Department of Chemical and Nuclear Engineering
Assessment Plan for Chemical Engineering B.S. Program

Overview

The assessment plan of the B.S. program in Chemical Engineering (ChE) is designed to satisfy the intent of the UNM Academic Program Review, as well as the requirements and best practices recommended by the Accreditation Board for Engineering and Technology (ABET). Formal assessment occurs at three levels in our programs: (1) program objectives assessment; (2) program outcomes assessment; and (3) course outcome assessment. Program objectives assessment deals with achievements and competencies of graduates several years after graduation. Program outcomes assessment deals with competencies of students at or near the time of graduation. Course outcomes assessment is done for each required undergraduate course within the department, based on the desired outcomes from that particular course.

The chemical engineering program has defined program objectives that, to be consistent with ABET conventions, are meant to convey the capabilities and achievements that the program expects its graduates will demonstrate within several years after graduation. These objectives are developed by the department assessment committee, in consultation with the faculty and the department Advisory Council (AC). The current program objectives are provided in Appendix A. Since program objectives deal with graduates several years after graduation, the primary means of assessment is by alumni and employer surveys. We do alumni surveys every other year in the spring, surveying graduates from 2 and 3 years before. For example, in spring of 2008, surveys were conducted for B.S. graduates from 2005 and 2006. In spring of 2010, surveys will be conducted for graduates of 2007 and 2008. An example of the alumni survey form for the chemical engineering program is provided in Appendix B.

The ChE program also has identified program outcomes that are consistent with the 11 outcome elements (a-k) required by ABET. The current list of program outcomes is provided in Appendix A. For each of these outcomes, specific measured tasks and deliverables from directly relevant courses in the curriculum are used to determine a quantitative measure of the extent to which that outcome is achieved (e.g., by number or fraction of students demonstrating acceptable performance). We are currently implementing a process for this quantitative assessment that involves identification of several specific performance criteria for each program outcome, and a specific quantitative assessment plan for each of the performance criteria based on specific relevant courses. As an example, Appendix C shows the performance criteria that have been identified for Outcome (B), and a plan for assessing each of those performance criteria using a rubric that will be based on a mixture of course deliverables and in-class observations by the instructor.

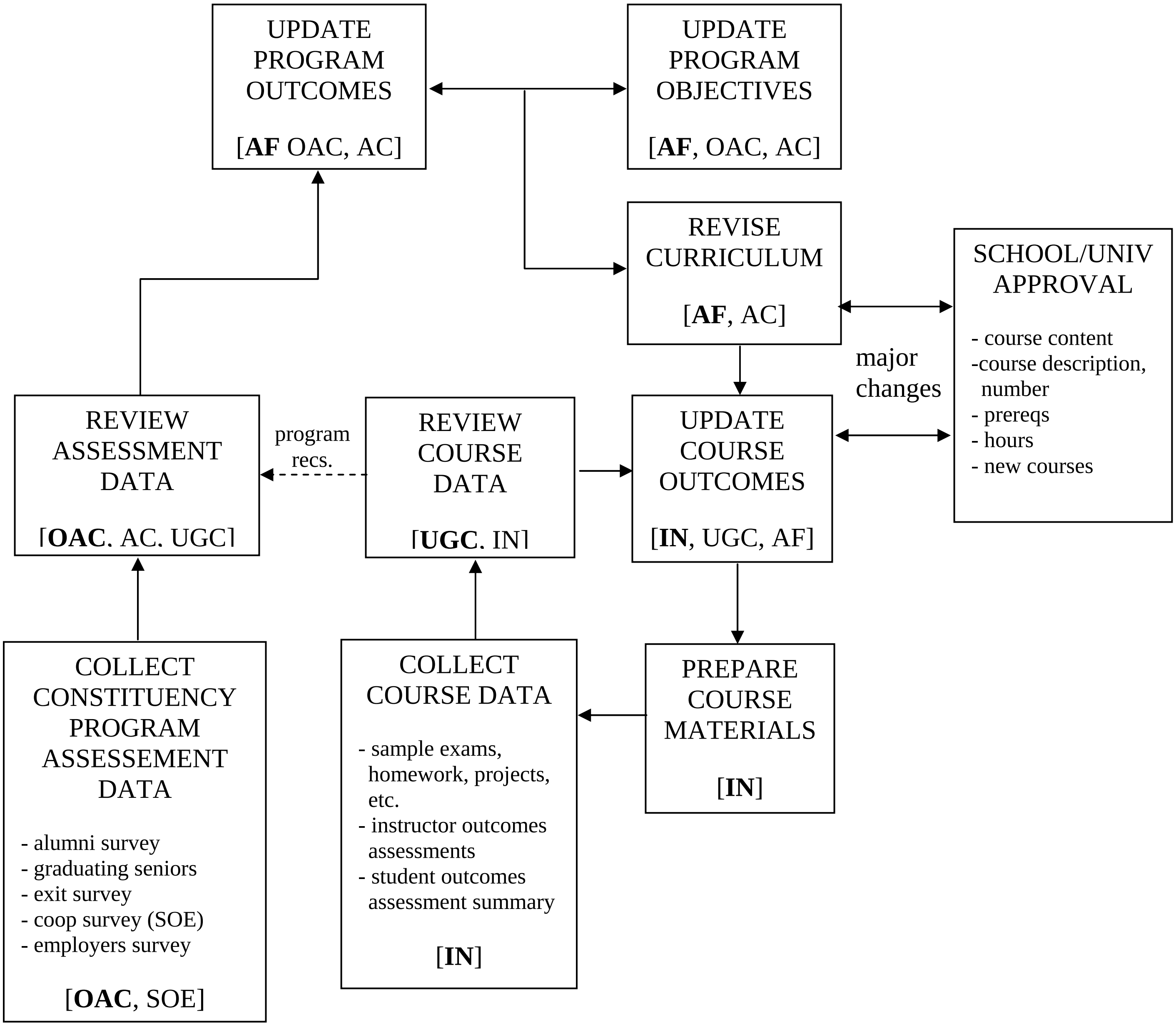
Course outcomes are developed by the course instructor based on the key knowledge and competencies that are expected by students completing the course. Assessment of course outcomes is done by a combination of specific measured tasks or deliverables in the course, and by surveys completed by the students and instructor at the end of the course. This information is primarily used by the instructor to improve the course. However, course outcomes are also reviewed by the department Undergraduate Program Committee (UPC) to ensure that course outcomes are appropriate relative to the overall curriculum. Course outcomes are also consulted by the department Assessment Committee and UPC when reviewing program outcomes and consideration of curriculum changes. Appendix shows one example of course outcomes, the student assessment survey for that course, and a table that summarizes how course tasks and deliverable map onto the course outcomes.

