Summary of ABET Student Outcomes Assessment, 2012-2013

Chemical and Biomolecular Engineering

University of California, Berkeley

June 30, 2013

Executive Summary

This report presents the direct and indirect student outcomes assessment data collected from instructors and students during the 2012-2013 academic year. It is intended for use in department-level curricular continuous improvement efforts, and creates a record for current and future ABET program evaluators and decision makers.

This report follows the approach outlined in the Process: Assessing and Evaluating Attainment of Student Outcomes document adopted January 4, 2013. Part 1 reports the direct measures results by first reviewing the process and then presenting data sampled from the course Outcome Assessment Templates during the spring 2013 semester. Part 2 reports the indirect measures results by first reviewing the process and then presenting data from the spring 2013 graduating senior survey, and the fall 2012 and spring 2013 student focus groups (AIChE Student Lunch and Honors Student Tea).

Part 1: Direct Measures: Student Course Work

Process excerpt:

a. *Each Student Outcome is assessed in at least two core chemical engineering courses that apply the Outcome to a high degree.*
    i. *See Student Outcome-Course Matrix for mapping.*
    ii. *For each Outcome, core courses are chosen from different levels of the curriculum (such as sophomore and senior) so that the development of each Student Outcome may be monitored over time.*
    iii. *Each core course in the curriculum is used to assess at least one Student Outcomes.*

b. *Faculty and graduate student instructors of each course assess student course work and use the course Outcome Assessment Template to report the number of students who fail, pass, or pass with distinction each of the Student Outcomes.*
    i. *Outcome Assessment Templates are also used for course-level outcome assessment.*
    ii. *When a course-level outcome is highly similar to the given Student Outcome, the same measure is used for both.*
    iii. *See Outcome Assessment Templates for Student Outcomes for details.*
    iv. *Outcome Assessment Templates are collected each semester by instructor submission to a specified site in the Berkeley online course management system, administered by the department ABET coordinator.*

c. *In June of each year, the ABET coordinator generates a Quantitative Student Outcome Attainment report using the data from the Outcome Assessment Templates.*
    i. *For each Student Outcome, the lower level course is analyzed in odd calendar years, and the higher level course is analyzed in even calendar years. For example, Student Outcome b is analyzed in 142 (sophomore) in 2013 and in 154 (senior) in 2014.*
    ii. *The Outcome Assessment Template data are used to calculate a percentage pass rate for each Student Outcome.*
    iii. *Trends in pass rate are monitored over time.*

Data: Student Outcomes-Course Matrix:

The Student Outcomes-Course Matrix has been updated to include data from courses on the Spring 2013 sampling schedule, in Table 1 below. Grey boxes indicate a course which is due for sampling during a future semester. Green, yellow, or red boxes contain the percentage of students who passed the outcome as measured in the course. The data from Spring 2013 do not reflect any items below the action threshold of 50% or lower pass rate. We will continue to monitor all direct data from courses.

Table 1: June 30, 2013: Analysis of Outcome Assessment Templates for Student Outcomes				% Passing
ABET Student Outcome	**Measure from Outcome Assessment Templates**	**Year Analyzed**	**Year of Study**	**Spring 2013**
a- An ability to apply knowledge of mathematics, science, and engineering.	**150 A - Transport** - Course Outcome #3: Solve for the velocity field in simple geometries using the differential forms of conservation of mass and linear momentum.	2013, 2015, …	Junior	96%
	162 - Process Dynamics and Control - Course Outcome #2: Use principles of chemistry and physics to derive mechanistic process models.	2014, 2016, …	Senior	
b- An ability to design and conduct experiments, as well as to analyze and interpret data.	**142 - Reaction Engineering** - Course Outcome #4: Derive a reaction rate expression from a homogeneous or heterogeneous mechanism by employing most abundant surface intermediate, quasi-equilibrium, and pseudo-steady-state approximations.	2013, 2015, …	Sophomore	
	154 - Unit Operations Laboratory - Course Outcome #1: Set up and carry out an experimental plan for extracting information about chemical/physical processes.	2014, 2016, …	Senior	
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.	**40 - Intro to Chem Eng Design** - Course Outcome #4: Create a process flow diagram for a chemical or physical process protocol, applying standard process flow diagram conventions including stream labeling and standard names for physical and chemical unit operations.	2013, 2015, …	Freshman	
	150B - Transport and Separations - Course Outcome #4: Design a binary distillation unit with various design specifications.	2014, 2016, …	Senior	
	160 - Process Design - Course Outcome #3: Optimize the [process simulation] flowsheet based on heuristics, scheduling considerations, and the results of systematic variation of process parameters in the simulation package.	2014, 2016, …	Senior	
d- An ability to function on multi-disciplinary teams.	**40 - Intro to Chem Eng Design** - NEW item: Function effectively on project teams.	2013, 2015, …	Freshman	
	154 - Unit Operations Laboratory - NEW item: Function effectively on project teams.	2014, 2016, …	Senior	
	160 - Process Design - NEW item: Function effectively on project teams.	2014, 2016, …	Senior	
e- An ability to identify, formulate, and solve engineering problems.	**141 - Thermodynamics** - Course Outcome #6: Calculate equilibrium composition or conversion in a homogeneous or heterogeneous chemical reaction.	2013, 2015, …	Sophomore	70%
	150A - Transport - Course Outcome #5: Perform energy balances on macroscopic control volumes using heat transfer coefficients.	2014, 2016, …	Junior	
f- An understanding of professional and ethical responsibility.	**185 - Technical Communications** - Course Outcome #8: Recognize the ethical responsibility of engineers, and articulate morally justified solutions to ethical problems.	2013, 2015, …	Junior	96%
	160 - Process Design - Course Outcome # 9: Demonstrate awareness of ethical and contemporary issues related to the design and operation of chemical or biological processes.	2014, 2016, …	Senior	

