



**Department of  
Chemical and Biomedical Engineering  
Fenn College of Engineering**

*Annual Report*

*Program Assessment*

*Bachelor of Chemical Engineering Program*

*July 2004*

*Based on data from Academic Year 2002-2003*

**Prepared by:** Jorge E. Gatica, Ph.D.  
Professor of Chemical & Biomedical Engineering  
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### 1. Goals/objectives

The program goals were determined by the faculty with input from the alumni. They are shown below, along with the assessment strategies for each goal.

<div style="text-align: center;"><b>Strategy</b></div> <div style="text-align: center;"><b>Objectives</b></div>	Curriculum (Curriculum-Outcomes Matrix is presented separately, attached)	Senior Exit Survey	Senior Exit Assessment	Design Instructor Assessment	Fundamentals of Engineering	Annual Advisory Committee Visit	Laboratory Instructor(s) Assessment(s)	Participation in Professional Soc.	Participation in Professional Act.	Visiting/Advisory Committee	Alumni Survey
1. Provides a sound education in Chemical Engineering fundamentals and related topics.	■	■	■	■	■	■	■				■
2. Trains students such as they can design, analyze, and operate manufacturing processes involving physical and chemical changes.	■		■				■				■
3. Trains students such as they can design and operate chemical processes satisfying social, environmental, and economical constraints.	■		■		■	■				■	■
4. Prepares students for careers in the Chemical and related Industry within the Northeast Ohio region and beyond.	■					■				■	■
5. Prepares students for practical engineering applications, as well as providing the depth of knowledge required for graduate studies.	■										■
6. Motivates graduates' participation in life-long learning and professional development activities.								■	■		■

## 2. Outcomes

The outcomes were specified by the Engineering Accreditation Commission, with some modification by the department faculty. They are shown below, along with the assessment strategies.

<div style="text-align: center;"> <p><b>Strategy</b></p> <p><b>Outcome</b></p> </div>	Curriculum (Curriculum-Outcomes Matrix is attached)	Senior Exit Survey	Senior Exit Assessment	Design Instructor Assessment	Integrated Design Experience	Employers Survey	Laboratory Instructor(s) Assessment(s)	Participation in Professional Societies	Participation in Professional Activities	Alumni Survey
<p><b>Degree of correlation:</b> (■) Direct, (▣) Reasonable, (□) Remote, (□) N/A</p>										
Ability to apply Math, Science & Engineering Knowledge	■			▣	■		▣			
Experimental Data Collection, Analysis & Design	■	▣					■			
Engineering Design (Chemical Systems, Units & Processes)	■	▣		■	▣					▣
Multidisciplinary Team Work		▣		▣						▣
Identification, Formulation & Solution of Engineering Problems	■			■	■	<b>No Longer Used</b>	▣			▣
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 Program Criteria	■	▣	▣	■	■		▣			▣

### **3. Research**

#### **3.1 Assessment Methods**

The Department of Chemical & Biomedical Engineering uses a number of assessment instruments. Most of them consist of collections of responses to selected questions. The results of each assessment tool are selectively used for weight average and final tally (Table with the degree of significance assigned to the results of each method is enclosed, cf. I.2).

All results are compiled and analyzed by the Engineering Criteria Department Coordinator. The results are normalized between 0 to 3. Results are compiled separately for each Assessment Method and affected by a weight factor (according to the correspondence table in I.2). 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.

Assessment methods and their descriptions are presented below:

#### **Curriculum Assessment (a.k.a. "Course Reflections")**

This activity is performed at the end of each term (semester). The results are compiled via the department website (form attached, see Appendices). 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 has been prepared (see Appendices) and it is reviewed for appropriateness at each Annual Department Retreat. The results for each course are used to compile a weighted (according to Table ?) average.

#### **Senior Design Instructor Assessment**

This activity is performed at the end of each term (semester). This questionnaire is completed by Senior Design Instructors only. The format is similar to the Course Assessment form.

#### **Laboratory Instructors Assessment**

This activity is performed at the end of each term (semester). This questionnaire is completed by Instructors of courses with a laboratory component only. The format is similar to the Course Assessment form. Special attention is given to outcomes related to team work, experimental design and ability to work in laboratory environments (see correspondence matrix in I.2).

