

**Assessment Report
Bachelor of Science in Civil Engineering
Montana State University
2014 – 2015 Academic Year**

Department: Civil Engineering

Department Head: Jerry Stephens

Assessment Coordinators: Joel Cahoon and Jerry Stephens

Date: Fall 2015, Reporting Period Academic Year 2014 – 2015

Programs: BS Civil Engineering, BS Civil Engineering – BioResources Option

Background

The following annual performance assessment of the Civil Engineering Program at Montana State University was prepared in the context of the program Assessment Plan prepared by the CE Department in February 2011. The Civil Engineering Program at Montana State University has approximately 400 undergraduate students, and is accredited by the Accreditation Board for Engineering and Technology (ABET®).

Note that ABET reaccreditation of the Civil Engineering Program (and the Bioresources Option) is underway (these reviews are on a six year review cycle), with a program self-study having been submitted to ABET in summer of 2015, a site visit planned by an ABET program evaluator in Fall 2015, issuance by ABET in Spring 2016 of a program audit form, and final notice of ABET's accreditation action expected in August 2016.

Summary of Assessment Plan

Program Educational Objectives

The Civil Engineering Bachelor of Science Program is a traditionally structured program that provides graduates with a strong background in math, basic sciences and engineering mechanics, and prepares graduates to become registered professional engineers capable of practicing civil engineering in the areas of environmental, geotechnical, structural, transportation and water resources engineering. The background of graduates who select the Bio-Resources option is focused on soil, water resources and environmental concerns.

The civil engineering baccalaureate educational program objectives were adopted in April of 2003. Program constituents reconsidered these objectives in 2006 and re-adopted them without revision at that time. Further assessment activities in 2014 resulted in some modifications to the program educational objectives, and these modifications are reflected in the current objectives as stated below. The educational objectives of the Civil Engineering Bachelor of Science

Program describe what graduates can expect to accomplish during the first years after graduation.

All graduates can expect to be able to:

1. Enter the profession of Civil Engineering and advance in the profession to become registered professional engineers and leaders in the field of Civil Engineering.
2. Work on multi-disciplinary teams and effectively communicate with Civil Engineers of various sub-disciplines, architects, contractors, the public and public agents, scientists and others to design and construct Civil Engineering projects.
3. Begin to develop expertise in one of the sub-disciplines of Civil Engineering and engage in the life-long learning necessary to advance in the Civil Engineering profession.
4. Contribute to society and the Civil Engineering profession through involvement in professional related and/or other service activity.
5. Conduct their affairs in a highly ethical manner holding paramount the safety, health and welfare of the public and striving to comply with the principles of sustainable development.

Some graduates can expect to be able to:

6. Earn advanced degrees in Civil Engineering or other fields.

Process for Evaluating CE Program Educational Objectives

Each August prior to the start of the new academic year, the department holds a one day retreat. One of the agenda items at the retreat is the review of assessment data and the evaluation of program outcomes and objectives. At these retreats, the department head and/or program coordinator distributes recent and historical assessment data and a comparison of assessment results with metric goals. Annually the departmental External Advisory Committee evaluates the extent to which they believe MSU Civil Engineering graduates meet the program objectives on a scale of 0 (not at all) to 10 (completely), and the extent to which they believe each of them is suitable, similarly scaled from 0 (not at all suitable) to 10 (completely suitable).

If assessment results fall below metric goals, the faculty are responsible for developing a strategy or strategies for improving these levels of achievement. A drop below metric goal levels for one survey will not necessarily require action. However, several occurrences of scores below metric goal levels requires corrective action. In the event that all scores exceed metric goal levels, the faculty may use assessment data to identify weaker areas of student performance and choose to develop strategies for improvement. The faculty strive to continually improve the program. While the whole faculty participates in strategy development, implementation of these strategies is assigned to the curriculum committee, the program coordinator, the department head or department staff as appropriate for implementation.

