Department of

Chemical and Biomedical Engineering

Fenn College of Engineering

Annual Report

Program Assessment

Bachelor of Chemical Engineering

Academic Year 2008-2009

Prepared by: Dhananjai B. Shah/Jorge E. Gatica
Department of Chemical and Biomedical Engineering, *July 2009*

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:
1. Standard 4-year program option
2. 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, 2007. 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 hi 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

Dr. Dhananjai B. Shah
Professor and Chairperson
Department of Chemical and Biomedical Engineering
Cleveland State University
Phone: (216) 687-2571
Fax: (216) 687-9220
Email: d.shah@csuohio.edu

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
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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, in line with the Program Outcomes, the Chemical Engineering curriculum **aims to educating students to acquire the knowledge/understanding in [the]**

- **(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 modem 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/) 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.

E. 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	▣			■	■				▣
Principles and working knowledge as defined by AIChE (www.aiche.org) Program 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(2.0) are highlighted as areas requiring action (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.

<u>Note:</u> The Assessment Coordinator (Dr. Jorge E. Gatica) was on sabbatical and Fulbright Assignment for the Summer and Fall 2008 terms, the Department Retreat for the 2007-2008 Assessment Cycle was held during a special meeting during the Spring 2009 term (March 2009).

In view of the unresolved "concern" identified by ABET:

> ***"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."***

Which resonated with the Review (provided in § G) of our own CSU's Office of Student Learning Assessment (OSLA):

> ***"... since the concern related to Program Outcomes and Assessment remains unresolved, primarily due to the lack of a direct measure of student learning, you may want to consider a few actions that would complement the ones you have already identified..."***
>
> ***"Consider highlighting some of the direct measures of student learning currently in use in the program by involving faculty in determining ways to make them consistent and reliable across courses or sections of the same course."***

A new methodology was identified by the Department Faculty at the last Department Retreat/Program Assessment (March 2009). The methodology is currently being formalized and streamlined for web-access under the sponsorship of the OSLA (a summary/example is provided as an appendix)

Implementation of this new methodology was initiated late in the Spring 2009 term, and most of the faculty's feedback has been converted to the new rubrics/metrics. A preliminary analysis of the Curriculum Assessment is presented in the sections below.

F. Findings

Data collection for the 2008-09 AY was not complete at the time this Report was prepared. The following list summarizes the status of each Assessment Tool at the time of the Report completion:

1. Curriculum Assessment (a.k.a. "Course Reflections") [CM]: The data for most of the courses pertaining to the Engineering portion of the Curriculum is available and included in the Report.

2. Senior Design Instructor Assessment [DIA]: Feedback complete, available and included in the Report.

3. Laboratory Instructors Assessment [LIA]: Feedback from one course is missing [instructor on sabbatical leave for Spring/Summer 2009]. The remaining data is available and included in the Report.

4. Senior Assessment [SEA]: Data available and included in the Report.

5. Senior Exit Interview [SES]: Summary of Exit Interviews not available at time of the Report.

6. Professional Student (AIChE) Chapter Activities [PS]: Student chapter did not provide any information for this Assessment cycle.

7. ***Alumni Survey[AS]:*** Survey was implemented and mailed to alumni according to the data base provided by the Office of Alumni Relations. Most of the information was outdated, with a large portion of the mailing returning to the programs as undeliverable material. Response rate was negligible and data was considered sufficient for any statistical analysis of alumni feedback. Survey mechanism is to be revised at Department Retreat.

