

Department of
Chemical and Biomedical Engineering
Fenn College of Engineering
Annual Report
Program Assessment
Bachelor of Chemical Engineering
Academic Year 2007-2008

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A. Background Information

[What information about your program or unit is it important for assessment reviewers to understand?]

1. Degree Titles

The program assessment below pertains to the Bachelor of Chemical Engineering (B.S. ChE). Some of the students majoring in Chemical Engineering also follow the Biotechnology Certificate Program. In addition, students in the program complete the requirements for minors in Chemistry and Physics.

2. Program Modes

The B.S. ChE program is offered in two modes:

- Standard 4-year program option
- Co-op 5-year option

3. Program Accreditation

All Engineering Programs are periodically (typically every six years) evaluated by the Accreditation Board of Engineering and Technology (ABET, www.abet.org). The B.S. ChE Program was evaluated by ABET in 2004. During their Fall 2004 visit, ABET found two (2) Program Concerns, and one (1) Program Observation. In addition, one (1) Institutional Weakness and one (1) Institutional Concern were found. No Program or Institutional Deficiencies were found. One Program Concerns and the Program Observation have been resolved, only one (1) Program Concern remains unresolved. The Department submitted a response and ABET should issue their final review shortly.

ABET's Glossary:

- *Deficiency: A deficiency indicates that a criterion, policy, or procedure is not satisfied. Therefore, the program is not in compliance with the criteria.*
- *Weakness: A weakness indicates that a program lacks the strength of compliance with a criterion, policy, or procedure to ensure that the quality of the program will not be compromised. Therefore, remedial action is required to strengthen compliance with the criterion, policy, or procedure prior to the next evaluation.*
- *Concern: A concern indicates that a program currently satisfies a criterion, policy, or procedure; however, the potential exists for the situation to change such that the criterion, policy, or procedure may not be satisfied.*
- *Observation: An observation is a comment or suggestion which does not relate directly to the accreditation action but is offered to assist the institution in its continuing efforts to improve its programs.*

Chemical Engineering and three (3) other Engineering programs were fully accredited to September 30, 2010. This action indicates that the program has no weaknesses.

ABET's report

Program Concerns

1. Criterion 2. Program Educational Objectives

Criterion 2 states that program educational objectives are intended to be statements that describe the expected accomplishments of graduates during the first several years' following graduation. At the time of the previous review, the objectives the program had defined were mostly written in terms of the skills that a graduate would possess after having completed the program, these mirrored many of the stated program outcomes and did not satisfy the definition of program educational objectives. The program was encouraged to consider restatement of their objectives in terms of this definition and to establish an assessment process that explicitly measures the accomplishments of their graduates.

The newly developed objectives for the program are consistent with the definition of program objectives stated in Criterion 2. The involvement of the program constituents in the development of the objectives has been documented. An assessment process for determining if the program objectives are being met is in place and the initial results are being evaluated.

- This concern is resolved.

2. Criterion 3. Program Outcomes and Assessment

The previous review noted that in the outcomes assessment process common to all programs, the only opportunity for the incorporation of a direct measure of outcomes achievement through the evaluation of student -work was provided by what were called course reflection forms. The intent of this tool was to have faculty members indicate the extent to which students had achieved the individual course outcomes. The use of this tool varied among the programs and was not consistently used as intended. While, in most programs, some indication of student achievement of outcomes could be drawn from this tool, many faculty members seemed to treat this as an indication of whether or not certain material had been covered in a course.

The sample form provided did not have a clear identification of the specific work used to assess the achievement of an outcome or an expected level of demonstrated proficiency to indicate achievement of the outcome. It is the program's responsibility to clearly demonstrate the assessment of outcomes, to define requirements that indicate achievement of an outcome, and to make program changes based on the assessments.

- This concern remains unresolved.

4. Contact Information

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B. Program Educational Objectives [or Goals]

[What are your programs' or units' goals? How and when were your unit's goals of student learning developed? Who was involved? Have you reviewed your goals? Have they been modified based on assessment information?]

ABET's Glossary:

Program Educational Objectives: A set of broad statements describing how the program will satisfy the needs of its constituency and fulfills its needs. These are expected to be achieved 3-5 years after graduation.

