BSIE and BSE Assessment Plan
Department of Engineering
Colorado State University-Pueblo

Table of Contents

Schedule of assessment activities 2
Constituencies 3
Program Educational Objectives 3
Student Outcomes 4
Relationship of Student Outcomes to Program Educational Objectives 5
Outcome Champions 6
Design of program to support Student Outcomes 7
Matrix showing course support of outcomes for BSE 8
Assessment of Outcomes 10
Evaluation of Outcomes 10
Most recent evaluation of each Outcome 12
Changes to this document 29

Schedule of assessment activities

	2018-2019		2019-2020		2020-2021		2021-2022		2022-2023		2023-2024		2024-2025	
	FA	SP	FA	SP	FA	SP	FA	SP	FA	SP	FA	SP	FA	SP
Advisory Board meets		√		x		x		x		x		x		x
Program educational objectives														
Faculty and Advisory Board evaluate objectives		x						x						x
Faculty review info from LinkedIn		x						x						x
Student outcomes														
Faculty review outcomes and course/outcome matrix			x						x					
Every semester, assessments are performed according to outcome/course matrix to measure the extent to which that outcome is achieved in that course														
Faculty review results of assessments and apply to development of the program:														
1. identify, formulate, and solve complex engineering problems.	x						x						x	
2. engineering design					x						x			
3. communicate effectively			x						x					
4. ethical and professional responsibilities		x						x						x
5. team					x						x			
6. experimentation and data				x						x				
7. acquire and apply new knowledge						x						x		

Constituencies

The Program Educational Objectives for the BSE and BSIE programs are based on the needs of our constituency, local and regional companies as employers of our students and alumni. In revising the PEOs faculty also consider the needs of students and alumni, particularly their needs to be prepared for successful careers and for graduate school.

As discussed below, we rely on our Advisory Board for feedback. That Board includes entrepreneurs, small businesses, businesses with a regional market, businesses with national and international markets, and subsidiaries of major international companies. Thus, our designated constituency, local and regional companies, can bring us information from a local, regional, national and world perspective on what our graduates should be expected to achieve.

Program Educational Objectives

During the first few years after graduation, BSIE and BSE graduates should be able to:

BSIE Educational Objectives	BSE Educational Objectives
1. Identify root causes and solve engineering problems.	1. Identify root causes and solve engineering problems.
2. Function well as individual contributors and on multidisciplinary teams,	2. Function well as individual contributors and on multidisciplinary teams,
3. Obtain jobs of increasing responsibility applying industrial engineering skills and knowledge to a wide range of problems in a wide range of industries,	3. Obtain jobs of increasing responsibility applying engineering skills and knowledge to a wide range of problems in a wide range of industries,
4. Continue their education at the graduate level,	4. Continue their education at the graduate level,
5. Obtain additional engineering certifications.	5. Obtain additional engineering certifications.
6. Design new and improve existing production and service systems.	6. Design new and improve existing mechatronic systems.

Program Educational Objectives 1-5 are identical for the two programs.

The Advisory Board meets every year. At least every three years, the faculty and then the Board review these objectives. Information from tracking alumni on LinkedIn is used to determine the career success achieved by our graduates. At least every three years, a summary of information on job titles, degree and certifications earned, and other career achievements are reviewed by the faculty and the Board.

Student Outcomes

For both programs, the Department has adopted ABET's (1)-(7).

At the time they graduate, BSIE and BSE graduates should have:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Evaluation of the Student Outcomes is done in conjunction with the evaluation of the Program Educational Objectives so that if the Objectives change, the effect on the Outcomes will be considered at that same time.

Relationship of Student Outcomes to Program Educational Objectives

The table shows which Student Outcomes support (+) and strongly support (++) each Program Educational Objective (PEO), as explained below.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. Identify root causes, solve problems	++	+				++	
2. Function well on teams			+		++		
3. Obtain jobs of increasing responsibility	++	++	+	+	+	++	+
4. Continue education	+		+				++
5. Obtain certifications				+			++
6. Design and improve systems		++	+	+		+	+

1. Identifying root causes and solving engineering problems require a strong foundation in experimentation and the analysis of data (6), in identification, formulation, and solution of engineering problems (1), and in the ability apply engineering design (2).
2. A graduate must be able to contribute as an individual and to function well on teams. While we expect graduates to continue to grow in this area, to ensure that our graduates can function well on teams after they graduate, they must have achieved a certain level of performance on teams before they graduate (5). Achieving this PEO also requires an ability to communicate effectively (3).
3. Each Student Outcome helps prepare graduates to obtain jobs of increasing responsibility. We find that companies look strongly at the technical skills for initial hires (1), (2), and (6), but that moving further in a career requires a graduate to enhance teamwork (5) and communication (3) abilities, while also demonstrating ethical and professional responsibilities, making informed judgments in context (4), and continuing to acquire and apply new knowledge (7).
4. If we can help our students understand the importance of acquiring and applying new knowledge (7), they are more likely to seek to continue education at the graduate level. Since admission to graduate programs usually requires good scores on standardized test, the ability to apply math and science (1) and the ability to communicate effectively (3) also prepare students to attain this outcome.
5. As with graduate education, students are prepared to attain this outcome primarily based on their commitment to continuing to acquire and apply new knowledge (7).
6. An ability to apply engineering design (2) is necessary preparation for graduates to be able to design and improve systems after they graduate, but the design ability must be supported by other skills (3), (4), (6), and (7), especially those that provide the larger context for design and that support continued learning.