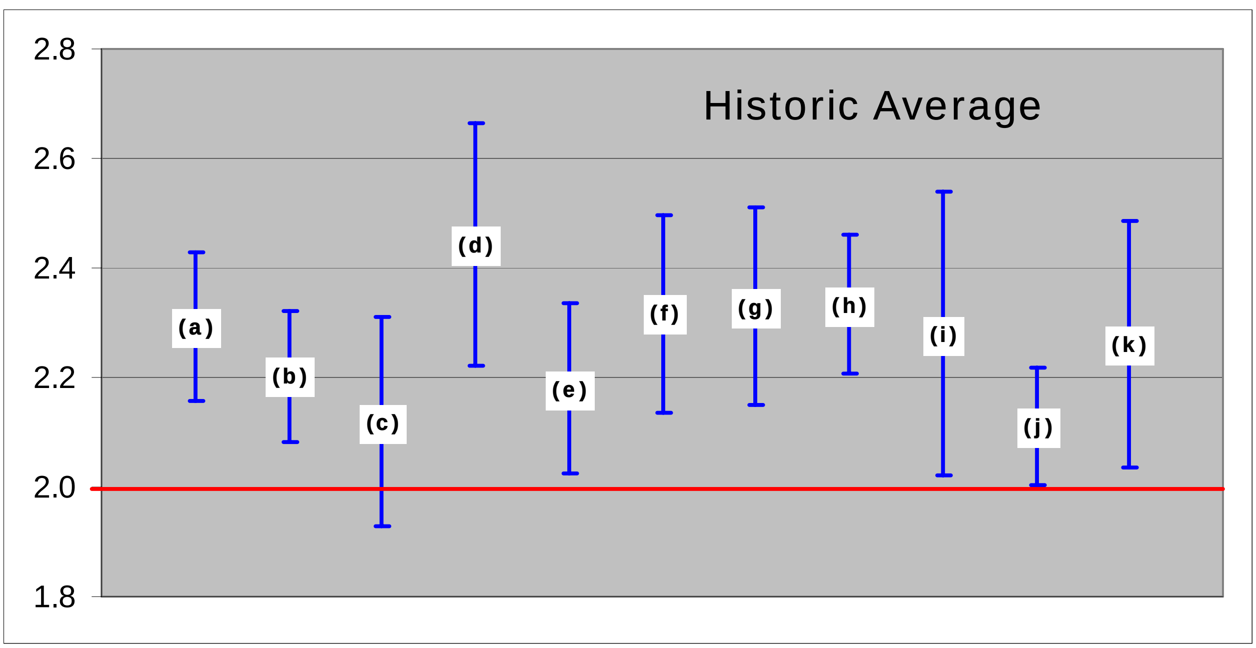
8. Employers/Industrial Advisory Committee [IAC]: the IAC Meeting was held at CSU on August 20, 2008 [Agenda included as an appendix]. Minutes of the IAC Meeting were not available at the time of the Report.

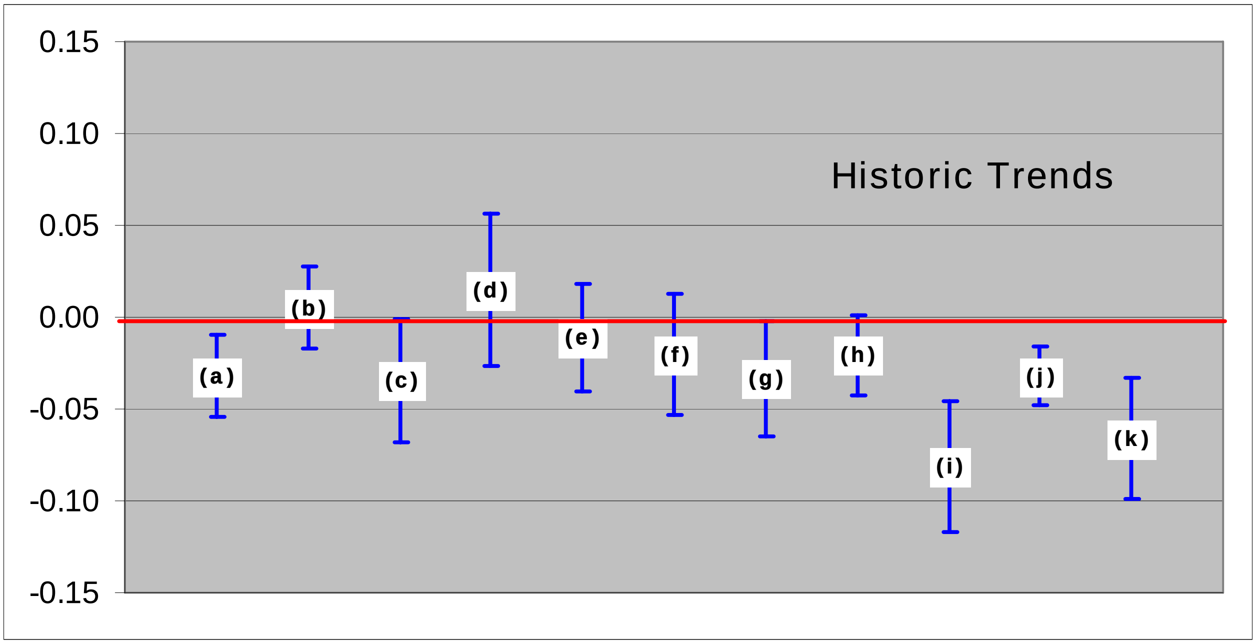
Notice that, beginning with the 2008-09 Assessment cycle, ***Tools 1-3 have been completely re-designed and now require a more involved participation of course instructors.*** *It is to be expected that the information missing will be completed through the Summer and Fall 2009 terms.*

