	CE135	CE137	CE146	CE147	CE161	CE170	CE171A	CE190	
1	-	D	D	D	D	D	D	D	D	I	D	D	D	D	D	D	-	D	D	G	G	G	G
2	-	-	I	-	D	-	I	-	-	I	-	I	-	G	G	D	-	G		D	D	G*	G
3	-	-	-	I	-	-	-	-	I	-	-	-	D	-			-	D	I	D	I	G	G
4	-	-	-	-	-	-	I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I/G**	G
5	-	-	I	-	I	-	I	D	I	I	I	D	D	D	D	D	-	I	D	G	D	G	G
6	I	-	-	-	D	I	-	-	-	I	-	-	-	I	-	-	G	-	-	D	D	D	G
7	-	-	-	I	I	I	I	-	I	I	-	I	I	D	D	D	I	I	I	I	I	D	D
8	I	-	-	-	I	I	-	-	-	-	-	-	-	-	-	-	G	D	-	D	D	G	G
9	I	-	-	I	D	I	D	-	-	-	-	-	-	D	D	-	D	D	-	D	D	G	G
10	I	-	-	-	I	D	-	-	-	I	-	-	D	I	-	-	D	D	-	D	I	G	G
11	I	-	-	-	I	D	-	-	-	-	-	-	D	I	-	-	D	D	-	D	I	G	G
12	I	I	I	I	D	-	D	D	I	D	-	G	D	D	G	G	-	D	I	G	G	G	G

Key: I = Introduced, D = Developed and practiced with feedback, G = Demonstrated mastery level appropriate for graduation

* No design or conducting of experiments, but mastery of gathering, analyzing, and interpreting data

** Depends on how "interdisciplinary" is defined. (If it is one type of civil engineer working with another type of civil engineer, the level is G. If it is completely different skill sets (e.g. engineer and lawyer), the level is I.)

1 = Ability to apply knowledge of mathematics, science, and engineering
2 = Ability to design and conduct experiments and to analyze and interpret data
3 = Ability to design a system, component, or process to meet desired needs
4 = Ability to function on a team
5 = Ability to identify, formulate, and solve practical engineering problems
6 = Understanding of professional and ethical responsibility
7 = Recognition of need for, and ability to engage in lifelong learning
8 = Understanding of Civil Engineering practice
9 = Ability to communicate effectively
10 = Understanding impacts of engineering solutions in the global and societal context
11 = Knowledge of contemporary issues
12 = Ability to use techniques, skills and modern engineering tools

One specific programmatic learning outcome that was selected to be evaluated during the 2012/2013 AY was a student's *ability to apply knowledge of mathematics, science, and engineering* (PLO 1). As will be discussed in this report, the Department started using results from the national Fundamentals of Engineering (FE) Exam to assess this outcome.

2. *As a result of last year's assessment effort, have you implemented* ***any other changes at the department, the college or the university, including advising, co-curriculum, budgeting and planning?***
    - *If so, what are those changes? How did you implement those changes?*
    - *How do you know if these changes have achieved the desired results?*
    - *If no, why not?*

Based on the Department's mission statement, educational objectives, and ABET general and program criteria, the Department developed the learning outcomes that are summarized in Table 3 below. The learning outcomes have been mapped to ABET learning outcomes (ABET Criterion 3). The Department evaluated all of its learning outcomes as part of its last ABET review cycle and decided to streamline its assessment plan by eliminating one former program learning outcomes (*ability to function on a team*) and by retaining another (*understanding of Civil Engineering practice*), as shown in Table 3 below.

Table 3. CE Program Learning Outcomes Mapped to ABET Learning Outcomes

Sacramento State Civil Engineering Program Learning Outcome (PLO)	**ABET Learning Outcome**
1. Ability to apply knowledge of mathematics, science, and engineering (formerly PLO 1A)	a
2: Ability to design and conduct experiments and to analyze and interpret data (formerly PLO 2A)	b
3: Ability to design a system, component, or process to meet desired needs (formerly PLO 2B)	c
"Teamwork" 4. Ability to function on an interdisciplinary team (formerly PLO 2D) ~~Ability to function on a team (formerly PLO 2C)~~	 d ~~(none)~~
5. Ability to identify, formulate, and solve engineering problems (formerly PLO 2E)	e
"CE Practice" 6. Understanding of professional and ethical responsibility (formerly PLO 5B) 7. Recognition of need for, and ability to engage in lifelong learning (formerly PLO 2F) 8. Understanding of Civil Engineering practice (formerly PLO 5A)	 f i (none)
Communication 9. Ability to communicate effectively (formerly PLO 3)	 g
Contemporary Issues & Context 10. Understanding impacts of engineering solutions in the global and societal context (formerly PLO 4A) 11. Knowledge of contemporary issues (formerly PLO 4B)	 h j
12: Ability to use techniques, skills and modern engineering tools (formerly PLO 1B)	k

In addition to providing a comprehensive BS CE program, the Department has been focused on reducing the number of units required in the program while maintaining and improving

the quality of graduates. Beginning in the 2011-12 academic year, the Department implemented curriculum changes that reduced the number of units from 138 to 132. *Circuits* (Engineering 17, 3 units) was eliminated from the program, and *Reinforced Concrete Design* (Civil Engineering 164, 3 units) was reclassified from a requirement to a design elective. During the 2011-12 academic year, the Department worked with colleagues in the Department of Chemistry to approve *General Chemistry for Engineers* (Chemistry 1E), which resulted in additional one unit reduction, resulting in a major requirement of 131 units as of Fall 2013. During the 2012-13 year, the Department spent some time exploring the overlap between the GE learning goals and the program learning goals to evaluate if there are redundancies. The Department continues to work on determining if further unit reductions can be made.