Outcome Champions

The following are the designated champions for each outcome:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. Prof Bedoya
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. Prof Ansaf
3. an ability to communicate effectively with a range of audiences. Prof Jaksic
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts. Prof Fraser
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives. Prof Wollega
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions. Prof Bedoya
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies. Prof Duong

The champion is expected to:

- Every third year, according to the specified schedule, review assessments for that outcome and report to the faculty.
- Suggest teaching methods and assessment methods (including rubrics) for that outcome.

Design of program to support Student Outcomes

The overall program is designed to ensure support of all Student Outcomes. The matrix “Course support of outcomes” (shown on the next page) summarizes how strongly each course supports each Student Outcome, where

- I = introductory material is used
- D = developing expertise is expected from students
- P = proficiency is expected from students
- blank = no emphasis on this program outcome

In addition, the following notation is used to indicate if assessment is done in the course.

- A = considerable content and Assessment is done for this program outcome.
- A* = considerable content and Assessment (separated by BSIE and BSE) is done for this program outcome.

This matrix is evaluated by the faculty at the same time that the Program Educational Objectives and Student Outcomes are evaluated.

Matrix showing course support of outcomes for BSE

BSE Student Outcome																									
A graduate of the program should be able to:	101 Intro	103 Progg	107 Graphics	211 Statics	212 Dynamics	231 Circuits	260 Electronic	263 ElecMech	321 Thermo	324 Materials	343 Econ	360 Contrl I	361 DigElec	362 IntroMech	363 VirtMach	375 Prob/Stat	430 Project	441 manuf	443 QC	460 Contrl II	462 Robots	473 CIM	486 seminar	487 Sr Proj	Number of A's
1. an ability to identify, formulate, and solve complex engineering problems ...	I	I	I	D	D	D, A	D	D	P	x	P	D	D	P	D	D	I	D	P	A	P	P	P	P, A*	3
2. an ability to apply engineering design ...	I		I	I						x		A	D	D	P	D		D	D	D	P	P	P	P, A*	2
3. an ability to communicate effectively with a range of audiences	I		I			D				x			D			D	A	D	D			D	P	P, A*	2
4. an ability to recognize ethical and professional responsibilities ... and make informed judgments, ...	I, A										D				I	D	D	D	D			D	P, A*	P, A*	3
5. an ability to function effectively on a team ...	I		I, A			D							D				P, A*	I				P	P		2
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and ... draw conclusions.	I					D				x		I			D	P, A*		D	P, A			P		P	2
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	I, A	I	I	D	D				D	x	I			D	D	D		D	D		P	P	P	P, A*	2

Matrix showing course support of outcomes for BSIE

BSIE Student Outcome																								
A graduate of the program should be able to:	101 Intro	103 Progg	107 Graphics	211 Statics	212 Dynamics	215 IE Intro	231 Circuits	321 Thermo	324 Materials	343 Econ	375 Prob/Stat	420 Simltn	430 Project	439 Hum Perf	440 Safety	441 manuf	443 QC	471 OR	473 CIM	475 Fac Plng	477 Ops Plng	486 seminar	488 Sr Proj	Number of A's
1. an ability to identify, formulate, and solve complex engineering problems ...	I	I	I	D	D	I	D, A*	P	x	P	D	P	I	P	x	D	P	P, A	P	P	P	P	P, A*	3
2. an ability to apply engineering design ...	I		I	I		I			x		D	P		P	x	D	D	P, A	P	P, A	P	P	P, A*	3
3. an ability to communicate effectively with a range of audiences	I		I			I, A	D		x		D	P	A	P	x	D	D	I	D	P	I	P	P, A*	3
4. an ability to recognize ethical and professional responsibilities ... and make informed judgments, ...	I, A					D				D	D	P	D	P	x	D	D	D	D	P	D	P, A*	P, A*	3
5. an ability to function effectively on a team ...	I		I, A			I, A	D					P	P, A*	P	x	I		I	P	P	D	P		3
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and ... draw conclusions.	I						D		x		P, A*	P, A		P	x	D	P A	D	P	P	D		P	3
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	I, A	I	I	D	D	I, A		D	x	I	D	P		P	x	D	D	I	P	P	I	P	P, A*	3

Assessment of Outcomes

The following form is to be completed for each outcome-course combination in which assessment is done. The form is completed each time that course is offered. The completed forms are maintained in notebooks in the Department office.

Semester:_____ **Course**: _____

Outcome:_____

Describe the assignment:

Attach the assignment and samples of student work: strong, medium, and weak.

ANALYSIS:

The goal for student performance on this assignment:

The degree to which the goal was met:

Changes implemented this semester to the process for this outcome:

The degree of success of those changes:

Suggestions for improvement for the next semester this course is taught:

Signature: _____ **Date**: _____

Evaluation of Outcomes

The assessments for each outcome are evaluated periodically using the following questions as guidance.

- Is the assessment process for this outcome working well? What can be improved?
- To what extent is this outcome being achieved?
- What changes to the program should be considered based on the results of these assessments?

An example of such an assessment is shown on the next page.