The results for the 2008-09 Assessment cycle are tabulated below

Summary													
Percent Curriculum Allotment		31%	3%	8%	4%	26%	2%	7%	1%	0%	10%	7%	
	Outcome	a	b	c	d	e	f	g	h	i	j	k	
Academic Year 2008-2009													
Curriculum	Out of 3	1.73	2.00	2.00	2.25	1.79	2.25	2.00	2.33	2.00	1.89	2.11	
Action may be required		Maybe	No	No	No	Maybe	No	No	No	No	Maybe	No	
Seniors	Out of 3	2.52	2.34	2.40	2.46	2.40	2.46	2.16	2.16	2.52	2.34	2.22	
Action may be required		No	No	No	No	No	No	No	No	No	No	No	
Instructors (Design/Lab)		2.05	2.00	2.02	2.00	2.25	2.25	1.92	2.38	1.50	2.02	1.99	
Action may be required		No	No	No	No	No	No	Maybe	No	Maybe	No	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		2.10	2.11	2.14	2.24	2.15	2.32	2.03	2.29	2.01	2.08	2.11	
Attention required		No	No	No	No	No	No	Maybe	Maybe	Maybe	No	No	
Action may be required		N/A	N/A	N/A	N/A	N/A	N/A				N/A	N/A	
(*) IAC is used as Employers' Feedback to Review Curriculum and Program Objectives									[Minutes not available at time of Report]				
(*) Alumni Survey percent response was too low for any analysis with statistical significance													

Since assessment data has been collected in a format commensurate with the existing Program Outcomes since the 2000-01 AY, qualitative observations about historic performance trends can be drawn as follows





These results suggest that attention might have to be paid to how the Program addresses the fulfillment of the following Program Outcomes:

(g) ***Effective Communication Skills***
(h) ***Contemporary Issue & Global/Social Impact of Engineering Solutions.***
(i) ***Need and Ability to engage in Lifelong Learning***

and, perhaps,

(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)*.**

To properly interpret the results shown in this table some explanation may be in order:

1. The evidence indicates that the Curriculum may be lacking of attention to some of the students' skills. The information available, however, is missing feedback from General Education [outcomes (g) and (h)], Science and Math [outcomes (i)], and some Engineering portions of the Curriculum [outcomes (h) and (i)].
2. The assessment of the Curriculum percentage attention to each outcome is new information not available [not collected/compiled in this fashion] before to the Program.
3. Historical trends [also data that had not received a detailed analytical treatment as reported here before] represent data from different populations; and, therefore, only qualitative conclusions can be drawn from their inspection.
4. The last two outcomes may be missing data from key courses in the Curriculum for which data was not provided for this assessment cycle.

G. Review

The results, trends and possible remedial actions for the AY 2006-2007 Program Assessment were discussed at the Annual Department Retreat (November 2007). The section of the minutes for the Retreat pertaining to ABET and Program Assessment can be found in Appendix A.

The point of major significance related to Program Assessment and Enhancements during the 2006-2007 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.

- **This concern remains unresolved.**

Review from CSU's Office of Student Learning Assessment (OSLA)

The OSLA's Review for the 2007-2008 Report included the following observations:

1. During the last ABET evaluation for re-accreditation (in 2004), there were two program concerns, 1 program observation, 1 institutional concern, and 1 institutional weakness identified by the visiting team. We appreciate the prompt response provided by the program faculty and administration. However, since the concern related to Program Outcomes and Assessment remains unresolved, primarily due to the lack of a direct measure of student

learning, you may want to consider a few actions that would complement the ones you have already identified, as follows:

- Developing a scoring rubric that could be agreed upon as an evaluative tool for a particular set of student assignments. For instance, looking at the 2007 report, such a scoring rubric could be used for the final project report in CHE 404. In this instance, reporting on student learning assessment data would make reference to the range of student project reports that met (and/or surpassed) the expected level of performance (which would also be determined by course instructors and/or the rest of the program faculty). The benefit of pursuing this type of assessment tool relates to the fact that we can evidence a range of student performance levels to accompany the final course grades, thus eliminating any concerns about the over-reliance on the latter.
- Identifying several assessment tools that would provide both program faculty and students with formative (or diagnostic) information about how our program curriculum engages students in the acquisition of knowledge as well as the development of skills and positive dispositions (both personally and professionally).
- Your program already has a very clear and useful tool designed to map out the different types of assessment tools providing faculty, staff, and students with relevant data – see the Table outlining Attributes of an Engineer to specific Program Educational Objectives (on p. 7 in your report). We would suggest using it to determine the existing direct and indirect measures of student learning as a first step toward creating additional ones that would strengthen the program.