Note that the program educational objectives assessment process outlined above is considerably less involved than that presented in the 2011 Assessment Plan. In 2012, ABET changed their procedural requirements relative to stringent assessment of program educational objectives. ABET removed the requirement for a program to demonstrate graduate attainment of program educational objectives; ABET now only requires periodic review of these Objectives to ensure they are consistent with the mission of the institution and needs of the profession. In response to

this policy change, the Civil Engineering Department developed the evaluation process described above. Further note that while the 2011 Assessment Plan calls for the department head and/or program coordinator to prepare and distribute an Annual Program Assessment Report prior to this retreat, the decision was made two years ago to present assessment data at this retreat, and to prepare the annual Assessment Report thereafter, including proposed activities for continuous improvement for the next year.

Program Outcomes

The CE baccalaureate program Outcomes were approved by the CE faculty in August of 2006. At that time, the department adopted ABET Criterion 3 Outcomes (a-k) listed sequentially as Outcomes (1-11) below, and four additional outcomes, based on the ASCE Body of Knowledge, which are listed as Outcomes (12-15) below:

To satisfy the academic prerequisites for the professional practice of civil engineering, MSU civil engineering graduates will be able to:

1. apply knowledge of mathematics, science, and engineering
2. design and conduct experiments and analyze and interpret experimental data
3. 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
4. function as a member of a multidisciplinary team
5. identify, formulate and solve engineering problems
6. explain professional and ethical responsibility
7. compose and present effective written, verbal and graphical communications
8. draw upon a broad education to explain the impact of engineering solutions in a global, economic, environmental and societal context
9. explain the need for, and demonstrate the capacity for, life-long learning
10. explain contemporary issues as they relate to the solution of engineering practice
11. apply the techniques, skills and modern tools necessary for engineering practice
12. [MS Programs Only] synthesize/evaluate knowledge in a specialized areas related to CE
13. explain the elements of project management, construction and asset management
14. explain the fundamentals of business, public policy and administration
15. explain the role of the leader, leadership principle, and attitudes conducive to effective professional practice of civil engineering.

Processes to Assess CE Program Outcomes

The following are the primary instruments being used to assess whether student outcomes are being met:

Fundamentals of Engineering Exam

- All CE students are required to take the FE exam in order to graduate.
- The assessment process documents program performance in each topic area of the Civil Engineering discipline specific exam.
- Student performance in each topic area is compared to metric goals. Our goal is to exceed the national pass rate for civil engineering students taking the civil exam and

for the MSU student performance to exceed the national performance in each subject area of the exam. Three consecutive cycles below the national pass rate overall, or three consecutive cycles of less than the national pass rate on a per-topic basis, identify concerns requiring discussion, comment, and appropriate action by the department.

Review of Student Work

- Representative student work from selected classes is collected. Faculty representatives and the External Advisory Committee review this work and assess student performance relative to program outcomes.
- Results are documented every third year and summarized in the Annual Assessment Report.

Student Interviews/Surveys

- Central administration sends out exit surveys to all graduating seniors.
- Results are documented yearly and summarized in the Annual Assessment Report.

Career Fair Employer Surveys

- Employers that participate in MSU Career Fairs complete a survey on student career preparedness, communication skills, and interview preparedness (note that previous to this academic year, employers at MSU Career Fairs completed a much more detailed survey of their assessment of student career preparedness closely aligned with the department's student outcomes).
- Results are documented yearly and summarized in the Annual Assessment Report.

Departmental External Advisory Board

- Provides heuristic assessment of students' achievement of program outcomes. Further, completes an evaluation of the extent to which they believe MSU Civil Engineering graduates meet Program Outcomes on a scale of 1–very poor to 6 - excellent. The goal for this evaluation is that 80 percent of the responses are 4 – good or better.
- Provides input concerning department commendations and recommendations for improvement.
- Student performance related to each outcome is compared to metric goals.
- Results are documented and summarized in the Annual Report.