(k): use techniques, skills, and modern engineering tools necessary for engineering practice

Course	Semester	Goal met?	Notes	IE, E or both	Instructor
EN103	Sp13	Yes	The mean score goal of 75% was surpassed. Actual score was 95%	Both	DePalma
	Fa12	Yes	The mean score goal of 75% was surpassed. Actual score was 91.3%	Both	DePalma
	Sp12	Yes	The mean score goal of 75% was surpassed. Actual score was 95%	Both	DePalma
	Fa11	Yes	The mean score goal of 75% was surpassed. Actual score was 96.2%	Both	DePalma
	Sp11	Yes	The mean score goal of 75% was surpassed. Actual score was 97%	Both	DePalma
	Fa10	Yes	The mean score goal of 75% was surpassed. Actual score was 91%	Both	DePalma
	Sp10	Yes	The mean score goal of 75% was surpassed. Actual score was 100%	Both	DePalma
EN107	Sp13	Yes	The goal of 80% of students to score at 80% or better was met since 91% of students scored at 80% or better	Both	Paudel
	Fa12	No	The goal of 80% of students to score at 80% or better was not met since 75% of students scored at 80% or better.	Both	Paudel
	Sp12	Yes	The goal of 80% of students to score at 80% or better was met since 80.9% of students scored at 80% or better	Both	Paudel
	Fa11		not evaluated - adjunct	Both	Cakdi
	Sp11	Yes	The goal of 80% of students to score at 80% or better was met since 83% of students scored at 80% or better	Both	Cakdi
	Fa10		not evaluated	Both	Bloxsom
	Sp10	No	90% goal of completion of the final exam was not met since only 84% of the students completed the final exam	Both	Bloxsom
EN361	Sp13		not evaluated - adjunct	BSE	Paredes
	Sp12	Yes	The goal of 75% mean score on the assignment was met with 88% actual mean score	BSE	DePalma
	Sp11	Yes	The goal of 75% mean score on the assignment was met with 93% actual mean score	BSE	DePalma
	Sp10	Yes	The mean score goal of 75% was surpassed. Actual score was 87%	BSE	DePalma
EN443	Sp13		not evaluated - adjunct	Both	Russel
	Sp12	Yes	The goal of 80% of the students to score 80% or better was met. 13 out of 15 students (87%) scored over 80%.	Both	Sarper
	Sp11		not evaluated - adjunct	Both	Wiley
	Sp10		not evaluated - adjunct	Both	Wiley

Analysis:	The goal was met. There were only two instances in which the goal was not met.	
		N. Jaksic
Faculty Discussion:	The only two negative results were in EN 107. Corrective actions in EN 107 were succesful . Also, we addressed students' programming skills and ways to improve them.	

Most recent evaluation of each Outcome

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. Formerly (a) and (e).

(a) an ability to apply knowledge of mathematics, science, and engineering

Outcome a: apply knowledge of math, science, and engineering

Course	Semester	Goal Met	Notes	IE,BSE or both
EN 211	Fa14	Yes		Both
	Fa15			
	Fa16	No	Nearly met. 75% score at 80% the value was 74.35%	
EN 231	Fa14	Yes		Both
	Fa15	No		
	Fa16	No		
EN 460	Fa14	Yes		BSE
	Fa15	Yes		
	Fa16	Yes		
EN 471	Fa14			IE
	Fa15	Yes		
	Fa16	Yes		

Observations

Data supports that we are achieving this outcome. Attention needs to be made in EN 231. We discussed the two extremes of student's ability to recall and apply what they have been taught in previous classes. We need to make sure that they can apply the knowledge that they have been taught.

Jude L DePalma, May 2017

From 3 March 2017 department minutes: We do seem to be achieving this outcome, but sometimes the students have trouble formulating the mathematics and trouble then solving the mathematics. We discussed two extremes of their ability to recall and apply what they have been taught in previous classes – for example, some are comfortable with summation notation and others seem not to remember it. It is our job to make sure they can apply this knowledge.

(e) an ability to identify, formulate, and solve engineering problems

Outcome e: an ability to identify, formulate, and solve engineering problems			
Course	Semester	Goal met?	Notes
EN 231 Both	Fall 14	Yes	
	Fall 15	Yes	
	Fall 16	Yes	
EN 260 BSE	Spring 14	?	
	Spring 15	?	
	Spring 16	?	
EN 471 BSIE	Fall 14	Yes	
	Fall 15	Yes	
	Fall 16	Yes	
EN 487-488 Both	Spring 14	Yes	All five projects met the goal
	Spring 15	Yes	All projects met the goal
	Spring 16	Yes	All projects met the goal

The assessment process uses EN 231, EN 471, and EN 488 students. For BSE students EN 260 was added but not assessed yet. The outcome is being achieved for all the courses assessed.