Table 1 summarizes the assessment methods and instruments for each of the levels of assessment in our undergraduate programs.

Table 1. Summary of assessment levels and instruments for chemical and nuclear engineering undergraduate programs.

	Assessment Instruments
Program Objectives	• Alumni surveys • Employer surveys
Program Outcomes	• Specific measured tasks and deliverables in relevant courses • Rubrics based on specific tasks, deliverables or activities in relevant courses
Course Outcomes	• Specific measured (graded) course tasks and deliverables • Student and instructor surveys

Figure 1 below shows how the different levels of assessment are integrated, implemented, and how constituencies are involved in this process. Continuous improvement requires some mechanism of feedback from the assessment process to the curriculum, courses, instructional methods, etc. In Figure 1, an inner course-level feedback loop is seen, as well as an outside feedback loop that deals with assessment and revision of program-level objectives and outcomes. Course-level assessment also feeds into the outer loop, and decisions regarding curriculum and program-level objectives and outcomes may feed into and impact course-level outcomes.



Acronym	Group	Frequency
IN	Course Instructor	Term
UGC	Program Undergrad Curriculum Committee	Term
OAC	Dept. Outcomes Assessment Committee	Annually
SOE	School of Engineering	as needed
AF	All Dept./Program Faculty	as needed
AC	Dept. Advisory Council	Annually

Figure 1. Schematic depicting the flows in the process for establishing, evaluating, and revising program objectives, program outcomes and course outcomes in chemical engineering and nuclear engineering programs. Primary party responsible for implementation is in bold.

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Appendices

Appendix A: Chemical Engineering Program Objectives and Program Outcomes

Appendix B: Alumni Survey Form Used for Assessment of Program Objectives

Appendix C: Example of Performance Criteria and Planned Assessment Methods for Program Outcome B

Appendix D: Example of Course Outcomes and Assessment Plan for ChNE 493 – Chemical Engineering Design

Appendix A: Chemical Engineering Program Objectives and Program Outcomes

Chemical Engineering Program Objectives

Graduates of the undergraduate program in chemical/nuclear engineering will:

1. have the technical knowledge and skills to achieve success in their chemical/nuclear engineering-related professional or post-graduate educational endeavors.
2. think creatively, applying problem-solving skills to engineering design and other professional activities.
3. be able to communicate effectively.
4. be able to function effectively on independent projects and as a member of multidisciplinary teams.
5. understand their professional and ethical responsibilities, and the social and environmental impacts of their work
6. pursue post-graduate learning and professional development throughout their careers.