Table 1 (Continued): June 30, 2013: Analysis of Outcome Assessment Templates for Student Outcomes				% Passing
ABET Student Outcome	**Measure from Outcome Assessment Templates**	**Year Analyzed**	**Year of Study**	**Spring 2013**
g- An ability to communicate effectively.	**185 - Technical Communications** - Course Outcomes #2. Write clearly, directly, and concisely in technical documents.	2013, 2015, …	Junior	94%
	154 - Unit Operations Laboratory - Course Outcome #6: Present technical information effectively.	2014, 2016, …	Senior	
h- The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.	**142 - Reaction Engineering** - NEW item (from Course Objectives): Analysis and awareness of reactive hazards including but not limited to hot spots and thermal runaway in packed-bed and stirred-tank reactors.	2013, 2015, …	Junior	
	160 - Process Design - Course Outcome #8: Use profitability measures (such as net present value or Internal Rate of Return) to compare different process optimization schemes.	2014, 2016, …	Senior	
i- A recognition of the need for and an ability to engage in life-long learning.	**40 - Intro to Chemical Engineering Design** - NEW item: Recognize the need for and have an ability to engage in life-long learning.	2013, 2015, …	Freshman	
	160 - Process Design -NEW item: Recognize the need for and have an ability to engage in life-long learning.	2014, 2016, …	Senior	
j- A knowledge of contemporary issues.	**140 - Chem Process Analysis** - NEW item (from topics covered): Deconstructing chemical accidents, runaway reactors, adiabatic flames.	2013, 2015, …	Sophomore	
	160 - Process Design - Course Outcome #1: Discuss the principal issues in environmental protection and safety, including reactive hazards, as they relate to the design of new chemical and biological processes and retrofitting older plants.	2014, 2016, …	Senior	
k- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	**140 - Chem Process Analysis** - Course Outcome #2: Perform steady species/element mass balances on chemical processes including multiple reactions, recycle and purge to establish overall conversion, yield, and selectivity.	2013, 2015, …	Sophomore	
	162 - Process Dynamics and Control - Course Outcome #1: Analytically and computationally solve ordinary differential equations.	2014, 2016, …	Senior	
Color Key:				
Grey- No data; course not offered or not on sampling schedule this semester				
Green- Over 75% of students passed this outcome by the course direct measure				
Yellow- Over 50% of students passed this outcome by the course direct measure				
Red- Action level: 50% or fewer of students passed this outcome by course direct measure				

Part 2: Indirect Measures: Student Survey and Focus Groups

Process excerpt:

a. *Graduating seniors are surveyed about the Student Outcomes on the senior graduation survey administered by the College of Chemistry.*
    i. *Graduating seniors are asked to rate the level to which the curriculum prepared them to attain each Student Outcome.*
    ii. *The survey is administered in spring of each year.*
    iii. *Survey completion is required for tickets to the Commencement ceremony.*
    iv. *Survey results are reported to the Chemical and Biomolecular Engineering Department in spreadsheet format by August of the same calendar year.*

b. *Student focus groups occur twice each academic year, giving student representatives a forum to discuss curricular issues with faculty representatives.*
    i. *The AIChE Lunch is each fall semester, with 5-10 students from the Berkeley AIChE Student Section, including officers and non-officers across all years of study.*
    ii. *The Honors Tea is each spring semester, with 10-15 chemical engineering honors students across all years of study.*
    iii. *During these focus groups, students are asked to consider the Student Outcomes and comment on those that the curriculum addresses well, and those that should be improved.*
    iv. *The student feedback is recorded in the meeting minutes.*