Leonardo Bedoya-Valencia, 10 of March 2017

From 10 March 2017 department minutes: *EN 471 performance improved due to the changes implemented, which involved more practice. The key is practice. The senior projects showed no difference between BSIE and BSE students.*

2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. Formerly (c)
(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.

			outcome (c) an ability to design a system, component, or process to meet desired needs.	
Semester	Course	Goal met?	Notes	
EN 360	Fall 14	Yes		E
	Fall 15	Yes		E
	Fall 16	Yes		E
EN 362	Fall 14		not avaiable	E
	Fall 15	Yes	student work samples not collected	E
	Fall 16	Yes		E
EN 460	Spring 14	No	This is the first time the lecture and the lab portions of the course were separated, the instructor still tried to figure out a way to cope with the MATLAB-related practice in class.	E
	Spring 15	Yes		E
	Spring 16	Yes		E
EN 475	Fall 14	Yes		IE
	Fall 15	Yes		IE
	Fall 16	Yes		IE
EN 477	Spring 14	Yes		IE
	Spring 15	Yes		IE
	Spring 16	Yes		IE
	Spring 17	Yes		IE
EN 487	Spring 14	Yes		E
	Spring 15	No	Mostly the mentoring worked very well. The two least successful groups did not have strong mentoring.	E
	Spring 16	Yes		E
EN 488	Spring 14	Yes		IE
	Spring 15	No	Mostly the mentoring worked very well. The two least successful groups did not have strong mentoring.	IE
	Spring 16	Yes		IE

obseravations:			**In genral the goal is met for outcome c**	

Faculty Dicussion: (10th March) (as shown in department notes)

We can test student progress on their ability to design in EN 360 and 460 (BSE) students and in EN 475 (BSIE students, so we will drop EN 362 and EN 477 for assessment.

Bahaa Ansaf

10 March 2017 department minutes: *The problem in EN 460 Spring 14 was fixed; same for EN 487/488. "Design" is a key word here. We can test student progress on their ability to design in EN 360 and 460 (BSE) students and in EN 475 (BSIE students, so we will drop EN 362 and EN 477 for assessment. The larger context for design can best be assessed in EN 487/488.*

3. an ability to communicate effectively with a range of audiences. Formerly (g)
(g) an ability to communicate effectively

Outcome g: EN215, EN487/488: 2014 - 2016 and EN430: Fall 2016				
Course	Semester	Goal met?	Notes	
EN215	Fall 2014	Yes	Since 14 out of 17 students scored 80% or above, the goal was met.	IE
	Fall 2015	Yes	Assessment of this objective was not performed	IE
	Fall 2016	Yes	All students earned 80% or more	IE
EN 430	Fall 2016	Yes	All students reached the goal (80% or higher)	Both
EN487/488	Spring 2014	Yes	All students met the goal even though one of the final project reports was excessively long (over 150 pages)	Both
	Spring 2015	N/A	Assessment of this objective was not performed	Both
	Spring 2016	Yes	All students followed professional communication standards, both in written and oral communications (proposals, weekly progress reports, final reports, poster boards, and final project presentations).	Both

Analysis:	The goal was met in each reported instance. During this assessment period, faculty had opportunities to judge all senior project presentations for the ABET communications outcome.
Faculty Discussion:	The goal is well-met. In most of the lab courses, we still require students to write lab reports.

N. Jaksic
3/10/2017

From 10 March 2017 department meeting minutes: *Many classes do presentations, lab reports, and other writing. EN 487 and 488 involve a lot of communication and a lot of growth. As documented in the 487 and 488 reports, no difference was detected between BSE and BSIE students.*

4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts. Formerly (f), (h), and (j).
(f) an understanding of professional and ethical responsibility

Outcome f: an understanding of professional and ethical responsibility

Course	Semester	Goal Met	Notes	IE,BSE or both
EN 101	Fa14	Yes		Both
	Fa15	No	computer issues - less time spent in classs on topic	
	Fa16	Yes, No		
	Sp14	NA		
	Sp15	No		
	Sp16	Yes		
EN 486	Fa14	Yes		Both
	Fa15	No	82% of students could identify two violations of the ABET code of ethics. The standard was 85%	
	Fa16	No	83% of students could identify two violations of the ABET code of ethics. The standard was 85%	

Observations

Data supports that more work is needed in achieving this outcome. Attention needs to be made in EN 486. Discussion included taking advantage of opportunities to discuss ethics in other classes where appropriate. Also we discussed teaching personal ethics and the relationship between personal ethics and professional ethics.

Jude L DePalma, May 2017

From the 21 April 2017 department meeting minutes:
Jude presented data and led the discussion. Leonardo described what he does in EN 101: one day of presentation of material (codes of ethics, Order of the Engineer); one day for students to work on analysis of a case study (for homework). In EN 486 he uses the same overview and the same

case, with higher expectations (knowledge, analysis, use of numbers) than in EN 101. We discussed at length that we all do something about ethics in every class, including opportunities to rant. For example, Bahaa described that in the Virtual Machine Design class he tells the students that design starts with the engineering code of ethics. In EN 477 Leonardo talks about how lean manufacturing that gets too lean can threaten safety and quality. We talk about idiot proofing for safety in several classes. Bahaa described the Daniels Fund workshop he attended recently on campus. We agreed that while we focus on knowledge and behavior for professional ethics, these cannot be separated from personal ethics. We seek to serve as role models for our students. We are disappointed that we had several "no" answers on whether the goal was achieved, but we think we are approaching the teaching of ethics the right way (throughout the curriculum) and we need to keep working at it.