#### **Senior Assessment**

This questionnaire is filled by all the students of each graduating class at the end of the academic year. The format is similar to the Course Assessment form.

**Senior Exit Survey**

It consists in a meeting with the Department Chairperson and the Department Secretary. It is meant to be an open forum where students can voice their concerns, 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.

**Professional Student (AIChE) Chapter Activities**

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**

This survey is conducted every two years. Alumni are asked a series of questions aligned with the Program Outcomes and Program Objectives (cf. sample questionnaire attached)

**Employers Survey**

This survey was typically conducted every two years. It requested the employers' opinion and assessment of graduates from the program. The mailed questionnaire was aimed to assess the graduates' skills in areas directly related to the Program Outcomes (cf. sample attached).

This Survey has been removed as one of the assessment tools and it has been replaced by the input provided by the Annual Program Advisory Committee Visit (2003 Advisory Committee Visit).

## 4. Findings

### 4.1 Results related to Outcomes

Entries followed by “?” corresponded to the original Outcomes/Assessment Matrix but were questioned (difficulty in quantifying assessment data) and will be re-evaluated for significance at the Annual Department Retreat. **Results in bold** will be discussed at the Retreat. Results are presented in decreasing degree of relevance.

#### Outcome a: Ability to apply knowledge of Mathematics, Science & Engineering

This outcome relies heavily on the background acquired by students during the service courses provided by the departments of Mathematics, Chemistry and Physics. Support provided by Engineering Science Courses is also relevant to this outcome. All major Chemical Engineering courses require skills in basic Algebra, Calculus, Chemistry and Physics. Results from the Curriculum (Course) Assessment and Integrated Design Experience are the major assessment strategies; complemented by the Senior Design and Laboratory Instructors Assessments. Senior Exit and Alumni (not run) Surveys provide some supplementary information.

#### Results:

Assessment Strategy	← Degree of Relevance		
Curriculum Assessment	2.5		
Integrated Design Experience	2.3		
<b>Senior Design/Lab. Instructors</b>		<b>1.8?</b>	
Senior Exit Assessment			2.7
Alumni Survey			N/A
Student Chapter Activities			2

#### Conclusions and Action Taken/Recommended:

This outcome seems to be met satisfactorily. The department has adopted the policy of reinforcing the importance for students to join the Student Chapter early on in their careers and seek tutoring when learning the fundamentals of Mathematics, Physics, and Chemistry.

#### Outcome b: Ability to design experiments, collect and analyze experimental data

This outcome relies primarily on the Curriculum and Laboratory Instructor Assessments., surveys provide complementary assessment information. The responsibility for teaching laboratory practices has gradually been shifted from support courses (Chemistry and Physics) to the major discipline courses. The Program recognizes that although supporting departments can prepare students in general safety and laboratory practices, engineering disciplines present students with more open-ended assignments and rely more heavily on statistics. These topics are covered in more detail during sophomore and junior-level classes.

**Results:**

<b>Assessment Strategy</b>	<b>← Degree of Relevance</b>		
Curriculum Assessment	2.3		
<b>Laboratory Instructors</b>	<b>2</b>		
<b>Senior Exit Survey</b>		<b>?</b>	
Senior Exit Assessment			2.5
<b>Alumni Survey</b>			<b>N/A</b>

**Conclusions and Action Taken/Recommended:**

Some weakness (although much less significant as AY 2001-02) was detected by Laboratory Instructor. In response to the results from AY 2001-02 and comments from the Senior Exit Survey; a new (1 credit-hour) course was implemented. This course: "*Junior Chemical Engineering Laboratory*," will be offered first time Fall 2003. The course is complemented by the laboratory component of "*Chemical Reactor Design*" (offered during the second, sixth, Junior semester) and the Capstone Laboratory Course during Senior year. The next AY Exit Survey and student performance will be used to better assess this outcome.

**Outcome c: Ability to design chemical units, systems and processes.**

The assessment for this outcome relies primarily on the "Course Reflections" provided by the Senior Design Instructor and, to a smaller extent, on the Curriculum Assessment results and Surveys.

