



Department of
Chemical and Biomedical Engineering
Fenn College of Engineering
Annual Report
Program Assessment
Bachelor of Chemical Engineering
Academic Year 2005-2006

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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.

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 accredited to September 30, 2007. This action indicates that the program has one or more weaknesses. The nature of the weaknesses is such that an on-site visit will not be required to evaluate the remedial actions taken by the institution. A report describing the actions taken to correct these shortcomings is due to ABET by July 1, 2006. The reaccreditation evaluation will focus on these shortcomings. A visit is not required.

ABET's report

Program Concern: 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. The objectives the program has defined are mostly written in terms of the skills that a graduate would possess after having completed the program. These mirror many of the stated program outcomes and do not satisfy the definition of the program educational objectives. The program is 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.

This concern remains unresolved pending evidence of the conclusion of the objective definition process along with a process to assess the achievement of the new objectives.

Program Observation: If the faculty member having lead responsibility for the senior design courses were unavailable, this heavy teaching responsibility would probably fall to the chair, presenting conflicts with his other responsibilities. Two suggestions, not mutually exclusive, to address this are: to involve outside personnel with industrial design expertise and to develop capability for additional faculty members to lead this senior design activity.

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:”

Since the only Program Concern identified by ABET was the drafting of the Program Objectives, the Department held a Program Retreat in January 2005 (01/13/05) where ABET's report was discussed. One of the main topics was the re-formulation of the Program Educational Objectives. A second Department Retreat was held in December 2005 (12/13/05) where the re-formulation was completed.

(Old Program Educational Objectives)

1. Prepare students for careers in the chemical and related industries within the Northeast Ohio region and beyond
2. Prepare students for practical engineering applications, as well as providing the depth of knowledge required for graduate studies
3. Motivate graduates' participation in life-long learning and professional development activities.

(New 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.

These new objectives were also evaluated by alumni and employers.

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 (this was a change from previous methodologies decided at the January 2005 Department Retreat).

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/chemical_engineering/EC2000/) 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.

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. Results for 1998 and 2003 surveys are included in Appendix I.F.