(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.					
Course	**Semester**	**Goal met?**	**Notes**	**IE, E, or both?**	
EN 343	Fa 15			**Both**	
EN 487/488	Sp 13	Yes	Five of six reports included appropriate discussion of global and societal issues. All discussed sustainability	Both	Jaksic
EN 487/488	Sp 14	Yes	Four of five five teams discussed global and societal issues: factory in China, recycling. Only the Open-Source Robotic Arm did not discuss such issues. They did not generally include a separate section on such issues.	Both	Jaksic
EN 487/488	Sp 15	Yes	Seven of nine reports had strong discussions. Four projects were related to sustainability. Topics discussed included material choice, utilization of resources, energy use, and more.	Both	Fraser
		Yes	Both primarily IE teams had projects related to sustainability (evacuation and Pueblo county energy savings) and their discussions were strong.	IE	Fraser
		No	Five of the seven (71%) BSE reports had strong discussions.	E	Fraser
EN 488	Sp16	Yes	The two reports had adequate, but not really strong sections.	IE	Fraser
EN 487	Sp16	Yes	All five reports adequately described their project's societal/global impact.	E	Jaksic

The evidence shows that our students are able to understand and discuss the impact of engineering solutions.
We stress sustainability as the topic for students to address since sustainability includes the global, economic, environmental and societal context.
Jane Fraser, 11 May 2016

9 May 2016 discussion:

We should continue to ask senior project teams to write a separate paragraph, even if the entire project has a focus on such impacts because we want them to recognize and focus on these ideas at some point during the project. We currently ask teams to provide two paragraphs:

> *The report must include a section on the impact of your proposed solution in a **global and societal context**. Issues you may consider include: impact on workers, impact on the local community, environmental issues, and other relevant issues facing the community, state, nation, and world.*
>
> *The report must include a section on **sustainability** aspects of the project. Topics may include optimization of resources, product life cycle, benefits to the current and future generations, etc.*

We will integrate these two paragraphs into one, since sustainability involves a global, economic, environmental and societal context.

We think that our PROPEL funded emphasis on integrating sustainability throughout the curriculum has changed the curriculum and has had an impact on our students. For example, in the senior seminar in fall 2015, Professor Bedoya asked the students to brainstorm sustainability issues in the design of a smart phone and they were successful, with industrial engineering students focusing on manufacturing and material choice and engineering students focusing on design and energy use. We are having an impact on our students. They have to get it: it's their earth.

This section is worth 5 points of the final grade and will be graded using the following rubric:

Points	
5	Impacts of science or technology that are mentioned are appropriate, and the explanation of those impacts is complete. Tradeoffs are considered, as well as how the choice of engineering design affects the impacts.
4	Impacts discussed are appropriate, but explanation is incomplete or unclear.
3	Explanation is clear, but impacts discussed are incomplete or only somewhat appropriate.
2	Impacts mentioned are incomplete or only somewhat appropriate, and explanation is incomplete or unclear.
1	Impacts mentioned are either very obvious or not important, and there is no explanation of them.
0	Section is omitted or has none of the features described above.

Also, the report must include a section on **sustainability** aspects of the project. Topics may include optimization of resources, product life cycle, benefits to the current and future generations, etc.

This section is worth 5 points of the final grade and will be graded using the following rubric:

Points	
5	Section consists of one or more paragraphs. Sustainability aspects are well documented and integrated within the project.
4	Section consists of a single paragraph with appropriate examples, but justifications are incomplete or vague.
3	Section consists of a single paragraph but is not integrated into the project.
2	Section includes a single sentence.
1	Sustainability is mentioned only as a part of another objective.
0	Section is omitted.

(j) a knowledge of contemporary issues

	A	B	C	D	E
1	Outcome j: a knowledge of contemporary issues				
2	Course	Semester	Goal met?	Notes	
3	EN 343	Fa15	Yes	Buy auto insurance or self insure	
4	EN 343	Fa16	Yes	Buy auto insurance or self insure	
5	EN 487/488	Sp15	Weak yes	Thirty-two students working in teams completed nine senior design projects, seven with BSE students and two with BSIE students (one BSE student was on a primarily BSE team). The sustainability discussion in each report at least alluded to some contemporary issue, and for each report the goal was met, but only weakly. There was no difference between the BSE groups and the two BSIE groups.	
6	EN 487	Sp16	Yes	Seventeen students working in five teams (two IE and fifteen BSE students) completed five senior design projects. The goal was met since all five teams discussed contemporary issues (mostly sustainability) related to their projects in separate sections within the narrative of their final reports. There were no differences between the IE and the BSE-Mechatronics students with respect to this outcome.	
7	EN 488	Sp16	Yes	Five students working in teams completed two senior design projects: improvement of layout at pewag, and location for a new CT scanning device at Memorial Hospital. The pewag team discussed Pueblo employment and the Memorial Hospital team discussed the need to provide healthcare more efficiently.	
8	The assessments in courses show that we are achieving this outcome.				
9	In senior projects, is discussion of sustainability enough on contemporary issues? Or do we want teams to explicitly mention other contemporary issues?				
10	In December 2014 we said: Contemporary issues about which students should have knowledge: policy behavior; health care; how robotics and workers working together achieve high efficiency in US manufacturing; sustainability, which includes everything; energy and fracking; effects of cheap gasoline; AI is the death of humanity (Hawking); earthquake in China. Faculty should occasionally start class with "did you read about this in the news?" We should bring articles to class. Engineers need knowledge of contemporary issues, even those not directly related to engineering.				