Chemical Engineering Program Outcomes

By the time our graduates complete the chemical engineering program, they will have successfully demonstrated the following:

(A) an ability to apply knowledge of mathematics, science and engineering to chemical engineering problems.
(B) an ability to design and conduct experiments, and analyze and interpret data.
(C) an ability to design processes, systems or components to meet desired needs and subject to realistic constraints, such as economic, environmental, social, political, ethical, health, safety, manufacturability, and sustainability.
(D) an ability to function on multidisciplinary teams.
(E) an ability to identify, formulate and solve engineering problems.
(F) an understanding of the professional and ethical responsibilities of engineers.
(G) an ability to communicate effectively.
(H) an understanding of the global, economic, environmental and societal impacts of engineering activities.
(I) a recognition of the need for lifelong learning and awareness of how this can be achieved in their subsequent career.
(J) a knowledge of contemporary issues.
(K) an ability to use modern techniques, skills and engineering tools to address problems encountered in engineering practice.

Appendix B: Alumni Survey Form Used for Assessment of Program Objectives

Alumni Survey

Purpose: The response to this survey will help us assess the effectiveness and quality of our undergraduate program. To this end, we ask you to answer the questions as honestly as possible, and to make any comments that you feel are important to efforts to evaluate and improve our undergraduate program. Thank you in advance for participating in the survey.

Confidentiality: The information that your provide us will be treated confidentially. Your name (if provided) will be removed from the survey form before the results are compiled for presentation to the faculty.

Survey Return Information: You may enter responses on the electronic document and return as an electronic attachment to Susan Pinter at pinter@unm.edu, or print the form and send to:
Susan Pinter
Department of Chemical and Nuclear Engineering
MSC 01-1120
1 University of New Mexico
Albuquerque, NM 87131

The personal information given will be separated from the rest of the survey results before being given the faculty.

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1. Personal Information
Name:
Email Address:
Contact Address:

Professional Experience: Please briefly outline your professional experiences since graduating from the chemical engineering program at UNM. Please include names of companies that you have worked for, the positions you have held, your principal duties, the names of any graduate or professional schools that you have attended, any degrees earned, and any other continuing education or professional development courses that you have participated in.

For each of the statements below, please rank from one to five (one being “strongly disagree”, five being “strongly agree”) how well your undergraduate chemical engineering education at UNM prepared you for success in your professional career, including preparation for graduate or professional school if you have continued your education. Please add any specific comments that you feel are important.

1. The technical knowledge and skills that I gained prepared me for success in my career and/or post-graduate education.

(strongly disagree) 1 2 3 4 5 (strongly agree) Not applicable

Comments:

2. The mathematical and computer skills that I gained prepared me for success in my career and/or post-graduate education.

(strongly disagree) 1 2 3 4 5 (strongly agree) Not applicable

Comments:

3. My design and problem-solving experience prepared me for success in my career and/or post-graduate education.

(strongly disagree) 1 2 3 4 5 (strongly agree) Not applicable

Comments:

4. The communication skills that I developed prepared me for success in my career and/or post-graduate education.

(strongly disagree) 1 2 3 4 5 (strongly agree) Not applicable

Comments:

5. My education prepared me to function effectively as a member of a multidisciplinary team.

(strongly disagree) 1 2 3 4 5 (strongly agree) Not applicable

Comments:

6. My education prepared me to recognize and account for the social, ethical and environmental impacts of my scientific and engineering activities.

(strongly disagree) 1 2 3 4 5 (strongly agree) Not applicable

Comments:

7. My education made me aware of the need for lifeling learning in my career, and the various ways in which this can be pursued .

(strongly disagree) 1 2 3 4 5 (strongly agree) Not applicable

Comments:

Appendix C: Example of Performance Criteria and Planned Assessment Methods for Program Outcome B

Outcome: (B) an ability to design and conduct experiments, and analyze and interpret data.