2. Related to the previous point, you may want to consider the “course reflections” as a valuable tool to investigate the relevance of the program curriculum, thus representing a program review item, not one related to student learning assessment. The same seems to apply to the Senior Design Instructor Assessment and Laboratory Instructors Assessment, primarily due to the emphasis on the instructors’ summative evaluation of the class content and related pedagogy.

- On the other hand, the Senior Assessment, Senior Exit Interviews, Alumni Survey, and Employers Advisory Committee (through its survey) are useful sources of indirect evidence of student learning which could be used to guide any necessary program changes (either in terms of curriculum or assessment plan).

3. Consider highlighting direct measures of student learning currently in use in your program, in addition to course grades, which, in most cases, are not considered direct evidence due to differences among course instructors, their pedagogy, selection of assignments, etc.

Strengths: Program faculty commitment to continuous improvement. Wide range of assessment tools in use.

Limitations: No evidence of direct measures of student learning that could be used consistently within the program and across different courses or sections of the same course.

Recommendations: Consider highlighting some of the direct measures of student learning currently in use in the program by involving faculty in determining ways to make them consistent and reliable across courses or sections of the same course.

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 March 2009 Department Retreat the Department Faculty formulated the following strategies:

1. The existing mechanism and forms (cf. Appendix) 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, cf. sample in Appendix D).
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 implemented retroactively to the Fall 2008 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 (cf. section F above). The difference with the Spring 2008 formulation will consist on including specific information [previously available to the course instructor only] on the results for each specific course grading element.

Appendices
Assessment: *New Data Collection Methodology and Metrics*

Project Description and Technology

This project involves the development of an on-line evaluation management system to record and process course/program assessment information submitted by faculty and staff members. It would consist on a system of on-going evaluation that provides monitoring of achievement of Program Outcomes and with a built-in feedback mechanism towards improving the Program effectiveness. Interacting with a database, the system will maintain and provide access to records for the various submissions such as Course Assessments, Laboratory assessments, Senior Design Assessments, etc.

The user needs to login from the welcome screen (cf. Fig. 3). Once logged onto the system, the user will have access to a number of possible tasks (cf. Fig. 4); submitting an evaluation, for instance, or log out. The forms are designed to enable their completion is the shortest possible time (cf. Fig. 5).