From 3 March 2017 department meeting:
We used EN 343 as a place to assess this outcome because Prof Sarper was enthusiastic, but Ebisa is not sure it is good to do it in that class. In the senior projects, yes, the discussion of sustainability should mean that the report has discussed contemporary issues, but the report should also discuss other relevant contemporary issues. The professors who teach EN 487/488 call our students' attention to the requirements to include discussion of sustainability, contemporary issues, and lifelong learning, including grading and rubrics.
We confirmed our previous list of important contemporary issues, especially the role of engineering in putting people out of work. We need to help students learn critical thinking – how to understand news and information. We discussed examples of difficult topics we address in class – how someone's belief systems (including religion) can support sustainability, the implications of AI for free will and consciousness. We expressed some discomfort about the potential for a faculty member to be chastised for discussing some topics. If asked a direct question (e.g. who did you vote for?) it is ok to

answer, but we cannot ever forget we have a power relationship with a student. We will ask our visiting ABET team for advice in the fall.

5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives. Formerly (d).
(d) an ability to function on multi-disciplinary teams,

Course	Semester	Goal met?	Notes	IE, E, or both?	
EN 107	Fa16	Yes	Assignment: group project - create assembly working drawing. Performance standard: 85% of students score at least 90% or better and class average of 90%. Result: 85.71% students scored 90%, and the class average was 91.19.	Both	Ansaf
EN 215	Fa15	Yes	Assignment: describe lessons learned from teamwork. Performance standard: score 80% or better. Result: the goal was met.	IE	Fraser
EN 215	Fa16	Yes	Assignment: understand system design where inter-disciplinarily skill is needed. Performance standard: score 80% or higher. Result: 83% of the students earned 80% or higher.	IE	Wollega
EN 430	Sp16	Yes	Assignment: group project - apply project planning tools. Performance standard: 80% of the students score at least 80% or better. Result: both mechatronics and industrial engineering students earned 80% or higher.	Both	Wollega
EN 430	Sp17	Yes	Assignment: group project - apply project planning tools. Performance standard: 80% of the students score at least 80% or better. Result: both mechatronics and industrial engineering students earned 80% or higher.	Both	Wollega

From 1 December 2017 department meeting minutes:
Ebisa presented a summary of assessments; the goal was met in all classes and for both BSE and BSIE students. We discussed the difficulty in getting our students experience on "multi-disciplinary teams." Teams in EN 430 do have BSE and BSIE members. We think the new ABET outcomes remove this difficulty. We also discussed the need for engineering graduates to be able to work on multi-level teams, that is, teams with technicians as well as engineers. The evidence supports that our graduates achieve this outcome and we recommended no changes to the programs.

6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions. Formerly (b)
(b) an ability to design and conduct experiments, as well as to analyze and interpret data,
The assessment process is generally working well for this outcome. The evidence we have demonstrates that our graduates have achieved this outcome. On 1/8/2014, the department discussed this report and concluded that we do provide necessary amount of practice to meet this goal.

Outcome b: Analyze and Interpret Data, Design and Conduct Experiments				
Course	**Semester**	**Goal met?**	**Notes**	**EN/IE**
EN 375	Fa 14	Yes	39 students; 5 did not complete the assignment. Of the 34 projects completed, 91% scored 80% or better, so goal was met for those projects.	Both
EN 375	Fa 15	Yes	19 students; 1 did not complete the assignment. The rest were 80% or better. "I was very pleased with the level of the projects this year. Many of them were outstanding, going well beyond the minimum requirements and really demonstrating strong evidence of understanding the material from the course."	Both
EN 375	Fa 16	Yes	21 students (15 BSE students and 6 BSIE students); 18 out of the 21 students (86%), 13 out of the 15 BSE students (87%), and 5 out of the 6 BSIE students (83%) achieved 80% or better so the goal was met. The two BSE students with 0 did not turn in projects. BSE and BSIE students do not seem to differ in their performance on this assignment. Overall, the students demonstrated good “ability to design and conduct experiments, as well as to analyze and interpret data.” The assignment involves less design of experiments and more analysis and interpretation of data.	Both
EN 420	Sp 14	Yes	Develop a simulation model for a specified situation; design a process (including number of replications) to estimate a measure of performance with 95% confidence level.	IE
EN 439	Fa 14	Yes	Analyze and interpret data from a work sampling study to answer specific questions.	IE
EN 439	Fa 15	Yes	Analyze and interpret data from a work sampling study to answer specific questions.	IE
EN 439	Fa 16	No	Analyze and interpret data from a work sampling study to answer specific questions.	IE
EN 443	Sp 14	Yes	HW analyzing data from an experiment the class designed and grad students performed; Two of the 16 undergraduate students did not do the homework. The 14 other undergraduate students (87.5%) scored 80 or above, so the goal was met. The IE students average was 91.4 and the EN average was 93.4; the difference is not statistically or practically significant.	Both

EN 443	Sp 15	Yes	HW assignment to create and explain factorial and 1/2 fraction designs in Minitab. The class had 36 students, 10 BSIE students and 26 BSE students. Two of the 36 undergraduate students did not do the homework. Of the 34 who attempted the homework, 31 (91.2%) scored 8 out of 10 or above, so the goal was met. Omitting the students who did not do the assignment (two EN students), the average for the 10 IE students was 8.8 and the average for the 24 EN students was 9.1. Three nondegree students from Brazil are omitted from this analysis.	Both
EN 443	Sp 16	Yes	The class had 18 undergraduate students, 3 BSIE students and 15 BSE students. Four (1 BSIE and 3 BSE students) did not do the homework. Of the 14 who attempted the homework, all scored 8 out of 10 or above, so the goal was met. There was no difference between BSIE and BSE students in performance on this assignment.	Both
EN 473	Fa 14	Yes	Program a CNC mill to produce a part.	Both
EN 473	Fa 15	Yes	Program a CNC mill to produce a part.	Both