Performance Criteria	Strategies (Courses)	Sources of Assessment	Assessment Method(s)
1. Plans a laboratory investigation, including the necessary measurements and analysis strategies	ChNE 318,319 418,419	ChNE 319 ChNE 419	Rubric based on performance on pre-Lab report
2. Demonstrates hands-on skills in conducting engineering laboratory experiments	ChNE 318,319 418,419	ChNE 319 ChNE 419	Rubric based on Instructor observation in laboratory
3. Uses scientific and engineering theories and/or correlations to interpret data	ChNE 318,319 418,419	ChNE 319 ChNE 419	Rubric based on performance on laboratory report
4. Estimates and accounts for error and error propagation, and reports measurements and uncertainties appropriately.	ChNE 253,318,319 418,419	ChNE 319 ChNE 419	Rubric based on performance on laboratory report
5. Explains physical meaning and/or significance of data and observations	ChNE 318,319 418,419	ChNE 319 ChNE 419	Rubric based on performance on laboratory report

Assessment Method Details

- Using ChNE 319 and 419 will give two sets of data on each student/class.

Criterion 1: Each student normally does the pre-lab report on at least one experiment – that prelab report will be the basis for each student.

Criterion 2: Instructor will observe and assess based on the rubric – may be based on a specific experiment, or be an overall evaluation based on observation throughout the semester.

Criterion 3 - 5: Based on individual reports for team-conducted experiments. Instructor will complete for each student in addition to the normal report grading done for the class. May be based on one particular experiment for the entire class to give uniformity.

Basis for Rubric Assessment

Prelab Reports: measure criterion 1

Lab Reports A, B, C: measure performance criteria 3,4,5
In-lab observation: measure criterion 2

Draft of a Rubric for Performance Criteria Associated with Outcome B

Performance Criteria	Unacceptable (0 points)	Marginal (1 point)	Acceptable (2 points)	Good (3 points)	Exceptional (4 points)	Points
1. Plans a laboratory investigation, including the necessary measurements and analysis strategies	No plan or completely inadequate	A plan, but not adequate to smoothly execute the lab	Adequate plan to conduct lab, but incomplete in some aspects	A good plan enabling the lab and analysis to be conducted smoothly	Unusually well thought out plan for lab and analysis	
2. Demonstrates hands-on skills in conducting engineering laboratory experiments	Completely avoids hands-on lab activities	Participates in some hands-on activities, but with limited skill and/or care.	Average level of hands-on participation and skill	Better than average skill and versatility in hands-on work	Unusually capable in hands-on skills, instinct and insight in the lab	
3. Uses scientific and engineering theories and/or correlations to interpret data	Reports lab observations with no attempt to interpret or explain	Makes limited attempt to explain results, but with poor theoretical or other support	Makes reasonable attempt to interpret results with mostly appropriate theoretical or other support	Better than average analysis and interpretation with solid support based on theory and/or correlations	Unusually insightful application of theory and other supporting information in interpretation of results.	
4. Estimates and accounts for error and error propagation, and reports measurements and uncertainties appropriately.	No attempt to account for error or uncertainty in quantitative or qualitative way	Cites error and uncertainty in analyses, but not quantitative, incorrect, or not careful.	Cites error and uncertainty in analyses, with some quantitative treatment and mostly appropriate choices.	Relatively thorough and accurate accounting and analysis of error and uncertainty	Unusually thorough, appropriate and accurate accounting and analysis of error and uncertainty	
5. Explains physical meaning and/or significance of data and observations	No physical interpretation	Some attempt to explain and interpret results physically, but shallow and/or not very correct	Acceptable level of physical interpretation with mostly sound reasoning	Thorough and sound explanation of physical significance	Unusually comprehensive and deep (and sound) analysis and explanation	
Overall Performance						

Appendix D: Example of Course Outcomes and Assessment Plan for ChNE 493 – Chemical Engineering Design

ChNE 493 Course Outcomes

1. Students should be able to apply basic science, math and engineering material learned in other classes to complex but practical chemical engineering problems, working both individually and in teams.
2. Students should be able to formulate and solve an open-ended process or product-design problem subject to realistic constraints and standards.
3. Students, working in teams, should be able to design chemical processes and process components that accomplish desired needs, satisfy realistic engineering constraints, and address relevant safety, environmental and social issues.
4. Students should have a working knowledge of basic engineering economic concepts, such as time value of money, interest, taxes, etc.
5. Students should be able to work problems involving cash flow streams and compounding.
6. Students, working in teams, should be able to conduct an engineering economic analysis and make a sound recommendation based on that analysis.
7. Students should be able to recognize, prepare and work with common process industry design tools and documentation such as: material and energy balances, process flow diagrams, and piping and instrumentation diagrams.
8. Students should be able to competently utilize ASPEN-Plus, or a comparable tool, to model and design multi-unit steady-state chemical processes.
9. Students should be able to use short-cut methods and heuristics for preliminary analysis and design of equipment or parts of a process.
10. Students, working as a team, should be able to prepare written reports on a team design project.
11. Students should have a basic understanding of some common safety and hazard management tools, such as HAZOP, FMEA and fault-tree analysis.