CE Faculty/Curriculum Committee

- Due to high degree of interest in student success and high degree of interaction between MSU CE faculty and program constituents, the CE faculty is well-informed about constituent issues/concerns with CE programs. Therefore, CE faculty input is invaluable in the continuous quality improvement efforts of the department.
- The department Curriculum Committee includes a representative from each of the sub-disciplines of civil engineering and construction engineering technology, the senior capstone class instructors, and the program coordinators. The department head and department academic advisor are ex-officio members of the committee.

Program Educational Objectives Assessment – Academic Year 2014 - 2015

As stated above, program objectives are evaluated each year by the Department’s External Advisory Board and its faculty. The External Advisory Board, composed of representatives from the engineering consulting and construction industries, are asked as part of their annual meeting to assess a) the extent to which they believe MSU Civil Engineering graduates meet the Program Objectives (on a scale of 0 to 10), b) the extent to which they believe the Objectives are suitable for the program (again on a scale of 0 to 10), and c) if the Objectives need to be revised. On the quantitative assessment, the metric goal for this evaluation is an average score of 7 for each objective. The Civil Engineering faculty review the program objectives at the beginning of the year, and with due consideration of any recommendations from the External Advisory Board, revise them as appropriate.

The numerical results of the External Advisory Board review of the Civil Engineering Program Educational Objectives during the 2014-2015 academic year are presented in Table 1 below. The average External Advisory Board assessments rendered in spring of 2015 all exceeded a score of 7. At the CE Department retreat in August (2015), the faculty reviewed the Program Educational Objectives and the External Advisory Board assessment of them. The Program Educational Objectives were re-affirmed by the faculty with no changes.

Table 1. Results of the External Advisory Board review of the Civil Engineering Program Objectives during the 2014-2015 academic year.

OBJECTIVE	Suitable?			Met?		
	2013	2014	2015	2013	2014	2015
All graduates of the Civil Engineering Program can expect to be able to:						
1. enter the profession of Civil Engineering and advance in the profession to become registered professional engineers and leaders in the field of Civil Engineering	9.6	9.4	9.4	8.5	9.4	9.1
2. work on multi-disciplinary teams and effectively communicate with Civil Engineers of various sub-disciplines, architects, contractors, the public and public agents, scientists and others to design and construct Civil Engineering projects	9.5	9	9.6	7.9	8.1	8.6
3. begin to develop expertise in one of the sub-disciplines of Civil Engineering and engage in the life-long learning necessary to advance in the Civil Engineering profession	8.9	9.6	9	8.5	9.1	8.6
4. contribute to society and the Civil Engineering profession through involvement in professional related and/or other service activity, and	8.8	9.5	8.8	8.4	8.8	8.5
5. conduct their affairs in a highly ethical manner holding paramount the safety, health and welfare of the public and striving to comply with the principles of sustainable development.	9.5	9.8	9.9	8.1	8.6	9.3
Some graduates of the Civil Engineering Program can expect to be able to:						
6. enter the surveying profession and become licensed to practice surveying;	7.5	4.8	-	6.9	6.3	-
7. begin careers in the construction industry; or	8	8.5	-	8.5	8.4	-
8. earn advanced degrees in Civil Engineering or other fields.	8.1	8.4	nv	8.8	8.5	nv

Notes: Table 1 - Following this same assessment process, Program Educational Objectives 6 and 7 were eliminated in 2013-2014. Note that Program Educational Objective 8 (renumbered as program educational objective 6 following 2013-2014) was not included in the EAB survey in 2014-2015.

Program Outcomes Assessment – Academic Yr 2014 - 2015

As summarized above, program Outcomes each year are assessed using the following instruments:

1. Fundamentals of Engineering Exam
2. Review of Student Work
3. Student Interviews/Surveys
4. Department External Advisory Board
5. Career Fair Surveys
6. CE Faculty/Curriculum Committee

Assessment data and analysis from each of these instruments is presented below. This assessment data is presented to the faculty at the Department's annual retreat in August each year, at which time it is thoroughly discussed and action items established for the following academic year.