The following description of Chemical Engineering and our specific program educational objectives is quoted from our departmental publications such as brochures, flyers, CSU undergraduate catalog (<http://www.csuohio.edu/undergradcatalog/eng/programs/che.htm>), web pages, etc.

“The chemical engineering curriculum prepares the student for a successful career in a dynamic and progressive profession. A chemical engineer may pursue a wide scope of projects. Chemical engineers are responsible for the design and operation of processes that accomplish chemical changes. Examples of such processes are the production of antibiotics, detergents, drugs, paints, plastics, petrochemicals, advanced materials, and synthetics. A chemical engineer may also work on the research and development preceding or accompanying a given process design, or the management of a plant or an entire enterprise. The CSU chemical engineering curriculum provides a strong foundation to work in energy conservation and utilization, environmental pollution control, as well as the petrochemical industry and many other chemical-related industries. Consistent with mission of the university, college and department, this program has been designed to provide an attractive avenue for students interested in Chemical Engineering, aiming to:”

(Program Educational Objectives)

The chemical engineering program at CSU strives to prepare our graduates to:

1. Utilize practical engineering skills for productive, gainful, and ethical careers in chemical and related industries and organizations; and
2. Engage in life-long learning through professional activities and/or the pursuit of higher educational degrees.

Program objectives are mapped into the curriculum following a strict sequence of pre-requisites. Each course has specific course evaluations element to ensure that students are prepared in a manner commensurate with the program objectives (cf. assessment process detailed below). Significant constituencies of Bs. ChE program are; 1) students, 2) employers/companies, 3) alumni, and 4) faculty.

Students:

Student input to program objectives is primarily sought at senior level through two main mechanisms; 1) senior assessment, and 2) senior exit interview. Senior assessment is explained in Section D.

The senior exit interview is conducted by the Chairperson every year. This is a group meeting where the Chair solicits free input from the students. The Chair identifies a set of issues before the meeting and leads discussions in that direction. The department secretary takes notes. The interview results are transcribed later as a summary and distributed.

Employers/Companies:

The main mode of soliciting input from external constituencies is through the departmental Industrial Advisory Committee (IAC). The IAC is comprised of practicing engineers. We intentionally set up the visiting committee to cover fairly new engineers (about 5 years of school) to higher-ranking individuals with 20-plus years of experience. Some of the members are our own alumni.

The visiting committee members receive announcements, news, etc. during the year. The main half-day meeting occurs once a year. There is an agenda set before the meetings and supplementary materials are sent to the members beforehand. The meeting minutes are transcribed and distributed to the committee members, faculty and others (e.g. the Dean) after the meeting.

Alumni:

Alumni surveys are directly conducted by the Department. These survey are conducted every other year [next Survey is Scheduled for Spring 2008]

Faculty:

The Program Educational Objectives were originally outlined by departmental faculty after a year of deliberations in 2000. The major ongoing role of the faculty is to analyze and evaluate the input from students (seniors), the Visiting Committee, and alumni survey, and combine these inputs with their own assessment of the program. These are discussed yearly at a faculty retreat.

C. Program Outcomes

[What are your program or unit's intended outcomes? How and when were your department/unit's outcomes for each goal developed? Who was involved? Have they been modified based on assessment information?]

ABET's Glossary

Program Outcomes: List of topics/skills that students are expected to know/have after completing the program curriculum.

Description of Program Outcomes

The Bachelor of Chemical Engineering graduates must have the attributes collectively referred to as the **Attributes of an Engineer**. Consequently, Program Outcomes aims to educating students who has knowledge/understanding of:

- (a) Application of Mathematics, Science and Engineering Principles.
- (b) Experimental Design and Experimental Data Collection and Analysis
- (c) Engineering Design (Chemical Systems, Units & Processes)
- (d) Multidisciplinary Team Work
- (e) Identification, Formulation and Solution of Engineering Problems
- (f) Professional and Ethical Responsibilities, including Safety and Environmental aspects related to Chemical Systems, Units and Processes.
- (g) Effective Communication Skills
- (h) Contemporary Issue & Global/Social Impact of Engineering Solutions.
- (i) Need and Ability to engage in Lifelong Learning
- (j) Techniques, skills and tools common in modern Engineering practice
- (k) Principles and Working Knowledge of subject areas as defined by the Program Criteria of the American Institute of Chemical Engineers (AIChE).