We are achieving this outcome. The assessment process seems to be working well.
Jane Fraser, 21 April 2017

From the 14 April 2017 department minutes: *We discussed the meaning of each clause. While "Analyze and interpret data" is clear to us, what is the meaning, in an engineering, not scientific framework, of "Design and conduct experiments." What is an engineering experiment? EN 375 addresses data, while EN 443 addresses experimentation. We tentatively agreed to add A back to EN473.*

21 April 2017 department minutes: Current: (b) an ability to design and conduct experiments, as well as to analyze and interpret data
Proposed: (3) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
Dictionary.com: experimentation is "the act, process, practice, or an instance of making experiments."
Jane presented a rubric from Cornell ECE that seems to use engineering experiments, not scientific experiments. We agreed to use the EN 473 assignment (students must write a CNC program to drill two holes, mill around the part, and debug it until it works); They must experiment and see what works.
EN 375 has considerable material on analyzing and interpreting data, and EN 443 on design of experiments from a statistical analysis point of view.
We are covering the material and our assessment process is good.

7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies. Formerly (i).
(i) a recognition of the need for, and an ability to engage in life-long learning
We focus on a recognition of the need for life-long learning in EN 101 and assess it by asking on the midterm why engineers need to engage in life-long learning. We all reinforce life-long learning in all Engineering courses. In EN 487/488, the students discuss how you detect and remedy a gap in knowledge; we will make sure the discussion covers the points we discussed. We will assess lifelong learning in EN 487/488 by having the students include a section on it in their reports.

Points we will stress in EN 487/488 discussion:
You detect a gap in knowledge when someone point it out to you, when you feel a lack of certainty, or when you have questions you can't answer. You fill a gap in knowledge by reading books, industry publications, and articles. You can find and ask an expert. In some cases you can learn by trial and error: you can try, make errors, and fix what you did. If you forget something from a previous course, you need to learn it again. Part of life-long learning is reviewing what you knew once so you can apply it again. As you progress in your career, you will accumulate knowledge, but you will also gain professional wisdom. Remembering concepts is more important than details. You need to know where you can find answers. You need to know who you can ask to find answers.

Assessment in EN 487/488: The Senior Design final report must include a section "in which you (briefly) describe knowledge that you did not learn in any engineering course, but that you had to learn in order to complete your project. This section is meant to demonstrate your ability to engage in life-long learning. How did you determine what you needed to learn? How did you select the material and the learning method you used?"

That section is worth 5 points of the final grade and will be graded using the following rubric:

Points	
5	Describes clearly knowledge that was needed and why it was needed; how learning material was located and evaluated; how a learning method was selected; material used to learn the new knowledge; and how the knowledge was applied in the project.
4	All required topics are covered but some are not clearly described.
3	Description is clear but some required topics are omitted.
2	Some required topics are omitted and others are not clearly described.
1	The required section is present, but only minimally completed.
0	Section is omitted or has none of the features described above. Project did not involve learning and using knowledge not learned in an engineering course.

Outcome i: a recognition of the need for, and an ability to engage in life-long learning					
Course	**Semester**	**Goal met?**	**Notes**	**IE, E, or both?**	
EN101	Fa14	Yes	"Why is it so important for engineers to commit life-long learning?" 86% scored 80% or better.	Both	Bedoya

EN101	Fa14	Yes	"Why is it so important for engineers to commit life-long learning?" 91% scored 80% or better.	Both	Yuan
EN101	Sp15	Yes	Midterm: "Describe a way that you will engage in lifelong learning after you graduate." All but one student received full points.	Both	Fraser
EN101	Fa15	Yes	"Why is it so important for engineers to commit life-long learning?" 91% scored 80% or better.	Both	Yuan
EN101	Fa15	Yes	Essay written in pairs about why it is so important to commit to life-long learning. 100% gave good reasons, such as changing technology, knowledge, rules, and regulations	Both	Bedoya
EN101	Sp16	Yes	"Why is it so important for engineers to commit life-long learning?" 81% scored 80% or better.	Both	Yuan
EN215	Fa14	Yes	Midterm question: Describe one activity you plan to use after you graduate to ensure that you continue to learn. How and what will you learn by doing this activity? All received full points.	Both	Fraser
EN215	Fa15	Yes	Midterm question: How will you keep up with developments in industrial engineering after you graduate? All received full points	Both	Fraser
EN487 and 488	Sp14	Yes	All 17 students (in five teams) demonstrated this ability. While students did not document in a separate secton of their final reports what they learned, they included detailed information on acquired new knowledge throughout their final reports.	Both	Jaksic
EN487 and 488	Sp15	No	17/32 students (54%) and 5/9 projects (55%) gave clear statements, even though all teams did engage in LLL.	Both	Fraser
		Yes	8/8 students and 2/2 projects gave clear strong statements on LLL. Used online material and experts.	BSIE	Fraser
		No	9/16 and 3/7 projects gave clear statements on LLL.	BSE	Fraser
EN 487	Sp16	Yes	All had clear statements	BSIE	Fraser/Jaksic
EN 488	Sp16	Yes	All had clear statements	**BSE**	Fraser/Jaksic

Analysis: The assessment process is generally working well for this outcome. Students in EN 487/488 demonstrate that they can learn new material.