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

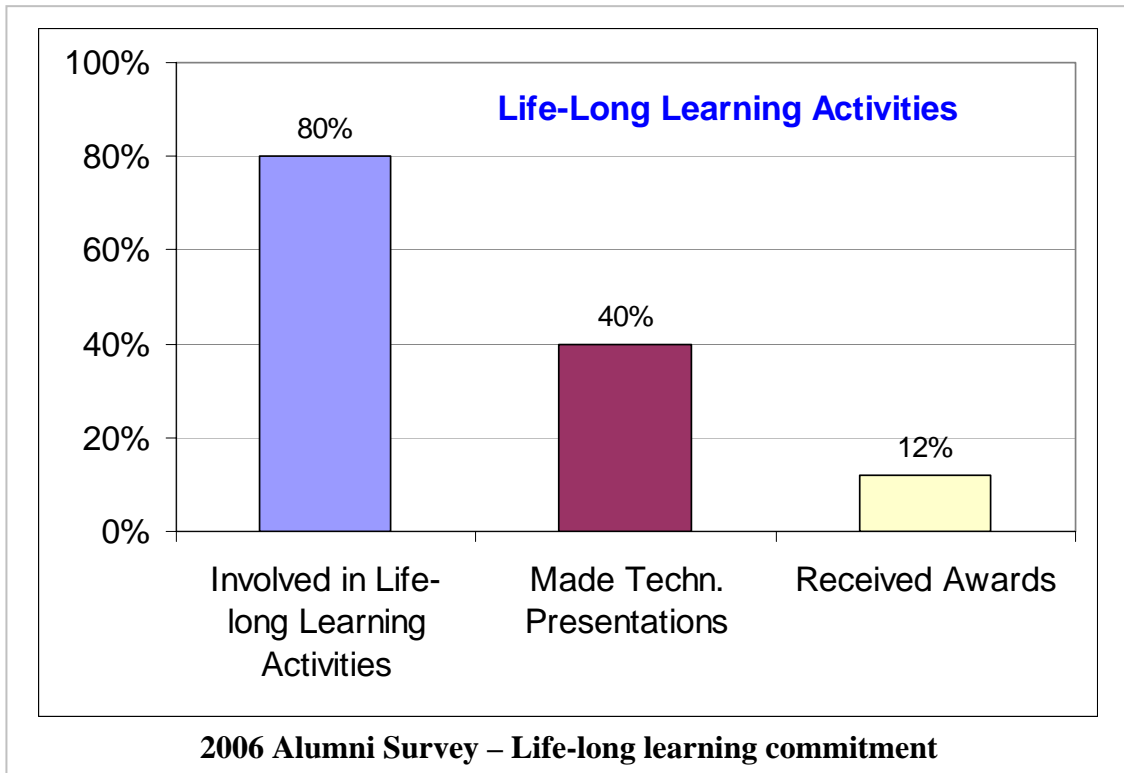
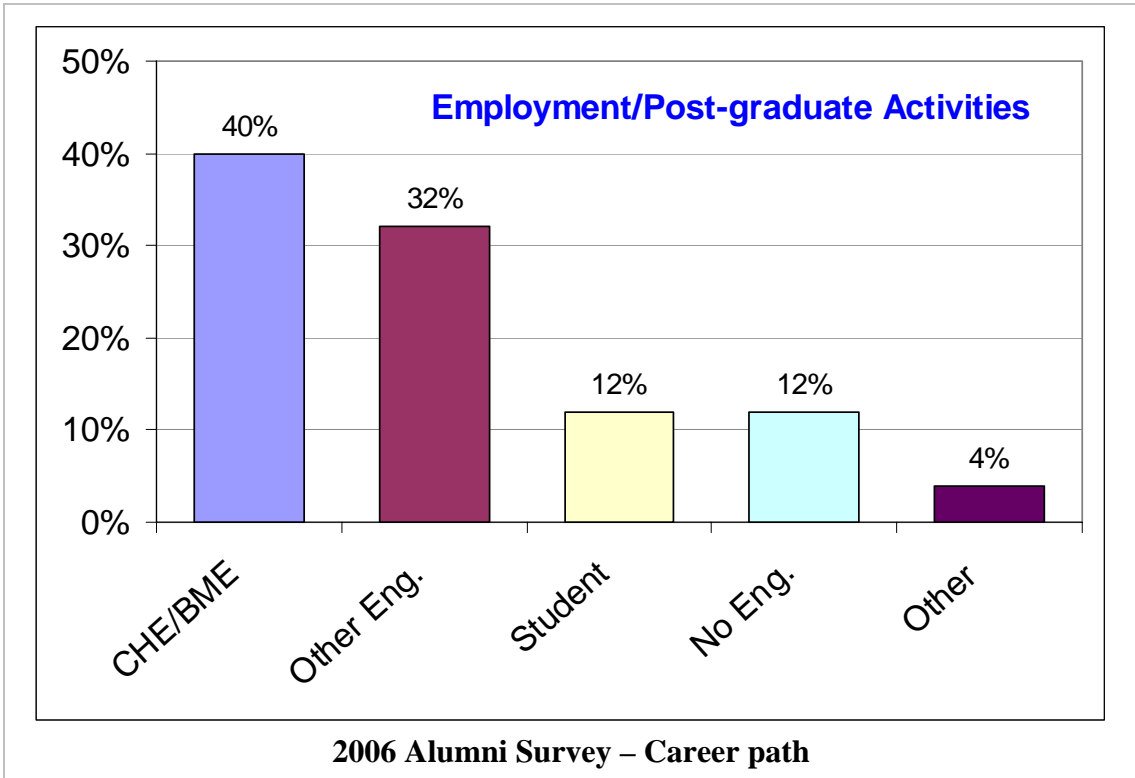
The results for the 2005-06 Academic Year are tabulated below

<i>Academic Year 2005-2006</i>	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
Curriculum	2.35	2.15	2.48	2.12	1.78	2.44	2.40	2.66	2.63	2.14	2.32
Action may be required	No	No	No	No	Yes	No	No	No	No	No	No
Seniors	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)	2.52	2.00	2.23	N/A	1.56	3.00	2.38	2.03	2.25	1.97	2.19
Action may be required	No	No	No	Maybe	Yes	No	No	No	No	Maybe	No
Alumni Survey	2.25	2.28	2.06	2.25	2.25	2.00	2.29	1.97	2.67	2.12	2.78
Action may be required	No	No	No	No	No	No	No	Maybe	No	No	No
Average	2.45	2.30	2.30	2.41	2.06	2.53	2.48	2.36	2.59	2.18	2.44