According to the American Institute of Chemical Engineers (AIChE, www.aiche.org), the following program criteria apply to engineering programs including "chemical" and similar modifiers in their titles:

“The program must demonstrate that graduates have: thorough grounding in chemistry and a working knowledge of advanced chemistry such as organic, inorganic, physical, analytical, materials chemistry, or biochemistry, selected as appropriate to the goals of the program; working knowledge, including safety and environmental aspects, of material and energy balances applied to chemical processes; thermodynamics of physical and chemical equilibria; heat, mass, and momentum transfer; chemical reaction engineering; continuous and stage-wise separation operations; process dynamics and control; process design; and appropriate modern experimental and computing techniques.”

The following table shows the relevance of Attributes of an Engineer to the specific Program Educational Objectives.

	a	b	c	d	e	f	g	h	i	j	k
Prepares students for careers in the Chemical and related industries within the Northeast Ohio region and beyond.	■	■	■	■	■	■	■	■	■	■	■
Prepares students for practical engineering applications, as well as provides the depth of knowledge required for graduate studies.	■	■	■		■		■	■	■	■	■
Motivates graduates' participation in life-long learning and professional development activities.						■	■	■	■	■	

D. Description of Assessment Tools [or Research Methods]

[What indirect and direct evidence have you gathered to measure accomplishment of your goals? What testing instruments, methods, and processes do you use to collect assessment data? Have these instruments been modified since your last report? If so, why?]

A number of assessment instruments are used for Program Outcomes, which are collections of responses from faculty, students and external constituencies. A dedicated web site (<http://www.csuohio.edu/engineering/chemical/ec2000/assess.html>) is used to collect most of initial data.

Curriculum Assessment (a.k.a. “Course Reflections”) [CM]

This activity is performed at the end of each semester. The results are compiled via the department website. The form used for each course is provided as an Appendix. Instructors assess the performance of students in eleven (11) specific fields (directly correlated with the Program Outcomes). Forms also contain space for comments and recommendations. A table indicating level of significance on each Program Outcome for each course in the curriculum is also included in the Appendix. This relevance table is reviewed for appropriateness at each Annual Department Retreat. The results for each course are used to compile a weighted average for each Program Outcome.

[A sample of a Course Assessment Form is provided in the Appendix]

Senior Design Instructor Assessment [DIA]

Senior Design Instructor performs this activity at the end of each semester only. The format is similar to the Course Assessment form.

Laboratory Instructors Assessment [LIA]

This activity is performed at the end of each semester. The instructors of courses with a laboratory component complete this form only. The format is similar to the Course Assessment form. Special attention is given to outcomes related to teamwork, experimental design and ability to work in laboratory environments.

Senior Assessment [SEA]

All the students of each graduating class fill this questionnaire at the end of the academic year. The format is similar to the Course Assessment form and it is included as an Appendix

Senior Exit Interview [SES]

As explained above, this is a meeting with the senior students by the Chairperson and the Secretary. It is meant to be an open forum where students can voice their concerns and provide feedback on the program. Special attention is given to the students' perception of the Chemical Engineering core courses. Students are also requested to identify the weakest and strongest elements of the curriculum. Comments are recorded (anonymously) by the Department Secretary, transcribed and distributed.

Professional Student (AIChE) Chapter Activities [PS]

Activities carried out by the American Institute of Chemical Engineers Student Chapter are compiled and classified into two major categories: (i) Student participation (membership, membership by levels, etc.) and (ii) Participation in activities sponsored by the Regional and National Professional Societies (Seminars, Competitions, Workshops, etc.).

Alumni Survey[AS]

This survey is conducted every five years. Alumni are asked a series of questions aligned with the Program Outcomes and Program Objectives.

Employers/Industrial Advisory Committee [IAC]

Originally intended to be conducted every five years, this survey requested the employers’ opinion and assessment of graduates from the program. The questionnaire had questions aimed to assess the graduates’ skills in areas directly related to the Program Outcomes. This survey was abandoned in 2002 due to lack of response. Instead, the feedback gathered at the Annual meeting with the Industrial Advisory Committee is being used.

1. Description of Assessment Methodology

The results of each assessment tool are selectively used for weight average and final tally against Program Educational Objectives and Outcomes.