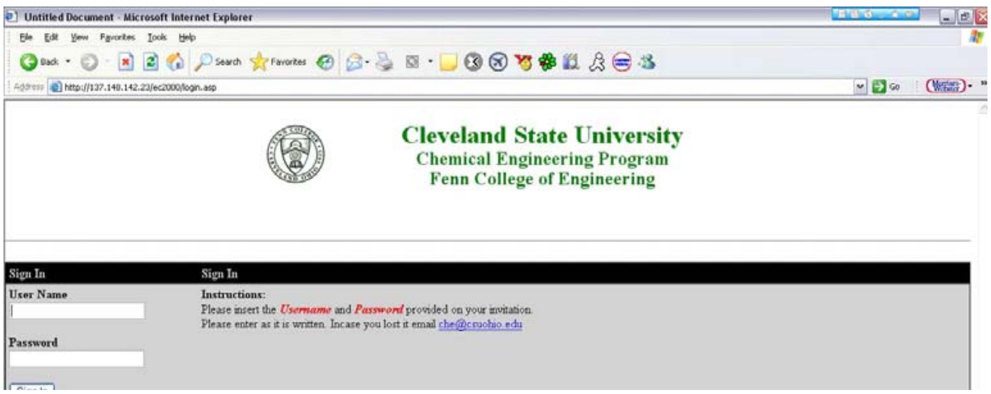


Figure 3: Welcome/login screen

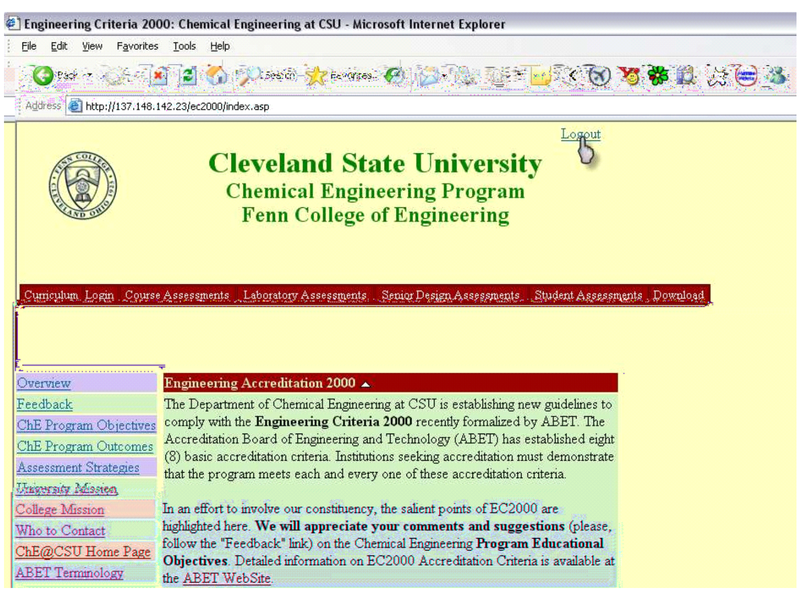
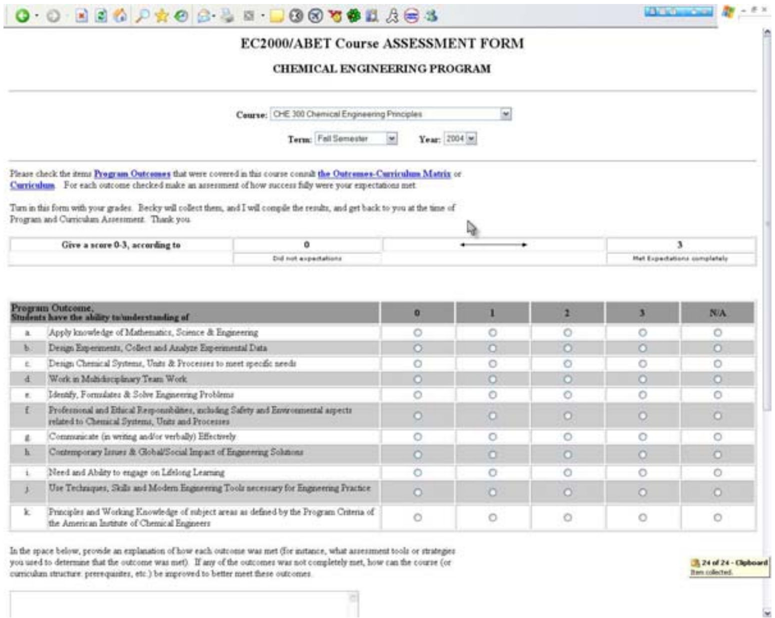


Figure 4: Main screen and log out option

On completing the assessment and submitting the user receives an acknowledgement of successful submission. He could either submit another assessment or logout from the system using the logout button that is provided at the top right of the screen.



EC2000/ABET Course ASSESSMENT FORM

CHEMICAL ENGINEERING PROGRAM

Course: CHE 300 Chemical Engineering Principles

Term: Fall Semester Year: 2004

Please check the items Program Outcomes that were covered in this course consult the Outcomes-Curriculum Matrix or Curriculum. For each outcome checked make an assessment of how success fully were your expectations met.

Turn in this form with your grades. Becky will collect them, and I will compile the results, and get back to you at the time of Program and Curriculum Assessment. Thank you.