1. Fundamentals of Engineering Exam

Pass rates for students from the MSU Civil Engineering Department on the FE Exam over the past several years are presented in Figure 1. Pass rates for MSU CE students consistently exceed the national average pass rate. Three consecutive cycles below the national pass rate overall, or three consecutive cycles of less than the national pass rate on a per-topic basis, trigger action. Topic area results are presented in Table 2. Referring to Figure 1 and Table 2, overall and by topic areas CE students performed better on the exam compared to the national average. No action was taken.

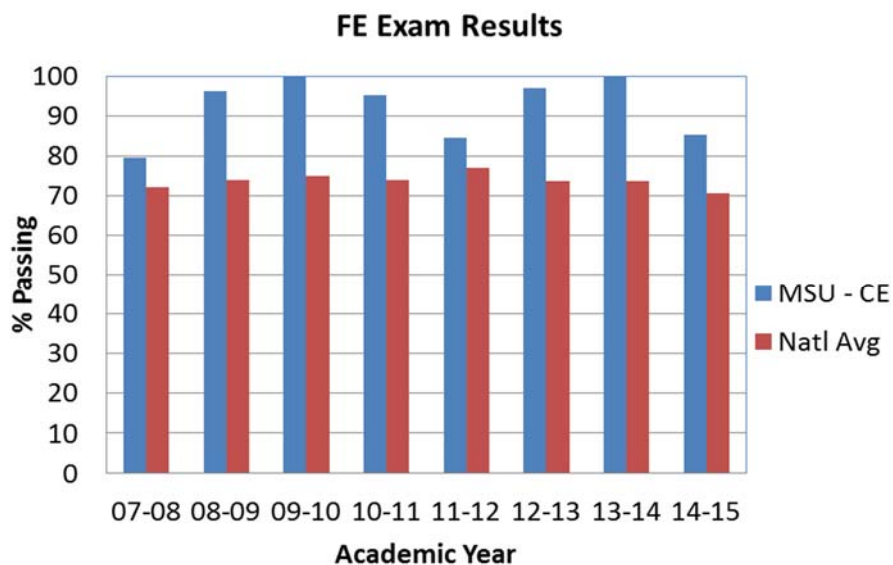


Figure 1. Overall FE exam pass rates.

Table 2. Topic specific results of the FE Exam.