These results that attention might have to be paid to four outcomes

- (d) Multidisciplinary Team Work
- (e) Identification, Formulation and Solution of Engineering Problems
- (h) Contemporary Issue & Global/Social Impact of Engineering Solutions.
- (j) Techniques, skills and tools common in modern Engineering practice

The Alumni Survey and the Industrial Advisory Committee visit input were used to assess the Program Educational Objectives. A summary of the most significant metrics is presented in the bar charts below:



In summary

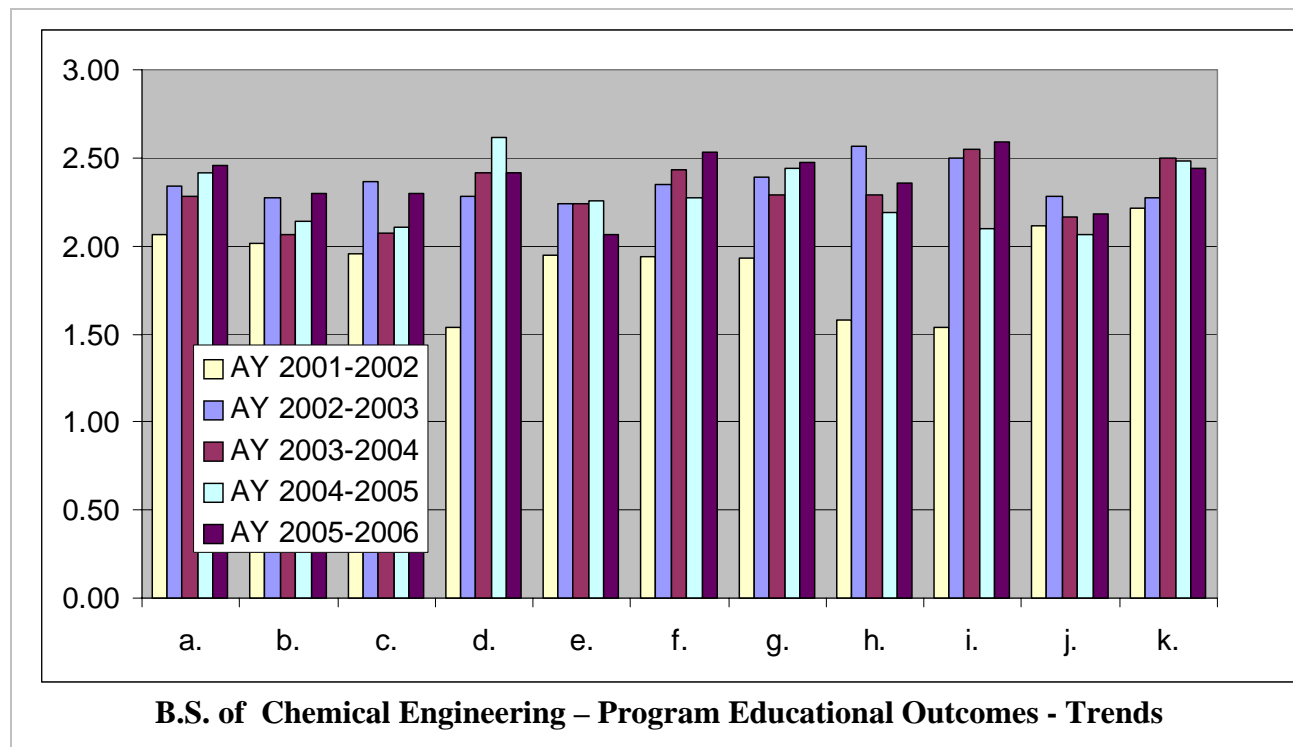
Objective	Responses
1. Utilize practical engineering skills...	Feedback from IAC members (employers): <ul style="list-style-type: none"> • Need for more multi-disciplinary efforts and how to work with other engineers • Young engineers typically do not show problems with presentations • Young engineers do not know how to measure results or how to measure success • Lack of knowledge about environmental, health, and safety issues, including regulatory requirements (e.g. FDA guidelines)
1. ...for productive, gainful careers....	3 alumni received recognitions for their work (one graduate earned a Six Sigma Greenbelt and 2 U.S. patent applications; another graduate achieved a 91% yield in his/her plant in December 2003, which was a company record; another graduate received both a management award and the Bill Weich award for outstanding performance. 10 alumni have made technical presentations.
1. ... in chemical and related industries and organizations...	19 of 25 alumni are employed in chemical or other field of engineering; another alumnus is a project manager in manufacturing/production; another alumnus is a product manager
2. Engage in life-long learning through professional activities...	20 of 25 alumni have participated in some form of life-long learning after graduation (e.g. enrolled in a graduate course, attended workshops, regularly read professional journals)
2. and/or pursuit of higher educational degrees.	3 of 25 alumni are in graduate school full-time.