Outcome \ Tool	CM	SES	SEA	DIA	IDE	IAC	LIA	PS	AS
Degree of correlation: (■) Direct, (□) Reasonable									
Ability to apply Math, Science & Engineering Knowledge	■			□	■		□		
Experimental Data Collection, Analysis & Design	■	□					■		
Engineering Design (Chemical Sys., Units & Processes)	■	□		■	□				□
Multidisciplinary Team Work		□		□		■			□
Identification, Formulation & Solution of Eng Problems	■			■	■		□		□
Understanding of Professional and Ethical Responsibilities	□	□	□	□	□	■		□	■
Ability to Communicate Effectively	■			■	■	■	■	□	□
Contemporary Issues & Understanding of Global/Social Impact of Engineering Solutions.	□	□	□	□	□	□		□	■
Need and Ability to engage on Lifelong Learning		□		□	□	□	□	■	■
Techniques, Skills & Tools in Modern Engineering Practice	□			■	■				□
Pples and Working knowledge def. by AIChE Pgm Criteria	■	□	□	■	■		□		□

All results are compiled and analyzed by the Engineering Criteria Department Coordinator. The results are normalized from 0 to 3. Results are compiled separately for each Assessment Method and affected by a weight factor (according to the above correspondence table). Results below 1.5 are highlighted as areas requiring action; results below 2.0 are identified as areas requiring attention, while results above 2.0 are considered satisfactory.

The compiled results are presented to the department faculty at the Department Annual Retreat (in November). The areas identified as critical are analyzed again and any discrepancies (stemming from results from different methods) are resolved. The Department Retreat is where possible actions are recommended and approved, with specific decision about timelines and responsibilities for implementation.

A summary of the Department Retreat is compiled by the Engineering Criteria Department Coordinator and circulated among faculty for accuracy. Curriculum changes are then officially brought before the Department, College and University committees for approval and implementation.

E. Findings

The results for the 2007-08 Academic Year are tabulated below

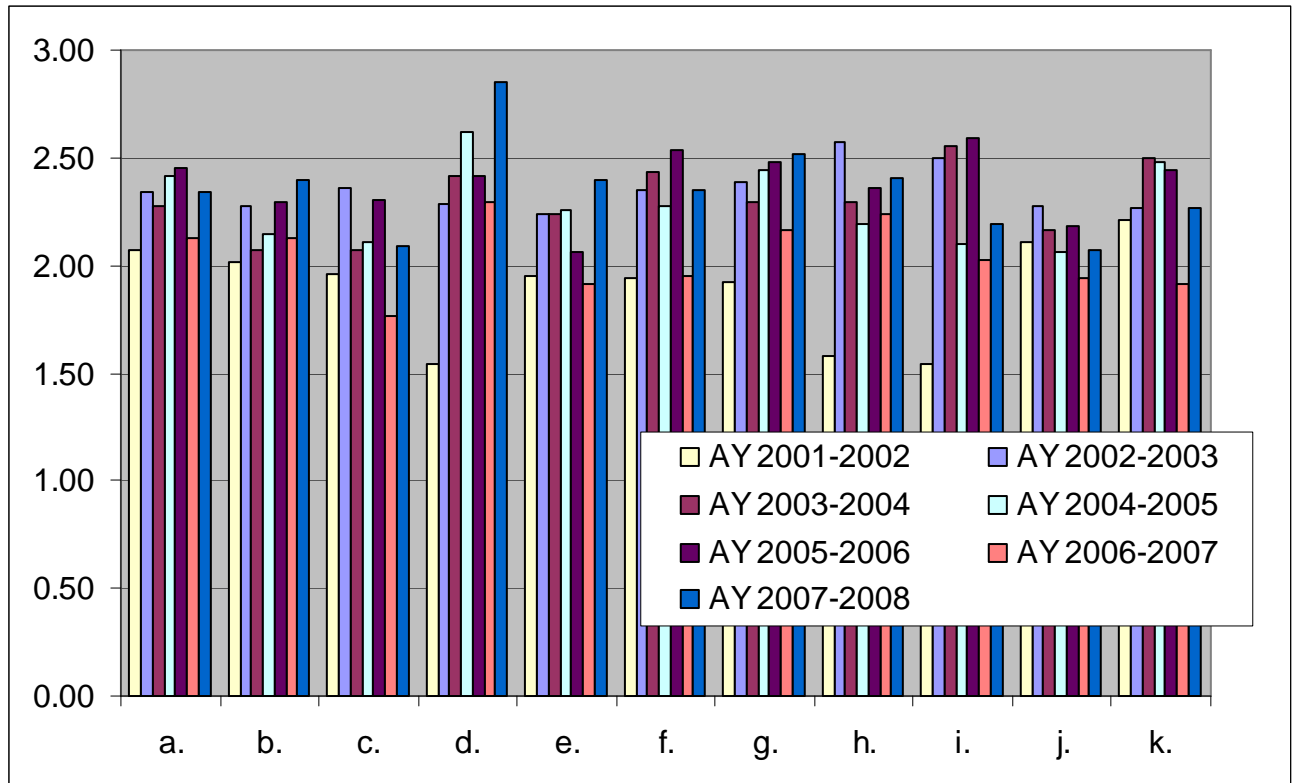
Summary												
<i>Weight</i>		2	2	2	0	2	2	2	2	2	2	2
	Outcome	a	b	c	d	e	f	g	h	i	j	k
Academic Year 2007-2008												
Curriculum	Out of 3	2.33	2.33	2.18	2.83	2.40	2.00	2.50	2.19	2.00	1.90	2.33
Action may be required		No	No	No	No	No	No	No	No	No	No	No
Seniors	Out of 3	2.70	2.77	2.43	2.87	2.67	2.70	2.83	2.77	2.82	2.51	2.47
Action may be required		No	No	No	No	No	No	No	No	No	No	No
Instructors (Design/Lab)		1.99	2.08	1.67	N/A	2.13	N/A	2.22	2.25	1.75	1.81	2.00
Action may be required		No	No	No	No	No	No	No	No	No	Maybe	No
Surveys (Alumni/Employers)		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Action may be required		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Average		2.34	2.39	2.09	2.85	2.40	2.35	2.52	2.40	2.19	2.07	2.26
Attention required		No	No	No	No	No	No	No	No	No	Maybe	No
Action may be required		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	??	N/A
Outcomes that require attention [To be discussed at next Department Retreat, May 2009]												
		j	Techniques, skills and tools common in modern Engineering practice									