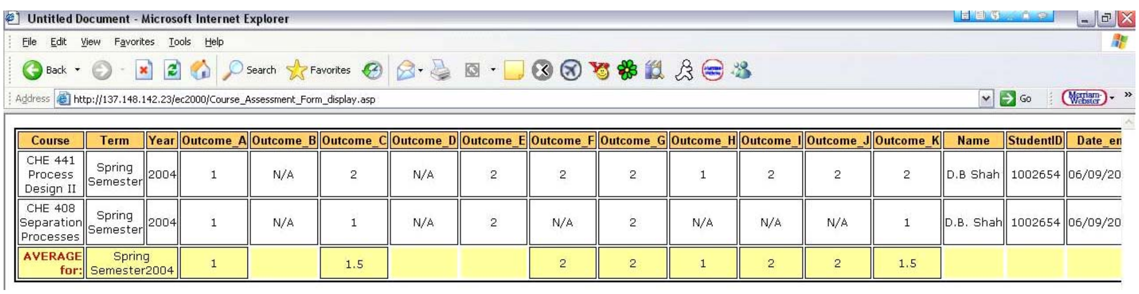
Give a score 0-3, according to	0	←→	3
	Did not expectations		Met Expectations completely

Program Outcome, Students have the ability to/understanding of		0	1	2	3	N/A
a.	Apply knowledge of Mathematics, Science & Engineering	○	○	○	○	○
b.	Design Experiments, Collect and Analyze Experimental Data	○	○	○	○	○
c.	Design Chemical Systems, Units & Processes to meet specific needs	○	○	○	○	○
d.	Work in Multidisciplinary Team Work	○	○	○	○	○
e.	Identify, Formulates & Solve Engineering Problems	○	○	○	○	○
f.	Professional and Ethical Responsibilities, including Safety and Environmental aspects related to Chemical Systems, Units and Processes	○	○	○	○	○
g.	Communicate (in writing and/or verbally) Effectively	○	○	○	○	○
h.	Contemporary Issues & Global/Social Impact of Engineering Solutions	○	○	○	○	○
i.	Need and Ability to engage on Lifelong Learning	○	○	○	○	○
j.	Use Techniques, Skills and Modern Engineering Tools necessary for Engineering Practice	○	○	○	○	○
k.	Principles and Working Knowledge of subject areas as defined by the Program Criteria of the American Institute of Chemical Engineers	○	○	○	○	○

In the space below, provide an explanation of how each outcome was met (for instance, what assessment tools or strategies you used to determine that the outcome was met). If any of the outcomes was not completely met, how can the course (or curriculum structure, prerequisites, etc.) be improved to better meet these outcomes.

Figure 5: Sample of a Course Assessment Form

Once the form is submitted, it is entered into the database. There are several forms that can then be requested for statistical analysis of the data submitted (current or historical trends, cf. Fig. 6)



Course	Term	Year	Outcome_A	Outcome_B	Outcome_C	Outcome_D	Outcome_E	Outcome_F	Outcome_G	Outcome_H	Outcome_I	Outcome_J	Outcome_K	Name	StudentID	Date_en
CHE 441 Process Design II	Spring Semester	2004	1	N/A	2	N/A	2	2	2	1	2	2	2	D.B Shah	1002654	06/09/20
CHE 408 Separation Processes	Spring Semester	2004	1	N/A	1	N/A	2	N/A	2	N/A	N/A	N/A	1	D.B. Shah	1002654	06/09/20
AVERAGE for:	Spring Semester2004		1		1.5			2	2	1	2	2	1.5			

Figure 6: [Demonstration of] Statistical Analysis of Submitted Information

Once the assessment form for each course taught through a given academic year is submitted, three such [compiled] tables [as shown in Figure 6] will be available: Curriculum, Laboratory Experience, and Capstone Design Experience.

These tables provide entries ranging between 0-3 indicating different levels of achievement of Student Learning Outcomes (a through k). The Department of Chemical and Biomedical Engineering then analyzes these metrics assigning a "Satisfactory Achievement" level to those outcomes with overall scores of 2.0 or higher. Scores between 1.5 and 2.0 indicate potential problem areas, and scores below 1.5 deserve immediate attention. The Department meets once a year in their Annual Department Retreat and discusses possible course of action in light of these results.

There were two issues highlighted by ABET as potential deficiencies for the Program: Consistency in the use of the Assessment Forms, and lack of information which can support the assignment of final scores to each of the metrics. This proposal attempts to resolve these two issues by centralizing and streamlining the data entry on part of the faculty.

To identify the key elements in the Program Assessment Methodology and to illustrate the approach proposed here, let us use a model course from the present curriculum.