**Results:**

<b>Assessment Strategy</b>	<b>← Degree of Relevance</b>		
Curriculum Assessment	2.4		
Senior Design Instructor	2.2		
<b>Senior Exit Survey</b>		<b>?</b>	
Senior Exit Assessment		2.5	
Alumni Survey		N/A	
Student Chapter Activities			?

**Conclusions and Action Taken/Recommended:**

This is the first year after the Integrated Design Experience (IDE) was implemented. This initiative, together with the close relationship between the department faculty and the senior class, seems to have yielded positive results.

This experience brought to light the need to reinforce in students the idea that the curriculum was all tied together. This was of particular relevance when it came to the major Chemical Engineering core courses, where the prerequisites clearly indicate a progressive chain-link relationship between courses.

The process of assessment of Seniors' presentations by the entire faculty was adopted as a practice for the 2002-2003 Academic Year. The Senior Design syllabus was modified accordingly. It was made clear to students that this practice would have no effect on their grade or Senior Design Instructor grading scale. It was meant for the program to have a more comprehensive picture of the preparation of its graduating class.

One significant modification to the curriculum was the insertion of the idea of Design-across-the-Curriculum (several institutions have shown a movement towards similar

approaches). This idea referred to as “Integrated Design Experience’ (IDE) was first implemented during the Spring 2002, and it is aimed to bring the students close to the idea of intimate relationship among all core courses. Details on its implementation can be found in the Assessment Report for AY 2001-02.

The “reflections” provided by the faculty after the Senior Design interim/final presentations have also been incorporated as an additional assessment tool.

**Outcome d: Ability to work in a multidisciplinary team**

This outcome was very difficult to assess. The curriculum does not have many entries in the correspondence matrix. Although alumni and employers’ surveys might be the most reliable tools, no results are available. Only some loosely related indices are provided below.

**Results:**

<b>Assessment Strategy</b>	<b>← Degree of Relevance</b>		
<b>Senior Exit Survey</b>		<b>?</b>	
Alumni Survey		N/A	
Senior Exit Assessment			2.9
<b>Senior Design Instructor</b>			<b>1.5</b>
Curriculum Assessment			2.5
<b>Student Chapter Activities</b>			<b>1</b>

**Conclusions and Action Taken/Recommended:**

The results might seem to indicate that action is needed. The reality is that the curriculum has very few opportunities to cover this issue. The Exit Survey seems to indicate that no problem exists; internal measurements seem to be contradicting that measurement.

Modifications to the curriculum include plans to implement a multidisciplinary certificate track (School of Business and School of Engineering). This proposal is being evaluated in the College of Engineering.

Activities in other courses, ESC 301: Fluid Mechanics have been slowly making a transition to implement this idea on a regular basis. Activities in PHL 215: Ethics for Engineers might have some relevance on this issue as well. The Student Chapter is seriously trying to recruit students from other majors for the National Engineering Design Competition. This issue must be re-evaluated.

**Outcome e: Ability to Identify, Formulates & Solve Engineering Problems.**

This outcome relies on the Design Instructor and Curriculum Assessments. Minor complementary indices are provided by the Laboratory Instructors Assessments and Surveys.

**Results:**

<b>Assessment Strategy</b>	<b>← Degree of Relevance</b>		
Curriculum Assessment	2.3		
Senior Design Assessment	2.1		
Laboratory Instructors		2.5	
Alumni Survey		N/A	
<b>Senior Exit Survey</b>		?	
Senior Exit Assessment		2.5	

**Conclusions and Action Taken/Recommended:**

No serious deficiencies were identified with these skills.

**Outcome f: Understanding of Professional and Ethical Responsibilities, including Safety and Environmental aspects related to Chemical Systems, Units and Processes**

This outcome's assessment relies primarily on the Alumni Survey. A variety of assessment tools are used as complementary tools. Some assessment methods provide some measurement but is difficult to quantify.