To properly interpret the results shown in this table some explanation may be in order: These results that attention might have to be paid to four outcomes

(j) Techniques, skills and tools common in modern Engineering practice

Trends

The compiled data for the last seven (7) assessment cycles is shown below



Although the data corresponds to different populations, and the assessment tools have changed or been adapted over the years, one could identify trends, and maybe an analysis is in order.

The first observation to be made is that the level of achievement for the outcomes rose for all outcomes as compared to the previous year. The second observation is a consistent record of achievement at acceptable (2 out of 3) level seems to be the norm for most outcomes.

F. Review

The Department typically schedules an Annual Retreat every November. This Retreat is largely devoted to the Review of Assessment Findings, including analysis of the results, and possible changes to the curriculum and/or assessment tools and practices. Last year, with the ABET Coordinator being on sabbatical leave, this review did not take place.

A preliminary analysis of results, trends and possible remedial actions for the AY 2007-2008 Program Assessment were discussed at a special Department Meeting (February 19, 2009). An extended discussion on these items will take place during a Special Spring Retreat scheduled later in the Spring 2009 term.

The point of major significance related to Program Assessment and Enhancements during the 2007-2008 AY pertained to the Observations made by ABET's Engineering Accreditation Committee (EAC):

ABET's Program Observations

2. Criterion 3. Program Outcomes and Assessment

The previous review noted that in the outcomes assessment process common to all programs, the only opportunity for the incorporation of a direct measure of outcomes achievement through the evaluation of student -work was provided by what were called course reflection forms. The intent of this tool was to have faculty members indicate the extent to which students had achieved the individual course outcomes. The use of this tool varied among the programs and was not consistently used as intended. While, in most programs, some indication of student achievement of outcomes could be drawn from this tool, many faculty members seemed to treat this as an indication of whether or not certain material had been covered in a course.

The sample form provided did not have a clear identification of the specific work used to assess the achievement of an outcome or an expected level of demonstrated proficiency to indicate achievement of the outcome. It is the program's responsibility to clearly demonstrate the assessment of outcomes, to define requirements that indicate achievement of an outcome, and to make program changes based on the assessments.