The Curriculum Assessment relies on the **[Curriculum or] Course-Outcomes Matrix**: This matrix provides a set of binary coefficients for each course in the Curriculum (the current matrix for the Chemical and Biomedical Engineering Undergraduate Program is attached in the appendix)

For instance, if we take a given course, e.g. **CHE XXX: Chemical Engineering Major Subject.** According to the **Curriculum-Outcomes Matrix**, this class contributes to fulfilling the following **Program [or Student-learning] Outcomes**:

CHE XXX: Chemical Engineering Major Subject		aims to teach students how to
Outcome		
Apply knowledge of Mathematics, Science & Engineering	**a**	**1**
Design Experiments, Collect and Analyze Experimental Data	**b**	**1**
Design Chemical Systems, Units & Processes to Meet Specific Needs	**c**	**1**
Work in Multidisciplinary Team Work	**d**	**1**
Identify, Formulates & Solve Engineering Problems	**e**	**1**
Professional and Ethical Responsibilities, Including Safety and ...	**f**	**0**
Communicate (in writing and/or verbally) Effectively	**g**	**1**
Contemporary Issues & Global/Social Impact of Engineering Solutions	**h**	**0**
Need and Ability to Engage on Lifelong Learning	**i**	**0**
Use Techniques, Skills and Modern Engineering Tools Necessary ...	**j**	**1**
Principles and Working Knowledge of Subject Areas as defined by ...	**k**	**1**

Therefore, this particular class has a set of Student Learning [or Educational] Goals that correlate the materials taught and course objectives with each of the Program Outcomes checked in the above matrix. Similarly, this given course will have several elements to assess student learning: **The Grading Matrix**, for instance

Homeworks	10%
Computer Exercises	5%
Quizzes	5%
Laboratories	25%
Mid-Terms Exams (2)	30%
Final Exam	25%
Total	**100%**

Where one can also see how these elements will make a composite score that later will translate in a letter grade for [each student in] the course.

The faculty can elect to describe each assignment in as much detail as he/she finds it convenient. A simple, and proposed here, approach is to assign a percent to each assignment that indicates how much of the assignment is aimed to address a particular outcome. For instance for a given Homework, that addresses three outcomes:

Due 01/30/08

Additional Problem No. 1: [*Problem 2-8 (2nd Ed)]*

Goals Associated with this Assignment

Educational Goal (a):

This course develops in students the ability to apply Mathematics, Science & Engineering Principles.

Educational Goal (c):

This course develops in students the criteria for design of Chemical Reactors and related equipment.

Educational Goal (k):

This course develops in students the Principles and Working Knowledge of subject areas as defined by the Program Criteria of the American Institute of Chemical Engineers.

At this stage the procedure provides the faculty with a tool that enables him/her to review the objectives of her/his course, as well as the appropriateness Curriculum-Outcomes Matrix. In other words, the faculty needs to find a composite among these elements that would ensure that each of the outcomes is covered in his/her course [or re-define the list provided above to better correspond with the course objectives].

One could decide that **30%** of the assignment was dedicated **to Goal/Outcome (a), 50% to Goal/Outcome (c)** and **20% to Goal/Outcome (k).** This analysis can be done for each of the assignments (Quizzes, Labs, etc ...), and then with this information the **"Outcomes-Assignments Matrix,"** is formulated. By the end of the semester, this matrix could have the structure below:

Outcomes-Assignments Matrix											
Outcome	a	b	c	d	e	f	g	h	i	j	k
Assignment											
Homework No. 1	0.30	0	0.50	0	0	0	0	0	0	0	0.20
Computer Exercise No. 1	0.20	0	0.30	0	0.10	0	0	0	0	0.30	0.10
Laboratory No. 1	0	0.50	0	0.10	0	0	0.30	0	0	0	0.10
Homework No. 2	0.30	0	0.50	0	0	0	0	0	0	0	0.20
Computer Exercise No. 2	0.20	0	0.30	0	0.10	0	0	0	0	0.30	0.10
Laboratory No. 2	0	0.50	0	0.10	0	0	0.30	0	0	0	0.10
Homework No. 3	0.30	0	0.50	0	0	0	0	0	0	0	0.20
Computer Exercise No. 3	0.20	0	0.30	0	0.10	0	0	0	0	0.30	0.10
Laboratory No. 3	0	0.50	0	0.10	0	0	0.30	0	0	0	0.10
Quiz No. 1	0	0	0.80	0	0	0	0	0	0	0	0.20
First Mid-Term	0.20	0	0.50	0	0	0	0	0	0	0	0.30
Second Mid-Term	0.20	0	0.50	0	0	0	0	0	0	0	0.30
Final Exam	0.20	0	0.50	0	0	0	0	0	0	0	0.30