	Oct 2009	April 2010	Oct 2010	April 2011	Oct 2011	April 2012	Oct 2012	April 2013	Oct 2013	Spring 2014	Fall 2014	Spring 2015	Avg
Math	1.22	1.09	1.16	1.11	1.07	1.01	1.14	1.09	1.15	1.10	0.95	1.00	1.10
Statistics	1.25	1.13	1.11	1.06	1.03	0.94	1.17	1.15	1.19	1.08	1.02	1.02	1.10
Chemistry	1.14	1.08	0.92	1.09	1.03	0.97	1.04	1.00	1.10				1.04
Computer	1.04	1.03	1.10	1.00	0.73	0.96	0.96	0.99	1.06	0.92	1.08	0.95	0.99
Ethics/Business	1.14	1.01	1.04	1.05	1.04	0.98	1.11	1.02	1.03	1.10	1.04	0.98	1.05
Economics	1.19	1.15	1.07	1.08	1.03	0.99	1.11	1.09	1.25	1.35	1.17	1.02	1.13
Statics	1.31	1.20	1.15	1.19	1.04	1.03	1.12	1.03	1.25	1.09	0.99	0.98	1.13
Dynamics	1.26	1.24	1.12	1.11	1.21	1.12	1.13	1.07	1.29	1.10	0.98	1.04	1.15
Strength	1.20	1.21	1.16	1.15	1.20	1.13	1.19	1.03	1.24	1.02	0.97	1.02	1.14
Materials Prop	1.28	1.10	1.18	1.22	0.96	0.89	1.19	0.92	1.16	0.96	1.10	1.05	1.09
Fluid Mechanics	1.20	1.27	1.09	1.16	1.18	1.06	1.13	1.10	1.19	1.14	0.93	1.03	1.13
Elect/Mag	0.91	0.98	0.77	0.93	0.98	0.91	1.04	0.81	1.15				0.94
Thermodynamics	1.02	1.36	1.08	1.19	1.11	1.05	1.27	1.10	1.30				1.16
Surveying	1.37	1.24	1.07	1.20	1.09	1.05	1.18	1.18	1.04	1.36	1.07	1.10	1.17
Hydraul/Hydrolog	1.37	1.19	1.28	1.13	1.17	1.27	1.33	1.14	1.41	1.11	1.04	1.08	1.22
Soil Mechanics	1.18	1.27	1.12	1.10	1.15	1.17	1.21	1.10	1.25	1.23	1.07	1.03	1.17
Environmental	1.18	1.09	1.17	1.05	1.07	1.07	1.18	1.18	1.16	1.06	0.99	1.02	1.11
Transportation	1.14	1.12	1.07	1.31	1.23	1.06	1.11	1.24	1.17	1.10	0.96	1.03	1.14
Struct Analysis	1.11	1.21	1.09	1.22	1.07	1.07	1.26	1.06	1.18	1.04	0.99	1.05	1.12
Struct Design	1.15	1.11	1.02	1.11	1.16	1.04	1.14	1.13	1.25	0.99	1.07	0.96	1.11
Const Mgmt	1.13	1.27	1.07	1.15	1.15	1.13	1.21	1.11	1.11	1.21	0.93	1.00	1.13
Materials	1.09	1.11	1.11	1.11	1.00	1.07	1.23	1.14	0.95				1.09

2. Review of Student Work

The Civil Engineering program assessment plan calls for review of a portfolio of student work by the CE Department Curriculum Committee and by members of the CE Department External Advisory Board. Material reviewed in 2014-2015 was:

Presentations

- ECIV 492 Reno Prep Class
- ECIV 499 Capstone Senior Design – 2nd Semester

Posted on secure EAB website

- EGEN 115 Engineering Design Graphics
- EGEN 201 Statics
- ECIV 312 Structures I
- ECIV 405, Scheduling and Planning

The review by both entities generally found satisfactory to outstanding student performance relative to targeted program outcomes. The External Advisory Board further commented on the quality of the ECIV 499 presentations, but noted potential for improvement of communication skills. No specific action was taken.

3. Student Interviews

Senior exit interviews occur on two levels – departmental and college. At the departmental level, senior exit interviews consist of optional one-on-one visits between the graduating student and the Department Head. Students are alerted to the opportunity to engage in these open forum discussions as part of ECIV 499. Students rarely take advantage of the opportunity, and when they do they often focus the discussion on personnel rather than curriculum or facilities. Occasionally, constructive feedback is generated in the process and the Department Head passes this to the faculty at the annual faculty retreat if it is appropriate. No such input was received during this evaluation period.

For the past several years, the CE Department has obtained student input on its programs through a senior exit survey administered electronically by the central administration. For students from the College of Engineering, this survey has questions specifically configured to assist in outcomes assessment for engineering curriculums (in this case, Outcomes 1-11 in the MSU Civil Engineering program). For each outcome, students are asked to indicate if their curriculum was highly effective, effective, neutral, ineffective, or completely ineffective in realizing it. These responses have been numerically represented using a scale of 0 – completely ineffective - to 4 – highly effective.