Course Outcome Assessment Summary – Fall 2008

		Course Outcomes										
Assessment Event	Pts	1	2	3	4	5	6	7	8	9	10	11
Team Project Report												
Writing Quality + Mechanics/Aesthetics											x	
Description and Soundness of Design		x	x	x				x	x		x	
Economic Analysis			x		x	x	x				x	
Safety and Environmental Factors			x	x							x	
Other Sections: Front Matter, Exec. Summary, Introduction, Conclusions and Recommendations, Appendices											x	
Homework (all individual)												
HW1: T&S 4.5 – Flowsheet/Mat Balance		x						x				
HW2: Aspen Column Design		x		x					x			
HW3: Materials				x								
HW3:Hydraulics/Heuristics				x						x		
HW3: Design Pressure		x		x								
HW4: Control								x				
HW5: Pinch Analysis												
HW6: Economics					x	x						
HW 7: Economics					x	x						
HW8: Critical Path												
HW9: HAZOP								x				x
In-Class Exercises (all team)												
Heuristics Quiz Game										x		
Final Exam (individual)												x
		1	2	3	4	5	6	7	8	9	10	11

ChNE 493L – Chemical Engineering Design
Student Course Outcomes Assessment
Fall 2008

For each of the following course outcomes, indicate whether you strongly agree, mildly agree, are neutral, mildly disagree or strongly disagree. In some cases, it might make more sense to think of "agree" as "confident", i.e. strongly confident, mildly confident, etc.

1. I am able to apply basic science, math and engineering material learned in other classes to complex but practical chemical engineering problems, working both individually and in teams.

Strongly Agree_____ Mildly Agree______ Neutral______ Mildly Disagree______ Strongly Disagree______

2. I am able to formulate and solve an open-ended process design problem subject to realistic constraints and standards.

Strongly Agree_____ Mildly Agree______ Neutral______ Mildly Disagree______ Strongly Disagree______

3. I am able to work in a team to design chemical processes and process components that accomplish desired needs, satisfy realistic engineering constraints, and adequately address safety, environmental and social issues.

Strongly Agree_____ Mildly Agree______ Neutral______ Mildly Disagree______ Strongly Disagree______

4. I have a working knowledge of basic engineering economic concepts, such as time value of money, interest, taxes, etc.

Strongly Agree_____ Mildly Agree______ Neutral______ Mildly Disagree______ Strongly Disagree______

5. I am able to work problems involving cash flow streams and compounding.

Strongly Agree_____ Mildly Agree______ Neutral______ Mildly Disagree______ Strongly Disagree______

6. I am able to work in a team to conduct an engineering economic analysis and make a sound recommendation based on that analysis.

Strongly Agree_____ Mildly Agree______ Neutral______ Mildly Disagree______ Strongly Disagree______

7. I am able to recognize, prepare and work with common process industry design tools and documentation such as: material and energy balances, process flow diagrams, piping and instrumentation diagrams, and equipment specification sheets.

Strongly Agree_____ Mildly Agree______ Neutral______ Mildly Disagree______ Strongly Disagree______

8. I am able to competently utilize ASPEN-Plus, or a comparable tool, to model and design complex steady-state chemical processes.

Strongly Agree_____ Mildly Agree______ Neutral______ Mildly Disagree______ Strongly Disagree______

9. Students should be able to use short-cut methods and heuristics for preliminary analysis and design of equipment or parts of a process.

Strongly Agree_____ Mildly Agree______ Neutral______ Mildly Disagree______ Strongly Disagree______

10. I am able to work in a team to prepare and deliver effective written reports on a team design project.

Strongly Agree_____ Mildly Agree______ Neutral______ Mildly Disagree______ Strongly Disagree______

11. I have a basic understanding of some common safety and hazard management tools, such as HAZOP, FMEA, and fault-tree analysis.

Strongly Agree_____ Mildly Agree______ Neutral______ Mildly Disagree______ Strongly Disagree______

Open Questions for Comment

What would you suggest to improve the course the next time it is taught?

What would you suggest to improve this assessment process?

Do you have any other comments on the course that you would like to share?