Finally, changes were made in the Department to better advise students about the national Fundamentals of Engineering (FE) Exam, which is a prerequisite to professional licensure later in a civil engineering's professional career, by providing recommendations about when to take the exam and which exam to take. Through exit interviews, the Department found that many students were taking the exam during their junior year (or earlier) when they had not yet completed many of topics covered on the exam. It was also discovered that many students were taking the "General Engineering" section of the exam instead of the more appropriate "Civil Engineering" section. As a result, CE faculty started advising students to follow exam guidelines posted on the Department website (http://www.ecs.csus.edu/wcm/ce/pdfs/FE_Exam_Info_Sheet.pdf), which suggested that 1) students wait until their last year at Sacramento State to take the exam, and 2) take the "Civil Engineering" section. It is believed that both suggestions will help students to be successful on the exam. This suggestion that students wait until their last year at Sacramento State to take the exam was also reflected in a revision to the undergraduate curriculum flowchart (http://www.ecs.csus.edu/wcm/ce/pdfs/flowchart.pdf). Also as result of this assessment effort, it was discovered that not all faculty were aware of the material on the contemporary FE exam, so all civil engineering faculty were given a copy of the FE-supplied reference handbook that students use during the exam. Faculty were encouraged to review the subject material in the manual that relates to courses they teach and incorporate them into the curriculum.

3. What **PROGRAM** (not course) learning outcome(s) have you assessed this academic year?

As part of the planned use of the FE Exam in the Department Assessment plan, Program Learning Objective 1, the *ability to apply knowledge of mathematics, science, and engineering (formerly PLO 1A)*, was assessed this academic year.

4. What method(s)/measure(s) have you used to collect the data?

While this broader learning outcome is also evaluated through other means, this specific outcome is evaluated through graduating senior exit interviews, graduating senior surveys, and results from institutional reports provided by National Council of Examiners for Engineering and Surveying (NCESS), the administrators of the FE Exam itself.

5. What are the criteria and/or standards of performance for the program learning outcome?

The Department considered using the institutional pass rate in comparison to the national pass rate to assess the program, but NCEES specifically cautions institutions against this practice (Barrett et al., 2010, page 2)[i]:

> One potential error in using the FE exam results as an assessment tool is focusing on the percentage of students who pass the exam. This criterion is too broad to be effective in improving instruction in specific topics; more specific measures are needed. Too often, the passing rates of individual programs are compared with those of other institutions, and these rates become more important than the subject matter evaluations. Administrators or faculty who select those who are allowed to attempt the exam may be demonstrating this faulty mentality.

While the Department may want to compare its institutional pass rate against national pass rates for anecdotal purposes, better use of the FE exam would involve setting criteria for discipline-specific subject areas. For example, because the department emphasizes its breadth in all five main areas of civil engineering, the Department may expect a higher annual (academic year) subject pass rate – say 50 percent – in subjects emphasized in the upper-division civil engineering core and taught by full-time faculty members at Sacramento State, such as: Water Resources Engineering (Hydraulics and Hydrologic Systems), Environmental Engineering, Structural Engineering (Analysis and Structural Design), Soil Mechanics and Foundations, and Transportation Engineering. At the same time, the Department may choose a lower subject pass rate – say at least 40 percent – in the other civil engineering topics taught in the lower-division or taught by part-time faculty members, such as: Surveying or Engineering Probability and Statistics. While these performance standards may seem low, NCEES specifically warns against setting the evaluation thresholds too high, stating that "expectations of faculty typically exceed actual performance of their students on the FE exam" (p. 6)

The Department may also want to evaluate the pass criterion to determine if passing the exam before graduation, even after multiple attempts, is important to the Department's goals. This may be difficult to obtain from NCESS reports because they only report the pass rate during the first attempt on the exam.