In EN101 we introduce the idea and make sure they are aware; in EN215 we reinforce methods for LLL; in EN487/48 we require them to demonstrate their ability to engage in LLL.

Recommend being more explicit about 487/488 paragraph - courses they applied; what and how they learned new material

I recommend no changes to the BSE program, the BSIE program, or our assessment methods. We are doing well on this outcome.

Jane Fraser, 10 May 2016

From 10 May 2016 department meeting minutes:

Leonardo reported on a discussion at the IISE national meeting. People recommended against using multiple choice questions to assess this outcome (we already do not do this) and recommended getting students into student organizations to promote lifelong learning. Programs assess the outcome by looking at the percent of students in student organizations. Our department pays the first year of student membership in any one professional organization: IISE, IEEE,ASME, SWE, NSBE, MAES, SHPE; we will put a permanent announcement on the Engineering Majors blackboard so students are aware of this policy.

Jude described how Space Grant projects require lifelong learning. In the required reports, he asks students to answer questions such as: what did you learn, how did you know you needed to learn this material, and how did you choose to learn the material. He doesn't require students to answer all questions. He plans to add examples of good answers to future instructions for the report.

We agreed with Jane's conclusion that we have a good strategy for promoting lifelong learning throughout the program and we have a good method of assessment. The evidence is that our students are meeting this criterion.

We discussed our assessment of lifelong learning in the senior project classes, EN 487 and EN 488. We agreed that most of the attention in that class is appropriately on the project. We will continue to require a paragraph related to lifelong learning: describe what you already knew; describe what you needed to learn to complete the project; and describe how you learning that material. The instructions to students in EN 487/488 and the rubric will be revised to reflect this change.

Changes to this document

- 20 October 2007, added material from 1 November 2006 department meeting about which FE afternoon test a Mechatronics student should take.
- 5 December 2008, added description of constituencies, as approved at 19 November 2008 department meeting.
- 21 April 2009, changed “above 30” to “above 40” in II of the FE exam goals.
- 9 September 2009, moved advice about which FE afternoon exam to take to the advising handbook.
- 4 December 2009, aligned outcomes with ABET language and added Outcome Champions.
- 28 January 2010, updated list of Outcome Champions.
- 4 February 2010, added material from 3 February 2010 department meeting about outcome i.
- 29 March 2011, fixed EN 103 on assessment schedule – should be EN 101.
- 6 April 2011, fixed other occurrences of EN 103.
- 14 March 2012, changed sixth BSIE objective. From “achieve management positions” to “lead a project team.” See 13 March 2012 department minutes.
- Spring 2016. Deleted review of FE. Deleted survey of graduates. Reduced number of constituencies. Added review of LinkedIn entries. Revised and aligned PEOs as approved by Advisory Board. Updated champions.
- 9-11 May 2016, added latest evaluations and faculty discussions of all outcomes.
- 3 March 2017, Replaced Prof DePalma as Outcome Champion for outcome (c) with Professor Ansaf. Added latest evaluations and faculty discussion of (a) and (j). Added A for EN 107, outcome (d).
- 17 March 2017, Added latest faculty discussion of (c), (e), and (g). Dropped A for EN 362 and EN 477 for outcome (c).
- December 2017. Added latest faculty discussion of (d).
- 26 October 2018. Revised (a)-(k) to be (1)-(7), using mapping provided by ABET. See next page. Deleted “Review of performance in EN 101, EN 215, and EN 231.” Updated table showing relationship of Student Outcomes to Program Educational Objectives. Updated outcome champions.

Table 2. Changes in Criterion 3 - Student Outcomes

Current Language EAC Criteria effective 2017-18 and 2018-19 Cycles	New Language Approved by the EAD October 20, 2017 Applicable beginning in the 2019-20 cycle
Criterion 3. Student Outcomes The program must have documented student outcomes that prepare graduates to attain the program educational objectives. Student outcomes are outcomes (a) through (k) plus any additional outcomes that may be articulated by the program.	**Criterion 3. Student Outcomes** The program must have documented student outcomes that support the program educational objectives. Attainment of these outcomes prepares graduates to enter the professional practice of engineering. Student outcomes are outcomes (1) through (7), plus any additional outcomes that may be articulated by the program.
(a) an ability to apply knowledge of mathematics, science, and engineering (e) an ability to identify, formulate, and solve engineering problems	1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
(b) an ability to design and conduct experiments, as well as to analyze and interpret data	6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
(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	2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
(d) an ability to function on multidisciplinary teams	5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
(f) an understanding of professional and ethical responsibility (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context (j) a knowledge of contemporary issues	4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
(g) an ability to communicate effectively	3. an ability to communicate effectively with a range of audiences
(i) a recognition of the need for, and an ability to engage in life-long learning	7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	Implied in 1, 2, and 6

Source: http://www.abet.org/wp-content/uploads/2018/03/C3_C5_mapping_SEC_1-13-2018.pdf