Data: Senior Survey:

Graduating seniors were surveyed on the degree to which they agree that they possess each skill or ability described in the Student Outcomes (a-k). The survey responses from approximately 70 graduating seniors are compiled in Table 2, below.

Student responses were especially positive on outcomes:

- **Outcome a** (an ability to apply knowledge of mathematics, science, and engineering; 93% agree)
- **Outcome b** (an ability to design and conduct experiments, as well as to analyze and interpret data; 89% agree)
- **Outcome i** (a recognition of the need for, and an ability to engage in life-long learning; 88% agree)

The survey also identifies potential opportunities for increasing students' skills in outcomes:

- **Outcome j** (a knowledge of contemporary issues; 51% agree; 7% disagree)

- **Outcome 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; 60% agree; 4% disagree)
- **Outcome h** (the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context; 67% agree; 7% disagree)

Table 2: Resuslts of College of Chemistry Exit Survey Spring 2013 - Question 17					
If your major is Chemical Engineering, or any Chemical Engineering joint major, please answer this question. If your major is Chemistry or Chemical Biology, please skip to question 18. For each of the statements below, please indicate the degree to which you agree that you possess this skill or ability:					
Answer Options	**Disagree**	**Neutral**	**Agree**	**Response Count**	**% Agree**
a-An ability to apply knowledge of mathematics, science, and engineering	0	5	66	71	93%
b-An ability to design and conduct experiments, as well as to analyze and interpret data	0	8	62	70	89%
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	3	25	42	70	60%
d-An ability to function on multidisciplinary teams	1	9	60	70	86%
e-An ability to identify, formulate, and solve engineering problems	0	10	59	69	86%
f-An understanding of professional and ethical responsibility	4	12	53	69	77%
g-An ability to communicate effectively	1	13	55	69	80%
h-The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	5	18	46	69	67%
i-A recognition of the need for, and an ability to engage in life-long learning	2	6	60	68	88%
j-A knowledge of contemporary issues	4	29	35	68	51%
k-An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	1	13	54	68	79%

Data: Student Outcomes Reflections from the AIChE Student Lunch, November 19, 2012

Students discussed a wide variety of curricular topics with faculty at the AIChE Student Lunch. Reflections relating directly to the Student Outcomes a-k including the following:

- **Outcome b (ability to design and conduct experiments, analyze and interpret data):** Students requested more emphasis in the design of experiments, to complement other components of outcome b.
- **Outcome i (a recognition of the need for, and an ability to engage in life-long learning**): Students recognize life-long learning need and are interested in engaging in this within the action of applying course material to other situations.
- **Outcome j (a knowledge of contemporary issues):** Students love to see emphasis of contemporary issues in courses, and wish more of this, though several courses already have some of this. Specifically, students are interested in how contemporary issues can be understood using tools taught in courses.

Data: Student Outcomes Reflections from the Honors Student Tea, April 29, 2013:

Honors students discussed a wide variety of curricular and departmental topics with faculty at the Honors Student Tea. Reflections relating directly to the Student Outcomes a-k include the following:

- **Outcome 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):** Students desired more emphasis on safety practice in organic chemistry laboratory classes, 112A and 112B.
- **Outcome d (an ability to function on multidisciplinary teams):** Students note that the teams in CBE classes are not multidisciplinary, but feel that they get enough practice working across disciplines in supporting elective courses.
- **Outcome j (a knowledge of contemporary issues):** Students wonder what range of issues they should have knowledge of. They feel they have opportunities to learn in depth about some contemporary issues through faculty mentored undergraduate research, but that some students don't have research experiences. Note that they can be savvy about a particular area, but not know about all contemporary issues. C96 (freshman) course did give some view to contemporary issues, but not in much depth.

*Taken as a whole, these indirect measures identify **outcome j (a knowledge of contemporary issues)** as a key priority area for discussion before and during the August 2013 Faculty Retreat.*