Therefore, it can be concluded that the chemical engineering program is clearly achieving objective 2, with 92% of recent graduates participating in some form of life-long education. Similarly, the program has achieved reasonable success in achieving objective 1, with 84% of its graduates employed in chemical or related engineering fields (with another 12% enrolled full-time in graduate school) and 52% of alumni making presentations on their work or being recognized for their accomplishments.

There is clearly some room for improving the attainment of the first objective. The employers would like the graduates of the chemical engineering program to have greater knowledge in aspects of environmental, health, safety, and regulatory affairs. The department faculty will address means of incorporating this information into the curriculum at the department retreat in August 2006. Furthermore, 42% of alumni who identified themselves as working in engineering are actually in engineering fields outside of chemical engineering. And many of the comments from the alumni stressed the need for additional help in finding co-op and permanent positions in

chemical engineering. The department faculty recognize the need to expand the number of positions for chemical engineering majors in internships, co-op's, and permanent placement, both in Northeast Ohio as well as outside the region. The department is working closely with the University and College engineering coordinator for co-op/placement to accomplish this objective.

If these results are compared to recent years it becomes apparent that the Program is evolving towards achieving most program outcomes, namely



Thus, except for two exceptions (Outcomes (d) and (e) where a significant drop can be appreciated), the Program is evolving towards achieving most Program Educational Outcomes satisfactorily.

Since the Program Educational Objectives were recently modified, no historical trends can be reported.

F. Review

The Alumni Survey results were presented to the Industrial Advisory Committee during their recent visit. The IAC comments and recommendations have been discussed in the “Findings” section already.

These results, trends and possible remedial actions will be discussed at the next Department Retreat (November 2006).

G. Actions

These points have already extensively discussed. The most significant changes have been the reformulation of the Program Educational Objectives. These changes were made in response to ABET evaluation.

Other points of significance in Program Assessment and Enhancements during the 2005-2006 AY pertain to Observations made by ABET's Engineering Accreditation Committee (EAC):

ABET's Program Observations

- 1. If the faculty member having lead responsibility for the senior design courses were unavailable, this heavy teaching responsibility would probably fall to the chair, presenting conflicts with his other responsibilities. Two suggestions, not mutually exclusive, to address this are to involve outside personnel with industrial design expertise and to develop capability for additional faculty members to lead this senior design activity.*

Department Response

In 2005-06, the senior design courses were taught, for the first time, by Professor Orhan Talu. Dr. Talu has extensive contacts with industry, via research grants and consulting. Dr. Talu was assisted by Dr. Lawrence Novak, Technical Manager at Lubrizol Corp., who volunteered his time to teach several of the classes. The department now has two full-time faculty (Dr. Talu and Dr. Shah) who have experience in teaching the senior design sequence. In addition, Dr. Novak, who now holds the position of Adjunct Professor in the department and is retired from Lubrizol, will continue providing assistance with this course.

- 2. The ongoing renovation/upgrading of the Chemical Engineering and Chemistry laboratory facilities needs to be continued.*

Department Response

Experiments using fuel cell test systems were added to the unit operations lab in 2005-06. This year the department received \$60,000 from the university to install a fume hood in the unit operations laboratory. This upgrade will permit the installation and commissioning of a recently purchased gas absorption system. The installation of the fume hood and the absorption system, and general upgrades of instrumentation and renovations of the unit operations lab will be performed in the summer of 2006.