Now we can calculate the **Maximum Assessment Score,** and the **Class Assessment Score. For instance, for** the **Assignments Matrix** defined as

	(1)	(2)	(3)
Assignment	**Average**	**Weight**	**Class**
Homework No. 1	50	3.33%	2
Computer Exercise No. 1	87	1.67%	1
Laboratory No. 1	45	8.33%	4
Homework No. 2	75	3.33%	3
Computer Exercise No. 2	92	1.67%	2
Laboratory No. 2	50	8.33%	4
Homework No. 3	80	3.33%	3
Computer Exercise No. 3	97	1.67%	2
Laboratory No. 3	65	8.33%	5
Quiz No. 1	70	5.00%	4
First Mid-Term	66	15.00%	10
Second Mid-Term	70	15.00%	11
Final Exam	80	25.00%	20

We can identify three key column vectors: (1) the **Class Average,** (2) the **Assignment Weight**, and (3) the **Class score** vectors.

Then we can calculate the **Achievement Maximum,** the **Class Achievement Score,** and the **Class Achievement Level.**

Now the faculty has an objective tool to define the scores that he/she will report in the **Course [Class] Assessment Form.** For the demonstration example, we will find

Class Achievement Score (s)	11	6.7	28	1.3	0.5	0	4	0	0	1.4	16
Achievement Maximum (m)	15	13	38	3	1	0	8	0	0	2	23
Outcome	a	b	c	d	e	f	g	h	i	j	k
Class Achievement Level (l)	74%	53%	73%	53%	92%		53%			92%	71%
Evaluation (0-3)	2	1	2	1	3	N/A	1	N/A	N/A	3	2

Note that, for demonstration purposes, I arbitrarily decided that below 40% would be a 0, below 60% a 1, below 75% a 2, and above 90% a 3.

And we will have a clear correlation between the **Class [Educational] Objectives**, the **class [average] performance**, and the entries in the corresponding **Course Assessment [or "Reflection"] Form**: the **Evaluation** row in the form above. This is repeated for each course in the curriculum. These metrics are then integrated into three measurements of Student Learning Assessment: Curriculum, Laboratory Experience, and Capstone Design Experience; which are then used to complete the Program Assessment, as discussed earlier.

The mathematical formulation is a simple sequence of linear algebra operations:

Let us call the **Outcomes-Assignments Matrix, "A".** This matrix is composed of three column-vectors: (1) the **Class Average, "a"** (2) the **Assignment Weight**, **"w"** and (3) the **Class score, "c",** vectors, i.e.

$$A = \begin{bmatrix} a & w & c \end{bmatrix}$$

Elementary linear algebra manipulations enable to identify the **Maximum Assessment Score, "m",** and the **Class Achievement Level, "l"**

$$m = 100\, w^T \cdot A$$

$$s = a^T \cdot A$$

$$[l_i] = \left[s_i / w_i \right]$$

One can check for consistency by comparing the summation of the elements of the **Class Achievement Score, "s,"** vector with the summation of the elements of the **Class Average, "a,"** vector. If the formulas are programmed correctly, both summations must agree, and equal the average final grade for the class.

$$\sum_i^N s_i = \sum_i^N a_i$$

Where "N" represents the total number of outcomes (in our case, N = 11)

The web-based applications will be created using Active Server Pages (ASP) as front end and Microsoft Access as backend using D[ynamic]HTML, JavaScript, Visual Basic (VB) Script, and protocols such as CSS. Macromedia Dreamweaver and Macromedia Homesite will be the development environments. Some of the screen shots presented above have been generated with a preliminary implementation in MS Excel and HTML forms that was completed for demonstration purposes.

Department of Chemical & Biomedical Engineering
Industrial Advisory Committee Meeting

Wednesday, August 20th, 2008
Stillwell Hall 103 (Compton Lounge)

1:45 to 2:00	Coffee/Pastries
2:00 – 2:15	Introduction
2:15 – 2:20	Welcome (Interim Dean, Dr. Ghorashi)
2:20 – 2:45	Departmental Overview (Dr. Shah)
	Enrollment/Degrees Conferred
	Research Funding
	New Curricular initiatives
	Challenges
	Update on State of the College/Strategic Planning Process
2:45 – 3:30	Research Highlights (Materials: Synthesis, Characterization & Applications
	Dr. Tewari
	Dr. Talu
	Dr. Shah
3:30 - 3:45	Break
3:45 – 4:30	Discussion
4:30	Adjournment