6. *What data have you collected? What are the results and findings, including the percentage of students who meet each standard?*
    - *In what areas are students doing well and achieving the expectations?*
    - *In what areas do students need improvement?*

The data resulting from these recent changes are not yet available, but data have been collected from past exams and data will continue to be collected on subject pass rates to determine if they improve as part of continued assessment. Based on the data available, students appear to be improving and generally meeting the Department's expectations. These conclusions were supported by NCEES recommendations which cautioned against making drastic changes based on small sample sizes. Again, one of the issues with the FE Exam was that many Sacramento State Civil Engineering students were taking the exam in the junior year (or earlier) and were not taking the "Civil Engineering" exam: "One possible explanation for this sporadic performance can be associated with the small number of students who take any one particular exam" (Barrett et al., 2010, p. 8). Also, NCEES cautions, "Do not attempt a curricular change in a subject matter area unless the students' performance has been below the expected goal for three consecutive exam administrations" (Barrett et al., 2010, p. 8). As a result, there was no need for immediate improvement in any specific subject area within the curriculum as shown in Table 4 below.

Table 4. FE Exam Results (Annual Weighted Averages) in CE Subject Areas

Subject Area	2011/2012	2010/2011	2009/2010
Surveying	59.8	52.3	42.3
Hydraulics & Hyd Systems	50.8	50.3	41.3
Soil Mech & Foundations	50.8	50.5	47.5
Environmental Engg	50.6	58.8	57.3
Transportation	61.3	47.1	54.7
Structural Analysis/Design*	48.9	55.0	55.0
Construction Management	60.2	60.6	45.2
Materials	59.7	53.8	52.5

*- Weighted average of structural analysis and structural design

Based on data from our annual Graduating Senior Survey, the Department believes that at least 59% of our undergraduates have passed the FE exam before they graduate, 21% have not passed it before graduating, and 20% do not know the results of their exam before graduating. The Graduating Senior Survey also suggests that approximately 7% of our student do not take the exam before graduation, while 68% of students take it once, 20% of students take it twice, and about 4% of students take it more than twice. Data from graduating senior exit interviews confirmed these findings; approximately, 66% of students graduating in Fall 2013 had passed the FE Exam, while 26% were still waiting to receive their scores from the most recent exam.

7. *As a result of this year's assessment effort, do you anticipate or propose any changes for your program (e.g. structures, content, or learning outcomes)?*
    - *If so, what changes do you anticipate? How do you plan to implement those changes?*
    - *How do you know if these changes will achieve the desired results?*

Additional assessment efforts will continue to try to assess our students' success in the FE Exam, which is a prerequisite to professional licensure later in their civil engineering career, and the Department will continue to better understand and address students who do not attempt the exam or who take the exam more than twice. The Department may also try to contact those students who are still waiting for their exam results shortly after they graduate to obtain these data. The Department currently collects future contact information from its graduating seniors.

8. *Which program learning outcome(s) do you plan to assess next year? How?*

As the Department moves closer to its ABET Evaluation, it will likely make small assessment efforts with most if not all of its existing program learning outcomes over the two years. Some focus will be on the FE exam as others have shown that results from this exam can be used as a tool to assess a wide range of program learning outcomes (Barrett et al., 2010, page 2)[i]:

> FE exam results can be used to assess particular aspects of the following ABET Criterion 3 outcomes: (a) an ability to apply knowledge of mathematics, science, and engineering; (b) an ability to design and conduct experiments, as well as to analyze and interpret data; (c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability; (e) an ability to identify, formulate, and solve engineering problems; (f) an understanding of professional and ethical responsibility; and (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Other outcome outcomes will be assessed through direct measures in courses through the use of standardized rubrics, indirect measures with student surveys, such as the graduating senior survey and exit interviews, as well as indirect measures from our alumni. Feedback will come from students, faculty, and members of industry advisory committees. Table 5 shows the assessment activities planned for this year (AY 2013/2014) and for next year (AY 2014/2015) for the undergraduate program.

Table 5. On-Going Assessment Plan for the Undergraduate Civil Engineering Program

AY 2013/2014	AY 2014/2015
1. Graduating senior survey 2. Senior project evaluation 3. Exit interviews of graduating seniors 4. Course reflections 5. Alumni Focus group – Spring 2014	1. Graduating senior survey 2. Senior project evaluation 3. Exit interview of graduating seniors 4. Assessment of writing 5. Alumni Focus group – Spring 2015

On-going assessment efforts by the Department include the following: 1) direct assessment, 2) indirect assessment, and 3) focus group meetings.

1. **Direct Measures**. The Department plan for assessment includes direct measure for its Educational Objective 2 stated in the self-study as: *Identify, analyze, and solve complex practical civil engineering problems in their chosen field of specialty.* The Department gathered data from projects and assignment in a range of undergraduate courses. A five-point rubric is used for the assessment of the activities, and the Department considers that 70% of the students should be in the range of 4 and 5 as an acceptable criterion for this learning outcome**.**
2. **Indirect Measures** - A Graduate Alumni Survey is being prepared using the StudentVoice website and will be e-mailed to the alumni next year.
3. **Focus Group Meetings –** The Department is planning to hold a focus group meeting for alumni and employers in the Environmental Engineering area. Subsequent meetings are planned for next four years to cover other areas of specialty in Civil Engineering including geotechnical, structural, transportation, and water resources, respectively.

[i] See http://cdn1.ncees.co/wp-content/uploads/2012/11/White-paper-Using-the-FE-as-an-Outcomes-Assessment-Tool.pdf.