**Results:**

<b>Assessment Strategy</b>	<b>← Degree of Relevance</b>		
Alumni Survey	N/A		
Curriculum Assessment		2.4	
<b>Senior Exit Survey</b>		?	
Senior Exit Assessment		2.4	
Senior Design Instructor		2.2	
Student Chapter Activities		2.5	

**Conclusions and Action Taken/Recommended:**

The results might seem to indicate that no immediate actions are required. With almost no exceptions the indices seem to suggest that there is no reason for concern in this area. It would have been more definite having the input from Employers; but is no longer a viable assessment tool. Some measurements (Senior Exit Assessment, for instance) are difficult to quantify. Activities carried out by the Student Chapter can definitely be used in assessing this outcome, explicit measurements are needed. Compilation of activities and department-sponsored seminars/workshops/plant visits were stressed this year.

**Outcome g: Effective Communication Skills**

The fulfillment of this outcome is assessed primarily through “Course Reflections”: Curriculum Assessment, and Senior Design and Laboratory Instructors Assessments. Some complementary information is extracted from the Surveys and Student Chapter Activities.

**Results:**

<b>Assessment Strategy</b>	<b>← Degree of Relevance</b>		
Curriculum Assessment	2.5		
Senior Design Instructor	N/A		
Laboratory Instructors	2		
Alumni Survey		N/A	
<b>Student Chapter Activities</b>			<b>?</b>
Senior Exit Assessment			2.7
<b>Senior Exit Survey</b>			<b>?</b>

**Conclusions and Action Taken/Recommended:**

The results do not appear to be conclusive. Comments of faculty appear to highlight the some deficiencies more in written communication skills than in verbal communication. Two new components in the curriculum (IDE & Junior Lab) may have an effect towards ameliorating this deficiency. These measures should be investigated on a comparative basis after these modifications have been introduced in the curriculum.

**Outcome h: Knowledge of contemporary issues, and understanding of global/social impact of engineering solutions.**

This outcome is also affected by the problems of Outcomes (d) and (f), where very few measurements are available for judging the efficiency of the Program in achieving them. It relies primarily on the Alumni Survey; while all other measurements play a complementary role. The Curriculum provides some vehicles to assess its effectiveness through electives, but the Program cannot ensure consistency on that regard.

**Results:**

<b>Assessment Strategy</b>	<b>← Degree of Relevance</b>		
Alumni Survey	N/A		
Curriculum Assessment		2.7	
<b>Senior Exit Survey</b>		<b>?</b>	
Senior Exit Assessment		2.5	
Senior Design Instructor		2.5	
<b>Student Chapter Activities</b>		<b>?</b>	

**Conclusions and Action Taken/Recommended:**

The results might seem to indicate not significant deficiencies in this area. Most of the internal measurements can be judged on the light of the lack of avenues within the curriculum to convey this type of information. General Education Courses are supposed to have a significant effect on this issue, but are completely outside the control environment for the Program. Possible modifications considered were College Service

Courses such as PHL 215 and ESC 282 as vehicles to present case studies. Also Senior Electives must have an increasing component to raise awareness on social impact of engineering solutions. No definite action was taken or suggested.

**Outcome i: Understanding of the need to engage in lifelong learning activities.**

This outcome is in direct parallel with one of the Program Educational Objectives. It relies primarily on the input provided by the Alumni Survey. Student Chapter Activities can also be used to judge the students perception on this area.

**Results:**

<b>Assessment Strategy</b>	<b>← Degree of Relevance</b>		
Alumni Survey	N/A		
Student Chapter Activities	3.0		
<b>Senior Exit Survey</b>		<b>?</b>	
Senior Exit Assessment			2.5
Senior Design Instructor		2.3	
Curriculum Assessment			2.5

**Conclusions and Action Taken/Recommended:**

The two primary assessment measurements were difficult to assess. The Student Chapter was a very active group showing genuine concern to engage in supplementary learning activities. Alumni Surveys that are critical to assess this outcome were not scheduled for this period.

**Outcome j: Ability to Use Techniques, Skills and Modern Engineering Tools necessary for Engineering Practice**

A number of measurements are used in a complementary fashion. There is no specific measurement that allows to judge this outcome directly.