Department Response

Although the intent of the "Course Reflection forms" was common throughout the College, the applications (and format) varied among the programs. In the chemical engineering program, the reflection form was used by the faculty in a manner consistent with its original intent, as described below.

The chemical engineering faculty is aware that the forms provide only a partial view of the assessment scenario. Therefore, the program provided the ABET Evaluation Committee with files for each of the major Engineering Science (ESC) and Chemical Engineering (CHE) courses during the original EAC/ABET review. Each course file contained a page that listed the program outcomes addressed by the course as well as identified the specific course elements (e.g. exam, quiz, homework, or report) that were used to assess each of the program outcomes (cf. a representative example in Appendix B). In addition, the course file contained representative

samples of student work (typically representative work showing highest, lowest, and average grade). These materials were tagged with labels identifying the program outcome that was addressed by specific questions or assignments.

A matrix summarizing the materials that were available and marked according to relevant outcome in one of the course files is provided in Appendix B as well. Since these were graded assignments, the reviewer could view the level of achievement that was considered acceptable. This was the primary method of direct assessment of program outcomes.

All the material used to assess student learning (e.g. exams, assignments) were graded for each student. The course instructor, who is doing the assessment, then integrates the level of achievement observed for each outcome via the exams and assignments. The reflection form is thus a method of recording this integrative assessment, which is then translated to a numerical score so that it can be combined with other outcome assessment tools in a quantitative manner.

The response was not considered adequate by the ABET Visiting Team

- **This concern remains unresolved.**

G. Actions

These points have already been extensively discussed. The most significant changes have been the addition of supplementary metrics and the formulation of additional strategies for Program Assessment. These changes were made in response to the final ABET evaluation.

At the February Special Department Meeting (02/19/09) the Department Faculty formulated the following strategy:

1. The existing mechanism and forms to collect end-of-the-term “course reflections” from the instructors will be retained.
2. In order to add more quantitative information Problems assigned as Homeworks, Open-ended Projects, and Exams will be assigned a label associating each question/problem with a particular outcome (or a set of outcomes, as deemed appropriate by the instructor)
3. Instructors will save copies of representative (graded) student submissions.
4. The average class grade and percent passing will be compiled.
5. These metrics will be entered into a Program Outcomes matrix and thus a quantitative measure of Outcome Achievement be drawn.
6. This strategy will be first implemented for the Spring 2009 term.

One should note that this strategy is not a new approach adopted by the Department; it simply formalizes the approach discussed in the original Department Response. The difference with the Spring 2009 formulation will consist on including specific information [previously available to the course instructor only] on the results for each specific course grading element.

Program Outcomes, and Student-Learning Objectives, along with the Assessment Forms used by the Program (Faculty, Students, and Alumni) can be found in the web pages for the Department of Chemical and Biomedical Engineering:

<http://www.csuohio.edu/engineering/chemical/ec2000/progoutcom.html>

<http://www.csuohio.edu/engineering/chemical/ec2000/assess.html>

Appendix B: Correlation between Course Elements and Program Outcomes

[These materials are part of the Course Assessment Files compiled and maintained by the Program for all the Fundamental Courses, CHE & ESC]

The Department discussed the implementation of a new approach were evidence of

CHE 404: Chemical Reactor Design, fulfills

*[the following Chemical Engineering Program Objectives and Outcomes:
This course develops in students...]*

(a) ability to apply Mathematics, Science & Engineering Principles.

Homeworks, Quizzes, Exams and Laboratory Calculations

(b) an ability to design experiments, collect and analyze experimental data.

Laboratory Work and Laboratory Reports

(c) criteria for design of Chemical Reactors and related equipment.

Homeworks, Exams, Open-Ended Project (OEP), and Integrated Design Experience (IDE)

[(d) ability to work in multidisciplinary teams.]

Some elements are covered by the Laboratory Work/Report Preparation (Presentations), OEP, and the IDE.

(e) ability to identify, formulate, and solve Engineering Problems

Homeworks, Exams, OEP, and IDE.

(g) effective Communication Skills

Laboratory Reports and Presentations.