A summary of student response over the past five years by program outcome is presented in Figure 2. Average student outcome assessments generally range from 2.5 (somewhat effective) to 3.0 (effective). Comments are also solicited on the senior surveys on program strengths and weaknesses. These comments are scrutinized by the faculty (at the annual retreat) and External Advisory Board (at the annual meeting) for repeated themes within the current year and across consecutive years. Based on these assessments, action has been triggered with respect to the “awareness of contemporary issues” (three consecutive cycles with a score of less than 2.5 on a scale of 1 to 4, or 3.5 on a scale of 1 to 5). The action will begin with a review and discussion by the department curriculum committee, which will take place during the Fall of 2015, and proceed from there.

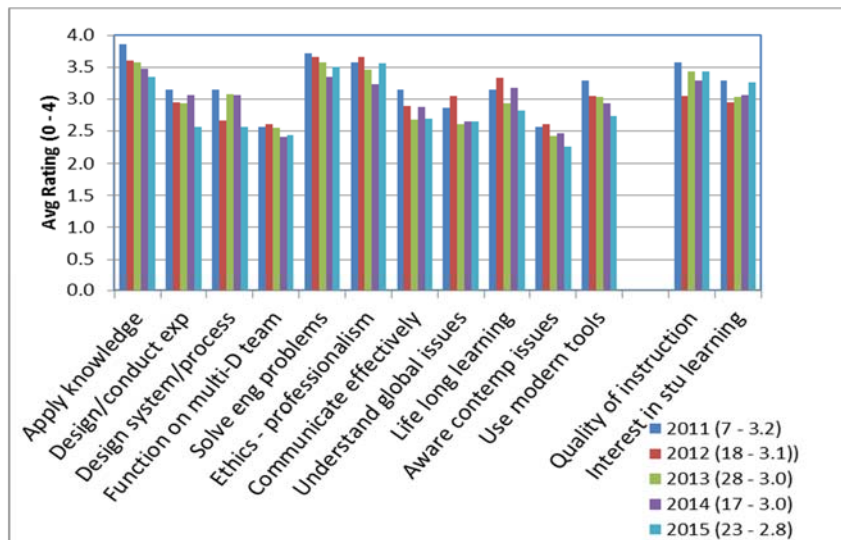


Figure 2. Summary of centrally administered senior surveys.

4. Department External Advisory Board

The Department's External Advisory Board meets annually to review from a professional practice perspective almost all aspects of the Department's programs. Some of their roles in outcome assessment have already been described above as the results from various assessment instruments have been presented and discussed. The majority of the Board's input is obtained at the annual Board meeting by the CE Department Head and CE Program Coordinator. This information is then disseminated as appropriate to Department faculty and committees.

Program Outcomes are directly evaluated each year by the Department's External Advisory Board. The External Advisory Board is asked to assess the extent to which they believe MSU Civil Engineering graduates meet the program outcomes (on a scale of 1–very poor to 6 - excellent). The goal for this evaluation is that 80 percent of the responses are 4 – good or better.

The numerical results of the External Advisory Board review of the Civil Engineering program outcomes over the last three years are presented in Table 3 below. The overall average rating for this past year is 5.1/6 which was deemed very acceptable and represents a nominal improvement over the previous year. No actions were taken.

Table 3. Assessment of program outcomes by the EAC.