**Results:**

<b>Assessment Strategy</b>	<b>← Degree of Relevance</b>		
Curriculum Assessment		2.5	
Senior Design Instructor		2.3	
Alumni Survey		N/A	
<b>Senior Exit Survey</b>			<b>?</b>
Senior Exit Assessment			2.5
<b>Student Chapter Activities</b>		<b>?</b>	

**Conclusions and Action Taken/Recommended:**

No apparent problems were detected from assessment measurements. Proper updating of individual course curricula should ensure that this outcome is met satisfactorily,

***Outcome k: Understanding of Principles and Working Knowledge of subject areas as defined by the Program Criteria of the American Institute of Chemical Engineers***

This outcome is judged primarily via the Curriculum and the Senior Design Instructor Assessments. The remaining measurements are used as complementary indicators with diverse degrees of weighting.

**Results:**

<b>Assessment Strategy</b>	<b>← Degree of Relevance</b>		
Curriculum Assessment	2.2		
Senior Design Instructor	2.3		
Laboratory Instructors		2.5	
Senior Exit Assessment		2.2	
<b>Senior Exit Survey</b>		<b>?</b>	
Alumni Survey		N/A	
<b>Student Chapter Activities</b>			<b>?</b>

**Conclusions and Action Taken/Recommended:**

This outcome is to an extent the summary of the effectiveness of the Program. The measurements were not conclusive; some indicated the need for improvement, while others seem to suggest that the Program has been effective in conveying the working knowledge outlined as Program Criteria by the AIChE. Although no immediate action was decided on this outcome, it is anticipated that the implementation of the Integrated Design Experience will have significant effect in achieving this outcome. To be re-evaluated after changes in the curriculum are implemented.

***5. Review***

The compiled results are presented to the department faculty at the Department Annual Retreat (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.

A Final Report is prepared during the ensuing Fall or Summer Semesters (May-August).

## 6. Actions

A detail of the key findings and corresponding program modifications has been provided in the previous sections. The relationship between results and Program Outcomes/Objectives has been discussed in detail in the corresponding sections.

A summary of findings, actions recommended and changes implemented in the Program is as follows:

- ↳ **Modify questionnaire for IDE assessment** The questions are difficult to relate with the outcomes sought to be assessed by this initiative.
  - ↳ **Include new questions in Alumni Survey**
  - ↳ **Recover information from ESC 282 and PHL 215** to complement Department's collected assessment information.
  - ↳ **Translate Seniors Exit Survey into numbers**, some actions were taken in response to AY 2000-2001 and 2001-2002 Senior Surveys, but we need some systematic form to account for Senior's responses. This is an issue left unresolved from last year [Chairman was to evaluate options and would resume discussions on the issue]
  - ↳ Two major changes were implemented for the Program:
    - ***Integrated Design Experience: IDE*** (see details in binder)
    - ***Junior Laboratory Experience***, a.k.a. "Junior Lab"  
(see syllabus in binder)
      - The lab will not add credits to the Curriculum
      - The lab is a 0-2-1 credits course
    - The 1 credit will count towards the Advanced Science requirement (3 credits = 1 + 2 now, see Curriculum for Details)
- There are not enough results to judge the effect of these changes, but some of the deficiencies identified the previous period seem to have lost some relevance as weaknesses of the program.

## ***Appendices***

### ***Student Chapter Activities*** **2002-2003 Academic Year**

- 1.) Membership of 37 students
  - Grad. Students - 9
  - Seniors - 5
  - Juniors - 12
  - Sophomores - 9
  - Freshman - 2
  
- 2.) Sixteen (16) student members attended the National Conference in Indianapolis. We competed in the chemical car competition and finished 8th.
  
- 3.) Five (5) Students attended the Regional conference at Michigan Tech. We competed in the chemical car competition and finished 2nd.
  
- 4.) We went on plant tours to Ben Venue Labs (Pharmaceuticals), McDermott Technology (Fuel Cells) and the Great Lakes Brewery.
  
- 5.) We had on campus speakers from Ben Venue Labs (Pharmaceuticals), McDermott Technology (Fuel Cells) and PolyOne (Polymer production).
  
- 6.) Regular meetings were held on campus once a month (7 meetings total).
  
- 7.) Thirteen (13) members volunteered to help operate a booth at the Great Lakes Science center during National Engineers Week.