(j) ability to use of Techniques, Skills, and Modern Engineering Tools necessary for Engineering Practice.

Homeworks, Exams, Laboratory Data Analysis, OEP, and IDE.

*(k) principles and Working Knowledge of subject areas as defined by the Program Criteria of the American Institute of Chemical Engineers [...momentum transfer; **chemical reaction engineering**; continuous ...] _ . •*

This course covers the Fundamentals of Chemical Reaction Engineering.

Appendix C: Sample of Course Assessment

Course Assessments for the Spring 2007 were completed by the Department Faculty prior to the Summer break.

The links can be found in the Department home page

http://www.csuohio.edu/chemical_engineering

>> Follow the link to Student Learning Assessment Tools

http://www.csuohio.edu/chemical_engineering/EC2000/assess.htm

There are three types of Assessments: Course, Laboratory, and Senior Design Assessment(s)

To: EC2000/ABET Course Assessment
From: [E-mail/Alias deleted]
Date: 05/18/2007 12:50PM
Subject: Mail From Web

Course [Course number deleted]
Term Fall Semester - Year 2006

Outcome_A 3
Outcome_B N/A
Outcome_C N/A
Outcome_D N/A
Outcome_E 2
Outcome_F N/A
Outcome_G N/A
Outcome_H N/A
Outcome_I N/A
Outcome_J 2
Outcome_K 2

Comments: Assessment tools

- Interactive lectures (largely question/answer-style, not graded).
- Recitations (group discussions, not graded).
- Weekly homework (graded).
- IDE project (collective group discussions, hints as handouts, pass/no-pass).
- 1 Midterm examination (graded).
- Final examination (graded).

Grade distribution over 10 students:

A's: 3
B's: 3
C's: 4
D's: 0
F's: 0

Comments: General

The course was again heavily biased into the understanding of the fundamentals of this discipline rather than presenting a collection of recipes for problem solving. This constitutes an alternative teaching strategy for Thermodynamics, which has proved effective over a number of semesters.

Typical assumptions are introduced at a later stage, leading the students to a clearer understanding of the implications of approximations. This semester, again, this approach appeared to mature students faster than the usual opposite route.

Comments: Program outcomes

a) Ability to apply Mathematics, Science, and Engineering knowledge.

This part has been fully achieved by adjusting the course to deficits in Mathematics, Physics, and Chemistry, relevant to Chemical Engineering Thermodynamics. However, the necessity of doing so continues to be frustrating in view of the prerequisites for this course. The interconnectivity of mathematics, science, and engineering has been constantly stressed and the students appeared to end up with a satisfactory appreciation.

e) Identification, formulation, and solution of Engineering problems.

I do not provide any coherent collection of formulas or estimation methods. However, the students of this course will most likely be able to identify a proper route to solve non-familiar thermodynamic problems. They learned that there is no fundamental difference in dealing with different processes. The exercises in the recitation always take recourse to the above teaching strategy by pointing at the very few underlying concepts. Group discussions in class showed an increased (begin to end of course) ability to translate formulas into plain and precise language, and vice versa. However, I can still see deficits.

j) Use techniques, skills, and modern engineering tools necessary for engineering practice.

Some students appeared to understand the importance to develop general techniques, ever improving skills, and eventually the use of computers to accomplish a task of highly abstract nature.

In particular, I encourage the students to standardize their route of approach. This includes to never skip steps which appear to be trivial at first sight; a significant source of errors. Modern Chemical Engineering Thermodynamics clearly shifts towards the molecular point of view. Apparently, the students began to argue with molecular concepts in mind. This sure helps for both a deeper understanding of thermodynamic theory and practical application. However, such skills are still far from being "second nature".

k) Principles and working knowledge as defined by AIChE program criteria.

The Integrated Design Experience used as a project in this class, was part of AIChE's 2006 national design competition. This semester, again, the students were given an extensive project description including all necessary theoretical background, a report manual, experimental data, and an extensive functioning computer program for the solution. I hope the students learned about application of fundamental principles, I hope they developed a sound working knowledge, and I hope they matured through analyzing a given code for numerical and other methods learned in class. More important, the students were generically exposed to underlying concepts and programming strategies in widely used commercial software packages such as ASPEN.

Name: [Name deleted]
CSU_ID:[ID # deleted]
Date 05/15/07