OUTCOME	Out of 6			Change
	2013	2014	2015	
1. apply knowledge of mathematics, science, and engineering	5.4	5.8	5.6	0.97
2. design and conduct experiments and analyze and interpret	4.4	4.8	5.3	1.09
3. design a system, component, or process to meet desired needs within	4.4	5	5.1	1.03
4. function as a member of a multidisciplinary team	4.9	5.2	5.3	1.02
5. identify, formulate and solve engineering problems	5.4	5.7	5.8	1.01
6. explain professional and ethical responsibility	5.1	4.7	5.4	1.14
7. compose and present effective written, verbal and graphical	3.7	3.8	4.3	1.12
8. draw upon a broad education to explain the impact of engineering	4.7	4.5	5.0	1.11
9. explain the need for, and demonstrate the capacity for, life-long learning	4.8	4.7	5.1	1.08
10. explain contemporary issues as they relate to the solution of	4.5	4.8	4.9	1.02
11. apply the techniques, skills and modern tools necessary for engineering	5.1	5	5.3	1.05
12. synthesize and evaluate knowledge in a specialized area related to civil	4.8	5.2	5.6	1.08
13. explain the elements of project management, construction and asset	4.7	4.7	4.6	0.98
14. explain the fundamentals of business, public policy and administration	3.7	4.2	4.0	0.95
15. explain the role of the leader, leadership principle, and attitudes	4.2	4.7	4.8	1.01
Average	4.7	4.8	5.1	1.05

5. Career Fair Employer Surveys

Montana State University annually hosts two career fairs, one each in the fall and spring semesters. Prior to this assessment period, employers at the career fair were directly asked to comment on the on-the-job performance of our graduates, with the survey questions closely related to target program outcomes. A new survey was adopted this assessment period, with employers now commenting on our student's preparedness a) to enter the workforce and b) to interview with their company. Performance is assessed numerically on a scale of 1

(corresponding to “to a very limited extent”), to 5 (corresponding to “to a very great extent”). The action trigger for this assessment tool is three consecutive reportings with a category average below 3.5.

Results from the career fair employer surveys for the two career fairs during the 2014 – 2015 academic year are summarized in Figure 3. Survey responses most pertinent and appropriate in assessing student outcomes are:

- 1) Career Preparedness
- 2) Verbal Communication
- 3) Nonverbal Communication

The nominal numerical average score on each of these outcomes is 4 (“good”), and no action was taken.

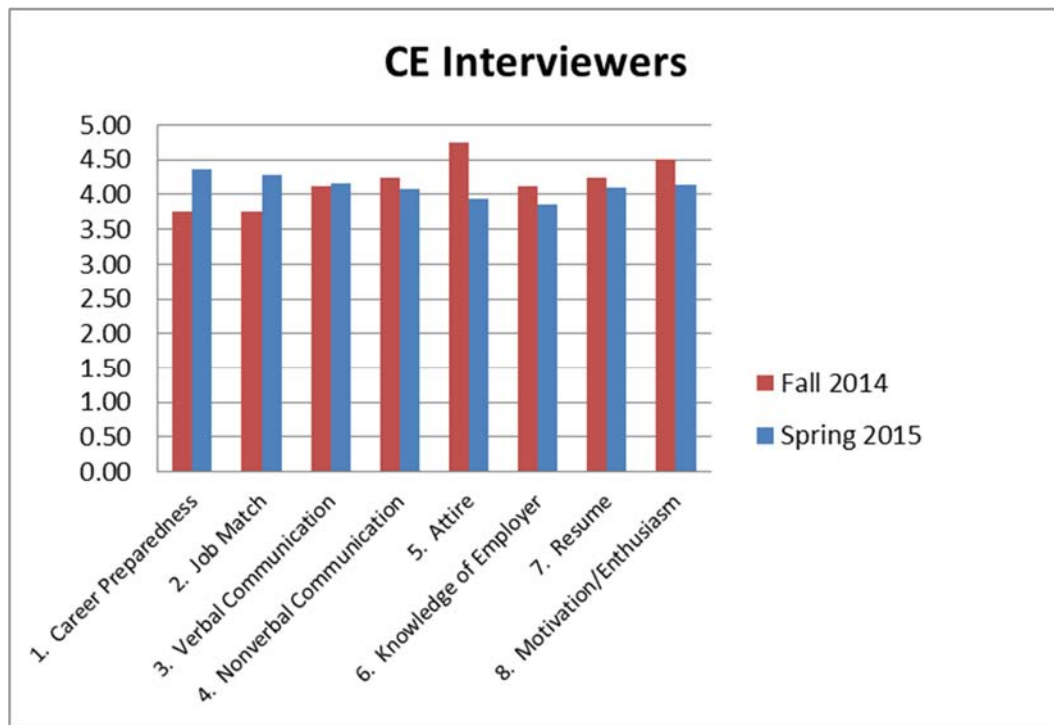


Figure 3. Career Fair employer survey results.

6. CE Faculty/Curriculum Committee

Department curriculum committee discussions/actions during the 2014-2015 academic year that resulted from the action items generated in the 2013-2014 assessment cycle included:

- Work on improving the written communication skills of students.
Central administration was asked to increase the availability of the university’s technical writing class, WRIT 221, to students in the civil engineering curriculum. Starting in Spring 2015, the number of sections of WRIT 221 was increased from two to three sections each semester. Faculty in the CE department also have committed to increasing student written communication exercises across their civil engineering

- courses. One notable example is that a technical editor was brought in to ECIV 315 to review and provide feedback to students on their laboratory reports.
- Support and review the results of the significant revision of the College of Engineering's interdisciplinary engineering design course, EGEN 310, relative to achievement of course objectives and student satisfaction with course conduct.
The COE has begun a critical review of the curriculum college-wide (started summer 2015), and this course has risen to prominence in that discussion. In Fall 2014, a new instructor was hired for EGEN 310, with various sections of the class now being focused on different engineering disciplines.
 - Investigate avenues to increase student awareness of contemporary societal and global issues.
The content in ECIV 401 has been altered to reflect his goal.
 - Investigate if the credits required by the program for graduation (128 cr) can be reduced, in response to a College request to look at this issue.
This task is on-going, as part of the college-wide curriculum review. The general consensus among CE faculty is that this would do more harm than good, although the discussion continues.

Other actions resulting from curriculum committee discussions include:

- The new BIM elective (ECIV 309) introduced in Fall 2014 will be increased from 2 to 3 credits in Fall 2015. The capabilities and role of BIM in infrastructure design and construction continues to expand, readily justifying this increase in course credits.

Department curriculum committee discussions that merit consideration as action items in the 2015 – 2016 academic year include:

- assessment of the environmental engineering curriculum in response to changes in faculty in this area,
- content realignment in the CAD course to reflect current software trends in the profession, and
- investigation of increased emphasis on sustainability in the curriculum, in anticipation of ABET changes that have been identified for the next cycle.
- a college-wide effort was started in Spring 2015 by the COE Dean to review all COE undergraduate curriculums “from the ground up.” This effort is timely, as planning gets underway for the new Asbjornson Innovation Center, as changes are proposed for the university CORE curriculum, as we prepare for ABET accreditation, and as the college moves forward with many new faculty hires. A COE committee will be formed for this purpose, with a representative from each department.

Action Items for Academic Year 2015-2016

Based on the above observations and discussions at the August 2015 department retreat, action items for the 2015 – 2016 academic year include:

- Continue to work on improving the written communication skills of students.
- Continue to examine the extent to which content concerning contemporary societal and global issues is represented in the curriculum, the possibility of shortcomings in that regard, and corrective action if warranted.
- Participate in the COE-wide reinventing the curriculum effort.
- Continue to support and review the potential for significant revision of the College of Engineering's interdisciplinary engineering design course, EGEN 310, relative to achievement of course objectives and student satisfaction with course conduct.
- Review the department's environmental engineering course offerings in the context of our new hires in environmental engineering.
- Investigate increased emphasis on sustainability, in anticipation of ABET changes that have been identified for the next cycle.
- Continue to review our graphics course offerings. The state-of-the-practice relative to the nature and role of technical graphics in the design and execution of engineering projects continues to evolve. Research needs to be conducted on what other programs are doing in these regards.
- Consider updating our program assessment plan. This plan was developed in 2011; since that time accreditation requirements, program objectives and outcomes, and available data on student performance have changed.